

KG

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Volume XVII
Harvard Lunar
Plates

No. 1307
1308
1309

Harvard Lunar Plates

Measures and Reductions

Mary Fowler

Volume XVII

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A/C 1307

1913 Mar 5.

Comparison Stars - Measures.

	α	δ	α	δ	α	δ
1						
4.7	14299		16685	16496	18655	
17.5	9020	20	11964	14110	11030	35
mag	17		60	10	39	
6.5	99		65	99	49	
				4.7614	7616	
	<u>17.5280</u>		<u>.5288</u>			
2						
5.0	18208		16754			
9.8	9720		15440	9103	12074	70
mag	20	20	39	9010	71	
9.4	97		39	11	11975	
	<u>9.8479</u>		<u>.8488</u>	<u>4.9907</u>	<u>.9903</u>	
3						
6.0	15670		15258	8049	10438	
22.7	8531	31	12405	47	10059	55
mag	28		00	7679	58	
8.0	68		57			
	<u>22.7139</u>		<u>.7144</u>	<u>6.0370</u>	<u>.0381</u>	
4						
27.6	16609		18580	15620	15002	
11.5	11329		13860	12048	8580	70
mag	20	29	50	55	80	
7.9	82		88	16	15	
	<u>11.5268</u>		<u>.5273</u>	<u>21.6433</u>	<u>.6433</u>	
5						
24.6	15602		15750	18380	15415	
30.8	7470	70	13870	14299	9490	90
mag	70		76	98	89	
8.6	82		70	60	38	
	<u>30.8116</u>		<u>.8118</u>	<u>24.5927</u>	<u>.5939</u>	

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1913 Mar. 5.

Comparison Stars - Measures.

	α	δ	α	δ	α	δ
$\downarrow$						
4.7	14 299		16 685	16 496	14 110	18 655
17.5	9 020	20	11 964	10	10	110 3035
mag	17		60	99		39
6.5	99		65			49
				4.7614		.7616
	<u>17.5280</u>		<u>.5288</u>			
$\frac{2}{5.0}$	18 208		16 754			
9.8	97 20		15 440	9 103		12 074
mag	20	20	39	9 010	08	71 70
9.4	97		39	11		119 75
	<u>9.8479</u>		<u>.8488</u>	<u>4.9907</u>		<u>.9903</u>
$\frac{3}{6.0}$	15 670		15 258	8 049	50	10 438
22.7	8 531	31	12 405	47		10 059
mag	28		00	76 79		58
8.0	68		57			
	<u>22.7139</u>		<u>.7144</u>	<u>6.0370</u>		<u>0381</u>
$\frac{4}{22.6}$	16 604		18 580	15 620		15 002
11.5	113 29	129	138 60	12 048	51	85 8070
mag	20		50	55		80
7.9	82		88	16		15
	<u>11.5268</u>		<u>.5273</u>	<u>21.6433</u>		<u>.6433</u>
$\frac{5}{24.6}$	15 602		15 750	18 380		15 915
30.8	74 70	70	13 870	14 299	00	94 90
mag	70		76	98		89 90
8.6	52		70	60		38
	<u>30.8116</u>		<u>.8118</u>	<u>24.5927</u>		<u>.5939</u>

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Longitude measures

1913 New. 5

2

d

N

d

N

18080
18.2 1274963
19.5 6063
min 76
to 7

17840
1312940
3840
45

19.5321.5294

2
18.0 17107
19.6 1169992
90
98

16827
1220804
9704
36

19.5408.5372

3
17.0 17200
19.9 812929
18
80

15737
1476670
7570
40

19.9057.9033

4
16.9 15555
20.0 1425037
42
60

15555
1425042
37
60

16870
817188
9988
80

5
16.3
21.0

16.8687.8693

18410
1042510
10
98

15965
1392941
20
72

6
16.1
21.5
min
to
2

16.2015
17340
841010
09
26

.2043
14650
1354030
4030
61

16.1083.1114

M101307

Moon Measures

1913 New V.

2

	α	δ	N
1	18080		17840
18.2	1274963		1312940
19.5	60		38
mm	76		45

$\frac{1}{2}$	19.5321	.5294
---------------	---------	-------

2	18.0	17107	16827
19.6	1169992	1220804	
	90	97	
	98	36	

$\frac{3}{2}$	19.5408	.5372	
3	17.0	17200	15737
19.9	1812929	1476670	
	18	75	
	80	40	

$\frac{4}{2}$	19.9057	.9033	
4	16.9	15555	15555
20.0	14217037	1425042	
	42	37	
	60	60	

$\frac{5}{2}$	16.3	15555	16870
21.0	14217037	1425042	817188
	42	37	99
	60	60	80

$\frac{6}{2}$	16.1	168687	8693
21.5	17340	18410	15965
mm	841010	1042510	1392941
$\frac{1}{2}$	09	10	20
	26	98	72

$\frac{6}{2}$	16.2015	.2043
17340	14650	
841010	1554030	
09	40	
26	61	

16.1083	1114
---------	------

MAC 1307 Moon-Measures

1913 May 5.

3

7
16.2
22.0

16242 17675
7720 16170
2530 7580
50 90

8
16.7
23.0

161476 1502
15194 16793
11690 1031000
9991 96
90 02

9
17.0 14220 15870
23.3 1118075 890900
80 1500
12 80

23.3040 3031

10
18.0 14140 15969
23.6 739490 1270000
9590 94
30 88

23.6740 6723

11
18.1 18112 15991
23.7 1129895 1178980
max 98 8880
in 00 09
8

23.6807 6789

12
19.0 17050 15071
23.5 11909 1015883
1911 7583
40 93
23.5132 5093

MC1307 Moon-Measures. 1913 May 5.

3

7
16.2
22.0

16242 17675
7720 16170
2534 7580
50 90

8
16.7
23.0

161476 1502
15194 16793
1169091 1031000
99 96
90 02

9
17.0 14220 15870
233 1118075 890900
80 1500
12 80

16.6500 6497

23.3040 3031

10
18.0 14140 15969
236 739490 1270000
9590 94
30 88

23.6740 6723

11
18.1 18112 15991
237 1129895 1178980
max 98 8880
8 00 09

23.6807 6789

12
19.0 17050 15071
235 11909 1016883
1911 7583
40 93
23.5132 5093

M61307 moon - measures

19137 moon 5

4.

13
19.6
23.0

17379
1454040
3740
80

18200
11028
2728
15

14
20.0
22.6

15457
930707
11
40

16594
1272619
1719
00

19.7160

.7186

15
20.2
22.0

22.6139

.6125

16720
891011
10
07

17060
1487468
70
73

16
20.3
21.6
max
in
76

20.2200

.2191

15274
778090
90
68

15992
1346175
80
15

17
20.2
21.0

20.2517

.2528

14339
601221
10
30

14932
13240
45-48
52

18
20.0
20.7
17805
1171005
20
94
18498
1456574
70
08

20.1682

.1691

20.6086

.6068

MC1307 *mean - measures*1913 *mean*

4.

13
19.6
23.0

17379
1454040
37
80

18200
11028
7728
15

14
20.0
22.6

15457
930707
11
40

16594
1272619
17
00

19.7160.7186

15
20.2
22.0

22.6139.6125

16720
891011
10
07

17060
1487468
70
73

16
20.3
21.6
max
in
x

20.2200.2191

15274
778090
90
68

15992
1346175
80
10

17
20.2
21.0

20.2517.2528

14339
601221
10
30

14932
13240
4548
52

18
20.0
20.7
17805
1171065
20
94
18498
1456574
70
08

20.1682.169120.60866068

MC 1307 moon-measures.

1918 Mar. 5 5.

$$\begin{array}{r} 19 \\ 19.5 \\ \hline 20.0 \end{array}$$

$$\begin{array}{r} 17554 \\ 1248590 \\ 60 \\ 44 \end{array}$$

$$\begin{array}{r} 17876 \\ 1291219 \\ 20 \\ 87 \end{array}$$

$$\underline{194943}$$

$$\underline{4963}$$

$$\begin{array}{r} 20 \\ 19.0 \\ \hline 19.7 \end{array}$$

negged

MIC 1307 moon measures 1913 Mar 5th 5th

19
19.5
20.0

17559
1298590
60
49

17876
1291219
20
87

194943

4963

20
19.0
19.7

rugged

Tables $a = 0.0$ $e = -2.2$ $a - e = +2.2$ $b + a = + 0.0$
 Uly $a = + 1.0$ $e = -0.1$ $a - e = + 1.1$ $+ 1.3$

1307 Preliminary Reduction.

1913 Mar. 25. 6

2	4.7615	4.9905	6.0376	21.6433	24.5933
3	5.0943	5.4198	6.3050	22.0497	24.7572
$\pi-3$	-3328	-4293	-2674	-0.4064	-1.639
4	17.5284	9.8484	22.7142	11.5270	30.8117
π	17.9441	10.2660	23.1463	12.1533	31.4724
$4-\pi$	-4157	-4176	-4321	-6263	-6617
$\pi-3$	-1253	-4	-x	+5535	

-3328	-2262	= -5530	-5	= -5535	= 0	incap.
-4293	-1238	= -5531	-5	= -5536	= -1	Wolfe
-2674	-2854	= -5528	-6	= -5534	= +1	of
-4064	-1449	= -5513	-22	= -5535	= 0	improvement
-1639	-3872	= -5511	-25	= -5536	= +1	
moon 18.1845	-2715		-18		= 18.4647	

$4-\pi$	+1242	+3568	
-4157	+590	= -3567	= +1
-4176	+619	= -3557	= +11
-4321	+749	= -3572	= -4
-6263	+2684	= -3579	= -11
-6617	+2050	= -3567	= +1

moon 21.6049 + 2255 = 221872

Times etc.			
Exp. to stars	1911 Oct 7	0 ^h 38 ^m	- 0 ^h 50 ^m
" " Moon		0 43	25.0 ^s - 0 43 25.3 ^s
Clock slow.		0	41.6 ^s
H Sid T.		0 44	06.75 ^s
H Long		4 44	31.05 ^s
G Sid T.		5 28	37.80 ^s
Sid T. to Sun		13 00	03.64 ^s
Time interval		16 28	34.16 ^s
Reduction		2	41.95 ^s
G to V.		16 25	52.21 ^s

From Nautical Almanac			
Moon 16 ^h	0	52	41.93 ^s + 3 56 59.4
Motion in 1 ^m 2.0406			16.112
" 25.8702			+ 52.79 ^s + 6 56.8 ^s
Tabular place	0	53	34.72 ^s + 4 03 56.2

Moon's parallax 58' 18.4^ssemidiameter 15' 59.8^sMoon 0^h 14^m 14^s past full

1907 Preliminary Reduction.

1913 Mar. 25. 6

2	4.7615	4.9905	6.0376	21.6433	24.5933
3	5.0943	5.4198	6.3050	22.0497	24.7572
2-3	- .3328	- .4293	- .2674	- .4064	- .1639
4	17.5284	9.8464	22.7142	11.5270	30.8117
5	17.9441	10.2660	23.1463	12.1533	31.4724
4-5	- .4157	- .4176	- .4321	- .6263	- .6617
2-3	- 1253	- 2	- 2	+ 5535	
- 3328	- 2262	- 5530	- 5	- 5535	= 0
- 4293	- 1238	- 5531	- 5	- 5536	= -1
- 2674	- 2854	- 5528	- 6	- 5534	= +1
- 4064	- 1449	- 5513	- 22	- 5535	= 0
- 1639	- 3872	- 5511	- 25	- 5536	= +1
moon 18.45	- 2715	- 18			= 18.4647
4-5	+ 1242	+ 3568			
- 4157	+ 590	- 3567	= +1		
- 4176	+ 619	- 3557	= +11		
- 4321	+ 749	- 3572	= -4		
- 6263	+ 2684	- 3579	= -11		
- 6617	+ 3050	- 3567	= +1		
moon 21.6049	+ 2255				= 22.1872

incap-
able
of
improvement

Times etc.

Exp. to stars	1911 Oct 7	0 ^h 38 ^m	- 0 ^h 50 ^m
moon		0 43	25.0 - 0 43 25.3
Clock slow.		0	41.6
H Sid T		0 44	06.75
H long		4 44	31.05
G Sid T		5 28	37.80
Sid T. from		13 00	03.64
Interval		16 28	34.16
Reduction		2	41.95
G. M. T.		16 25	52.21
from Nautical			
Moon 16"		0 52	41.93 + 3 56 59.4
Motion in 1 ^m 2.0406			16.117
25.8702		+ 52.99	+ 6 56.8
Tabular place		0 53	34.72 + 4 03 56.2
Moon's parallax		58'	18.4
semidiam		15'	59.8
Moon		0 ^h 14 ^m 18 ^s	past full.

Approximate Center

$$\begin{array}{r}
 x = 15.0 \quad y = 19.5390 \\
 \quad \quad \quad \underline{23.6732} \\
 \quad \quad \quad 43.2122 \\
 \text{mean } y = 21.6061
 \end{array}$$

$$\begin{array}{r}
 x = 17.0 \quad y = 19.9045 \\
 \quad \quad \quad \underline{23.3036} \\
 \quad \quad \quad 43.2081 \\
 \text{mean } y = 21.6040
 \end{array}$$

$$\begin{array}{r}
 x = 20.0 \quad y = 22.6132 \\
 \quad \quad \quad \underline{20.6071} \\
 \quad \quad \quad 43.2209 \\
 \text{mean } y = 21.6104
 \end{array}$$

$$\begin{array}{r}
 y - \text{min} = 19.5308 \\
 y - \text{max} = 23.6798 \\
 \quad \quad \quad \underline{43.2106} \\
 \text{mean } y = 21.6053
 \end{array}$$

$$\begin{array}{r}
 y = 20.0 \quad x = 16.8690 \\
 \quad \quad \quad \underline{19.4953} \\
 \quad \quad \quad 36.3643 \\
 \text{mean } x = 18.1822
 \end{array}$$

$$\begin{array}{r}
 y = 21.0 \quad x = 16.2029 \\
 \quad \quad \quad \underline{20.1686} \\
 \quad \quad \quad 36.3715 \\
 \text{mean } x = 18.1858
 \end{array}$$

$$\begin{array}{r}
 y = 22.0 \quad x = 16.1489 \\
 \quad \quad \quad \underline{20.2196} \\
 \quad \quad \quad 36.3685 \\
 \text{mean } x = 18.1842
 \end{array}$$

$$\begin{array}{r}
 y = 23.0 \quad x = 16.6498 \\
 \quad \quad \quad \underline{19.7173} \\
 \quad \quad \quad 36.3671 \\
 \text{mean } x = 18.1836
 \end{array}$$

$$\begin{array}{r}
 x - \text{min} = 16.1098 \\
 x - \text{max} = 20.2522 \\
 \quad \quad \quad \underline{36.3620} \\
 \text{mean } y = 18.1810
 \end{array}$$

$$\begin{array}{l}
 \text{Assume } \{ \begin{array}{l} x_0 = 18.1834 \\ y_0 = 21.6060 \end{array} \\
 \text{Center}
 \end{array}$$

Corrections for phase $\left\{ \begin{array}{l} x = 45' = +0.75 \\ y = -157' = -1.95 \end{array} \right.$

	x	y	$x - x_0$	$y - y_0$	$(x - x_0) + (y - y_0)$	correction
1	0	-208	0	+4.05	+4.05	+48
2	-0.18	-207	-0.13	+4.04	+3.91	+45
3	-0.18	-170	-0.88	+3.32	+2.44	+18
4	-1.31	-1.61	-0.98	+3.14	+2.16	+14
15	+2.04	+0.39	+1.53	-0.76	+0.77	+1
16	+2.07	0.00	+1.55	0.00	+1.55	+7
17	+1.99	-0.61	+1.49	+1.19	+2.68	+21
18	+1.82	-1.00	+1.36	+1.95	+3.31	+32
19	+1.31	-1.61	+0.98	+3.14	+4.12	+50

MC1307 moons Center

	x	$x - x_0$	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$x - x_0$	cor.
1	18.1834	0.0000	0.0000	4.3081	+ 85	+48
2	18.0000	-0.1834	0.0337	4.3078	+ 82	+45
3	17.0000	-1.1834	1.4005	4.2966	- 30	+18
4	16.8690	-1.3144	1.7276	4.3078	+ 82	+14
5	16.2029	-1.9805	3.9224	4.2897	- 99	
6	16.1098	-2.0736	4.2998	4.2998	+ 2	
7	16.1489	-2.0345	4.1392	4.2945	- 51	
8	16.6498	-1.5336	2.3520	4.2960	- 36	
9	17.0000	-1.1834	1.4005	4.2834	-162	
10	18.0000	-0.1834	0.0337	4.3087	+ 91	(-36)
11	18.1834	0.0000	0.0000	4.3023	+ 27	
12	19.0000	+0.8166	0.6669	4.2982	- 14	
13	19.7173	+1.5339	2.3529	4.2964	- 27	
14	20.0000	+1.8166	3.3001	4.3149	+153	
15	20.2196	+2.0362	4.1461	4.3014	+ 18	+1
16	20.2522	+2.0688	4.2800	4.2800	-196	+7
17	20.1686	+1.9852	3.9410	4.3083	+ 87	+21
18	20.0000	+1.8166	3.3001	4.2971	- 25	+32
19	19.4953	+1.3119	1.7210	4.3012	+ 16	+50
Mean 4.2996						+39

	y	$y - y_0$	Δy	$(y - y_0)^2$	Combined solution o-c	
-1	19.5308	-2.0752	-4	4.3081	1	+121
2	19.5390	-2.0670	-4	4.2741	2	+117
3	19.9045	-1.7015	-3	2.8961	3	- 8
4	20.0000	-1.6060	-3	2.5802	4	+102
5	21.0000	-0.6060	-1	0.3673	5	- 89
6	21.6060	0.0000	0	0.0000	6	+ 19
7	22.0000	+0.3940	+1	0.1553	7	- 30
8	23.0000	+1.3940	+3	1.9440	8	- 14
9	23.3036	+1.6976	+3	2.8829	9	- 14
10	23.6732	+2.0672	+4	4.2750	10	+ 14
11	23.6798	+2.0738	+4	4.3023	11	+ 14
12	23.5112	+1.9052	+4	3.6313	12	+ 37
13	23.0000	+1.3940	+3	1.9440	13	+ 30
14	22.6132	+1.0072	+2	1.0148	14	+ 116
15	22.0000	+0.3940	+1	0.1553	15	- 21
16	21.6060	0.0000	0	0.0000	16	- 230
17	21.0000	-0.6060	-1	0.3673	17	+ 69
18	20.6077	-0.9983	-2	0.9967	18	- 30
19	20.0000	-1.6060	-3	2.5802	19	+ 36

MS 1307 - *Hydromedusa*

x	$x - X_0$	$(x - X_0)^2$	$(x - X_0)^2 + (y - Y_0)^2$	$0 - C$	
1 18.1834	0.0000	0.0000	4.3081	+ 85	+ 48
2 18.0000	- 0.1834	0.0337	4.3078	+ 82	+ 45
3 17.0000	- 1.1834	1.4005	4.2966	- 30	+ 18
4 16.8690	- 1.3144	1.7276	4.3078	+ 82	+ 14
5 16.2029	- 1.9805	3.9224	4.2897	- 99	
6 16.1098	- 2.0736	4.2998	4.2998	+ 2	
7 16.1489	- 2.0345	4.1392	4.2945	- 51	
8 16.6498	- 1.5336	2.3520	4.2960	- 36	
9 17.0000	- 1.1834	1.4005	4.2834	- 162	
10 18.0000	- 0.1834	0.0337	4.3087	+ 91	- 36
11 18.1834	0.0000	0.0000	4.3023	+ 27	
12 19.0000	+ 0.8166	0.6669	4.2982	- 14	
13 19.7173	+ 1.5339	2.3529	4.2969	- 27	
14 20.0000	+ 1.8166	3.3001	4.3149	+ 153	
15 20.2196	+ 2.0362	4.1461	4.3014	+ 18	+ 1
16 20.2522	+ 2.0688	4.2800	4.2800	- 196	+ 7
17 20.1686	+ 1.9852	3.9410	4.3083	+ 87	+ 21
18 20.0000	+ 1.8166	3.3001	4.2971	- 25	+ 52
19 19.4953	+ 1.3119	1.7210	4.3012	+ 16	+ 504

Mean 4.2996

+ 3

y	$y - Y_0$	Δy	$(y - Y_0)^2$	Combined solution $0 - C$
-1 19.5308	- 2.0752	- 4	4.3081	1 + 121
2 19.5390	- 2.0670	- 4	4.2741	2 + 117
3 19.9045	- 1.7015	- 3	2.8961	3 - 8
4 20.0000	- 1.6060	- 3	2.5802	4 + 102
5 21.0000	- 0.6060	- 1	0.3673	5 - 89
6 21.6060	0.0000	0	0.0000	6 + 19
7 22.0000	+ 0.3940	+ 1	0.1553	7 - 35
8 23.0000	+ 1.3940	+ 3	1.9440	8 - 27
9 23.3036	+ 1.6976	+ 3	2.8829	9 - 158
10 23.6732	+ 2.0672	+ 4	4.2750	10 + 81
11 23.6798	+ 2.0738	+ 4	4.3023	11 + 13
12 23.5112	+ 1.9052	+ 4	3.6313	12 - 37
13 23.0000	+ 1.3940	+ 3	1.9440	13 - 60
14 22.6132	+ 1.0072	+ 2	1.0148	14 + 116
15 22.0000	+ 0.3940	+ 1	0.1553	15 - 21
16 21.6060	0.0000	0	0.0000	16 + 230
17 21.0000	- 0.6060	- 1	0.3673	17 + 69
18 20.6077	- 0.9983	- 2	0.9970	18 - 30
19 20.0000	- 1.6060	- 3	2.5802	19 + 36

Formation of normals

No	ab	an	bn	an	bn
1	- 0.00	+ 0.0	- 176.1	0.0	- 99.7
2	+ 0.38	- 15.0	- 169.0	- 8.1	- 93.1
3	+ 20.2	+ 35.5	+ 51.8	- 21.2	- 30.6
4	+ 21.1	- 107.8	- 131.5	- 18.4	- 22.6
5	+ 12.0	+ 196.0	+ 60.0		
6	- 0.00	- 4.1	+ 0.0		
7	- 0.80	+ 103.8	- 20.1		
8	- 21.4	+ 55.2	- 50.2		
9	- 20.1	+ 191.8	- 274.8		
10	- 0.38	- 16.6	+ 188.0		
	+ 0.38	+ 438.8	- 522.7	- 47.7	- 246.0

$$[a] = +19.31 \quad [b] = +23.68$$

$$[c] = -11.67 \quad [d] = -2.50 \quad [e] = -3.6$$

New Residuals

No	O	C	O - C
1	+ 133	+ 0 + 50 + 92 = + 142	- 9
2	+ 127	- 14 + 50 + 92 = + 128	- 1
3	- 12	- 90 + 41 + 92 = + 43	- 55
4	+ 96	- 100 + 39 + 92 = + 31	+ 65
5	- 99	- 151 + 15 + 92 = - 44	- 55
6	+ 2	- 158 - 0 + 92 = - 66	+ 68
7	- 51	- 154 - 9 + 92 = - 71	+ 20
8	- 36	- 116 - 33 + 92 = - 57	+ 21
9	- 162	- 90 - 41 + 92 = - 39	- 123
10	+ 91	- 14 - 50 + 92 = + 28	+ 63

 $X_0 =$

$$-243 + 237$$

$$\text{Average } (O - C) = 48$$

MC 1307 Moon's Center (Phase Limit)

1913 Apr. 18

	a	b	c	0	Residuals.	c	0-c	new
1	0.00	-2.08	+1.2	+85 ⁺⁴⁸	0 + 34 + 65 = +99	-14	-9	
2	-0.18	-2.07	+1.2	+82 ⁺⁴⁵	11 + 34 + 65 = +88	-6	-1	
3	-1.18	-1.70	+1.2	-30 ⁺¹⁸	74 + 28 + 65 = +19	-49	-55	
4	-1.31	-1.61	+1.2	+82 ⁺¹⁸	82 + 26 + 65 = +19	+73	+65	
5	-1.98	-0.61	+1.2	-99	124 + 10 + 65 = -49	-50	-55	
6	-2.07	+0.00	+1.2	+2	129 - 0 + 65 = -64	+66	+68	
7	-2.03	+0.39	+1.2	-51	127 - 6 + 65 = -68	+17	+20	
8	-1.53	+1.39	+1.2	-36	96 - 23 + 65 = -54	+18	+21	
9	-1.18	+1.70	+1.2	-162	74 - 28 + 65 = -37	-125	-123	
10	-0.18	+2.07	+1.2	+91	11 - 34 + 65 = +20	+71	+63	

Normal Equations.

+245 - 244

Average (0-c) = 49 | 48

$$\begin{aligned}
 +19.31 + 0.38 - 11.67 &= +439 + 391 \\
 +0.38 + 23.68 - 250 &= -523 - 769 \\
 -11.67 - 250 + 10.00 &= -356 + 89
 \end{aligned}$$

$$\begin{aligned}
 -0.38 - 0.01 + 0.23 &= -9 - 8 \\
 +11.67 + 0.23 - 7.05 &= +265 + 236
 \end{aligned}$$

$$\begin{aligned}
 +23.67 - 227 &= -532 - 777 \\
 -227 + 295 &= +229 + 325
 \end{aligned}$$

$$\begin{aligned}
 +227 - 0.22 &= -51 - 74\frac{1}{2} \\
 +273 &= +178 + 250\frac{1}{2} \quad c = +65 \quad c = +92
 \end{aligned}$$

$$\begin{aligned}
 -1.75 + 227 &= +176 + 250 \\
 +2192 &= -356 - 527 \quad b = -16 \quad b = -24
 \end{aligned}$$

$$\begin{aligned}
 -1.77 - 0.38 + 1.52 &= -5 + 14 \\
 -110.50 - 23.68 + 94.75 &= -341 + 843
 \end{aligned}$$

$$\begin{aligned}
 +17.54 &= -1015 = +434 + 405 \\
 -110.12 &= +92.25 = -864 + 74
 \end{aligned}$$

$$\begin{aligned}
 -12.11 &= +1015 = 95 + 8 \\
 +543 &= +339 + 413 \quad a = +62 \quad a = +76
 \end{aligned}$$

$$\alpha - A = +14.56$$

$$S - D = +1' 27.2$$

$$\text{Cov. } \Delta K = +0.08$$

$$\text{Cov. } \Delta S = 0.0$$

Solution giving (16) $\pm$ wt. Normal Equations

$$+ 20.50 + 1.20 + 12.34 = + 480$$

$$+ 1.20 + 14.99 + 3.56 = - 26$$

$$+ 12.34 + 3.56 + 8.50 = + 244$$

$$- 1.20 - 0.07 - 0.72 = - 28$$

$$- 12.34 - 0.72 - 7.44 = - 289$$

$$+ 14.92 + 2.84 = - 54$$

$$+ 2.84 + 1.06 = - 44$$

$$- 2.87 - 0.54 = + 10$$

$$+ 0.52 = - 30$$

$$c = - 65$$

$$- 7.60 - 2.87 = + 118$$

$$+ 7.32 = + 64$$

$$b = + 8.8$$

$$- 0.10 - 1.20 - 0.28 = + 2$$

$$- 0.28 - 3.56 - 0.85 = + 6$$

$$+ 20.40 + 12.06 = + 482$$

$$+ 12.06 + 7.65 = + 250$$

$$- 19.02 - 12.06 = - 394$$

$$+ 1.38 = + 88$$

$$a = + 63.8$$

Residuals

O	C	O - C
11 +27	0 + 2 - 23 = -21	+48
12 -14	+29 + 2 - 23 = +8	-22
13 -27	+55 + 1 - 23 = +33	-60
14 +153	+65 + 1 - 23 = +43	+110
15 +19	+73 - 0 - 23 = +50	-31
16 -94	+37 - 0 - 12 = +25	-119
17 +108	+71 - 1 - 23 = +47	+61
18 +7	+65 - 1 - 23 = +41	-34
19 +66	+47 - 2 - 23 = +22	+44

$$+ 263 - 266$$

$$\text{Average } (O - C) = 62$$

MC 13077 Moon's Center (1 pass limit)

1713 Apr. 18.

	a	b	c	0	Residuals	c	0-c	new
1	0.00	-2.08	+1.0	+85 ⁴⁸	0 + 34 + 65 = +99	-14	-9	
2	-0.18	-2.07	+1.0	+82 ²⁵	11 + 34 + 65 = +88	+6	-1	
3	-1.18	-1.70	+1.0	-30 ¹¹	74 + 28 + 65 = +19	-49	-55	
4	-1.31	-1.61	+1.0	+82 ¹⁹	82 + 26 + 65 = +9	+73	+61	
5	-1.98	-0.61	+1.0	-99	124 + 10 + 65 = -49	-50	-55	
6	-2.07	+0.00	+1.0	+2	129 - 0 + 65 = -64	+66	+68	
7	-2.03	+0.39	+1.0	-51	127 - 6 + 65 = -68	+17	+20	
8	-1.53	+1.39	+1.0	-36	96 - 23 + 65 = -54	+18	+21	
9	-1.18	+1.70	+1.0	-162	74 - 28 + 65 = -37	-125	-123	
10	-0.18	+2.07	+1.0	+91	11 - 34 + 65 = +20	+71	+63	

Normal Equations.

+245 - 244

Average (0-c) = 49 | 48

$$\begin{aligned}
 +19.31 + 0.38 - 11.67 &= +439 + 391 \\
 +0.38 + 23.68 - 2.50 &= -523 - 769 \\
 -11.67 - 2.50 + 10.00 &= -36 + 89
 \end{aligned}$$

$$\begin{aligned}
 -0.38 - 0.01 + 0.23 &= -9 - 8 \\
 +11.67 + 0.23 - 7.05 &= +265 + 236
 \end{aligned}$$

$$+23.67 - 2.27 = -532 - 777$$

$$-2.27 + 2.95 = +229 + 325$$

$$+2.27 - 0.22 = -51 - 74$$

$$+2.73 = +178 + 250 \quad c = +65 \quad c = +92$$

$$-1.75 + 2.27 = +176 + 250$$

$$+2192 = -356 - 527 \quad b = -16 \quad b = -24$$

$$-1.77 - 0.38 + 1.52 = -5 + 14$$

$$-110.50 - 23.68 + 94.75 = -341 + 843$$

$$+17.54$$

$$-10.15 = +434 + 405$$

$$-110.12$$

$$+92.25 = -864 + 74$$

$$-12.11$$

$$+10.15 = -95 + 8$$

$$+5.43$$

$$+339 + 413 \quad a = +62 \quad a = +76$$

No	at	an	bn	correction		
				an	bn	
11	+ 0.00	+ 0.0	+ 56.0			
12	+ 1.55	- 1.4	- 26.6			
13	+ 2.49	- 4.14	- 37.6			
14	+ 1.53	+ 278.0	+ 154.0			
15	+ 0.80	+ 36.6	+ 7.1	+ 2.0	+ 0.4	+ 1
16	+ 0.00	- 405.0	- 0.0	+ 19.5	+ 0.0	+ 7
17	- 1.20	+ 172.8	+ 52.7	+ 4.18	- 12.8	+ 21
18	- 1.81	+ 45.4	+ 24.9	+ 58.2	- 32.0	+ 32
19	- 2.11	+ 21.0	+ 25.7	+ 65.5	- 80.5	+ 50
	+ 1.20	+ 5.2	+ 99.4	+ 18.2	- 124.9	+ 11.1
				+ 5.2		+ 39
				+ 292.5		+ 94
				+ 479.7		+ 24.4

Corrected Residuals (16) full wt.

11	+ 2.7	-	0 - 2.7	+ 58	+ 3.1	- 3.4
12	- 1.4	-	20 - 2.5	+ 58	+ 13	- 2.7
13	- 2.7	-	38 - 1.8	+ 58	+ 2	- 2.9
14	+ 1.53	-	45 - 1.3	+ 58	- 0	+ 1.53
15	+ 1.9	-	50 - 5	+ 58	+ 3	+ 1.6
16	- 1.99	-	51 - 0	+ 58	+ 7	- 1.96
17	+ 1.08	-	49 + 8	+ 58	+ 17	+ 9.1
18	+ 7	-	45 + 13	+ 58	+ 26	- 1.9
19	+ 6.6	-	32 + 21	+ 58	+ 47	+ 4.9

- giving (16) $\pm$ wt. -

$$x_0 = 18.1734 \quad y_0 = 21.6060$$

$$\frac{1}{n} \sum x = \frac{+ 3.2}{18.1866} \quad \frac{1}{n} \sum y = \frac{+ 4}{21.6064}$$

from plate const $x = 18.4668$

$$\log 5 = 9.66913$$

$$9.99921$$

$$9.10724$$

$$1.16268$$

$$y = 22.1885$$

$$\log y_0 = 9.27531$$

$$7.33115$$

$$2.94416$$

$$x - A = 14.554$$

$$\text{const } \Delta x = +0.6$$

$$8 - 10 = 7.27.9$$

$$\text{const } \Delta y = +0.7$$

MC1307

Moon's Center (Full Moon)

1913 Apr 18

9

	a	b	c	0	c	0-c
11	0.00	+2.07	+1	= +27	0 - 15 + 67 = +52	-25
12	+0.82	+1.91	+1	= -14	-34 - 14 + 67 = +19	-33
13	+1.53	+1.39	+1	= -27	-64 - 10 + 67 = -7	-20
14	+1.82	+1.01	+1	= +153	-76 - 9 + 67 = -16	+169
15	+2.04	+0.39	+1	= +18	-85 - 3 + 67 = -20	+2
16	+2.07	+0.00	+1	= -196	-87 - 0 + 67 = -19	-177
17	+1.99	-0.61	+1	= +87	-83 - 4 + 67 = -10	+97
18	+1.82	-1.00	+1	= -25	-76 - 9 + 67 = +0	-25
19	+1.31	-1.61	+1	= +16	-55 - 1 + 67 = +25	-19

Normal Equations

-289 + 208

Average (0-c) = 62

Corrected (0-c)

11	-4
12	-27
13	-29
14	+153
15	+16
16	-196
17	+91
18	-19
19	+19

-275 + 279
Average (0-c) = 62

c = +67 c = +581

$$\begin{aligned}
 &+23.71 + 1.20 + 13.39 = -68 + 187 \\
 &+1.20 + 14.99 + 3.56 = +85 - 26 \\
 &+13.39 + 3.56 + 9.00 = +59 + 150 \\
 &-1.20 - 0.06 - 0.68 = +8 - 9 \\
 &-13.39 - 0.68 - 7.56 = +38 - 106 \\
 &+14.93 + 2.88 = +88 - 35 \\
 &+2.88 + 1.44 = +77 + 44 \\
 &-2.88 - 0.56 = -11 + 7 \\
 &+0.88 = +60 + 51 \\
 &-5.73 - 2.88 = -153 - 187 \\
 &+9.20 = -65 - 122
 \end{aligned}$$

$$\begin{aligned}
 &-450 - 120 - 303 = -13 - 51 \\
 &-5639 - 1499 - 3785 = -144 - 630
 \end{aligned}$$

$$\begin{aligned}
 &+19.26 + 10.55 = -81 + 136 \\
 &-5519 - 3434 = -79 - 656
 \end{aligned}$$

$$\begin{aligned}
 &-16.62 - 10.35 = -24 - 198 \\
 &+2.52 = -125 - 262
 \end{aligned}$$

$$\frac{\Delta y}{\Delta x} = -0.40$$

$$\frac{\Delta x}{\Delta y} = -1.14$$

Continued Solution (1.6 full wt) Normal Equations

$$+ 48.02 + 1.58 + 1.72 = +57.8$$

$$+ 1.58 + 38.67 + 1.06 = -79.5$$

$$+ 1.72 + 1.06 + 19.00 = +23.9$$

$$- 1.58 - 0.06 - 0.06 = -2.1$$

$$- 1.72 - 0.06 - 0.07 = -2.3$$

$$+ 38.61 + 1.00 = -81.6$$

$$+ 1.00 + 18.93 = +21.6$$

$$- 1.00 - 0.03 = +2.1$$

$$+ 18.90 = +23.7$$

$$a = +1.3$$

$$- 0.05 - 1.00 = -81.1$$

$$+ 38.56 = -82.7$$

$$b = -0.2$$

$$- 4.56 - 1.58 - 28.35 = -35.6$$

$$- 62.80 - 38.67 - 69.00 = -57.5$$

$$+ 40.46 - 26.63 = +22.2$$

$$- 61.28 - 69.00 = -95.20$$

$$+ 2.36 + 26.63 = +36.6$$

$$+ 42.82 = +58.8$$

$$a = +1.4$$

Solution giving (1.6) full wt

normals

$$+ 40.88 + 1.58 + 0.67 = +89.1$$

$$+ 1.58 + 38.67 + 1.06 = -79.5$$

$$+ 0.67 + 19.6 + 18.50 = +23.3$$

$$a = +1.9 \quad \text{wt } 18.46$$

$$b = -2.22 \quad \text{wt } 38.56$$

$$a = +2.2 \quad \text{wt } 40.79$$

KC 1307

Moon's Center (Full Moon)

1913 Apr. 18.

9

	a	b	c	0		c	0-c
11	0.00	+2.07	+1	= +27	0-15	+67	= +52
12	+0.82	+1.91	+1	= -14	-34	-14	+67
13	+1.53	+1.39	+1	= -27	-64	-10	+67
14	+1.82	+1.01	+1	= +153	-76	7	+67
15	+2.04	+0.39	+1	= +181	-85	3	+67
16	+2.07	+0.00	+1	= -196	-87	0	+67
17	+1.99	-0.61	+1	= +87	-83	4	+67
18	+1.82	-1.00	+1	= -25	-76	7	+67
19	+1.31	-1.61	+1	= +161	-55	14	+67

Normal Equations.

-289 + 268

Average (0-c) = 62

Corrected (0-c)

$$\begin{aligned}
 &+23.71 + 1.20 + 13.39 = -68 + 187 \\
 &+ 1.20 + 14.99 + 3.56 = +85 - 26 \\
 &+ 13.39 + 3.56 + 9.00 = +139 + 150 \\
 &- 1.20 - 0.06 - 0.68 = +3 - 9 \\
 &- 13.39 - 0.68 - 7.56 = +38 - 106 \\
 &+ 14.93 + 2.88 = +88 - 35 \\
 &+ 2.88 + 1.44 = +77 + 44 \\
 &- 2.88 - 0.56 = -17 + 7 \\
 &+ 0.89 = +40 + 51 \\
 &- 5.93 - 2.88 = -153 - 187 \\
 &+ 9.20 = -65 - 222
 \end{aligned}$$

11	-4
12	-27
13	-27
14	+153
15	+16
16	-196
17	+91
18	-19
19	+19
-275 + 279	
Average (0-c) = 62	

-275 + 279

Average (0-c) = 62

-275 + 279

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-275 + 279

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-275 + 279

Average (0-c) = 62

-275 + 279

Average (0-c) = 62

-275 + 279

Average (0-c) = 62

Combined Solution (16) full wt Normal Equations

$$+ 43.02 + 1.58 + 1.72 = +578$$

$$\frac{\Delta x}{\Delta z} = 0.04$$

$$+ 1.58 + 38.67 + 1.06 = -795$$

$$+ 1.72 + 1.06 + 19.00 = +239$$

$$- 1.58 - 0.06 - 0.06 = -21$$

$$- 1.72 - 0.06 - 0.07 = -23$$

$$+ 38.61 + 1.00 = -816$$

$$\frac{\Delta y}{\Delta z} = 0.06$$

$$+ 1.00 + 18.93 = +216$$

$$- 1.00 - 0.03 = +21$$

$$+ 18.90 = +237$$

$$c = +13$$

$$- 0.05 - 1.00 = -11$$

$$21 +$$

$$+ 38.56 = -827$$

$$b = -0.2$$

$$- 256 - 1.58 - 28.35 = -356$$

$$- 62.80 - 38.67 - 694.00 = -8725$$

$$+ 40.46 - 26.63 = +222$$

$$- 61.22 - 693.00 = -9520$$

$$+ 236 + 26.63 = +366$$

$$+ 42.82 = +588$$

$$a = +14$$

Solution giving (16) full
normals.

$$+ 40.88 + 1.58 + 0.67 = +891$$

$$+ 1.58 + 38.67 + 1.06 = -795$$

$$+ 0.67 + 1.06 + 18.50 = +233$$

$$a = +19 \quad \text{wt. } 18.46$$

$$b = -22 \quad \text{wt } 38.56$$

$$a = +22 \quad \text{wt } 40.79$$

Residuals on next page

M01307 Moon's Mean Position

1913 Apr. 19

10

$$X_0 = 18.1834$$

$$Y_0 = 21.6060$$

$$\frac{1}{2}a = +1.1$$

$$\frac{1}{2}b = -1.1$$

$$18.1845$$

$$21.6049$$

From Preliminary Reduction: $X = 18.4647$ $Y = 22.1872$ Plate constants - $a = 0$ $b = -7$ $\log = -2$ $c = +7$

$$22.1870$$

$$\bar{z} = +0.4647$$

$$\log = 9.66717$$

$$\cos \delta = 9.99921$$

$$\cos \alpha = 8.50724$$

$$(d-A) = 1.16072$$

$$K-A = +14.48$$

$$A = 0 \ 53 \ 25$$

$$K_0 = 0 \ 53 \ 39.48$$

$$\text{Red} = +3.01$$

$$\alpha' = 0^{\circ} 53' 42.49''$$

$$\eta = +0.1870$$

$$\log \tan \delta = 8.77811$$

$$\log \bar{z} = 9.3343$$

$$\eta = 51.658$$

$$\eta = 0$$

$$\log \eta_0 = 9.27184$$

$$\cos \alpha = 7.33115$$

$$(d-D) = 1.94069$$

$$\delta-D = +1 \ 27.2$$

$$D = +3 \ 25 \ 45$$

$$\delta_0 = +3 \ 27 \ 12.2$$

$$\text{Red} = +20.9$$

$$\delta' = +3^{\circ} 27' 33.1''$$

C - O - C

1	+	0	+	46	-	19	=	-165	+	68
2	-	4	+	45	+	19	=	+59	+	67
3	-	26	+	37	+	19	=	+29	-	42
4	-	29	+	35	+	19	=	+24	-	71
5	-	43	+	13	+	19	=	-12	-	88
6	-	45	+	0	+	19	=	-27	+	28
7	-	44	-	9	+	19	=	-35	-	17
8	-	33	-	31	+	19	=	-46	+	9
9	-	26	-	37	+	19	=	-45	-	118
10	-	4	-	45	+	19	=	-31	+	121
11	-	0	-	46	+	19	=	-28	+	54
12	+	18	-	42	+	19	=	-6	-	9
13	+	33	-	31	+	19	=	+20	-	48
14	+	40	-	22	+	19	=	+36	+	116
15	+	44	-	9	+	19	=	+53	-	13
16	+	23	+	0	+	19	=	+32	-	1260 (-252)
17	+	43	+	13	+	19	=	+74	+	33
18	+	40	+	22	+	19	=	+80	-	74
19	+	29	+	35	+	19	=	+84	-	19

+567-8556

Average (O-C) = 61

+567-682

Average (O-C) = 66

MC1307 Moon's Mean Position

1913 Apr. 19.

10

$$X_0 = 18.1834$$

$$Y_0 = 21.6060$$

$$\Delta\alpha = +1.5$$

$$\Delta\delta = -1.1$$

$$18.1845$$

$$21.6049$$

From Preliminary Reduction. $X = 18.4647$ $Y = 22.1872$

Plate Constants -

ax

0

-7

by

-2

c

-7

$$22.1870$$

$$S = +0.4647$$

$$\log = 9.66717$$

$$\cos \delta = 9.99921$$

$$\cos \alpha = 8.50729$$

$$(3-1) = 1.16072$$

$$X-A = +14.48$$

$$A = 0 \quad 53 \quad 25$$

$$X_0 = 0 \quad 53 \quad 39.48$$

$$\text{Red} = +3.01$$

$$\alpha' = 0^\circ 53' 42.49$$

$$\eta = +0.1870$$

$$\log \tan \delta = 8.7781$$

$$S = 9.3343$$

$$\eta_1 = 5.1658$$

$$\eta_2 = 0$$

$$\log \eta_0 = 9.27184$$

$$\cos \alpha = 7.33115$$

$$(6-0) = 1.94069$$

$$S-D = +1 \quad 27.2$$

$$D = +3 \quad 25 \quad 45$$

$$S_0 = +3 \quad 27 \quad 12.2$$

$$\text{Red} = +20.9$$

$$\delta' = +3^\circ 27' 33.1$$

MC 1307

Lunar Parallax

1913 May 12.

$$\alpha' = 0^h 53^m 42.49$$

$$\delta' = +3 \ 27 \ 33.1$$

$$G \quad 0 \ 44 \ 06.75$$

$$\theta - \alpha' = - \quad 9 \ 35.74$$

$$= -20 \ 23' \ 55''$$

$$IT = 58' \ 18.4$$

$$\frac{1}{2}(\alpha - \alpha') = - \ 54''$$

$$(\theta - \alpha') - \frac{1}{2}(\alpha - \alpha') = -20 \ 23' \ 01''$$

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

$$\log \sin \pi = 8.22942$$

$$\log \sin(\theta - \alpha') = 8.62171$$

$$- \log \cos \delta = 9.99891$$

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

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

$$\log(\theta - \alpha') - \frac{1}{2}(\alpha - \alpha') = 9.99962$$

$$- \log \tan \phi = 9.95765$$

$$\log \sin(\alpha - \alpha') = 6.72135$$

$$\alpha - \alpha' = - \ 1' \ 48.6$$

$$= - \ 5 \ 7.24$$

$$\delta = 42^\circ \ 12' \ 39.2$$

$$\delta' = 3 \ 27 \ 33.1$$

$$\delta - \delta' = 38 \ 45 \ 06.1$$

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

$$\log \sin \pi = 8.22942$$

$$\log \sin(\delta - \delta') = 9.79554$$

$$- \log \sin \phi = 9.82728$$

$$\log \sin(\alpha - \delta') = 8.02508$$

$$\delta - \delta' = + \ 36 \ 25.3$$

$$\delta = +4 \ 03 \ 58.4$$

$$\alpha = 0 \ 53 \ 35.25$$

$$\text{am Ephm } \delta = +4 \ 03 \ 56.2$$

$$\alpha = 0 \ 53 \ 34.72$$

$$O - C = +2.2$$

$$O - C = +0.53$$

MG 1307 Lunar Parallax

$$\alpha = 0^h 53^m 42.49^s$$

$$\delta = 0^\circ 44' 06.75''$$

$$\alpha - \alpha' = -9^\circ 35.74'$$

$$= -2^\circ 23' 55''$$

$$\frac{1}{2}(\alpha - \alpha') = -59''$$

$$(\alpha - \alpha') - \frac{1}{2}(\alpha - \alpha') = -2^\circ 23' 01''$$

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

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

$$(\alpha - \alpha') - \frac{1}{2}(\alpha - \alpha') = 9.99962$$

$$\tan \phi = 9.95765$$

$$\phi = 42^\circ 12' 39.2''$$

$$\delta' = 3^\circ 27' 33.1''$$

$$\phi - \delta' = 38^\circ 45' 06.1''$$

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

$$\sin \pi = 8.22942$$

$$\sin(\phi - \delta') = 9.79654$$

$$\sin \phi = 9.82728$$

$$\sin(\alpha - \delta') = 8.02508$$

$$\delta - \delta' = +3^\circ 36' 25.5''$$

$$\delta = +4^\circ 03' 58.4''$$

$$\text{Ann Ephs } \delta = +4^\circ 03' 56.2''$$

$$O-C$$

$$+2.2$$

1913 May 12. 11

$$\delta' = +3^\circ 27' 33.1''$$

$$\pi = 58' 18.4''$$

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

$$\sin \pi = 8.22942$$

$$\sin(\delta - \delta') = 8.62171$$

$$\cos \delta = 9.99891$$

$$\sin(\alpha - \alpha') = 6.72135$$

$$\alpha - \alpha' = 1^\circ 48.6'$$

$$= 7.24$$

$$\alpha = 0^h 53^m 35.25^s$$

$$\alpha = 0^h 53^m 34.72^s$$

$$O-C = +0.53$$

MC.1308

1913 Mar. 10.

12

Comp. Stars - Measures.

x

1	d	n	d	n
3.4	17770	17320	17587	18218
17.3	149.15 ²⁰	10175 ⁷³	10830 ³⁰	14989 ⁸⁹
mag.	16	80	28	90
6.5	80	09	00	03
	<u>17.2856</u>	<u>.2864</u>	<u>3.3233</u>	<u>.3224</u>
2				
3.6	15740	16617	16200	17003
9.6	9718 ¹⁴	12664 ⁶⁴	11813 ²⁰	11405 ⁰⁰
mag.	08	60	13	06
9.4	49	27	10	15
	<u>9.6032</u>	<u>.6042</u>	<u>3.5611</u>	<u>.5605</u>
3				
4.6	18540	16900	19200	18600
22.5	13795 ⁰⁰	11671 ⁷¹	15139 ³⁰	12675 ⁷¹
mag.	95	71	30	66
8.0	47	24	10	14
	<u>22.4746</u>	<u>.4759</u>	<u>4.5929</u>	<u>.5937</u>
4				
20.2	17750	15847	17342	16529
14.3	14720 ²⁸	8900 ¹⁰	9498 ⁹⁸	14394 ⁹⁰
mag.	20	00	00	89
7.9	80	69	70	58
	<u>11.3036</u>	<u>.3041</u>	<u>20.2135</u>	<u>.2144</u>
5				
23.1	16574	14998	16131	18284
30.5	10660 ⁶⁵	10930 ²⁰	7520 ²⁰	16849 ⁰⁰
mag.	64	30	25	99
8.6	80	16	30	06
	<u>30.5914</u>	<u>.5922</u>	<u>23.1395</u>	<u>.1388</u>

mC.1308

1913 Mar. 10.

12

Comp. Stars - Measures.

x

$\frac{1}{d}$	$\frac{1}{d}$	$\frac{1}{d}$	$\frac{1}{d}$	$\frac{1}{d}$
3.4	17770	17320	17587	18218
17.3	14915 ²⁰	10175 ⁷³	10830 ³⁰	14989 ⁸⁹
mg.	16	80	28	90
6.5	80	09	00	03
	<u>17.2856</u>	<u>.2864</u>	<u>3.3233</u>	<u>.3224</u>
$\frac{2}{d}$				
3.6	15740	16617	16200	17003
9.6	9718 ¹⁴	12664 ⁶⁴	11813 ²⁰	11405 ⁰⁰
mg.	08	60	13	06
9.4	49	27	10	15
	<u>9.6032</u>	<u>.6042</u>	<u>3.5611</u>	<u>.5605</u>
$\frac{3}{d}$				
4.6	18540	16900	19200	18600
22.5	13795 ⁰⁰	11671 ⁷¹	15139 ³⁰	12675 ⁷¹
mg.	95	71	30	66
8.0	47	24	10	14
	<u>22.4746</u>	<u>.4759</u>	<u>4.5929</u>	<u>.5937</u>
$\frac{4}{d}$				
20.2	17750	15847	17342	16529
14.3	14720 ²⁸	8900 ¹⁰	9498 ⁹⁸	14394 ⁹⁰
mg.	20	00	00	89
7.9	80	69	70	58
	<u>11.3036</u>	<u>.3041</u>	<u>20.2135</u>	<u>.2144</u>
$\frac{5}{d}$				
3.1	16574	14998	16131	18284
30.5	10660 ⁶⁵	10930 ²⁰	7529 ²⁰	16899 ⁰⁰
8.6	64	30	25	99
mg.	80	16	30	06
	<u>30.5914</u>	<u>.5922</u>	<u>23.1395</u>	<u>.1388</u>

MK1308 Synon-measures

1913 Mar 10 13

1 17.5 16190 16767
 19.8 817748 14765
 min 03 65-62
 in 80
 19.8010 .7994

2 17.0 15214 15743
 19.8 6945 14020
 2840 2935
 32 51
 19.8291 .8284

3 16.5 18319
 20.0 1287670
 6070
 45
 16.4536

16889
 1235681
 7081
 90
 4520

4 16.0 17329 16000
 20.4 14425 889799
 2919 9099
 35 09

20.2907 .2889

5 15.5 17496
 21.0 1213741
 3941

6 15.4646

15.3
 21.9
 min
 in
 20

7 15.3
 22.0

17784
 12440
 3440
 90

15.4651

16712
 9412
 1015
 30

15.2687

15709
 8448
 5045
 20

15.2731

14901
 1022226
 28
 00

4673

14068
 1137275
 61
 80

2702

13073
 1033830
 3030
 00

2747

MK1308 Moon-measures.

1913 Nov. 10. 13.

$\frac{1}{17.5}$ 16190
 $\frac{1}{19.8}$ 817748
 $\frac{1}{19.8}$ 917748
 $\frac{1}{19.8}$ 03
19.8010

$\frac{2}{17.0}$ 15214
 $\frac{2}{19.8}$ 6945
 $\frac{2}{19.8}$ 2840
 $\frac{2}{19.8}$ 32
19.8291

$\frac{3}{16.5}$
 $\frac{3}{20.0}$

$\frac{4}{16.0}$ 17329
 $\frac{4}{20.4}$ 14425
 $\frac{4}{20.4}$ 2919
 $\frac{4}{20.4}$ 35
20.2907

$\frac{5}{15.5}$ 17496
 $\frac{5}{21.0}$ 1213741
 $\frac{5}{21.0}$ 39
 $\frac{5}{21.0}$ 90
20.2907

$\frac{6}{15.3}$ 17496
 $\frac{6}{15.3}$ 1213741
 $\frac{6}{15.3}$ 39
 $\frac{6}{15.3}$ 90
20.2907

$\frac{7}{15.3}$
 $\frac{7}{15.3}$
 $\frac{7}{15.3}$
 $\frac{7}{15.3}$

$\frac{8}{15.3}$
 $\frac{8}{22.0}$

$\frac{1}{16.767}$
 $\frac{1}{14.765}$
 $\frac{1}{65.62}$
 $\frac{1}{80}$
7994

$\frac{1}{15.743}$
 $\frac{1}{14.020}$
 $\frac{1}{29}$
 $\frac{1}{51}$
8284

$\frac{1}{18319}$
 $\frac{1}{12876}$
 $\frac{1}{6070}$
 $\frac{1}{45}$

16.4536

$\frac{1}{16889}$
 $\frac{1}{1235681}$
 $\frac{1}{70}$
 $\frac{1}{90}$

4520

$\frac{1}{17784}$
 $\frac{1}{12440}$
 $\frac{1}{3440}$
 $\frac{1}{90}$

15.4651

$\frac{1}{16712}$
 $\frac{1}{9412}$
 $\frac{1}{1015}$
 $\frac{1}{30}$

15.2687

$\frac{1}{15709}$
 $\frac{1}{8448}$
 $\frac{1}{5045}$
 $\frac{1}{20}$

15.2731

$\frac{1}{14901}$
 $\frac{1}{1022226}$
 $\frac{1}{28}$
 $\frac{1}{00}$

4673

$\frac{1}{14068}$
 $\frac{1}{1137275}$
 $\frac{1}{61}$
 $\frac{1}{80}$

2702

$\frac{1}{13073}$
 $\frac{1}{10338}$
 $\frac{1}{3030}$
 $\frac{1}{00}$

2747

1101308 moon-measures

1913 mar 18

14.

8
15.6
23.0

a 4 n

15694
11740
30
07

18965
12928
35
71

15.6038.6041 ✓

9

16.0 14230
23.4 971620
20
39

16380
1089810
00
96

23.4585.4515

10.0
17.0 795558
23.9 61
7120

12631
1179096
90.96

23.9162.9161

11
17.4 763430
23.9 25
max 7110

11658
11139
3535

8 23.9481.9478

12
18.0 18426
23.8 1001821
09
30

15481
1386065
63
92

23.8415.8380

13
19.0 18382
23.1 1710510
20
82

14560
582220
1420
78

23.1270.1243

1101308 moon - measures.

1913 mar. 13.

14.

8
15.6
23.0

a 4 n

a 2 n
15694 18965
11740 30 12928
30 35
07 71

15.6038.6041

9
16.0 14230
23.4 971620
20
39

16380
1087810
00
96

23.4515.4515

10
17.0 795558
23.9 61
7120

12631
1179096
9096

23.9162.9161

11
17.4 763430
23.9 25
mar 7110

11658
11139
3535

8 23.9481.9478

12
18.0 18426
23.8 1001321
09
30

15481
1386065
63
92

23.8415.8380

13
19.0 18382
23.1 1710510
20
82

14560
582220
19
78

23.1270.1243

MC1308 Moon-measures. 1913 Mar. 10. 15

<u>14</u>	d	n	d	n
19.4			16921	18642
22.0			1079.0	1457660
			9996	6060
			34	50

<u>15</u>			<u>19.4066</u>	<u>.4080</u>
19.4	15		15929	17596
21.7			10015	1350098
max			1512	00
in			36	00
76			<u>19.4081</u>	<u>.4097</u>

<u>16</u>			15957	17528
19.3			817688	15300
21.0			80	9804
			61	34

19.2221 .2228

<u>17</u>			16870
19.0	14720		13150
20.7	847774		6556
	5074		81
	36		

20.6263 .6283

18
18.2 rough
20.0

<u>18</u>			13747
18.0	8705		1278490
19.9	0000		81
	7750		

19.9048 .9038

19 scratch to	or used instead of no 13		
15131	14029	13392	14306
1255045	661010	1225060	544032
4245	10	28	00
30	27	90	
23.2585	2583	18.8861	.8864

MC1308 Moon-measures 1913 Mar. 10 15

14 d 4 N
19.4
22.0

d 2 N
169 21 18642
1079.0 1457660
9996 60
34 50

19.4066 .4080

15
19.4 15
21.7
max
in
72

15929 17596
10015 1350098
1572 00
36 00

19.4081 .4097

16
19.3
21.0

15957 17528
817688 15300
80 9804
61 34

19.2221 .2228

17
19.0 14720
21.7 847774
5074
36

16870
13150
6556
81

20.6263 .6283

18
18.2 rough
20.0

19
18.0 8705
19.9 0000
7750

13747
1278490
81

19.9048 .9038

19 scratch to be used instead of no 13
15131
1255045
4245

14029
661010
10
27

13392
1225060
48
90

14306
544032
40
00

232585

2583

188861

8864

Tables $a = 0.0$ $e = -2.3$ $a - e = +2.3$ $b + a = 0.0$
Obs $a = +1.7$ $e = +1.5$ $a - e = +0.2$ $b + a = +0.1$

MCI 308 Preliminary Reduction

1913 Mar 25. 16

x	3.3228	3.5608	4.5933	70.2140	23.1392
z	5.0943	5.4198	6.3050	22.0497	24.7572
$x-z$	-1.7715	-1.8590	-1.7117	-1.8357	-1.6180
y	17.2860	9.6037	22.4752	11.3038	30.5918
η	17.9441	10.2660	23.1463	12.1533	31.4724
$y-\eta$	-0.6581	-0.6623	-0.6711	-0.8495	-0.8806

Times etc

MC1308 Preliminary Reduction				1913 Mar. 25. 16	
x	3.3228	3.5608	4.5933	20.2140	23.1392
y	5.0943	5.4198	6.3050	22.0497	24.7572
$x - y$	-1.7715	-1.8590	-1.7117	-1.8357	-1.6180
y	17.2860	9.6037	22.4752	11.3038	30.5918
η	17.9441	10.2660	23.1463	12.1533	31.4724
$y - \eta$	-6581	-6623	-6711	-8495	-8806

$x - y$	-1134	$-1\frac{1}{2}x$	+1.9671
-1.7715 - 1953	= -1.9668	-5	= -1.9673
-1.8590 - 1085	= -1.9675	-5	= -1.9680
-1.7117 - 2540	= -1.9657	-7	= -1.9664
-1.8357 - 1277	= -1.9634	-30	= -1.9664
-1.6180 - 3457	= -1.9637	-35	= -1.9672
moon 73424 - 2472	-26		= 19.0597
$y - \eta$	+11326	-4	+6222
-6581 + 375	= -6206	-17	= -6223
-6623 + 402	= -6221	-10	= -6231
-6711 + 519	= -6192	-22	= -6214
-8495 + 2284	= -6211	-11	= -6222
-8806 + 2615	= -6191	-31	= -6222
moon 218722 + 1950	-72		= 22.6882

Times etc.				$-1^h 04^m$	
Exp. to stars	1911 Oct. 7	0 ^h 52 ^m		0 57	47.5
moon				0 57	47.8
clock slow				0	41.6
H Sid T.		0 58	29.25		
H long.		4 44	31.05		
G Sid T.		5 43	00.30		
Sid T. in moon		13 00	03.64		
Interval		16 42	56.66		
Reduction		2	44.31		
B. to L.		16 40	12.35		
From ant. film					
moon 16 ^h		0 ^h 52 ^m	41.93	+3 56	59.4
Motion in 1 ^m = 2.0409				16.114	
40.206		+ 1	22.06	+ 10	47.8
Tetular place		0 54	03.99	+4 07	47.1
Moon's parallax		58' 18.7"			
Semidiameter		15' 59.9"			
Moon is		0 ^h 29.1	past full		

Approximate Center

$$\begin{array}{r}
 x = 17 \quad y = 19.8288 \\
 \quad \quad \quad 23.9162 \\
 \quad \quad \quad 43.7450 \\
 \hline
 \text{mean } y = 21.8725
 \end{array}$$

$$\begin{array}{r}
 x = 16.0 \quad y = 20.2898 \\
 \quad \quad \quad 23.4515 \\
 \quad \quad \quad 43.7413 \\
 \hline
 \text{mean} = 21.8707
 \end{array}$$

$$\begin{array}{r}
 x = 18 \quad y = 23.8398 \\
 \quad \quad \quad 19.9043 \\
 \quad \quad \quad 43.7441 \\
 \hline
 \text{mean } y = 21.8720
 \end{array}$$

$$\begin{array}{r}
 x = 19.0 \quad y = 23.1256 \\
 \quad \quad \quad 20.6273 \\
 \quad \quad \quad 43.7529 \\
 \hline
 21.8764
 \end{array}$$

$$\begin{array}{r}
 y = \text{min} = 19.8082 \\
 y = \text{max} = 23.9480 \\
 \hline
 43.7462 \\
 21.8741
 \end{array}$$

$$y = 21.0 \quad x = 16.4528$$

$$\begin{array}{r}
 y = 20.0 \quad x = 15.4662 \\
 \quad \quad \quad 19.2224 \\
 \quad \quad \quad 34.6886 \\
 \hline
 \text{mean } x = 17.3943
 \end{array}$$

$$\begin{array}{r}
 y = 22.0 \quad x = 15.2739 \\
 \quad \quad \quad 19.4073 \\
 \quad \quad \quad 34.6812 \\
 \hline
 x = 17.3406
 \end{array}$$

$$\begin{array}{r}
 y = \text{max} = 15.2694 \\
 x = \text{min} = 19.4089 \\
 \hline
 34.6783 \\
 x = 17.3392
 \end{array}$$

$$\begin{array}{l}
 \text{Assume Center} \\
 \left\{ \begin{array}{l} X_0 = 17.3414 \\ Y_0 = 21.8731 \end{array} \right.
 \end{array}$$

Corrections for phase

	x	y	x^2	y^2	$(x^2 + y^2)$	$2.95(x^2 + y^2)^{1/2}$
1	0.00	-2.07	0.00	+3.93	+3.93	+46
2	-0.34	-2.04	-0.28	+3.88	+3.60	+38
3	-0.89	-1.87	-0.79	+3.55	+2.81	+23
4	-1.34	-1.58	-1.11	+3.00	+1.89	+11
5	-1.88	-0.87	-1.56	+1.65	+0.09	+0
14	+2.07	+0.13	+1.72	-0.25	+1.47	+6
15	+2.07	0.00	+1.72	0.00	+1.72	+9
16	+1.88	-0.87	+1.56	+1.65	+3.21	+30
17	+1.66	-1.25	+1.38	+2.38	+3.76	+42
18	+0.66	-1.97	+0.55	+3.74	+4.29	+54

$$\begin{array}{l}
 \left\{ \begin{array}{l} Y = +50' = +0.83 \\ Y = -1^{\circ}54' = -1.90 \end{array} \right.
 \end{array}$$

	MC1308	known -		1913 Apr. 17		17
	x	$x - x_0$	$(x - x_0)^2$	$(x - x_0)(y - y_0)$	$y - y_0$	cor. $\frac{1}{100}$
1	17.3414	0.0000	0.0000	4.2986	+1.8	+46
2	17.0000	-0.3414	0.1166	4.2974	+6	+38
3	16.4528	-0.8886	0.7896	4.2992	+24	+23
4	16.0000	-1.3414	1.7994	4.3072	+104	+11
5	15.4662	-1.8752	3.5164	4.2789	-179	
6	15.2694	-2.0720	4.2932	4.2932	-36	
7	15.2739	-2.0675	4.2746	4.2907	-61	
8	15.6040	-1.7374	3.0186	4.2889	-79	
9	16.0000	-1.3414	1.7994	4.2917	-51	-254
10	17.0000	-0.3414	0.1166	4.2924	-44	
11	17.3414	0.0000	0.0000	4.3069	+101	
12	18.0000	+0.6586	0.4338	4.3033	+65	
13	18.8862	+1.5448	2.3864	4.3050	+82	
14	19.4073	+2.0659	4.2680	4.2841	-127	+6
15	19.4089	+2.0675	(4.2746)	4.2746	-222	+9
16	19.2224	+1.8810	3.5382	4.3007	+39	+30
17	19.0000	+1.6586	2.7510	4.3030	+62	+42
18	18.0000	+0.6586	0.4338	4.3116	+148	+59
mean				4.2968	+2	

	y	$y - y_0$	Δy	$(y - y_0)^2$	Combined Solution	
					(11) full wt	(15) 2 wt
1	19.8002	-2.0729	-4	4.2986	+20	+12
2	18.8288	-2.0443	-4	4.1808	+5	+0
3	20.0000	-1.8731	-3	3.5096	+18	+17
4	20.2898	-1.5833	-3	2.5078	+96	+99
5	21.0000	-0.8731	-1	0.7625	-177	-172
6	21.8731	0.0000	0	0.0000	-16	-9
7	22.0000	+0.1269	0	0.0161	-39	-11
8	23.0000	+1.1269	+2	1.2703	-42	-38
9	23.4515	+1.5784	+3	2.4923	-10	-9
10	23.9162	+2.0431	+4	4.1758	-7	-14
11	23.9480	+2.0749	+4	4.3069	+135	+125
12	23.6398	+1.9667	+4	3.8695	+89	+74
13	23.2584	+1.3853	+2	1.9196	+84	+58
14	22.0000	+0.1269	0	0.0161	-149	-153
15	21.8731	+0.0000	0	0.0000	-243	-134
16	21.2000	-0.8731	-1	0.7625	+25	+2
17	20.6273	-1.2458	-2	1.5520	+56	+34
18	19.9043	-1.9688	-4	3.8778	+152	+139

[illegible]

MC1308		Known		1913 Apr 17		17	
x	$x - x_0$	$(x - x_0)^2$	$(x - x_0)(y - y_0)$	$y - y_0$	$(y - y_0)^2$	$0 - C$	
1	17.3414	0.0000	0.0000	4.2986	+18	+46	
2	17.0000	-0.3414	0.1166	4.2974	+6	+36	
3	16.4528	-0.8886	0.7896	4.2992	+24	+23	
4	16.0000	-1.3414	1.7994	4.3072	+104	+11	
5	15.4662	-1.8752	3.5164	4.2789	-179		
6	15.7694	-2.0720	4.2932	4.2932	-36		
7	15.2739	-2.0675	4.2746	4.2907	-61		
8	15.6040	-1.7374	3.0186	4.2889	-79		
9	16.0000	-1.3414	1.7994	4.2917	-51	-254	
10	17.0000	-0.3414	0.1166	4.2924	-44		
11	17.3414	0.0000	0.0000	4.3069	+101		
12	18.0000	+0.6586	0.4338	4.3033	+65		
13	18.8862	+1.5448	2.3864	4.3050	+82		
14	19.9173	+2.0639	4.2680	4.2841	-127	+6	
15	19.4089	+2.0675	4.2746	4.2746	-222	+9	
16	19.2224	+1.8810	3.5382	4.3007	+39	+30	
17	19.0000	+1.6586	2.7510	4.3030	+62	+42	
18	18.0000	+0.6586	0.4338	4.3116	+148	+104	
mean				4.2968	+2		

y	$y - y_0$	Δy	$(y - y_0)^2$	Combined Solution	
1	19.8002	-2.0729	-4	4.2986	10-6
2	19.8288	-2.0443	-4	4.1808	15-3
3	20.0000	-1.8731	-3	3.5096	
4	20.2898	-1.5833	-3	2.5078	
5	21.0000	-0.8731	-1	0.7625	
6	21.8731	0.0000	0	0.0000	
7	22.0000	+0.1269	0	0.0161	
8	23.0000	+1.1269	+2	1.2703	
9	23.4515	+1.5784	+3	2.4923	
10	23.9112	+2.0431	+4	4.1758	
11	23.9480	+2.0749	+4	4.3069	
12	23.6398	+1.9667	+4	3.8695	
13	23.2584	+1.3853	+2	1.9196	
14	22.0000	+0.1269	0	0.0161	
15	21.8731	+0.0000	0	0.0000	
16	21.0000	-0.8731	-1	0.7625	
17	20.6273	-1.2458	-2	1.5520	
18	19.9043	-1.9688	-4	3.8778	

Correction for phase

No	at	bu	bw	aw	bu	on
1	- 0.00 +	0.0 -	37.3 +	0.0 -	95.2	+46
2	+ 0.70 -	40 -	12.3 -	12.9 -	77.5	+38
3	+ 1.66 -	21.3 -	45.0 -	20.4 -	43.0	+23
4	+ 2.12 -	139.8 -	164.8 -	14.7 -	17.4	+11
5	+ 1.64 +	335.7 +	156.0 -	0.0 -	0.0	0
6	- 0.00 +	74.6 -	0.0			
7	- 0.26 +	126.0 -	7.7			
8	- 1.96 +	137.1 -	89.0			
9	- 2.12 +	68.5 -	80.5			
	+ 1.78 +	578.8 -	280.6 -	48.0 -	233.1	+118
		- 48.0 -	233.1			-254
		+ 530.8 -	513.7			-136

Corrected Residuals.

0	C	0-C
1 +64 + 0 + 39 + 46 = +85 -20		
2 +44 - 19 + 38 + 46 = +65 -20		
3 +47 - 51 + 35 + 45 = +30 +18		
4 +115 - 76 + 30 + 45 = 0 +116		
5 -179 - 107 + 16 + 45 = -45 -133		
6 -36 - 118 - 0 + 45 = -72 +37		
7 -61 - 118 - 2 + 45 = -74 +14		
8 -79 - 99 - 21 + 45 = -74 -4		
9 -51 - 76 - 30 + 45 = -60 +10		

MC 1308 Moon's Centre (Phase limb) 1913 Apr 19. 18

Conditional Equations

	a	b	c	0		c	0-c
1	-0.00	-2.07	+12	+18	+0+33+10	+43	-25
2	-0.34	-2.04	+12	+6	-13+32+10	+29	-23
3	-0.89	-1.87	+12	+24	-33+30+10	+7	+17
4	-1.34	-1.58	+12	+104	-50+25+10	-15	+119
5	-1.88	-0.87	+12	-179	-70+14+10	-46	-133
6	-2.07	+0.00	+12	-36	-77-0+10	-67	+31
7	-2.07	+0.13	+12	-61	-77-2+10	-69	+8
8	-1.74	+1.13	+12	-79	-65-18+10	-73	-6
9	-1.34	+1.58	+12	-51	-50-25+10	-65	+14

Normal Equations

+189-187

Average (0-c) = 42

$$+19.61 + 1.78 - 11.66 = +57.9 + 531$$

$$+ 1.78 + 19.04 - 5.61 = -281 - 514$$

$$- 11.66 - 5.61 + 9.00 = -254 - 136$$

$$- 1.78 - 0.16 + 1.06 = -57 - 48$$

$$+ 11.66 + 1.06 - 6.93 = +344 + 316$$

$$+ 18.88 - 4.55 = -333 - 562$$

$$- 4.55 + 2.07 = +90 + 180$$

$$+ 4.55 - 1.10 = -80 - 135$$

$$+ 0.97 = +10 + 44$$

$$- 9.95 + 4.55 = -197 + 394$$

$$+ 8.93 = -141 - 168$$

$$- 3.70 - 1.78 + 2.86 = -80 - 43$$

$$- 39.58 - 19.04 + 30.58 = -862 - 461$$

$$+ 15.91 - 8.80 = +499 + 488$$

$$- 37.80 + 24.97 = -1143 - 975$$

$$- 13.39 + 8.80 = -495 - 344$$

$$+ 2.52 = +94 + 144$$

$$\Sigma - A = +33.08$$

$$\text{corr to } \Delta x = +0.05$$

$$\Sigma - B = +5' 21'' 0$$

$$\text{corr to } \Delta \delta = 0.0$$

new 0-c

1 -21

2 -21

3 +17

4 +115

5 -134

6 +36

7 +13

8 -5

9 +9

+190-181

Average = 41

+100 = +45

-146 = -19

MAC 1308 Moon's Centre (Phase limit)
Conditional Equations

1913 Apr. 19.

18

	a	b	c	0		c	0 - c
1	0.00	-2.07	+1.2	+1.8	+ 0 + 33 + 10 =	+ 43	- 25
2	-0.34	-2.04	+1.5	+ 6	- 13 + 32 + 10 =	+ 29	- 23
3	-0.89	-1.87	+1.5	+ 24	- 33 + 30 + 10 =	+ 7	+ 17
4	-1.34	-1.58	+1.5	+ 104	- 50 + 25 + 10 =	- 15	+ 119
5	-1.88	-0.87	+1.5	- 179	- 70 + 14 + 10 =	- 46	- 133
6	-2.07	+0.00	+1.5	- 36	- 77 - 0 + 10 =	- 67	+ 31
7	-2.07	+0.13	+1.5	- 61	- 77 - 2 + 10 =	- 69	+ 18
8	-1.74	+1.13	+1.5	- 79	- 65 - 18 + 10 =	- 73	- 6
9	-1.34	+1.58	+1.5	- 51	- 50 - 25 + 10 =	- 65	+ 14

Normal Equations.

+189 - 187

Average (0 - c) = 42

$$+ 19.61 + 1.78 - 11.66 = + 5.79 + 5.31$$

$$+ 1.78 + 19.04 - 5.61 = - 2.81 - 5.14$$

$$- 11.66 - 5.61 + 9.00 = - 2.54 - 1.36$$

$$- 1.78 - 0.16 + 1.06 = - 5.7 - 4.8$$

$$+ 11.66 + 1.06 - 6.93 = + 3.49 + 3.16$$

$$+ 18.88 - 4.55 = - 3.33 - 5.62$$

$$- 4.55 + 2.07 = + 9.0 + 1.80$$

$$+ 4.55 - 1.10 = - 8.0 - 1.35$$

$$+ 0.97 = + 1.0 + 4.42$$

$$- 9.95 + 4.55 = + 1.97 + 3.94$$

$$+ 8.93 = - 1.41 - 1.68$$

$$- 3.70 - 1.78 + 2.86 = - 8.0 - 4.3$$

$$- 39.58 - 19.04 + 30.58 = - 8.62 - 4.61$$

$$+ 15.91 - 8.80 = + 4.99 + 4.88$$

$$- 37.80 + 24.97 = - 11.43 - 9.75$$

$$- 13.39 + 8.80 = - 4.05 - 3.44$$

$$+ 2.52 = + 9.4 + 1.44$$

new 0 - c

1 - 21

2 - 21

3 + 17

4 + 115

5 - 139

6 + 36

7 + 13

8 - 5

9 + 9

+190 - 181

Average = 41

0 - c = + 1.0 c = + 4.6

Formation of Normals (corrections)

No	ab	an	bn	an	bn	cn
10	-0.70	+15.02	90.0			
11	+0.00	+0.0	+209.5			
12	+1.24	+42.7	+127.8			
13	+2.14	+126.7	+113.4			
14	+0.27	-262.2	-16.1	+12.9	+0.8	+6
15	+0.00	-459.0	0.0	+18.6	0.0	-9
16	-1.64	+73.4	-34.0	+56.5	-26.1	+3.0
17	-2.07	+102.8	-77.1	+69.8	-52.5	+4.2
18	-1.24	+97.2	-291.3	+35.6	-106.2	+5.4
	-2.00	-263.4	-57.8	+192.9	-184.0	+14.1
		+192.9	-184.0			+1.04
		-70.5	-241.8			+24.5
		+331.2				
		+260.7				

Corrected Residuals

	O	C	O-C
10	-44	+32-96+152 = +88	-132
11	+101	-0-97+152 = +55	+46
12	+65	-62-93+152 = -3	+68
13	+82	-146-65+152 = -59	+141
14	-121	-196-6+152 = -50	-71
15	-213	-196-0+152 = -44	-169
16	+69	-178+41+152 = +15	+54
17	+104	-157+59+152 = +54	+50
18	+202	-62+93+152 = +183	+19

MC 1308 - Moon's Centre (Full Limit) 1913 Apr 19. 19
Conditional Equations.

	a	b	c	0		a	0-c
10	-0.34	+2.04	+1	-44	+29-65	+121	+85
11	+0.00	+2.07	+1	+101	-0-66	+121	+55
12	+0.66	+1.97	+1	+65	-57-63	+121	+1
13	+1.54	+1.39	+1	+82	-132-44	+121	-55
14	+2.07	+0.13	+1	-127	-177-4	+121	-60
15	+2.07	+0.00	+1	-77	-177-0	+121	-56
16	+1.88	-0.87	+1	+39	-161+48	+121	-12
17	+1.66	-1.25	+1	+62	-142-40	+121	+19
18	+0.66	-1.97	+1	+148	-57-63	+121	+127

Normal Equations.

+362-362

Average (0-c) = 80

$$+18.20 - 2.00 + 10.19 = -263 - 70$$

$$-2.00 + 20.48 + 3.51 = -58 - 242$$

$$+10.19 + 3.51 + 9.00 = +104 + 245$$

$$+2.00 - 0.22 + 1.12 = -29 - 8$$

$$-10.19 + 1.12 - 5.70 = +147 + 39$$

$$+20.26 + 4.63 = -87 - 250$$

$$+4.63 + 3.30 = +251 + 284$$

$$-4.63 - 1.06 = +20 + 57$$

$$+2.24 = +271 + 341$$

$$-6.50 - 4.63 = -352 - 398$$

$$+1376 = -439 - 648$$

$$+5.80 + 22.00 + 5.13 = +59 + 140$$

$$-59.45 - 20.48 - 52.50 = -606 - 1430$$

$$+24.00$$

$$-61.45$$

$$-19.22$$

$$+4.80$$

$$+15.32 = -204 + 70$$

$$-48.99 = -664 - 1672$$

$$-15.32 = -208 - 524$$

$$= -412 - 454$$

$$\frac{\Delta y}{\Delta x} = -0.47$$

$$\frac{\Delta x}{\Delta y} = -1.21$$

+378-372

Average = 83

+378-372

1308 Combined Solution Normal Equations

1913 May 6.

$$+ 37.81 - 0.22 - 1.47 = +4.61$$

$$- 0.22 + 39.52 - 2.10 = -7.56$$

$$- 1.47 - 2.10 + 18.20 = +10.9$$

$$+ 0.22 - 0.00 - 0.01 = + 3$$

$$+ 1.47 - 0.11 - 0.06 = + 1.8$$

$$+ 39.52 - 2.11 = -7.53$$

$$- 2.11 + 17.94 = +12.7$$

$$+ 2.11 - 0.11 = - 4.0$$

$$+ 17.83 = + 8.7$$

$$c = + 5$$

$$- 0.25 + 2.11 = + 1.8$$

$$+ 39.27 = -7.38$$

$$b = -19$$

$$+ 0.15 + 0.22 - 1.59 = - 1.1$$

$$- 27.65 - 39.52 + 338.90 = +2053$$

$$+ 37.96 - 3.36 = +4.50$$

$$- 27.87 + 336.80 = +1297$$

$$- 0.28 + 3.36 = + 3.13$$

$$+ 37.68 = +4.63$$

$$a = +12$$

Combined Solution (no. 15) gives 1/2 wt

normals:

$$+ 35.68 - 0.22 - 2.50 = +6.81$$

$$- 0.22 + 39.52 - 2.10 = -7.56$$

$$- 2.50 - 2.10 + 17.50 = +2.20$$

$$c = +14.5 \text{ wt } 17.215$$

$$b = -1.8 \text{ wt } 39.26$$

$$a = +20.7 \text{ wt } 35.40$$

Residuals p 17.

MC 1308 Morris Center (Jable Limit) 1913 Apr. 17. 19

Conditional Equations

	a	b	c	0		c	0-c
10	-0.34	+2.04	+1	= -44	+29	-65	+121 = +85
11	+0.00	+2.07	+1	= +101	= 0	-66	+121 = +55
12	+0.66	+1.97	+1	= +65	-57	-63	+121 = +1
13	+1.54	+1.39	+1	= +82	-132	-44	+121 = -55
14	+2.07	+0.13	+1	= -127	-177	4	+121 = -60
15	+2.07	+0.00	+1	= -22	-177	0	+121 = -56
16	+1.88	-0.87	+1	= +39	-161	+48	+121 = -12
17	+1.66	-1.25	+1	= +62	-142	+40	+121 = +19
18	+0.66	-1.97	+1	= +148	-57	-63	+121 = +127

Normal Equations

+362 - 362

Average (0-c) = 80

New (0-c)

$$+18.20 - 2.00 + 10.19 = -263 - 70$$

$$- 2.00 + 20.48 + 3.51 = -58 - 242$$

$$+10.19 + 3.51 + 9.00 = +1.04 + 245$$

$$+ 2.00 - 0.22 + 1.12 = -29 - 8$$

$$- 10.19 + 1.12 = 570 + 147 + 39$$

$$+ 20.26 + 4.63 = -87 - 250$$

$$+ 4.63 + 3.30 = +251 + 284$$

$$- 4.63 - 1.06 = +20 + 57$$

$$+ 2.24 = +271 + 341$$

$$- 6.50 - 4.63 = -352 - 398$$

$$+ 13.76 = -439 - 648$$

$$+ 5.80 + 12.00 + 5.13 = +59 + 140$$

$$- 59.45 - 20.48 - 52.50 = -606 - 1430$$

$$+ 24.00$$

$$- 61.45$$

$$- 19.22$$

$$+ 4.80$$

$$+ 15.32 = -204 + 70$$

$$- 48.99 = -664 - 1672$$

$$- 15.32 = -208 - 524$$

$$- 412 - 4540 = -912$$

+378 - 378

Average = 83

+1715 - 152

ARC 1308

Combined Solution

1913 May 6.

Normal Equations. (no. (15) full wt)

$$+ 37.81 - 0.22 - 1.47 = + 461$$

$$- 0.22 + 39.52 - 2.10 = - 756$$

$$- 1.47 - 2.10 + 18.00 = + 109$$

$$+ 0.22 - 0.00 - 0.01 = + 3$$

$$+ 1.47 - 0.11 - 0.06 = + 18$$

$$+ 39.52 - 2.11 = - 753$$

$$- 2.11 + 17.94 = + 127$$

$$+ 2.11 - 0.11 = - 40$$

$$+ 17.83 = + 87$$

$$c = + 5$$

$$- 0.25 + 2.11 = + 15$$

$$+ 39.27 = - 738$$

$$b = - 19$$

$$+ 0.15 + 0.22 - 1.49 = - 11$$

$$- 27.65 - 39.52 + 338.90 = + 2053$$

$$+ 37.96 - 3.36 = + 450$$

$$- 27.87 + 336.80 = + 1297$$

$$- 0.28 + 3.36 = + 13$$

$$+ 37.68 = + 463$$

$$a = + 12$$

Combined Solution (no. (15) given $\frac{1}{2}$ wt)

normals

$$+ 34.68 - 0.22 - 2.50 = + 792$$

$$- 0.22 + 39.52 - 2.10 = - 756$$

$$- 2.50 - 2.10 + 17.50 = + 220$$

$$c = + 14 \quad \text{wt } 17.21$$

$$b = - 18 \quad \text{wt } 39.25$$

$$a = + 24 \quad \text{wt } 34.25$$

Residuals p. 17.

Solution giving mv. 15 $\frac{1}{2}$ wt.
Normal Equations

$$+ 15.00 - 2.00 + 9.16 = +261 \quad 15.0$$

$$- 2.00 + 20.48 + 3.51 = -242$$

$$+ 9.16 + 3.51 + 8.50 = +356$$

$$+ 2.00 - 0.27 + 1.22 = +35$$

$$- 9.16 + 1.22 - 5.60 = -159$$

$$+ 20.21 + 4.73 = -207$$

$$+ 4.73 + 2.90 = +197$$

$$- 4.73 - 1.10 + 48$$

$$+ 1.80 = +245$$

$$c = +136.0$$

$$- 771 - 4.73 = -321$$

$$+ 12.50 = -528$$

$$b = -522$$

$$- 0.20 + 20.0 + 0.34 = -224$$

$$+ 0.34 - 3.51 - 0.60 = -41$$

$$+ 14.80$$

$$+ 9.50 = +237$$

$$+ 9.50$$

$$+ 7.90 = +399$$

$$- 11.42$$

$$- 9.50 = -478$$

$$+ 3.38$$

$$= -241$$

$$a = -71.4$$

	0	Residuals	C	0-C
10	-94	+ 27 - 91 + 146 = +82	+82	-126
11	+101	- 10 - 92 + 146 = +54	+54	+47
12	+65	- 53 - 88 + 146 = +5	+5	+60
13	+82	-124 - 6 + 146 = -40	-40	+122
14	-121	-167 - 6 + 146 = -27	-27	-94
15	-106	- 84 - 0 - 73 = -111	-111	-95
16	+69	-151 + 39 + 146 = +39	+39	+35
17	+104	-133 + 56 + 146 = +69	+69	+35
18	+202	- 53 + 88 + 146 = +181	+181	+21

$$a - A = +32.88$$

$$b - B = +520.5$$

$$+320 - 315$$

$$\text{av. } \Delta a = -0.15$$

$$\text{av. } \Delta b = -0.5$$

1308

Mean Position (1911.0)

$$\begin{array}{rcl}
 X & = & 17.3414 \\
 Y & = & 21.8731 \\
 \hline
 \frac{1}{2}a & = & \frac{+12}{17.3426} \\
 \frac{1}{2}b & = & \frac{-9}{21.8722}
 \end{array}$$

From Preliminary Elements

$$\begin{array}{rcl}
 X & = & 19.0599 \\
 Y & = & 22.6882 \\
 \text{Plate constant} & & \\
 \begin{array}{rcl}
 a_1 & = & +4 \\
 b_1 & = & +4 \\
 c & = & -6
 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 & & 19.0601 \\
 & & 22.6883
 \end{array}$$

$$\begin{array}{rcl}
 z & = & +1.0601 \\
 \log \beta & = & 0.02585 \\
 \log \delta & = & 9.99918 \\
 \log \eta & = & 8.50724 \\
 (A-A) & = & 151893
 \end{array}$$

$$\eta = +0.6883$$

$$\begin{array}{rcl}
 \log \tan \delta & = & 8.7429 \\
 \log \eta & = & 0.0505 \\
 \log \eta_1 & = & 5.8468 \\
 \eta_1 & = & +1
 \end{array}$$

$$(d-A) = +33.03$$

$$\eta_0 = +0.6882$$

$$A = 0.5325$$

$$\begin{array}{rcl}
 \log \eta_0 & = & 9.83771 \\
 \log \eta_1 & = & 7.33110
 \end{array}$$

$$a_0 = 0.5358.03$$

$$(S-D) = 250656$$

$$\text{Red. aph. place} + 3.01$$

$$S-D = +521.0$$

$$d' = 0.5401.04$$

$$D = +325.45$$

$$S_0 = +331.06.0$$

$$\text{Red. traph} + 20.9$$

$$S' = +331.26.9$$

1308

Run on parallax

1913 May 13.

20

$$\begin{aligned}\alpha' &= 0^h 54^m 01.04^s \\ \theta &= 0 \quad 58 \quad 29.25^s \\ \theta - \alpha' &= +4 \quad 28.21^s \\ &= +1^{\circ} 07' 03'' 15\end{aligned}$$

$$\delta' = +3 \quad 31 \quad 26.9^s$$

$$\pi = 58' 15'' 7$$

$$\frac{1}{2}(\alpha - \alpha') = + \quad 25^s$$

$$\theta - \alpha' - \frac{1}{2}(\alpha - \alpha') = +1^{\circ} 06' 38''$$

$$\log \rho \cos \phi = 9.86913$$

$$\sin \pi = 8.22946$$

$$\sin(\theta - \alpha') = 8.29009$$

$$\cos \delta = 9.99887$$

$$\log \sin(\alpha - \alpha') = 6.38981$$

$$\alpha - \alpha' = +0' 50.6$$

$$= +3.37$$

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

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

$$\sin(\theta - \alpha') - \frac{1}{2}(\alpha - \alpha') = 9.99992$$

$$\tan \gamma = 9.95735$$

$$\gamma = +42^{\circ} 11' 28.9''$$

$$\delta' = +3 \quad 31 \quad 26.9$$

$$\gamma - \delta' = 38 \quad 40 \quad 02.0$$

$$\log \rho \sin \phi = 9.82640$$

$$\sin \pi = 8.22946$$

$$\sin(\gamma - \delta') = 9.79574$$

$$\sin \gamma = 9.82712$$

$$\log \sin(\delta - \delta') = 8.02448$$

$$\delta - \delta' = +36 \quad 22.3$$

$$\delta = +4 \quad 07 \quad 49.2$$

$$\alpha = 0 \quad 54 \quad 04.41$$

$$\text{Am Eph } \delta = +4 \quad 07 \quad 47.2$$

$$\alpha = 0 \quad 54 \quad 03.99$$

$$0 - \alpha = +2.0$$

$$0 - \alpha = +0.42$$

MC1309 Comp Stars - Measures 1913 Mar. 11 21
 Reseau reversed,
 x

y

10368 N

d

N

✓ 968890
 3.5 85

1004740
 3940

14520
 934843

75946
 1110908

16.9 9350

47

10

mg

09

34

6.5 16.9662

.9674

3.4832

.4841

2 17229

18020

3.8 1433434

1089692

9.4 3034

89

mg

93

8.4

9.2891

.2891

3.7989

.7989

3

4.7 17120

16099

22.2 1545353

774348

mg

40

8.8

10

77

15932

16520

1295050

947870

44

75

20

00

22.1665

.1663

4.7020

.7032

4

20.5 14870

16748

11.2 1332930

831009

mg

08

7.9

80

75

15550

18700

987576

1438288

70

89

63

25

11.1543

.1538

20.4317

.4325

5

23.1 17940

18370

30.5 1328180

1302929

mg

26

8.6

28

53

17630

17792

927585

1612830

85

30

10

86

30.4657

.4667

231667

.1662

MC1309 - Moon-Meaning-Residual reversed

1913 Mar 11-22

	d	v	d	x	v
1	18119	17190			
18.1	16718	854143			
20.2	2018	52			
min	11	80			
u					
y	20.1400	.1364			

2	18.0	17110	17190
	20.2	15718	853855
		22	54
		10	78
	20.1393	.1370	

3	17.0	17121	16188
	20.5	12662	1061221
		71	08
		11	67
	20.4448	.4438	

4	16.5	17740	15472
	21.0	1179682	1140020
		71	11
		30	56

5	16.0	16.4049	4056
	22.0	12482	10560
		70	1050009
		75	05
		12235	

6	16.2	16.0241	0255
	23.0	16078	17553
		7731	1588075
		1618	76
		65	33
		16.1655	.1673

MC 1309 Moon measures.

1913 Mar. 11

23

Recan reversed

	d	N
7	1039487	12620
17.0	1 9087	1242005-
23.9	10182	22

239792.9796

8/		
18.0	18650	16260
24.3	1577487	909093
	81	99
	32	58

242864.2836

9		
19.0	14475	961310
24.1	1368185	10
	89	8850

24.0790.0763 ✓

10		1498678	9732
20.0		9178	9675
23.0		14925	6162

20.0060 ✓.0066 ✓

11			
20.2		18620	18870
22.0		1006964	1740005-
		72	08
		10	60

20.1455.1465

12		
20.0	16838	18008
21.5	1266056	1216574
	57	70
	28	88

21.4176.4174

MC1309 - Moon - measures 1913 Mar 10.

24.

a

H

N

Research reversed.

a

N

16936

19010

1460820

1730890

10

26

19

90

19.76817.68714

19.0

15071

15719

20.4

1155041

920922

50

19

70

00

20.3524.3510

Tables $a = 0.0$ $e = -2.2$ $a - e = +2.2$ $b + a = 0.0$
 Obs $a = +0.4$ $e = -1.5$ $a - e = +1.9$ $b + a = +0.3$

MC1309 Preliminary Reduction.

1915 Mar. 25

25

x	3.4836	3.7989	4.7026	20.4321	23.1664
3	5.0943	5.4198	6.3050	22.0497	24.7572
x-3	-1.6107	-1.6209	-1.6024	-1.6176	-1.5908
y	16.9668	9.2891	22.1664	11.1540	30.4662
y	17.9441	10.2660	23.1463	12.1533	31.4724
y-3	-9.7773	-9.769	-9.799	-9.993	-1.0062

$$x-3 \quad -1.44 \quad +1.6337$$

$$-1.6107 - 238 = -1.6345 = -8$$

$$-1.6209 - 130 = -1.6339 = -2$$

$$-1.6024 - 310 = -1.6334 = +3$$

$$-1.6176 - 156 = -1.6332 = +5$$

$$-1.5908 - 427 = -1.6335 = +2$$

$$\text{moon } 18.0861 - 311 = 19.6887$$

$$y-y \quad +1.44 \quad +4 \quad +97.06$$

$$-9773 + 49 = -9724 + 17 = -9707 = -1$$

$$-9769 + 53 = -9716 + 9 = -9707 = -1$$

$$-9799 + 66 = -9733 + 22 = -9711 = -5$$

$$-9993 + 286 = -9707 + 11 = -9696 = +10$$

$$-1.0062 + 325 = -9737 + 30 = -9707 = -1$$

$$\text{moon } 22.2129 + 253 = 23.2103$$

Times etc.

2p. to star 1911 Oct 7 1^h 07^m - 1^h 19^m

moon 1 12 46.6 - 1 12 46.9

clock slow 0 41.6

H. Sid T. 1 13 28.35

H. Long 4 44 31.05

G. Sid T. 5 57 59.40

Sid T. m. moon 13 00 03.64

Interval 16 57 55.76

Reduction 2 46.76

G. m. T. 16 55 09.00

from hant. Alm.

moon 17^h 0^h 54^m 44.42 + 4 13 06.1

moon in 1^m = 2.0427 16.108

.. = 4.85 - 9.91 - 1 18.1

Tabular place 0 54 34.51 + 4 11 48.0

Moon's parallax 58' 19"

Semidiameter 15' 55.6"

moon is 0^h 44^m past full

Approximate Center.

$$x = 18.0 \quad y = 20.1382$$

$$\begin{array}{r} 24.2850 \\ 44.4232 \end{array}$$

$$\text{Mean } y = 22.2116$$

$$x = 17.0 \quad y = 20.4443$$

$$\begin{array}{r} 23.9794 \\ 44.4237 \\ 22.2118 \end{array}$$

$$x = 19.0 \quad y = 24.0776$$

$$\begin{array}{r} 20.3517 \\ 44.4293 \end{array}$$

$$\text{Mean } y = 22.2146$$

$$y = 21.0 \quad x = 16.4052$$

$$\begin{array}{r} 19.7684 \\ 36.1736 \end{array}$$

$$\text{Mean } x = 18.0868$$

$$y = 22.0 \quad x = 16.0248$$

$$\begin{array}{r} 20.1460 \\ 36.1708 \\ 18.0854 \end{array}$$

$$y = 23.0 \quad x = 16.1664$$

$$\begin{array}{r} 20.0063 \\ 36.1727 \end{array}$$

$$\text{Mean } x = 18.0864$$

$$\text{Assumed Center } \begin{cases} x_0 = 18.0862 \\ y_0 = 22.2125 \end{cases}$$

Corrections for phase

	x	y	$x x$	$y y$	$(x x + y y)$	$295(x x + y y)$
1	0	-2.07	0.00	+3.88	+3.88	+44
2	-0.09	-2.07	-0.08	+3.88	+3.80	+43
3	-1.09	-1.77	-0.94	+3.32	+2.38	+17
4	-1.68	-1.21	-1.46	+2.27	+0.81	+2
10	+1.92	+0.79	+1.67	-1.48	+0.19	+0
11	+2.06	-0.21	+1.79	+0.39	+2.18	+14
12	+1.91	-0.80	+1.66	+1.50	+3.16	+30
13	+1.68	-1.21	+1.46	+2.27	+3.73	+41
14	+0.91	-1.86	+0.79	+3.48	+4.27	+54

$$\begin{cases} x = +52' = +0.87 \\ y = -1.525 = -1.875 \end{cases}$$

MC1309		Moon's Center		1913 Apr 21		26	
x		$x - X_0$	$(x - X_0)^2$	$(x - X_0)^2 (y - Y_0)^2$	$o - c$	corr.	
1	18.0862	0.0000	0.0000	4.3044	+22	+44	
2	18.0000	-0.0862	0.0074	4.3118	+96	+43	
3	17.0000	-1.0862	1.1798	4.3074	+52	+17	
4	16.4052	-1.6810	2.8258	4.2964	-58	+2	
5	16.0248	-2.0614	4.2493	4.2943	-79		
6	16.1664	-1.9198	3.6856	4.3059	+37		
7	17.0000	-1.0862	1.1798	4.3028	+6		
8	18.0000	-0.0862	0.0074	4.3043	+21		
9	19.0000	+0.9138	0.8350	4.3147	+125		
10	20.0063	+1.9201	3.6868	4.3071	+49	0	
11	20.1460	+2.0598	4.2428	4.2878	-144	+14	
12	20.0000	+1.9138	3.6626	4.2948	-74	+30	
13	19.7684	+1.6822	2.8298	4.3004	-18	+41	
14	19.0000	+0.9138	0.8350	4.2987	-35	+54	
mean				4.3022			

y	$y - Y_0$	Δy	$(y - Y_0)^2$	$o - c$
-1 20.1382	-2.0743	-4	4.3044	1 +47
2 20.1382	-2.0743	-4	4.3044	2 +120
3 20.4443	-1.7682	-3	3.1276	3 +49
4 21.0000	-1.2125	-2	1.4706	4 -76
5 22.0000	-0.2125	-0	0.0450	5 -98
6 23.0000	+0.7875	+1	0.6203	6 +19
7 23.9794	+1.7669	+3	3.1230	7 -10
8 24.2850	+2.0725	+4	4.2969	8 +6
9 24.0776	+1.8651	+3	3.4797	9 +111
10 23.0000	+0.7875	+1	0.6203	10 +35
11 22.0000	-0.2125	-0	0.0450	11 -145
12 21.4175	-0.7950	-1	0.6322	12 -60
13 21.0000	-1.2125	-2	1.4706	13 +7
14 20.3517	-1.8608	-3	3.4637	14 +1

+395-389

Average = 56

$$\begin{array}{r} X_1 = 18.0862 \\ + 0.0026 \\ \hline 18.0898 \end{array}$$

$$\begin{array}{r} Y_0 = 22.2125 \\ - 0.0000 \\ \hline \end{array}$$

$$\text{Plate constant } \lambda = 1.6924 \quad \mu = 23.2108$$

$$z = +1.6924$$

$$\eta = +1.2108$$

$$\begin{array}{r} \log z = 0.22850 \\ 9.99915 \\ \hline 5.50724 \\ 1.72211 \end{array}$$

$$\begin{array}{r} \eta_1 = +1 \\ \eta_0 = +1.2107 \end{array}$$

$$\begin{array}{r} \log \eta_0 = 0.08304 \\ 7.33115 \\ \hline 2.75189 \end{array}$$

$$X-H = +52.74$$

$$S-D = +924.8$$

$$\text{amt } \Delta d = +0.12$$

$$\text{Corr } \Delta S = +0.1$$

MC1309 Moon Center (Preceding limb) 1913 Apr. 21. 27

	a	b	c	0		c	0-c
1	0.00	-2.07	+1	= +66	+	0 - 2 + 108 = +106	-40
2	-0.09	-2.07	+1	= +139	-	6 - 2 + 108 = +100	+39
3	-1.09	-1.77	+1	= +69	-	79 - 2 + 108 = +27	+42
4	-1.68	-1.21	+1	= -56	-	121 - 1 + 108 = -14	-42
5	-2.06	-0.21	+1	= -79	-	147 - 0 + 108 = -41	-38
6	-1.92	+0.79	+1	= +37	-	139 + 1 + 108 = -30	+67
7	-1.09	+1.77	+1	= +6	-	79 + 2 + 108 = +31	-25

Normal Equations.

+148 - 145

Average (0-c) = 42

$$\begin{aligned}
 -a & & b & & c \\
 +13.13 & + & 1.15 & - & 7.92 = +93 \\
 + & 1.15 & + & 17.00 & - & 4.79 = -422 \\
 - & 7.92 & - & 4.79 & + & 7.00 = +182
 \end{aligned}$$

$$\begin{aligned}
 - & 1.15 & - & 0.10 & + & 0.69 = -8 \\
 + & 7.92 & + & 0.69 & - & 4.77 = +56
 \end{aligned}$$

$$+ 16.90 - 4.10 = -430$$

$$- 4.10 + 2.23 = +238$$

$$+ 4.10 - 1.00 = -105$$

$$+ 1.23 = +133$$

$$c = +108$$

$$- 7.55 + 4.10 = +438$$

$$+ 9.35 = +8$$

$$b = +1-$$

$$- 1.90 - 1.15 + 1.68 = +44$$

$$- 28.15 - 17.00 + 24.88 = +646$$

$$+ 11.23 - 6.24 = +137$$

$$- 27.00 + 20.09 = +224$$

$$- 8.37 + 6.24 = +69\frac{1}{2}$$

$$+ 28.6 = +206\frac{1}{2}$$

$$a = +7.2$$

$$\begin{array}{r} x = 18.0862 \\ \frac{1}{x} = \frac{-18}{18.0844} \end{array}$$

$$\begin{array}{r} x = 222125 \\ \frac{1}{x} = \frac{+6}{222131} \end{array}$$

$$\bar{x} = +1.6870$$

$$x_0 = +1.2113$$

$$\begin{array}{r} \log x = 0.22712 \\ 999915 \\ \hline 8.50720 \\ \hline 1.72073 \end{array}$$

$$\begin{array}{r} \log x_0 = 0.08325 \\ 7.33115 \\ \hline 2.75210 \end{array}$$

$$x-A = +52.57$$

$$+9251$$

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

$$\Delta S = +0.4$$

ML 1309 Ononis Centre (Following ^{Smith} 1913 Apr. 29.

Conditional Equations

	a	b	c	0		c	0 - c		
8	- 0.09	+ 2.07	+ 1	= + 21	+ 3	+ 27	+ 55	= + 85	- 64
9	+ 0.91	+ 1.87	+ 1	= + 125	- 32	+ 24	+ 55	= + 47	+ 78
10	+ 1.92	+ 0.79	+ 1	= + 45	- 68	+ 10	+ 55	= - 3	+ 48
11	+ 2.06	- 0.21	+ 1	= - 130	- 73	- 3	+ 55	= - 21	- 109
12	+ 1.91	- 0.80	+ 1	= - 44	- 67	- 10	+ 55	= - 22	- 22
13	+ 1.68	- 1.21	+ 1	= + 23	- 59	- 16	+ 55	= - 20	+ 43
14	+ 0.91	- 1.86	+ 1	= + 19	- 32	- 24	+ 55	= - 1	+ 20

Normal Equations

$$\begin{aligned}
 +16.10 - 2.66 + 9.32 &= -98 \\
 -2.66 + 14.01 + 0.64 &= +311 \\
 +9.32 + 0.64 + 7.00 &= +59
 \end{aligned}$$

$$\begin{aligned}
 +2.66 - 0.44 + 1.54 &= -16 \\
 -9.32 + 1.54 - 5.39 &= +57
 \end{aligned}$$

$$\begin{aligned}
 +13.57 + 2.18 &= +295 \\
 +2.18 + 1.61 &= +116
 \end{aligned}$$

$$\begin{aligned}
 -2.18 - 0.35 &= -47 \\
 +1.26 &= +69
 \end{aligned}$$

$$\begin{aligned}
 -2.95 - 2.18 &= -157 \\
 +10.62 &= +138
 \end{aligned}$$

$$\begin{aligned}
 +38.70 + 2.66 + 29.10 &= +246 \\
 -204.02 - 14.01 - 153.30 &= -1292
 \end{aligned}$$

$$\begin{aligned}
 +54.40 &+ 38.42 = +148 \\
 -206.68 &- 152.66 = -981
 \end{aligned}$$

$$\begin{aligned}
 -52.00 &- 38.42 = -247 \\
 +2.80 &= -99
 \end{aligned}$$

$$\begin{aligned}
 -195 + 189 \\
 \text{Average} &= 55
 \end{aligned}$$

$$\frac{\Delta x}{\Delta z} = -1.25$$

$$\frac{\Delta y}{\Delta z} = -0.33$$

$$c = +55$$

$$b = +13$$

$$a = -35$$

161309 Combined Solution Normal Equations

1913 May 6

$$+ 29.23 - 1.51 + 1.40 = -5$$

$$- 1.51 + 31.01 - 4.15 = -1.11$$

$$+ 1.40 - 4.15 + 14.00 = +24.1$$

$$+ 1.51 - 0.08 + 0.07 = 0$$

$$- 1.40 + 0.07 - 0.07 = +0$$

$$+ 30.93 - 4.08 = -1.11$$

$$- 4.08 + 13.93 = +24.1$$

$$+ 4.08 - 0.54 = -1.5$$

$$+ 13.39 = +22.6$$

$$c = +1.7$$

$$- 1.20 + 4.08 = +7.1$$

$$+ 29.73 = -4.0$$

$$b = -1.1$$

$$- 0.51 + 1.51 - 5.10 = -8.8$$

$$+ 10.46 - 31.01 + 104.65 = +180.0$$

$$+ 28.72 = 3.70 = -9.3$$

$$+ 8.95 = 10.050 = +16.89$$

$$+ 0.23 = 3.70 = +6.2$$

$$+ 29.05 = 3.1$$

$$a = -1$$

MC1309 Moon's mean Position (1911.0)

$$X_0 = 18\ 0862$$

$$Y_0 = 22\ 21\ 25$$

$$\frac{1}{2}a = \frac{-1}{18\ 0861}$$

$$\frac{1}{2}b = \frac{-1}{22\ 21\ 24}$$

$$18\ 0861$$

$$22\ 21\ 24$$

From Preliminary Reduction $X = 19.6887$ $Y = 23.2105$

Plato Constants

ay

+7

+10

by

-3

-11

c

-2

+3

$$19.6889$$

$$23.2107$$

correction for tilt

-2

$$Z = +1.6887$$

$$\eta = +1.2107$$

$$\log Z = 0.22755$$

$$\log \tan \delta = 8.7886$$

$$\log \delta_0 = 9.99915$$

$$\dots Z^2 = 0.4551$$

$$\log \sin \delta = 8.50724$$

$$\dots \eta_1 = 6.2971$$

$$(X-A) = 1.72116$$

$$\eta_1 = +1$$

$$X-A = +52.62$$

$$\eta_0 = +1.2106$$

$$A = 0\ 53\ 25$$

$$\log \eta_0 = 0.08300$$

$$\dots \log \eta_0 = 7.33115$$

$$A_0 = 0\ 54\ 17.62$$

$$(S-D) = 275185$$

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

$$S-D' = +9\ 24.7$$

$$A' = 0^h\ 54^m\ 20.63$$

$$D = +3\ 25\ 45$$

$$\delta_0 = +3\ 35\ 09.7$$

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

$$\delta' = +3^\circ\ 35'\ 30''.6$$

Reduction to Apparent Place for series of plates (1301-1315)

$$\begin{aligned} &= 0^h 51^m 36^s \\ G &= 21 \quad 36 \quad 12 \\ G + \Delta &= 22^h 27^m 48^s \\ &= -23^\circ 03' 00'' \end{aligned}$$

$$\begin{aligned} S_0 &= +3^\circ 01' 45'' \\ H &= 4^h 55^m 42^s \\ H + \Delta &= 5^h 47^m 18^s \\ &= +86^\circ 49' 30'' \end{aligned}$$

$$\begin{aligned} \log \frac{1}{r} &= 8.8239 \\ g &= 1.1520 \\ \sin(G + \Delta) &= 9.5928 \\ \tan S_0 &= 8.7236 \\ (g) &= 829.23 \sim \end{aligned}$$

$$\begin{aligned} \log \frac{1}{r} &= 8.8239 \\ h &= 1.2758 \\ \sin(H + \Delta) &= 9.9993 \\ \sec S_0 &= 0.0006 \\ (h) &= 0.0996 \end{aligned}$$

$$\begin{aligned} \log a &= 1.1520 \\ \cos(G + \Delta) &= 9.9639 \\ (g') &= 11159 \end{aligned}$$

$$\begin{aligned} \log h &= 1.2758 \\ \cos(H + \Delta) &= 8.7434 \\ \sin S_0 &= 8.7230 \\ &= 87422 \sim \end{aligned}$$

$$\begin{aligned} \log i &= 0.8960 \\ \cos S_0 &= 9.9999 \\ (i) &= 0.8954 \end{aligned}$$

$$\begin{aligned} f &= +1.77 \\ (g) &= -0.02 \\ (h) &= +1.26 \\ \text{Red. } \Delta &= +3.01 \end{aligned}$$

$$\begin{aligned} (g') &= +13.06 \\ (h') &= -0.06 \\ (i) &= +7.9 \\ \text{Red. } S &= +2.09 \end{aligned}$$

MC1309

Lunar Parallax

1913 May 13.

$$\begin{aligned}
 \alpha' &= 0 \quad 54 \quad 40.63 \\
 \theta &= 1 \quad 13 \quad 28.35 \\
 \theta - \alpha' &= + \quad 19 \quad 07.72 \\
 &+ 4^\circ \quad 46' \quad 56''
 \end{aligned}$$

$$\delta' = + 3^\circ 35' 30''$$

$$\pi = 58' 19''$$

$$\begin{aligned}
 \frac{1}{2}(\alpha - \alpha') &= + 1 \quad 48 \\
 \alpha - \alpha' - \frac{1}{2}(\alpha - \alpha') &= + 4 \quad 45 \quad 08 \\
 \log \tan \phi' &= 9.95727 \\
 \cos \frac{1}{2}(\alpha - \alpha') &= 0.00000 \\
 \cos(\alpha - \alpha' - \frac{1}{2}(\alpha - \alpha')) &= 9.99851 \\
 \tan \gamma &= 9.95876
 \end{aligned}$$

$$\begin{aligned}
 \log \cos \phi' &= 9.86913 \\
 \sin \pi &= 8.22951 \\
 \sin(\theta - \alpha') &= 8.92100 \\
 \cos \delta &= 9.99883
 \end{aligned}$$

$$\log \sin(\alpha - \alpha') = 7.02081$$

$$\begin{aligned}
 \alpha - \alpha' &= + 3' \quad 36''4 \\
 &+ 1 \quad 45.43
 \end{aligned}$$

$$\gamma = + 42^\circ 17' 02.4$$

$$\delta' = + 3 \quad 35 \quad 30.6$$

$$\gamma - \delta' = + 38 \quad 41 \quad 31.8$$

$$\begin{aligned}
 \log \rho \sin \phi' &= 9.82640 \\
 \sin \pi &= 8.22951 \\
 \sin(\gamma - \delta') &= 9.79597 \\
 \sin \gamma &= 9.82789
 \end{aligned}$$

$$\log \sin(\delta - \delta') = 8.02399$$

$$\delta - \delta' = + 36 \quad 19.8$$

$$\delta = + 4 \quad 11 \quad 50.4$$

$$\alpha = 0 \quad 54 \quad 35.06$$

$$\text{Ann. Eph. } \delta = + 4 \quad 11 \quad 48.0$$

$$\alpha = 0 \quad 54 \quad 34.51$$

$$O - C = + 2.4$$

$$O - C = + 0.55$$

Parallax Formulae.

$$\sin(\alpha - \alpha') = \frac{\rho \sin \pi \cos \phi' \sin t'}{\cos \delta}$$

$$\tan \gamma = \frac{\tan \phi' \cos \frac{1}{2}(\alpha - \alpha')}{\cos[t' - \frac{1}{2}(\alpha - \alpha')]}$$

$$\sin(\delta - \delta') = \frac{\rho \sin \pi \sin \phi' \sin(\gamma - \delta')}{\sin \gamma}$$

$$\begin{aligned}
 735.68 - 0.22 - 2.50 &= +681 \\
 -0.22 + 39.52 - 2.10 &= -756 \\
 -2.50 - 2.10 + 17.50 &= +220
 \end{aligned}$$

$$\begin{aligned}
 +0.22 - 0.60 - 0.02 &= +4 \\
 +2.50 - 0.02 - 0.175 &= +48
 \end{aligned}$$

$$\begin{aligned}
 +39.52 - 2.12 &= -752 \\
 -2.12 + 17.32 &= +268
 \end{aligned}$$

$$\begin{aligned}
 +2.12 - 0.112 &= 405 \\
 +17.21 &= +228
 \end{aligned}$$

$$\begin{aligned}
 -0.26 + 2.12 &= +33 \\
 +39.26 &= -719
 \end{aligned}$$

$$\begin{aligned}
 +0.26 + 0.22 - 1.83 &= -23 \\
 -40.76 - 39.52 + 329.20 &= +4142
 \end{aligned}$$

$$\begin{aligned}
 +3594 &= -4330 + 658 \\
 -40.92 &= +327.10 = +3386
 \end{aligned}$$

$$\begin{aligned}
 -0.54 &= +438 = +445 \\
 +35.40 &= +703
 \end{aligned}$$

$$c = +13$$

$$b = -18$$

$$a = +20$$

$$\begin{aligned}
 1 & 0 + 38 + 13 + 51 + 13 \\
 2 & -7 + 37 + 13 + 43 + 1 \\
 3 & -18 + 34 + 13 + 29 + 18 \\
 4 & -27 + 29 + 13 + 15 + 100 \\
 5 & -37 + 16 + 13 - 8 - 171 \\
 6 & -41 + 0 + 13 - 28 - 8 \\
 7 & -41 - 23 + 13 - 51 - 10 \\
 8 & -35 - 20 + 13 - 42 - 37 \\
 9 & -27 - 29 + 13 - 43 - 8 \\
 10 & -7 - 37 + 13 - 31 - 13 \\
 11 & -0 - 38 + 13 - 25 + 126 \\
 12 & +13 - 36 + 13 - 10 + 75 \\
 13 & +35 - 25 + 13 + 23 + 59 \\
 14 & +41 - 23 + 13 + 31 - 152 \\
 15 & +21 - 0 + 6 - 27 - 133 \\
 16 & +37 + 16 + 13 + 66 + 3 \\
 17 & +33 + 23 + 13 + 69 + 33 \\
 18 & +13 + 36 + 13 + 62 + 140
 \end{aligned}$$

$$+510$$

$$-531$$

$$+101$$

$$R - S = +0.5$$

$$R - S = +0.7$$

$$R - S = +0.3$$

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$$R - S = +0.3$$

$$R - S = +0.5$$

$$R - S = +0.7$$

$$R = 96.7$$

$$R = 96.8$$

$$R = 96.9$$

$$R = 97.0$$

$$R = 97.1$$

$$R = 97.2$$

$$R = 97.3$$

$$R = 97.4$$

$$R = 97.5$$

$$R = 97.6$$

$$R = 97.7$$

$$R = 97.8$$

$$R = 97.9$$

$$R = 98.0$$

$$R = 98.1$$

$$R = 98.2$$

$$R = 98.3$$

$$R = 98.4$$

$$R = 98.5$$

$$R = 98.6$$

$$R = 98.7$$

$$R = 98.8$$

$$R = 98.9$$

$$R = 99.0$$

$$R = 99.1$$

$$R = 99.2$$

$$R = 99.3$$

Book

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