

KG
11365
426

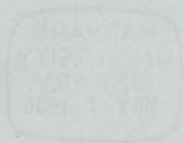
*Miscellaneous Tables
Formulae for
Zone Reductions*

Charles W. Sever, University Bookstore, Cambridge.

NG 11365.426

M21

This contains computations
relating to the Meridian Circle Stone work



KG 11365.426



$$\begin{aligned}\log n'' &= 1.30224 \\ \log 60 &= 1.77815 \\ \log n &= 9.52409\end{aligned}$$

$$\begin{aligned}\log \tan 52^\circ 30' &= 0.11502 \\ \log 17 &= 1.23045 \\ \log n &= 1.34547 \\ &= 1.30224 \\ &= 2.64571\end{aligned}$$

$$\begin{aligned}M &= 46.0825 = 30722 \\ \log m &= 0.48745 \\ \log 17 &= 1.23045 \\ \log 60 &= 1.77815 \\ b &= 52.23\end{aligned}$$

Tobular pressure in a and S for $\theta = 52^\circ 30'$

AR	AR	sin a	log m	No.	da	dS	AR	da	dS	cora
0 0	0 0	0	0	0.00	+0.522	+5.68	13 0	+4.46	-5.50	9.52409 10.0000
3 45	15	381560	9.28722	0.194	5.12	5.19	15	42.8	5.38	0.85495
7 30	30	9.11570	5.8732	0.884	5.61	5.59	30	40.9	5.26	
11 15	45	2.9029	7.6186	5.88	5.80	5.74	45	38.3	5.09	
	0	41300	8.8462	17.66	5.99	+5.50	14 0	37.6	-4.42	9.50894 2.98499
	15			1.1.6	5.38		15	36.0	4.71	0.73339
	30	58284	0.5466	11.34	5.26		30	34.3	4.69	
	45				5.09		45	32.8	4.26	
30 2	0	67897	1.7059	14.61	6.8	+4.92	15 0	31.3	-4.02	0.46153 9.3782
	15				8.6	+4.71	15	30.0	3.79	0.69198
	30				10.2	4.49	30	28.8	3.45	
45 3	0	84949	4.4420	20.90	13.2	+4.26	45	27.7	3.15	3.7349 8.9730
	15		3.2111		14.6	+3.74	16 0	26.6	-2.84	6.0494
	30				15.9	3.45	15	25.7	2.71	
	45				16.9	3.15	30	24.9	2.17	
60 4	0	9.3753	5.8524	25.65	17.9	+2.84	45	24.3	1.81	
	15		4.0915		18.8	+2.51	17 0	23.6	-1.47	2.2229 6.9897
	30				19.5	2.17	15	23.2	1.10	4.5342
	45				20.2	1.81	30	22.8	0.74	
75 5	0	9.98499	6.3265	28.61	20.8	+1.47	45	22.6	-0.37	9.3800 8.41300
	15		4.5656		21.2	1.10	18 0	22.7	0.37	1.6945
	30				21.3	+0.74	15	22.7	+0.74	8.63940 9.11570
	45				21.7	0.37	30	22.8	1.10	7.87015
90 6	0	10.000	6.4771	29.62	21.8	+0.00	45	23.6	+1.47	2 0.0
	15		4.7162		21.7	37	19 0	24.3	1.81	
	30				21.5	-0.74	15	24.8	2.17	
	45				21.2	1.10	30	24.7	2.51	
105 7	0	9.98499	6.3265	28.61	20.8	-1.47	45	24.6	+2.84	
	15				20.2	1.81	20 0	26.6	2.15	
	30				19.5	2.17	15	27.7	2.45	
	45				18.8	2.51	30	28.8	2.79	
120 8	0	9.3753	5.8524	25.65	17.9	-2.84	45	29.8	+4.02	
	15				16.9	3.15	15	30.8	4.26	
	30				15.9	3.45	30	34.3	4.49	
	45				14.6	3.74	45	36.0	4.71	
135 9	0	84949	4.4420	20.95	13.2	-4.26	22 0	37.1	+4.92	
	15				11.8	4.49	15	38.3	5.09	
	30				10.2	4.71	30	40.9	5.26	
	45				8.6	4.92	45	42.8	5.38	
150 10	0	67897	3.4468	14.61	6.8	-4.92	23 0	44.6	+5.50	
	15				5.2	5.09	15	46.9	5.59	
	30	58284	2.3055	11.34	3.6	5.26	30	48.4	5.74	
	45				1.6	5.38	45	50.3	5.88	
165 11	0	41300	0.4071	7.66	5.99	-5.50	24 0	52.2	+5.68	
	15				5.78	5.59				
	30				3.88	5.61				
	45	8.81560	1.46331	1.94	5.47	5.69				
180 12	0	8.8460	0.00	0.00	5.22	-5.68				
	15				5.22	5.69				
	30				50.3	5.59				
	45				48.4	5.54				
13 0					46.4	5.50				
					44.6	5.46				

Solar reduction to the horizontal wire.

Side argument = distance in time from the observed intersection with the horizontal wire to the middle wire = $T_m - T_s$

Angle of inclination adopted Nov 8 1870 = $28^{\circ} 15' 14''$ sin = 8.59470

Arg.	R''	Arg.	$\log_{10} 50 \text{ R}''$	Rp 52°	$\log_{10} 10$
1	.0379	1	.3792	.080	.3632
2	.076	2	.758	.016	.726
3	.113	3	1.138	.024	1.080
4	.151	4	1.517	.032	1.453
5	.189	5	1.896	.040	1.816
6	.226	6	2.276	.048	2.179
7	.264	7	2.654	.056	2.542
8	.302	8	3.034	.064	2.906
9	.340	9	3.413	.072	3.269
10		10	3.792	.080	3.632
11		11	4.171	.088	3.995
12		12	4.550	.096	4.358
13		13	4.930	.104	4.722
14		14	5.309	.112	5.085
15		15	5.688	.120	5.448
16		16	6.067	.128	5.811
17		17	6.446	.136	6.174
18		18	6.826	.144	6.538
19		19	7.205	.152	6.901
20		20	7.584	.160	7.264
21		21	7.963	.168	7.627
22		22	8.342	.176	7.990
23		23	8.722	.184	8.354
24		24	9.101	.192	8.717
25		25	9.480	.200	9.080
26		26	9.859	.208	9.443
27		27	10.238	.216	9.806
28		28	10.618	.224	10.170
29		29	10.997	.232	10.533
30		30	11.376	.240	10.896
31		31	11.755	.248	11.259
32		32	12.134	.256	11.622
33		33	12.514	.264	11.986
34		34	12.893	.272	12.349
35		35	13.272	.280	12.712
36		36	13.651	.288	13.075
37		37	14.031	.296	13.438
38		38	14.410	.304	13.802
39		39	14.789	.312	14.165
40		40	15.168	.320	14.528
41		41	15.547	.328	14.891
42		42	15.926	.336	15.254
43		43	16.306	.344	15.618
44		44	16.685	.352	15.981
45		45	17.064	.360	16.344
46		46	17.443	.368	16.707
47		47	17.822	.376	17.070
48		48	18.202	.384	17.434
49		49	18.581	.392	17.797
50		50	18.960	.400	18.160

Since the computation of the above tables I have ascertained that the value of one revolution of the collimation screw is twice that of the declination micrometer screw, I had assumed them to be the same. The angle of inclination therefore is $4^{\circ} 30' 28''$ and all the values of the tables are to be doubled.

Yobular tang S and sec S from 50° to 51°

S = 50°	0'	tang S	sec S
	15	1.109	1.55
	30	20	56
	45	21	54
51	00	22	58
		23	59

Products of the natural numbers from 1 to 40 and tang S

1.19 Product 1.20 Product 1.21 Product 1.22 Product 1.23 Product

.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.12
.13
.14
.15
.16
.17
.18
.19
.20
.21
.22
.23
.24
.25
.26
.27
.28
.29
.30
.31
.32
.33
.34
.35
.36
.37
.38
.39
.40

Formulas for the reduction of the Meridian Circle zone observations.

Let D = any assumed declination

T = $\text{clock error} + m$ for any given instant.

i = $n \tan D + c \sec D$

$4i$ = the change of i for 100' change in D

ϵ = $(A - 5)^{\text{sec}}$ for 1870, $(A - 4)^{\text{sec}}$ for 1871, $(A - 3)^{\text{sec}}$ for 1872 &c

$\log l' = A_2' (\log B + \log T) + h \log \gamma$

l = the l' of Bessel

J = the index error of the circle

R = the reduction to the horizontal wire = $(T_m - T)^{\text{sec}} \cdot 15 \sin 2' \cos D$

R' = the reduction to the meridian = $T \cos D \sin D$ (where $T = \frac{2 \sin \frac{1}{2}(T_m - T)}{\sin 1''}$)

E = the division error of the circle.

$s = \tan D : 15$

$s' = 8.4637 \sec^2 D : 15$

$T = \sec D : 15$

$T' = 8' \sin D$

$u = \cos D \tan a$

$u' = -8.4637 \tan a \sin D$

$v = \sin D$

$v' = 8.4637 \cos D$

$Q = l \tan(\phi - D)$

$dQ = 8.4637 \sec^2(\phi - D) + dl \tan(\phi - D)$

(= $-l \tan(\phi - D)$ for 4th quadrant)

(= $-8.4637 \sec^2(\phi - D)$ for 4th quadrant)

Then for the invariable quantities k and d

$$K = \pi + i - \epsilon - g \sin(l+a) - h T \sin(N+a)$$

$$d = -l'Q \pm J + E - bu - g \cos(l+a) - h v \cos(N+a)$$

and for the variations of these quantities, where $g \sin l = B$
 $g \cos l = 20.6545(l-s)$

$$K' = 4i - g s' \sin(l+a) - h T' \sin(N+a)$$

$$d' = -l' dQ - bu' - h v' \cos(N+a)$$

Then

$$a' = T' + k + \frac{(T - D)}{100} k' \quad (T \text{ being the observed time and } D \text{ the observed } D)$$

$$D' = D + d + \frac{(T - D)}{100} d'$$

where $(D) = \phi - (\text{Pointer} + \text{mean of microscopes} + \text{red. prisms} \pm R + R')$

(The quantity l is a function of the true zenith distance)

R is positive when the transit over the inclined wire occurs after the transit over the middle wire and negative when before

Catalogue of new stars.

Star	1875	$\frac{d\alpha}{dt} + u$	$\frac{d\delta}{dt} + v$	1870	1875	$\frac{d\alpha}{dt} + u$	$\frac{d\delta}{dt} + v$	1870
20 Cephei								
3 Cephei								
3 Lacertae								
1 Cephei								
1 Lacertae								
30 Cephei								
13 Lacertae								
o Androm.								
Br. 3077								
4 Cass								
i Androm								
x Androm								
q Cass								
3 Cass								
22 Andr.								
x Cass.								
3 Cass								
ar Cass								
o Cass.								
n Cass								
Br. 82								
7 Cass								
1 Cass								
2 Persei								
q Persei								
2 Cass								
7 Andr.								
6 Persei								
8 Persei								
1 Persei								
7 Persei								
7 Persei								
8 Persei								
i Persei								
a Persei								
2 Helix								

$$\log \frac{V^2}{2} \sin^2 i =$$

$$\log \frac{V^2}{2} \sin^2 i = 6.73672 \log 1952 = .07148$$

constants for new stars.

Star.	Right Ascension	Declination	Parallax	Proper Motion	Radial Velocity	Distance	Mass	Age	Notes
20 Cephei	22 17 5	62 8 56	1.89	-19 46 9"	9.5556	33050	16.57	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
3 Cephei	22 6 21	57 33 39	1.70	17 10 50	9.4902	27051	16.17	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
3 Lacertae	22 18 27	51 34 42	1.26	9 11 53	9.2093	20660	13.96	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
5 Cephei	22 29 21	54 45 01	1.58	15 22 12	9.4392	27277	16.26	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
7 Lacertae	22 25 56	49 36 53	1.18	7 14 04	9.1037	18848	13.39	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
30 Cephei	22 34 3	62 54 32	1.95	-20 31 43	9.5734	34161	19.05	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
13 Lacertae	22 35 18	41 8 15	.87	+1 46 26	8.3360	12313	11.52	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
0 Androm.	22 55 57	41 37 59	.89	+0 45 10	8.1186	12640	11.61	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
B 3077	23 7 2	56 27 3	1.51	-14 04 14	9.3990	25755	15.70	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
4 Cass.	23 19 4	61 34 9	1.85	-19 11 20	9.5416	32231	18.22	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
Androm.	23 31 12	45 45 10	.92	-0 10 06	7.4680	13272	11.77	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
Androm.	23 31 46	42 32 55	.92	-0 10 06	7.4680	13272	11.77	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
x Androm.	23 34 1	43 36 52	.95	-1 14 03	8.3333	14026	11.98	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
q Cass.	23 47 54	56 46 34	1.68	-14 23 45	9.4093	26130	15.83	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
B Cass.	0 2 15	58 25 57	1.63	-16 03 08	9.4590	28009	16.57	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
22 Androm.	0 3 34	45 20 55	.99	-2 58 06	8.7142	15317	12.35	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
x Cass.	0 25 37	62 12 50	1.90	-19 49 01	9.5567	33145	18.61	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
3 Cass.	0 29 44	58 10 57	1.34	-10 48 02	9.2805	22236	14.48	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
a Cass.	0 33 9	58 49 26	1.47	-13 26 37	9.3485	125047	15.44	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
o Cass.	0 37 29	47 32 30	1.09	-5 10 41	8.9572	17080	12.85	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Cass.	0 41 25	57 43 1	1.55	-14 44 42	9.4202	26535	15.98	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
B 82	0 42 52	63 32 20	2.01	-21 09 31	9.5878	35116	19.47	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
2 Cass.	0 48 53	60 0 43	1.67	-17 37 54	9.5022	30118	17.36	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Cass.	1 17 20	59 33 31	1.70	-17 10 42	9.4901	29528	17.12	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Persei	1 30 1	47 58 7	1.11	-5 35 18	8.9906	17423	12.96	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
q Persei	1 35 32	50 01 57	1.19	-7 39 8	9.1281	19223	13.51	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Cass.	45 4	63 01 42	1.96	-20 38 53	9.5762	34338	19.13	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
2 Andr.	55 56	41 41 16	.89	+0 41 33	8.0815	12681	11.62	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
6 Persei	2 4 58	50 27 36	1.21	-8 4 47	9.1524	19613	13.63	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Persei	35 20	48 40 35	1.14	-6 17 46	9.0430	15025	13.14	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Persei	41 14	55 21 14	1.45	-12 58 25	9.3622	24526	15.26	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
2 Persei	45 5	52 13 41	1.29	-9 50 52	9.2396	21284	14.16	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
7 Persei	55 24	52 59 41	1.33	-10 36 52	9.2729	22048	14.41	0.93827	log 1952 = 5.38454, log 1952 = 5.38454
h Persei	59 43	40 27 9	.85	+1 55 40	8.5265	11807	11.40	0.93827	log 1952 = 5.38454, log 1952 = 5.38454

Sobular reduction to the meridian

Let $P = -28.21 / (T_m - T_n)$

Then $R' = P \sin \delta \cos \epsilon$

$T_m - T_n$

by P

R'

$\epsilon = 50^\circ$ $\epsilon = 51^\circ$ $\epsilon = 52^\circ$ $\epsilon = 53^\circ$ $\epsilon = 54^\circ$

05

by P

R'

1

by P

R'

2

by P

R'

3

by P

R'

4

by P

R'

5

by P

R'

6

by P

R'

7

by P

R'

8

by P

R'

9

by P

R'

10

by P

R'

11

by P

R'

12

by P

R'

13

by P

R'

14

by P

R'

15

by P

R'

16

by P

R'

17

by P

R'

18

by P

R'

19

by P

R'

20

by P

R'

21

by P

R'

22

by P

R'

23

by P

R'

24

by P

R'

25

by P

R'

26

by P

R'

27

by P

R'

28

by P

R'

29

by P

R'

30

by P

R'

31

by P

R'

32

by P

R'

33

by P

R'

34

by P

R'

35

by P

R'

Values of R' for $40^\circ - 60^\circ$ and $\epsilon = 35^\circ$

δ	R'
40°	-330
45°	-334
50°	-330
55°	-315
60°	-290

Values of R' for 40° to 60° ϵ being $= 20^\circ$

δ	R'
40°	-107
45°	-109
50°	-107
55°	-103
60°	-094

Wine intervals for Odavis. Adopted for Nov. 13 1870 to Dec 18

$T_m - T_{\text{air}} = 0.00$ 0.00 " Dec 18 1870 to
 $T_m - T_c$ -4.95 4.962
 $T_m - T_f$ 4.42 4.426
 $T_m - T_g$ 4.40 4.877
 $T_m - T_n$ 12.40 12.411
 34.70 34.676
 6.940 by 84136
 6.675 6.935 84105

δ	log. ec.	i	δ	log. ec.	i
49° 50'	18040	-10.759	50° 26'	-10.895	10.887
51		762	27	899	891
52		765	28	903	895
53		769	29	907	899
54		773	30	19649	10.911
55		777	31	915	907
56		780	32	919	911
57		783	33	923	915
58		787	34	926	918
59		791	35	930	922
50 0	19193	10.796	36	934	926
50 1		800	37	938	930
2		804	38	942	934
3		808	39	945	937
4		811	40	19503	10.949
5		815	41	952	944
6		819	42	956	948
7		823	43	960	952
8		826	44	964	956
9		830	45	968	960
10	19344	10.834	46	972	964
11		838	47	976	968
12		842	48	980	972
13		846	49	984	976
14		850	50	19957	10.988
15		853	51	992	984
16		857	52	996	988
17		861	53	10.999	991
18		864	54	11.004	10.996
19		868	55	11.008	11.000
20	19496	10.872	56	012	004
21		876	57	016	008
22		880	58	020	012
23		883	59	024	016
24		887	50 0	20113	11.028
25		891	1		024
			2		028
			3		032
			4		036

The wine intervals for Nov. 10 1870 are as follows:

$T_m - T_{\text{air}} = 0.00$
 $T_m - T_c$ 4.81
 $T_m - T_f$ 4.22
 $T_m - T_g$ 4.72
 $T_m - T_n$ 12.26
 34.01
 6.802 by 83264

Nov 11 1870 the wines were disturbed by Mr. Belant's in trying to get a better illumination the above table can be used for Nov. 10 by adding $+0.22^{\circ}$

	$\delta = +10^\circ$ -10°	$\delta = +20^\circ$ -20°	$\delta = +30^\circ$ -30°	$\delta = +40^\circ$ -40°	$\delta = +50^\circ$ -50°	$\delta = +60^\circ$ -60°	
	Recessions from 0 to 24 with δ varying from -30° to $+60^\circ$						
0	3.07 +3	3.07 +3	3.07 +3	3.07	3.07 +3	3.07 +3	24
10	07	09	11	12	14	17	57
20	09	11	13	15	17	20	58
30	10	12	14	16	18	21	59
40	11	13	15	17	19	22	60
50	12	14	16	18	20	23	61
1	13	15	17	19	21	24	62
20	14	16	18	20	22	25	63
30	15	17	19	21	23	26	64
40	16	18	20	22	24	27	65
50	17	19	21	23	25	28	66
2	18	20	22	24	26	29	67
10	19	21	23	25	27	30	68
20	20	22	24	26	28	31	69
30	21	23	25	27	29	32	70
40	22	24	26	28	30	33	71
50	23	25	27	29	31	34	72
3	24	26	28	30	32	35	73
10	25	27	29	31	33	36	74
20	26	28	30	32	34	37	75
30	27	29	31	33	35	38	76
40	28	30	32	34	36	39	77
50	29	31	33	35	37	40	78
4	30	32	34	36	38	41	79
10	31	33	35	37	39	42	80
20	32	34	36	38	40	43	81
30	33	35	37	39	41	44	82
40	34	36	38	40	42	45	83
50	35	37	39	41	43	46	84
5	36	38	40	42	44	47	85
10	37	39	41	43	45	48	86
20	38	40	42	44	46	49	87
30	39	41	43	45	47	50	88
40	40	42	44	46	48	51	89
50	41	43	45	47	49	52	90
6	42	44	46	48	50	53	91
10	43	45	47	49	51	54	92
20	44	46	48	50	52	55	93
30	45	47	49	51	53	56	94
40	46	48	50	52	54	57	95
50	47	49	51	53	55	58	96
7	48	50	52	54	56	59	97
10	49	51	53	55	57	60	98
20	50	52	54	56	58	61	99
30	51	53	55	57	59	62	100
40	52	54	56	58	60	63	101
50	53	55	57	59	61	64	102
8	54	56	58	60	62	65	103
10	55	57	59	61	63	66	104
20	56	58	60	62	64	67	105
30	57	59	61	63	65	68	106
40	58	60	62	64	66	69	107
50	59	61	63	65	67	70	108
9	60	62	64	66	68	71	109
10	61	63	65	67	69	72	110
20	62	64	66	68	70	73	111
30	63	65	67	69	71	74	112
40	64	66	68	70	72	75	113
50	65	67	69	71	73	76	114
10	66	68	70	72	74	77	115
20	67	69	71	73	75	78	116
30	68	70	72	74	76	79	117
40	69	71	73	75	77	80	118
50	70	72	74	76	78	81	119
11	71	73	75	77	79	82	120
20	72	74	76	78	80	83	121
30	73	75	77	79	81	84	122
40	74	76	78	80	82	85	123
50	75	77	79	81	83	86	124
12	76	78	80	82	84	87	125
20	77	79	81	83	85	88	126
30	78	80	82	84	86	89	127
40	79	81	83	85	87	90	128
50	80	82	84	86	88	91	129
12	81	83	85	87	89	92	130
20	82	84	86	88	90	93	131
30	83	85	87	89	91	94	132
40	84	86	88	90	92	95	133
50	85	87	89	91	93	96	134
13	86	88	90	92	94	97	135
20	87	89	91	93	95	98	136
30	88	90	92	94	96	99	137
40	89	91	93	95	97	100	138
50	90	92	94	96	98	101	139
14	91	93	95	97	99	102	140
20	92	94	96	98	100	103	141
30	93	95	97	99	101	104	142
40	94	96	98	100	102	105	143
50	95	97	99	101	103	106	144
15	96	98	100	102	104	107	145
20	97	99	101	103	105	108	146
30	98	100	102	104	106	109	147
40	99	101	103	105	107	110	148
50	100	102	104	106	108	111	149
16	101	103	105	107	109	112	150
20	102	104	106	108	110	113	151
30	103	105	107	109	111	114	152
40	104	106	108	110	112	115	153
50	105	107	109	111	113	116	154
17	106	108	110	112	114	117	155
20	107	109	111	113	115	118	156
30	108	110	112	114	116	119	157
40	109	111	113	115	117	120	158
50	110	112	114	116	118	121	159
18	111	113	115	117	119	122	160
20	112	114	116	118	120	123	161
30	113	115	117	119	121	124	162
40	114	116	118	120	122	125	163
50	115	117	119	121	123	126	164
19	116	118	120	122	124	127	165
20	117	119	121	123	125	128	166
30	118	120	122	124	126	129	167
40	119	121	123	125	127	130	168
50	120	122	124	126	128	131	169
20	121	123	125	127	129	132	170
30	122	124	126	128	130	133	171
40	123	125	127	129	131	134	172
50	124	126	128	130	132	135	173
21	125	127	129	131	133	136	174
20	126	128	130	132	134	137	175
30	127	129	131	133	135	138	176
40	128	130	132	134	136	139	177
50	129	131	133	135	137	140	178
22	130	132	134	136	138	141	179
20	131	133	135	137	139	142	180
30	132	134	136	138	140	143	181
40	133	135	137	139	141	144	182
50	134	136	138	140	142	145	183
23	135	137	139	141	143	146	184
20	136	138	140	142	144	147	185
30	137	139	141	143	145	148	186
40	138	140	142	144	146	149	187
50	139	141	143	145	147	150	188
24	140	142	144	146	148	151	189
20	141	143	145	147	149	152	190
30	142	144	146	148	150	153	191
40	143	145	147	149	151	154	192
50	144	146	148	150	152	155	193
25	145	147	149	151	153	156	194
20	146	148	150	152	154	157	195
30	147	149	151	153	155	158	196
40	148	150	152	154	156	159	197
50	149	151	153	155	157	160	198
26	150	152	154	156	158	161	199
20	151	153	155	157	159	162	200
30	152	154	156	158	160	163	201
40	153	155	157	159	161	164	202
50	154	156	158	160	162	165	203
27	155	157	159	161	163	166	204
20	156	158	160	162	164	167	205
30	157	159	161	163	165	168	206
40	158	160	162	164	166	169	207
50	159	161	163	165	167	170	208
28	160	162	164	166	168	171	209
20	161	163	165	167	169	172	210
30	162	164	166	168	170	173	211
40	163	165	167	169	171	174	212
50	164	166	168	170	172	175	213
29	165	167	169	171	173	176	214
20	166	168	170	172	174	177	215
30	167	169	171	173	175	178	216
40	168	170	172	174	176	179	217
50	169	171	173	175	177	180	218
30	170	172	174	176	178	181	219
40	171	173	175	177	179	182	220
50	172	174	176	178	180	183	221
31	173	175	177	179	181	184	222
20	174	176	178	180	182	185	223
30	175	177	179	181	183	186	224
40	176	178	180	182	184	187	225
50	177	179	181	183	185	188	226
32	178	180	182	184	186	189	227
20	179	181	183	185	187	190	228
30	180	182	184	186	188	191	229
40	181	183	185	187	189	192	230
50	182	184	186	188	190	193	231
33	183	185	187	189	191	194	232
20	184	186	188	190	192	195	233
30	185	187	189	191	193	196	234
40	186	188	190	192	194	197	235
50	187	189	191	193	195	198	236
34	188	190	192	194	196	199	237
20	189	191	193	195	197	200	238
30	190	192	194	196	198	201	239
40	191	193	195	197	199	202	240
50	192	194	196	198	200	203	241
35	193	195	197	199	201	204	242
20	194	196	198	200	202	205	243</

$\delta = +10^\circ$ $\delta = +20^\circ$ $\delta = +30^\circ$ $\delta = +40^\circ$ $\delta = +50^\circ$ $\delta = +60^\circ$
 All corrections from $\delta = 30^\circ$ to $\delta = 60^\circ$

	$\delta = +10^\circ$	$\delta = +20^\circ$	$\delta = +30^\circ$	$\delta = +40^\circ$	$\delta = +50^\circ$	$\delta = +60^\circ$
12	00 3.07	01 3.07	02 3.07	03 3.07	04 3.07	05 3.07
10	07 05	08 05	09 05	10 05	11 05	12 05
20	04 05	05 05	06 05	07 05	08 05	09 05
30	03 03	04 03	05 03	06 03	07 03	08 03
40	02 02	03 02	04 02	05 02	06 02	07 02
50	01 01	02 01	03 01	04 01	05 01	06 01
13	00 00	01 00	02 00	03 00	04 00	05 00
10	2.99	2.99	2.99	2.99	2.99	2.99
20	98	98	98	98	98	98
30	97	97	97	97	97	97
40	96	96	96	96	96	96
50	95	95	95	95	95	95
14	00 95	01 95	02 95	03 95	04 95	05 95
10	94	94	94	94	94	94
20	93	93	93	93	93	93
30	92	92	92	92	92	92
40	91	91	91	91	91	91
50	90	90	90	90	90	90
15	00 90	01 90	02 90	03 90	04 90	05 90
10	89	89	89	89	89	89
20	88	88	88	88	88	88
30	87	87	87	87	87	87
40	86	86	86	86	86	86
50	85	85	85	85	85	85
16	00 85	01 85	02 85	03 85	04 85	05 85
10	84	84	84	84	84	84
20	83	83	83	83	83	83
30	82	82	82	82	82	82
40	81	81	81	81	81	81
50	80	80	80	80	80	80
17	00 80	01 80	02 80	03 80	04 80	05 80
10	79	79	79	79	79	79
20	78	78	78	78	78	78
30	77	77	77	77	77	77
40	76	76	76	76	76	76
50	75	75	75	75	75	75
18	00 75	01 75	02 75	03 75	04 75	05 75
10	74	74	74	74	74	74
20	73	73	73	73	73	73
30	72	72	72	72	72	72
40	71	71	71	71	71	71
50	70	70	70	70	70	70
19	00 70	01 70	02 70	03 70	04 70	05 70
10	69	69	69	69	69	69
20	68	68	68	68	68	68
30	67	67	67	67	67	67
40	66	66	66	66	66	66
50	65	65	65	65	65	65
20	00 65	01 65	02 65	03 65	04 65	05 65
10	64	64	64	64	64	64
20	63	63	63	63	63	63
30	62	62	62	62	62	62
40	61	61	61	61	61	61
50	60	60	60	60	60	60
21	00 60	01 60	02 60	03 60	04 60	05 60
10	59	59	59	59	59	59
20	58	58	58	58	58	58
30	57	57	57	57	57	57
40	56	56	56	56	56	56
50	55	55	55	55	55	55
22	00 55	01 55	02 55	03 55	04 55	05 55
10	54	54	54	54	54	54
20	53	53	53	53	53	53
30	52	52	52	52	52	52
40	51	51	51	51	51	51
50	50	50	50	50	50	50
23	00 50	01 50	02 50	03 50	04 50	05 50
10	49	49	49	49	49	49
20	48	48	48	48	48	48
30	47	47	47	47	47	47
40	46	46	46	46	46	46
50	45	45	45	45	45	45
24	00 45	01 45	02 45	03 45	04 45	05 45
10	44	44	44	44	44	44
20	43	43	43	43	43	43
30	42	42	42	42	42	42
40	41	41	41	41	41	41
50	40	40	40	40	40	40

$\delta = +40^\circ$ $\delta = +50^\circ$ $\delta = +60^\circ$ $\delta = -10^\circ$ $\delta = -20^\circ$ $\delta = -30^\circ$

$$\frac{d\omega}{dt} \text{ and } \frac{d\psi}{dt} \text{ for } 1875.0$$

$$m \text{ for } 1875.0 = 46."0887 = 3.07225$$

$$n = 240542 = 1.33695$$

$$\frac{0.7619}{12611} = 0.00006038$$

$$\frac{d\alpha}{dt} = 3.07225 + 1.33695 \sin a \tan \delta = 3.07225 + F \sin a \quad (F = 1.33695 \tan \delta)$$

$$\frac{d\delta}{dt} = 20.0542 \cos a$$

a	δ	$\sin a$	$\cos a$	α_c	α_0	$\sin a$	$\cos a$	α_T	α_0	$\sin a$	$\cos a$
22 30	33 36	9.58284	9.96564								
40	340	9.53405	9.97269								
22 50	342 30	9.47814	9.97942								
23 00	345 00	9.41300	9.98499								
23 10	347 30	9.33534	9.98958								
20	350 00	9.23967	9.99325	$\pm 10^\circ$	$\pm 20^\circ$	$\pm 30^\circ$	$\pm 40^\circ$	$\pm 50^\circ$	$\pm 60^\circ$		
30	352 30	9.11570	9.99624	I_a	I_a	I_a	I_a	I_a	I_a		
40	355 00	8.94030	9.99834								
50	357 30	8.63968	9.99959								
24 00	00 00	0	10.00000	± 0.00	± 0.00	± 0.00	± 0.48	± 0.00	± 0.00		
10	2 30	8.63968	9.99959	0.01	21	29	98	69	101		
20	5 00	8.94030	9.99834	21	42	67	197	139	202		
30	7 30	9.11570	9.99624	31	64	101	195	208	302		
40	10 00	9.23967	9.99325	41	85	134	293	276	402		
50	12 30	9.33534	9.98958	51	105	167	290	395	501		
1 00	15 00	9.41300	9.98499	61	146	200	337	412	599		
10	17 30	9.47814	9.97942	71	167	232	384	479	696		
20	20 00	9.53405	9.97269	81	187	264	429	535	792		
30	22 30	9.58284	9.96564	90	206	295	474	610	886		
40	25 00	9.62595	9.95728	100	224	326	518	673	979		
50	27 30	9.66441	9.94793	109	243	356	561	736	1069		
2 00	30 00	9.69897	9.93753	118	262	386	603	797	1158		
10	32 30	9.73022	9.92603	127	279	415	644	856	1244		
20	35 00	9.75859	9.91336	135	296	443	683	914	1328		
30	37 30	9.78445	9.89947	143	313	470	721	970	1410		
40	40 00	9.80807	9.88425	151	329	496	758	1024	1487		
50	42 30	9.82968	9.86763	159	344	522	793	1077	1564		
3 00	45 00	9.84949	9.84949	167	358	546	827	1127	1637		
10	47 30	9.86763	9.82968	174	373	569	860	1175	1708		
20	50 00	9.88425	9.80807	181	386	591	890	1221	1774		
30	52 30	9.89947	9.78445	187	399	612	919	1264	1838		
40	55 00	9.91336	9.75859	193	411	632	946	1305	1897		
50	57 30	9.92603	9.73022	199	422	651	972	1343	1953		
4 00	00 00	9.93753	9.69897	204	432	669	995	1380	2005		
10	02 30	9.94793	9.66441	209	441	685	1017	1413	2054		
20	05 00	9.95728	9.62595	213	450	702	1037	1444	2099		
30	07 30	9.96564	9.58284	218	457	718	1054	1472	2141		
40	10 00	9.97269	9.53405	221	463	726	1070	1496	2175		
50	12 30	9.97942	9.47814	225	468	736	1083	1519	2208		
5 00	15 00	9.98499	9.41300	228	475	745	1095	1540	2237		
10	17 30	9.98958	9.33534	230	480	754	1105	1568	2261		
20	20 00	9.99325	9.23967	232	483	760	1112	1587	2281		
30	22 30	9.99624	9.11570	234	485	765	1118	1595	2296		
40	25 00	9.99834	8.94030	235	486	769	1121	1597	2307		
50	27 30	9.99959	8.63968	236	486	771	1122	1592	2314		
6 00	30 00	10.00000	0	± 2.37	± 4.47	772	1122	1593	2316		
10	32 30										
20	35 00										
30	37 30										
40	40 00										
50	42 30										
7 00	45 00										
10	47 30										
20	50 00										
30	52 30										
40	55 00										
50	57 30										
8 00	00 00										
10	02 30										
20	05 00										
30	07 30										
40	10 00										
50	12 30										
9 00	15 00										
10	17 30										
20	20 00										
30	22 30										
40	25 00										
50	27 30										
9 00	30 00										
10	32 30										
20	35 00										
30	37 30										
40	40 00										
50	42 30										
9 00	45 00										
10	47 30										
20	50 00										
30	52 30										
40	55 00										
50	57 30										

$$\log 1.33695 = .12611$$

$\log R_{50^\circ}$	07618
$\log R_{51^\circ}$	09163
$\log R_{52^\circ}$	10718
$\log R_{53^\circ}$	12289
$\log R_{54^\circ}$	13874
$\log R_{55^\circ}$	15477

$$\log R_{50^\circ} = .20230$$

$$\log R_{51^\circ} = .21774$$

$$\log R_{52^\circ} = .23330$$

$$\log R_{53^\circ} = .24900$$

$$\log R_{54^\circ} = .26485$$

$$\log R_{55^\circ} = .28088$$

$$\log 20.0542 = 1.30222$$

	$R_{\text{Lay}} 50^\circ$	$R_{\text{Lay}} 51^\circ$	$R_{\text{Lay}} 52^\circ$	$R_{\text{Lay}} 53^\circ$	$R_{\text{Lay}} 54^\circ$	$R_{\text{Lay}} 55^\circ$	$\frac{da(50^\circ)}{dt}$	Sec. var.	$AS, 0$	$\frac{da(51^\circ)}{dt}$	Sec. var.
20	30 60 94										
21	31 60 83										
22	32 59 69										
23	33 59 04										
24	34 58 39										
25	35 57 75										
26	36 57 10										
27	37 56 45										
28	38 56 0										
29	39 55 15										
30	40 54 50										
31	41 53 85										
32	42 53 20										
33	43 52 54										
34	44 51 88										
35	45 51 22										
36	46 50 56										
37	47 49 90										
38	48 49 24										
39	49 48 58										
40	50 47 51										
41	51 47 25										
42	52 46 59										
43	53 46 33										
44	54 45 26										
45	55 44 59										
46	56 43 52										
47	57 43 25										
48	58 42 58										
49	59 41 91										
50	00 41 24										
51	01 40 57										
52	02 39 40										
53	03 39 22										
54	04 38 54										
55	05 37 97										
56	06 37 30										
57	07 36 62										
58	08 35 94										
59	09 35 26										
60	10 34 49										
61	11 33 51										
62	12 33 13										
63	13 32 45										
64	14 31 77										
65	15 31 09										
66	16 30 41										
67	17 29 73										
68	18 29 05										
69	19 28 36										
70	20 27 69										
71	21 26 99										
72	22 26 31										
73	23 25 62										
74	24 24 93										
75	25 24 24										
76	26 23 55										
77	27 22 86										
78	28 22 17										
79	29 21 48										
80	30 20 80										
81	31 20 11										
82	32 19 42										
83	33 18 73										
84	34 18 04										
85	35 17 35										
86	36 16 66										
87	37 15 97										
88	38 15 27										
89	39 14 58										
90	40 13 88										
91											
92											
93											
94											
95											
96											
97											
98											

α α_{11}'' $\frac{d\alpha}{dt}(52'')$ sec. var. α_{11}'' $\frac{d\alpha}{dt}(58'')$ sec. var. α_{11}'' $\frac{d\alpha}{dt}(54'')$ sec. var. α_{11}'' $\frac{d\alpha}{dt}(54'')$ sec. var.

1870phae.proj: 427R

	κ	$\kappa_{\text{tays}}^{\circ}$	$\kappa_{\text{tays}}^{\circ}$	$\kappa_{\text{tays}}^{\circ}$	$\kappa_{\text{tays}}^{\circ}$	$\kappa_{\text{tays}}^{\circ}$	$\kappa_{\text{tays}}^{\circ}$	$\frac{d\alpha}{dt}$	$\frac{d\delta}{dt}$	sec. par.	α	$\frac{d\alpha}{dt}$	$\frac{d\delta}{dt}$	sec. par.
23	45	1042						307225				307225		
	46	972						307946	721			307946	721	
	47	902						308667	721			308667	721	
	48	832						309388	720			309388	720	
	49	762						310108	720			310108	720	
	50	-0695						310828	720			310828	720	
	51	625						311548	720			311548	720	
	52	535						312268	720			312268	720	
	53	485						312988	720			312988	720	
	54	415						313708	720			313708	720	
	55	-0348						314428	720			314428	720	
	56	278						315147	719			315147	719	
	57	208						315866	719			315866	719	
	58	138						316585	719			316585	719	
	59	068						317304	719			317304	719	
+	0	0000	000000	000000	000000	000000	000000	318024	720			318024	720	
-	12	1						318742	718			318742	718	
	2	188						319460	718			319460	718	
	3	206						320178	718			320178	718	
	4	278						320896	718			320896	718	
	5	347						321614	717			321614	717	
	6	417						322333	717			322333	717	
	7	487						323052	717			323052	717	
	8	556						323765	717			323765	717	
	9	628						324480	717			324480	717	
50	10	+06950	07203	07464	07739	08027	08328	325199	717			325199	717	
	11	765						325914	717			325914	717	
	12	835						326629	717			326629	717	
	13	902						327344	717			327344	717	
	14	978						328059	717			328059	717	
	15	1042						328770	716			328770	716	
	16	1111						329488	713			329488	713	
	17	1180						330201	713			330201	713	
	18	1249						330914	713			330914	713	
	19	1318						331627	713			331627	713	
100	20	1387	14389	14914	15463	16038	16641	332341	711			332341	711	
	21	1458						333052	711			333052	711	
	22	1527						333763	711			333763	711	
	23	1596						334473	710			334473	710	
	24	1665						335183	710			335183	710	
	25	1734						335894	711			335894	711	
	26	1803						336602	708			336602	708	
	27	1872						337310	708			337310	708	
	28	1941						338018	708			338018	708	
	29	2010						338726	708			338726	708	
30	30	20797	21550	22336	23158	24019	24922	339434	708			339434	708	
	31	2148						340139	705			340139	705	
	32	2217						340844	705			340844	705	
	33	2286						341549	705			341549	705	
	34	2355						342254	705			342254	705	
	35	2423						342959	705			342959	705	
	36	2492						343661	702			343661	702	
	37	2561						344363	702			344363	702	
	38	2630						345064	701			345064	701	
	39	2729						345765	701			345765	701	
20	40	27668	28669	29715	30808	31904	33055	346467	702			346467	702	
	41	2835						347165	698			347165	698	
	42	2903						347863	698			347863	698	
	43	2971						348561	697			348561	697	
	44	3049						349259	698			349259	698	
	45	3108						349956	697			349956	697	
	46	3176												
	47	3244												
	48	3312												
	49	3380												
10	50	34486	35734	37038	38401	39828	41326							
	51	3516												
	52	3584												
	53	3652												
	54	3720												
	55	3787												
	56	3854												
	57	3921												
	58	3988												
	59	4055												
4	60	41239	42731	44290	45920	47627	49418							
13-														

a 40° $\frac{da(52^\circ)}{dt}$ sec. var. 40° $\frac{da(53^\circ)}{dt}$ sec. var. 40° $\frac{da(54^\circ)}{dt}$ sec. var. 40° $\frac{da(55^\circ)}{dt}$ sec. var.

	α	$R_{\text{tang}}(s_1)$	$R_{\text{tang}}(s_1)$	$R_{\text{tang}}(s_2)$	$R_{\text{tang}}(s_3)$	$R_{\text{tang}}(s_4)$	$R_{\text{tang}}(s_5)$	$\frac{da}{dt}(s_0)$	μ_{par}	α_1°	$\frac{da}{dt}(s_1)$	μ_{par}
15+	0	4124	4261									
	1	4191										
	2	4258										
	3	4325										
	4	4392										
	5	4459										
	6	4526										
	7	4593										
	8	4659										
	9	4725										
50	10	4791	49646									
	11	4858										
	12	4924										
	13	4990										
	14	5056										
	15	5122										
	16	5188										
	17	5254										
	18	5320										
	19	5385										
40	20	5450	56467									
	21	5515										
	22	5580										
	23	5645										
	24	5710										
	25	5775										
	26	5839										
	27	5904										
	28	5969										
	29	6033										
30	30	6097	63180									
	31	6161										
	32	6225										
	33	6289										
	34	6353										
	35	6417										
	36	6481										
	37	6545										
	38	6608										
	39	6671										
20	40	6734	69779									
	41	6797										
	42	6860										
	43	6922										
	44	6984										
	45	7047										
	46	7109										
	47	7171										
	48	7233										
	49	7295										
10	50	7357	76235									
	51	7419										
	52	7481										
	53	7542										
	54	7603										
	55	7664										
	56	7725										
	57	7786										
	58	7846										
	59	7906										
2+	0	7967	82549									
13-	1	8027										
	2	8087										
	3	8147										
	4	8207										
	5	8266										
	6	8325										
	7	8384										
	8	8443										
	9	8502										
50	10	8561	88708									
	11	8619										
	12	8676										
	13	8733										
	14	8790										
2+	15	8848										
13-												

a $4S_{10}$ $\frac{da(52)}{dt}$ sec. var. $4S_{10}$ $\frac{da(53)}{dt}$ sec. var. $4S_{10}$ $\frac{da(54)}{dt}$ sec. var. $4S_{10}$ $\frac{da(55)}{dt}$ sec. var.

	a	R_{Lamp}^{50}	R_{Lamp}^{51}	R_{Lamp}^{52}	R_{Lamp}^{53}	R_{Lamp}^{54}	R_{Lamp}^{55}	$d_{\text{eff}}^{(50)}$	$\rho_{\text{c,bar}}$	$q_{\text{f},0}$	$d_{\text{eff}}^{(52)}$	$\rho_{\text{c,bar}}$
	15											
	16											
	17											
	18											
	19											
10	20	9138	94696									
	21											
	22											
	23											
	24											
	25											
	26											
	27											
	28											
	29											
30	30	9900	100509									
	31											
	32											
	33											
	34											
	35											
	36											
	37											
	38											
	39											
20	40	10242	106123									
	41											
	42											
	43											
	44											
	45											
	46											
	47											
	48											
	49											
10	50	10864	111539									
	51											
	52											
	53											
	54											
	55											
	56											
	57											
	58											
	59											
2	0	11267	116743									
	1											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
50	10	11747	121723									
	11											
	12											
	13											
	14											
	15											
	16											
	17											
	18											
	19											
40	20	12205	126474									
	21											
	22											
	23											
	24											
	25											
	26											
	27											
	28											
	29											
	30	12641	130982									

a 40.0 $\frac{da(53^\circ)}{dt}$ $ac. var.$ $a(50)$ $\frac{da(54^\circ)}{dt}$ $ac. var.$ $a(50)$ $\frac{da(55^\circ)}{dt}$ $ac. var.$ $a(50)$ $\frac{da(56^\circ)}{dt}$ $ac. var.$

α $\Delta\beta_0$ $\frac{d\alpha(52^\circ)}{dt}$ v.e. var. $\Delta\beta_0$ $\frac{d\alpha(53^\circ)}{dt}$ v.e. var. $\Delta\beta_0$ $\frac{d\alpha(54^\circ)}{dt}$ v.e. var. $\Delta\beta_0$ $\frac{d\alpha(55^\circ)}{dt}$ v.e. var.

	$R_{\text{ray}}(50^\circ)$	$R_{\text{ray}}(50^\circ)$	$R_{\text{ray}}(50^\circ)$	$R_{\text{ray}}(50^\circ)$	$R_{\text{ray}}(50^\circ)$	$R_{\text{ray}}(50^\circ)$	$d_{\text{a}}(50^\circ)$	$d_{\text{a}}(50^\circ)$	$d_{\text{a}}(50^\circ)$	$d_{\text{a}}(50^\circ)$	$d_{\text{a}}(50^\circ)$	$d_{\text{a}}(50^\circ)$
45	15786											
46	15796											
47												
48												
49												
50	15796	157457										
51												
52												
53												
54												
55												
56												
57												
58												
59												
60	15890	157470										
61												
62												
63												
64												
65												
66												
67												
68												
69												
70	15555	161184										
71												
72												
73												
74												
75												
76												
77												
78												
79												
80	15891	162550										
81												
82												
83												
84												
85												
86												
87												
88												
89												
90	15794	163685										
91												
92												
93												
94												
95												
96												
97												
98												
99												
100	15872	164468										
101												
102												
103												
104												
105												
106												
107												
108												
109												
110	15918	164941										
111												
112												
113												
114												
115												
116												
117												
118												
119												
120	15933	165098										

a $\frac{d\lambda}{dt}$ $\frac{da}{dt}(52^\circ)$ ec. var. $\frac{d\lambda}{dt}$ $\frac{da}{dt}(53^\circ)$ ec. var. $\frac{d\lambda}{dt}$ $\frac{da}{dt}(54^\circ)$ ec. var. $\frac{d\lambda}{dt}$ $\frac{da}{dt}(55^\circ)$ ec. var.

$$\frac{dV}{dt} \quad \frac{dV}{dt} \quad \frac{dV}{dt} \quad \frac{dV}{dt}$$
John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

Secular Variations

Formulas

$$\text{Secular variation in } \alpha = .00189 + .01300 (\tan^2 \delta + \frac{1}{2}) \sin 2\alpha + .02987 \sin (\alpha + 91^\circ 6') \tan \delta$$

$$\text{Secular variation in } \delta = -.1950 \tan \delta \sin^2 \alpha + .4487 \cos (\alpha + 91^\circ 6')$$

(The proper motion being neglected)

$\delta = 50^\circ$	$\delta 20$	$\delta 40$	56°
$\log \tan \delta$ 0.7619	1.0719	1.3874	
$\log \tan^2 \delta$ 1.5238	2.1438	2.7748	
$\log (\tan^2 \delta + \frac{1}{2})$ 1.4202	1.6380	1.8944	
$\log (\tan^2 \delta + \frac{1}{2})$ 1.9202	2.1380	2.3944	
$\log \tan^2 \delta + \frac{1}{2}$ 2.8335	3.3001	3.7920	
$\log \cos (\alpha + 91^\circ 6')$ 8.11394	8.11394	8.11394	
$\log \sin 2\alpha$ 8.39729	8.44393	8.49314	
$\log \tan \delta$ 0.7619	1.0719	1.3874	
$\log .02987$ 8.47524	8.47524	8.47524	
$\log \cos (\alpha + 91^\circ 6')$ 8.55143	8.55243	8.61396	
$\log -1950$ 9.28003			
$\log \sin^2 \alpha$ 9.36622	9.39722	9.42877	
$\log \cos (\alpha + 91^\circ 6')$ 9.65137	9.65137	9.65137	

α	α_0	α'	2α	$\alpha + 91^\circ 6'$	$\sin \alpha$	$\sin 2\alpha$	$\sin 2\alpha$	$\sin (\alpha + 91^\circ 6')$	$\cos (\alpha + 91^\circ 6')$
0	0	0	0	91	8.63886	7.27772	8.94030	9.95552	8.28224
10	2	30	5	93	8.63986	7.27972	8.94030	9.95552	8.28224
20	5	00	10	96	8.94030	7.88060	9.23967	9.95553	9.02639
30	7	30	15	98	9.11570	8.23140	9.41300	9.95509	9.17474
40	10	00	20	101	9.23967	8.47934	9.53405	9.99180	9.28448
50	12	30	25	103	9.33534	8.67068	9.62595	9.98765	9.37133
1	15	00	30	106	9.41300	8.82600	9.69897	9.98262	9.44297
10	17	30	35	108	9.47814	8.95628	9.75859	9.97670	9.50374
20	20	00	40	111	9.53405	9.06810	9.80807	9.96986	9.55630
30	22	30	45	118	9.58284	9.16568	9.84949	9.96207	9.60244
40	26	00	50	116	9.62595	9.25190	9.88425	9.95329	9.64239
50	27	30	55	118	9.66441	9.32882	9.91336	9.94349	9.68066
2	30	00	60	121	9.69897	9.39794	9.93753	9.93261	9.71310
10	32	30	65	123	9.73022	9.46044	9.95728	9.92060	9.74303
20	35	00	70	126	9.75859	9.51718	9.97299	9.90741	9.77026
30	37	30	75	128	9.78445	9.56890	9.98494	9.89284	9.79510
40	40	00	80	131	9.81107	9.61619	9.99335	9.87712	9.81781
50	42	30	85	133	9.82968	9.65936	9.99834	9.85854	9.83861
3	45	00	90	136	9.84549	9.69898	10.00000	9.84058	9.85766
10	47	30	95	138	9.86763	9.73526		9.82041	9.87513
20	50	00	100	141	9.88425	9.76850		9.79753	9.89112
30	52	30	105	143	9.89947	9.79894		9.77336	9.90574
40	55	00	110	146	9.91336	9.82682		9.74644	9.91908
50	57	30	115	148	9.92603	9.85206		9.71685	9.93123
4	60	00	120	151	9.93753	9.87506		9.68420	9.94224
10	62	30	125	153	9.94753	9.89586		9.64800	9.95217
20	65	00	130	156	9.95728	9.91456		9.60761	9.96107
30	67	30	135	158	9.96567	9.93134		9.56215	9.96898
40	70	00	140	161	9.97299	9.94598		9.51043	9.97593
50	72	30	145	163	9.97942	9.95884		9.45077	9.98186
6	75	00	150	166	9.98494	9.96988		9.38062	9.98709
10	77	30	155	168	9.98958	9.97916		9.29591	9.99185
20	80	00	160	171	9.99335	9.98670		9.18952	9.99574
30	82	30	165	173	9.99627	9.99254		9.07155	9.99828
40	85	00	170	176	9.99834	9.99668		8.93261	9.99949
50	87	30	175	178	9.99959	9.99918		8.78796	9.99987
6	90	00	180	181	10.00000	10.00000		8.28324	9.99992

		50°		53°		55°	
6	9	Priza	Priza (a+g) be van. S,	Priza	Priza (a+g) be van. S,	Priza	Priza (a+g) be van. S,
	0						
	5						
	10						
	15						
	20						
	25						
	30						
	35						
	40						
	45						
	50						
	55						
	60						
	65						
	70						
	75						
	80						
	85						
	90						
	95						
	100						
	105						
	110						
	115						
	120						
	125						
	130						
	135						
	140						
	145						
	150						
	155						
	160						
	165						
	170						
	175						
	180						
	185						
	190						
	195						
	200						
	205						
	210						
	215						
	220						
	225						
	230						
	235						
	240						
	245						
	250						
	255						
	260						
	265						
	270						
	275						
	280						
	285						
	290						
	295						
	300						
	305						
	310						
	315						
	320						
	325						
	330						
	335						
	340						
	345						
	350						
	355						
	360						
	365						
	370						
	375						
	380						
	385						
	390						
	395						
	400						
	405						
	410						
	415						
	420						
	425						
	430						
	435						
	440						
	445						
	450						
	455						
	460						
	465						
	470						
	475						
	480						
	485						
	490						
	495						
	500						
	505						
	510						
	515						
	520						
	525						
	530						
	535						
	540						
	545						
	550						
	555						
	560						
	565						
	570						
	575						
	580						
	585						
	590						
	595						
	600						
	605						
	610						
	615						
	620						
	625						
	630						
	635						
	640						
	645						
	650						
	655						
	660						
	665						
	670						
	675						
	680						
	685						
	690						
	695						
	700						
	705						
	710						
	715						
	720						
	725						
	730						
	735						
	740						
	745						
	750						
	755						
	760						
	765						
	770						
	775						
	780						
	785						
	790						
	795						
	800						
	805						
	810						
	815						
	820						
	825						
	830						
	835						
	840						
	845						
	850						
	855						
	860						
	865						
	870						
	875						
	880						
	885						
	890						
	895						
	900						
	905						
	910						
	915						
	920						
	925						
	930						
	935						
	940						
	945						
	950						
	955						
	960						
	965						
	970						
	975						
	980						
	985						
	990						
	995						
	1000						

a Piza Pizati's de van S. a de Piza Pizati's de van S. Piza Pizati's de van S. Piza Pizati's de van S.

a Riza Riza'bevan, 1. 10 Riza Riza'bevan, 1. 10 Riza Riza'bevan, 1. 10

Secular variation in

$$\delta = 50^\circ \quad \text{Sec. var.} = -1950'' \tan \delta \sin \alpha + 448'' / \cos(\alpha + 90^\circ - \delta) \sin \delta$$

α	δ	$\sin \delta$	$\cos \delta$	$\tan \delta$	$\sin \alpha$	$\cos \alpha$	$\sin \delta \sin \alpha$	$\cos \delta \cos \alpha$	$\tan \delta \sin \alpha$	$\sec \delta \cos \alpha$
0	0	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000
5	0	0.0044	0.9999	0.0044	0.0044	0.9999	0.0044	0.9999	0.0044	0.9999
10	0	0.0088	0.9988	0.0088	0.0088	0.9988	0.0088	0.9988	0.0088	0.9988
15	0	0.0132	0.9968	0.0132	0.0132	0.9968	0.0132	0.9968	0.0132	0.9968
20	0	0.0176	0.9936	0.0176	0.0176	0.9936	0.0176	0.9936	0.0176	0.9936
25	0	0.0220	0.9896	0.0220	0.0220	0.9896	0.0220	0.9896	0.0220	0.9896
30	0	0.0264	0.9848	0.0264	0.0264	0.9848	0.0264	0.9848	0.0264	0.9848
35	0	0.0308	0.9792	0.0308	0.0308	0.9792	0.0308	0.9792	0.0308	0.9792
40	0	0.0352	0.9728	0.0352	0.0352	0.9728	0.0352	0.9728	0.0352	0.9728
45	0	0.0396	0.9656	0.0396	0.0396	0.9656	0.0396	0.9656	0.0396	0.9656
50	0	0.0440	0.9576	0.0440	0.0440	0.9576	0.0440	0.9576	0.0440	0.9576
55	0	0.0484	0.9488	0.0484	0.0484	0.9488	0.0484	0.9488	0.0484	0.9488
60	0	0.0528	0.9392	0.0528	0.0528	0.9392	0.0528	0.9392	0.0528	0.9392
65	0	0.0572	0.9288	0.0572	0.0572	0.9288	0.0572	0.9288	0.0572	0.9288
70	0	0.0616	0.9176	0.0616	0.0616	0.9176	0.0616	0.9176	0.0616	0.9176
75	0	0.0660	0.9056	0.0660	0.0660	0.9056	0.0660	0.9056	0.0660	0.9056
80	0	0.0704	0.8928	0.0704	0.0704	0.8928	0.0704	0.8928	0.0704	0.8928
85	0	0.0748	0.8792	0.0748	0.0748	0.8792	0.0748	0.8792	0.0748	0.8792
90	0	0.0792	0.8648	0.0792	0.0792	0.8648	0.0792	0.8648	0.0792	0.8648
95	0	0.0836	0.8496	0.0836	0.0836	0.8496	0.0836	0.8496	0.0836	0.8496
100	0	0.0880	0.8336	0.0880	0.0880	0.8336	0.0880	0.8336	0.0880	0.8336
105	0	0.0924	0.8168	0.0924	0.0924	0.8168	0.0924	0.8168	0.0924	0.8168
110	0	0.0968	0.7992	0.0968	0.0968	0.7992	0.0968	0.7992	0.0968	0.7992
115	0	0.1012	0.7808	0.1012	0.1012	0.7808	0.1012	0.7808	0.1012	0.7808
120	0	0.1056	0.7616	0.1056	0.1056	0.7616	0.1056	0.7616	0.1056	0.7616
125	0	0.1100	0.7416	0.1100	0.1100	0.7416	0.1100	0.7416	0.1100	0.7416
130	0	0.1144	0.7208	0.1144	0.1144	0.7208	0.1144	0.7208	0.1144	0.7208
135	0	0.1188	0.6992	0.1188	0.1188	0.6992	0.1188	0.6992	0.1188	0.6992
140	0	0.1232	0.6768	0.1232	0.1232	0.6768	0.1232	0.6768	0.1232	0.6768
145	0	0.1276	0.6536	0.1276	0.1276	0.6536	0.1276	0.6536	0.1276	0.6536
150	0	0.1320	0.6296	0.1320	0.1320	0.6296	0.1320	0.6296	0.1320	0.6296
155	0	0.1364	0.6048	0.1364	0.1364	0.6048	0.1364	0.6048	0.1364	0.6048
160	0	0.1408	0.5792	0.1408	0.1408	0.5792	0.1408	0.5792	0.1408	0.5792
165	0	0.1452	0.5528	0.1452	0.1452	0.5528	0.1452	0.5528	0.1452	0.5528
170	0	0.1496	0.5256	0.1496	0.1496	0.5256	0.1496	0.5256	0.1496	0.5256
175	0	0.1540	0.4976	0.1540	0.1540	0.4976	0.1540	0.4976	0.1540	0.4976
180	0	0.1584	0.4688	0.1584	0.1584	0.4688	0.1584	0.4688	0.1584	0.4688
185	0	0.1628	0.4392	0.1628	0.1628	0.4392	0.1628	0.4392	0.1628	0.4392
190	0	0.1672	0.4088	0.1672	0.1672	0.4088	0.1672	0.4088	0.1672	0.4088
195	0	0.1716	0.3776	0.1716	0.1716	0.3776	0.1716	0.3776	0.1716	0.3776
200	0	0.1760	0.3456	0.1760	0.1760	0.3456	0.1760	0.3456	0.1760	0.3456
205	0	0.1804	0.3128	0.1804	0.1804	0.3128	0.1804	0.3128	0.1804	0.3128
210	0	0.1848	0.2792	0.1848	0.1848	0.2792	0.1848	0.2792	0.1848	0.2792
215	0	0.1892	0.2448	0.1892	0.1892	0.2448	0.1892	0.2448	0.1892	0.2448
220	0	0.1936	0.2096	0.1936	0.1936	0.2096	0.1936	0.2096	0.1936	0.2096
225	0	0.1980	0.1736	0.1980	0.1980	0.1736	0.1980	0.1736	0.1980	0.1736
230	0	0.2024	0.1368	0.2024	0.2024	0.1368	0.2024	0.1368	0.2024	0.1368
235	0	0.2068	0.0992	0.2068	0.2068	0.0992	0.2068	0.0992	0.2068	0.0992
240	0	0.2112	0.0608	0.2112	0.2112	0.0608	0.2112	0.0608	0.2112	0.0608
245	0	0.2156	0.0216	0.2156	0.2156	0.0216	0.2156	0.0216	0.2156	0.0216
250	0	0.2200	0.0000	0.2200	0.2200	0.0000	0.2200	0.0000	0.2200	0.0000
255	0	0.2244	-0.0000	0.2244	0.2244	-0.0000	0.2244	-0.0000	0.2244	-0.0000
260	0	0.2288	-0.0000	0.2288	0.2288	-0.0000	0.2288	-0.0000	0.2288	-0.0000
265	0	0.2332	-0.0000	0.2332	0.2332	-0.0000	0.2332	-0.0000	0.2332	-0.0000
270	0	0.2376	-0.0000	0.2376	0.2376	-0.0000	0.2376	-0.0000	0.2376	-0.0000
275	0	0.2420	-0.0000	0.2420	0.2420	-0.0000	0.2420	-0.0000	0.2420	-0.0000
280	0	0.2464	-0.0000	0.2464	0.2464	-0.0000	0.2464	-0.0000	0.2464	-0.0000
285	0	0.2508	-0.0000	0.2508	0.2508	-0.0000	0.2508	-0.0000	0.2508	-0.0000
290	0	0.2552	-0.0000	0.2552	0.2552	-0.0000	0.2552	-0.0000	0.2552	-0.0000
295	0	0.2596	-0.0000	0.2596	0.2596	-0.0000	0.2596	-0.0000	0.2596	-0.0000
300	0	0.2640	-0.0000	0.2640	0.2640	-0.0000	0.2640	-0.0000	0.2640	-0.0000
305	0	0.2684	-0.0000	0.2684	0.2684	-0.0000	0.2684	-0.0000	0.2684	-0.0000
310	0	0.2728	-0.0000	0.2728	0.2728	-0.0000	0.2728	-0.0000	0.2728	-0.0000
315	0	0.2772	-0.0000	0.2772	0.2772	-0.0000	0.2772	-0.0000	0.2772	-0.0000
320	0	0.2816	-0.0000	0.2816	0.2816	-0.0000	0.2816	-0.0000	0.2816	-0.0000
325	0	0.2860	-0.0000	0.2860	0.2860	-0.0000	0.2860	-0.0000	0.2860	-0.0000
330	0	0.2904	-0.0000	0.2904	0.2904	-0.0000	0.2904	-0.0000	0.2904	-0.0000
335	0	0.2948	-0.0000	0.2948	0.2948	-0.0000	0.2948	-0.0000	0.2948	-0.0000
340	0	0.2992	-0.0000	0.2992	0.2992	-0.0000	0.2992	-0.0000	0.2992	-0.0000
345	0	0.3036	-0.0000	0.3036	0.3036	-0.0000	0.3036	-0.0000	0.3036	-0.0000
350	0	0.3080	-0.0000	0.3080	0.3080	-0.0000	0.3080	-0.0000	0.3080	-0.0000
355	0	0.3124	-0.0000	0.3124	0.3124	-0.0000	0.3124	-0.0000	0.3124	-0.0000
360	0	0.3168	-0.0000	0.3168	0.3168	-0.0000	0.3168	-0.0000	0.3168	-0.0000
365	0	0.3212	-0.0000	0.3212	0.3212	-0.0000	0.3212	-0.0000	0.3212	-0.0000
370	0	0.3256	-0.0000	0.3256	0.3256	-0.0000	0.3256	-0.0000	0.3256	-0.0000
375	0	0.3300	-0.0000	0.3300	0.3300	-0.0000	0.3300	-0.0000	0.3300	-0.0000
380	0	0.3344	-0.0000	0.3344	0.3344	-0.0000	0.3344	-0.0000	0.3344	-0.0000
385	0	0.3388	-0.0000	0.3388	0.3388	-0.0000	0.3388	-0.0000	0.3388	-0.0000
390	0	0.3432	-0.0000	0.3432	0.3432	-0.0000	0.3432	-0.0000	0.3432	-0.0000
395	0	0.3476	-0.0000	0.3476	0.3476	-0.0000	0.3476	-0.0000	0.3476	-0.0000
400	0	0.3520	-0.0000	0.3520	0.3520	-0.0000	0.3520	-0.0000	0.3520	-0.0000
405	0	0.3564	-0.0000	0.3564	0.3564	-0.0000	0.3564	-0.0000	0.3564	-0.0000
410	0	0.3608	-0.0000	0.3608	0.3608	-0.0000	0.3608	-0.0000	0.3608	-0.0000
415	0	0.3652	-0.0000	0.3652	0.3652	-0.0000	0.3652	-0.0000	0.3652	-0.0000
420	0	0.3696	-0.0000	0.3696	0.3696	-0.0000	0.3696	-0.0000	0.3696	-0.0000
425	0	0.3740	-0.0000	0.3740	0.3740	-0.0000	0.3740	-0.0000	0.3740	-0.0000
430	0	0.3784	-0.0000	0.3784	0.3784	-0.0000	0.3784	-0.0000	0.3784	-0.0000
435	0	0.3828	-0.0000	0.3828	0.3828	-0.0000	0.3828	-0.0000	0.3828	-0.0000
440	0	0.3872	-0.0000	0.3872	0.3872	-0.0000	0.3872	-0.0000	0.3872	-0.0000
445	0	0.3916	-0.0000	0.3916	0.3916	-0.0000	0.3916	-0.0000	0.3916	-0.0000
450	0	0.3960	-0.0000	0.3960	0.3960	-0.0000	0.3960	-0.0000	0.3960	-0.0000
455	0	0.4004	-0.0000	0.4004	0.4004	-0.0000	0.4004	-0.0000	0.4004	-0.0000
460	0	0.4048	-0.0000	0.4048	0.4048	-0.0000	0.4048	-0.0000	0.4048	-0.0000
465	0	0.4092	-0.0000	0.4092	0.4092	-0.0000	0.4092	-0.0000	0.4092	-0.0000
470	0	0.4136	-0.0000	0.4136	0.4136	-0.0000	0.4136	-0.0000	0.4136	-0.0000
475	0	0.4180	-0.0000	0.4180	0.4180	-0.0000	0.4180	-0.0000	0.4180	-0.0000
480	0	0.4224	-0.0000	0.4224	0.4224	-0.0000	0.4224	-0.0000	0.4224	-0.0000
485	0	0.4268	-0.0000	0.4268	0.4268	-0.0000	0.4268	-0.0000	0.4268	-0.0000
490	0	0.4312	-0.0000	0.4312	0.4312	-0.0000	0.4312	-0.0000	0.4312	-0.0000
495	0	0.4356	-0.0000	0.4356	0.4356	-0.0000	0.4356	-0.0000	0.4356	-0.0000
500	0	0.4400	-0.0000	0.4400	0.4400	-0.0000	0.4400	-0.0000	0.4400	-0.0000
505	0	0.4444	-0.00							

α F_2 $\text{P}_{20} + 91^\circ 6'$ $\text{De. var. } 1^\circ 41'$ F_2 $\text{P}_{20} + 91^\circ 6'$ $\text{De. var. } 1^\circ 41'$ F_2 $\text{P}_{20} + 91^\circ 6'$ $\text{De. var. } 1^\circ$

α $H\epsilon^2$ $H\delta(4100)$ de van. S_1 $4S_1$ $H\delta^2$ $H\delta(4100)$ de van S_1 $4S_1$ $H\epsilon^2$ $H\delta(4100)$ de van S_1

Formulae for reduction between various dates
 From 1836 to 1875 (Runkler)

$$m, 1855.5 = 46.0781 = 3.07154 \log 4874028$$

$$n \quad " \quad = 20.0560 \quad \log 1.3022443$$

$$= 1.33707 \quad \log 1.261542$$

$$39 \frac{da}{dt} = 1^m 59.803 + 1.71722 \sin a_m \tan \psi_m$$

$$39 \frac{d\psi}{dt} = 2.8933089 \cos a_m$$

From 1842 to 1875 (Argelande) A

$$m, 1858.5 = 3.07192 \log 4874098$$

$$n \quad " \quad = 20.0558 \quad " \quad 1.3022401$$

$$= 1.33705 \quad " \quad 0.1261447$$

$$33 \frac{da}{dt} = 1^m 41.374 + 1.64466 \sin a_m \tan \psi_m$$

$$33 \frac{d\psi}{dt} = 1.8207540 \cos a_m$$

From 1810 to 1875 (Groombridge)

$$m, 1842.5 = 46.0743 = 3.07162 \log 4873675$$

$$n \quad " \quad = 20.0571 = 1.33714 \quad " \quad 1.3022651$$

$$= 1.33714 \quad " \quad 0.1261769$$

$$65 \frac{da}{dt} = 3^m 19.655 + 1.93909 \sin a_m \tan \psi_m$$

$$65 \frac{d\psi}{dt} = 3.1151815 \cos a_m$$

From 1800 to 1875 (Lalande)

$$m, 1837.5 = 46.0720 = 3.07154 \log 4873561$$

$$n \quad " \quad = 20.0575 \quad " \quad 1.3022769$$

$$= 1.33717 \quad " \quad 0.1261869$$

$$75 \frac{da}{dt} = 3^m 50.366 + 2.0012480 \sin a_m \tan \psi_m$$

$$75 \frac{d\psi}{dt} = 3.1973382 \cos a_m$$

From 1455 to 1475 (Argelande₂) B

$$m, 1465 = 46.08082 = 3.07205 - \log .4874283$$

$$n \quad " \quad = 20.05511 \quad " \quad 1.3022248$$

$$= 1.338701 \quad " \quad 1.261346$$

$$\frac{20da}{dT} = 1^m 1.441 + 1.42\% / 16 \sin a \tan P$$

$$\frac{20dv}{dT} = 2.60325 \cos a$$

Sabian reduction to 1876.0

$$D = 50^{\circ} 30' \quad \varphi - D = -8^{\circ} 4'$$

$$\begin{aligned} \log \tan D & .0839 \\ \log S & .1965 \\ \cos D & 9.8035 \\ \tan \varphi D & 9.1542 \\ \sin D & 9.6375 \\ \log \varphi D & .0043 \\ \sec \varphi D & .0086 \\ \log L & 1.7614 \\ \Delta L & = 0 \\ \sin D & 9.8844 \end{aligned}$$

$$\begin{aligned} \log S & 8.9078 \\ " T & 9.0204 \\ " u & 9.4408 \\ " v & 9.8844 \\ " L & .9156_m \end{aligned}$$

$$\begin{aligned} \log s' & 7.6806 \\ " T' & 7.5680 \\ " u' & 7.9884_m \\ " v' & 8.2672 \\ " dQ & .2337_m \end{aligned}$$

$$D = 52^{\circ} 10'$$

$$\varphi - D = -9^{\circ} 4'$$

$$\begin{aligned} \log \tan D & .1098 \\ \log S & .2123 \\ \cos D & 9.7877 \\ \sin D & 9.8975 \\ \tan \varphi D & 9.2366 \\ \log \varphi D & .0069 \\ \sec \varphi D & .0128 \\ \tan D & = 1.29 \end{aligned}$$

$$\begin{aligned} \log S & 8.9337 \\ " T & 9.0362 \\ " u & 9.4250 \\ " v & 9.8475 \\ " L & .9980_m \end{aligned}$$

$$\begin{aligned} \log s' & .8894 \\ " T' & \\ " u' & \\ " v' & \\ " dQ & \end{aligned}$$

$$m \text{ for } 1872.5 = 3.0722$$

$$n = 11 \quad 20.0545$$

$$\begin{aligned} \tan 49^{\circ} 30' & 1.1778 \\ 51^{\circ} & 1.2488 \\ 4 \tan & .072 \end{aligned}$$

Reduction for Nov. 10 1870

log α 9.6977
 $\alpha - 5$ 4.986
 $\alpha - 5$ 4.5014
 $\log \alpha - 5$ 6.5335
 $\log \alpha$ 1.30222
 $\log \gamma$ 1.95557
 $\log \beta = \log \gamma - 30470$
 $\log \gamma$ 8.35213
 $\log \beta$ -1.14
 $\log \beta$ 1.7843
 $\log \gamma$ 1.95557

$\log \beta$ 1.7843
 α_0 337 30
 γ_0 38 55
 $(\alpha + \alpha_0)$ 156 13
 $(\beta + \alpha_0)$ 16 25
 $\log h$ 1.2950
 $\log b$ 1.0931
 $\log \gamma$ 1.21
 $\alpha_0 = +303$

$\log \alpha - 5$ 6.5335
 $\log \alpha - 5$ 4.986
 $\log \alpha - 5$ 1.14080
 $\alpha - 5$ 1.3830
 $\log \gamma$ 8.635
 $\log h$ 8.154
 $\log h$ 1.1824
 $\log \beta$ 3.42

Bar. 3015
 ΔT Th. 706
 ΔT Th. 33.5
 $\log \beta$ +0080
 $\log \gamma$ -0015
 $\log \beta$ +0095
 ΔT -0095 +0065
 ΔT +0131 +0131
 $\log \beta$ 40036 .0196
 $\log \beta$ 9156w 9156w
 $\log \beta$ 9192w 9352w
 $\log \beta$ -831

T of 22^h 10^m = -2 6.600
 $\alpha_0 = +303$
 $-Z = +13830$

-Cu = -342
 $-C' = +831$
 $+ \alpha = -1 54.20$

$\Delta T = -0.20$ per hour

$T + \alpha - Z = -1 52.468$
 $-Cu - C' + \alpha = -1 46.31$
 $\log \alpha - 5$ 6.5335
 $\log \alpha - 5$ 4.986
 $\log \alpha - 5$ 1.14080
 $\alpha - 5$ 1.3830
 $\log \gamma$ 8.635
 $\log h$ 8.154
 $\log h$ 1.1824
 $\log \beta$ 3.42

α	$\log \alpha$	$\log \beta$	$\log \gamma$
22 23d	156 13	16 25	
40	158 43	18 55	
50	161 13	21 25	
23 0	163 43	23 55	
10	166 13	26 25	
20	168 43	28 55	
30	171 13	31 25	
40	173 43	33 55	
50	176 13	36 25	
0 0	178 43	38 55	
10	181 13	41 25	
20	183 43	43 55	
30	186 13	46 25	
40	188 43	48 55	

α	$\log \alpha$	$\log \beta$	$\log \gamma$	$\log \delta$	$\log \epsilon$	$\log \zeta$	$\log \eta$	$\log \theta$	$\log \iota$	$\log \kappa$	$\log \lambda$	$\log \mu$	$\log \nu$	$\log \xi$	$\log \omicron$	$\log \pi$	$\log \rho$	$\log \sigma$	$\log \tau$	$\log \upsilon$	$\log \phi$	$\log \chi$	$\log \psi$	$\log \omega$
22 23d	-2.945	-5.84	-3.529	-7.52.461	1 55.990																			
40			3.322	4.64	1.786	204	002																	
50			3.108	4.67	5.75	21																		
23 0	2.048	.838	2.586	4.67	3.59	28																		
10			2.660	4.69	55.134	223																		
20			2.429	4.69	54.906	228																		
30	1.115	1.078	2.193	4.81	6.74	232																		
40			1.953	4.84	487	237																		
50			1.710	4.84	54.197	240																		
0 0	-164	1.299	1.463	4.91	53.954	243																		
10			1.212	4.94	7.06	248																		
20			1.960	4.97	457	249																		
30	+791	1.497	1.706	5.01	53.207	250																		
40			-450	5.04	52.954	253																		

$\log \gamma$ 1.9560
 $\log \delta$ 7.6810
 $\log \epsilon$ 9.6370

$\log h$ 1.2950
 $\log i$ 1.5610
 $\log j$ 8.8630

$\log k$ 4.637
 $\log l$ 0.86
 $\log m$ 1.7614
 $\log n$ 0.536
 $\log o$ 2.373

$\log p$ 1.0931
 $\log q$ 7.7849w
 $\log r$ 8.8915w
 $\log s$ 1.728

$\log t$ 1.2950
 $\log u$ 8.2612
 $\log v$ 9.5622
 $\log w$ +0.19

α	$\log \alpha$	$\log \beta$	$\log \gamma$	$\log \delta$	$\log \epsilon$	$\log \zeta$	$\log \eta$	$\log \theta$	$\log \iota$	$\log \kappa$	$\log \lambda$	$\log \mu$	$\log \nu$	$\log \xi$	$\log \omicron$	$\log \pi$	$\log \rho$	$\log \sigma$	$\log \tau$	$\log \upsilon$	$\log \phi$	$\log \chi$	$\log \psi$	$\log \omega$
22 23d	-1.75	-0.21	+0.19	-1.72	15																			
40				1.47	15																			
50				1.32	15																			
23 0	-121	-0.30		1.16	16																			
10				1.02	16																			
20				0.85	16																			
30	-0.66	-0.38		0.69	16																			
40				0.53	16																			
0 0	-0.40	-0.46		0.37	16																			
10				0.21	16																			
20				0.04	17																			
30	+0.47	-0.03		+0.18	17																			
40																								

α	$\log \alpha$	$\log \beta$	$\log \gamma$	$\log \delta$	$\log \epsilon$	$\log \zeta$	$\log \eta$	$\log \theta$	$\log \iota$	$\log \kappa$	$\log \lambda$	$\log \mu$	$\log \nu$	$\log \xi$	$\log \omicron$	$\log \pi$	$\log \rho$	$\log \sigma$	$\log \tau$	$\log \upsilon$	$\log \phi$	$\log \chi$	$\log \psi$	$\log \omega$
22 23d	-1.75	-0.21	+0.19	-1.72	15																			
40				1.47	15																			
50				1.32	15																			
23 0	-121	-0.30		1.16	16																			
10				1.02	16																			
20				0.85	16																			
30	-0.66	-0.38		0.69	16																			
40				0.53	16																			
0 0	-0.40	-0.46		0.37	16																			
10				0.21	16																			
20				0.04	17																			
30	+0.47	-0.03		+0.18	17																			
40																								

Nov. 13 1870

$\log \theta$ 97049
 θ 5069
 $\theta - 5$ 4.4931
 $\log \theta - 5$ 65255
 $\log \theta$ 1.30222
 $\log \theta$ 1.95477
 $\log \theta$ 31430
 $\log \theta$ 8.35953
 θ -1 19
 $\log \theta$ 178 41
 $\log \theta$ 1.95488

θ 178 41
 θ 338 30
 θ 36 04
 $\theta + a$ 156 11
 $\theta + a$ 13 34
 $\log \theta$ 1.2969
 $\log \theta$ 1.0668

$\log \theta - 5$ 65255
 $\log \theta - 5$ 4745
 $\log \theta$ 114000
 θ -13806
 $\log \theta$ 8.624
 $\log \theta$ 3173
 $\log \theta$ 1.1543
 $\log \theta$ 5076
 $\log \theta$ 3218

$\log \theta$ 1.0032
 $\log \theta$ 9156
 $\log \theta$ 9188
 $\log \theta$ 8.300
 $47 \text{ per hour} = .018$
 $m = +18 + 218$
 $- 2$
 $\log \theta 49 40 = 1.178$
 $" 51 20 = 1.250$

$T \text{ of } 22^h 35^m = -2^h 48^m$
 $- 2 = + 218$
 $- 2 = + 13806$
 $- \log \theta = -3.22$
 $- \log \theta + 830$
 $9 - 14343$

$T + \theta - 2 = -1^h 53^m 46^s$
 $- \log \theta - \log \theta + 1 = -1^h 42^m 35^s$

a	$\log \theta$	$\theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$
- 22 30	156 11	13 34	9.6062	9.9613	9.3703	9.5847
40	158 41	16 04	5605	9692		
50	161 11	18 34	5086	9761		
- 23 0	163 41	21 04	4486	9821	.5556	9.9700
23 10	166 11	23 34	3781	9872		
20	168 41	26 04	2928	9915		
- 30	171 11	28 34	1855	9948	.6796	.9436
40	173 41	31 04	9.0415	9978		
50	176 11	33 34	8232	9990		
- 0 0	178 41	36 04	73613	9999	.8222	.8728
10	181 11	38 34	63150	9999	.7679	.9076
20	183 41	41 04	58028	9991		
30	186 11	43 34	50323	9975	9.6283	9.8601

a	$\log \theta$	$\theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$
22 30	-2.944	-487	-3.431	-1 53 33	57270	-2.05	-1.2246	-1.4867	7.60
40	2.649	554	3.223	1 53 33	7.065	2.09			
50	2.351	660	3.011	845	6.856	2.09			
23 0	2.048	746	2.794	-1 53 34	6.642	2.14	2.650	1.424	1223
10	1.741	830	2.571	851	6.422	2.20			
20	1.431	912	2.343	854	6.197	2.25			
30	1.117	993	2.110	857	5.967	2.30	2908	1342	1566
40	.802	1072	1.874	860	5.734	2.33			
50	.485	1149	1.634	863	5.497	2.37			
0 0	-.167	1223	1.390	866	5.256	2.41	3011	1235	1776
10	+.150	1294	1.144	869	5.013	2.43			
20	.468	1363	.895	872	4.767	2.46			
30	+.785	1431	-.646	875	4.521	2.46	2963	-11.08	18.55

$\log \theta$ 8.6355 $\log \theta$ 8.8649

$\log \theta$ 2.9564

$\log \theta$ 8.4723

$\log \theta$ 2.337

$\log \theta$ 1.700

a	$\log \theta$	$\theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$	$\log \theta + a$
22 30	-.175	-.017	+.018	-179	1.64	+.1700	+.129	-.358	+.1464
40				164	1.49				469
50				149	1.34				474
23 0	-.121	-.026	.147	134	1.19			342	478
10				119	1.04				483
20				104	.888			322	492
30	-.066	-.035	.101	.072	.056				498
40				.056	.040				506
50				.024	.008			296	515
0 0	+.080	-.043	.083	-.040	-.008				524
10				-.008	-.008				534
20				+.009	+.009			-.266	544
30	+.047	-.051	-.04	+.009	+.009				554

Constants for new stars.

log 15 1.17609
log 50 1.69897
0.11754

log $\frac{15^2}{2} = 6.73672$

log $\frac{50^2}{2} = 6.73672$

log 8.668 = 9.34997

Star	alt	S	log $\frac{15^2}{2}$	log $\frac{50^2}{2}$	log $\frac{100^2}{2}$	log $\frac{150^2}{2}$	log $\frac{200^2}{2}$	log $\frac{250^2}{2}$	log $\frac{300^2}{2}$	log $\frac{350^2}{2}$	log $\frac{400^2}{2}$	log $\frac{450^2}{2}$	log $\frac{500^2}{2}$	log $\frac{550^2}{2}$	log $\frac{600^2}{2}$	log $\frac{650^2}{2}$	log $\frac{700^2}{2}$	log $\frac{750^2}{2}$	log $\frac{800^2}{2}$	log $\frac{850^2}{2}$	log $\frac{900^2}{2}$	log $\frac{950^2}{2}$	log $\frac{1000^2}{2}$
Pleio 0	2 15	58 26	1.63	9.93046	9.71891	9.64937	-16 03	9.4590	16.57	16.560	6.3861	9.8021											
22 And.	3 34	45 21	1.99	9.85212	9.84682	9.69694	-2 58	9.7142	12.35	12.385	6.4337	9.301											
X Car	25 38	62 13	1.90	9.94680	9.66851	9.61531	-14 49	9.5567	18.61	18.687	3.520	7.517											
5 Car	29 44	53 11	1.34	9.90339	9.77761	9.68100	-10 48	9.2805	14.48	14.485	4.177	8.608											
Alcor	33 9	53 49	1.47	9.91763	9.74261	9.66724	-13 27	9.3785	15.44	15.430	4.040	8.228											
o Car	37 29	47 34	1.09	9.86809	9.82913	9.69722	-5 11	8.9572	12.85	12.849	4.339	9.124											
h Car	41 15	57 08	1.55	9.92425	9.73455	9.65880	-14 45	9.4202	15.98	15.974	3.955	8.778											
Pr 82	42 51	63 32	2.01	9.95192	9.64902	9.60094	-21 10	9.5878	19.47	19.457	3.377	3.323											
Pleio 0	48 53	60 01	1.83	9.93760	9.69875	9.63635	-17 38	9.5022	17.36	17.346	3.731	7.820											
Cons 1	17 20	69 34	1.20	9.92562	9.70961	9.64023	-17 10	9.4801	17.12	17.114	3.768	7.878											
2 Peru	30 1	47 58	1.11	9.87085	9.82579	9.69664	-5 35	8.9906	12.96	12.946	4.334	9.090											
4 Peru	35 32	50 2	1.19	9.88447	9.80777	9.69224	-7 39	9.1281	13.51	13.495	4.290	8.910											
2 Car	45 4	63 2	1.96	9.95004	9.65658	9.60656	-20 39	9.5762	19.13	19.126	3.433	3.398											
2 Andel	55 58	41 41	1.59	9.82283	9.84322	9.69605	+0 42	8.0515	11.62	11.608	4.328	9.565											
6 Peru 2	4 58	50 28	1.21	9.88720	9.80382	9.69102	-8 05	9.1524	13.63	13.619	4.277	8.871											
8 Peru	35 20	48 41	1.14	9.87568	9.81969	9.69537	-6 18	9.0436	13.14	13.130	4.321	9.029											
h Peru	41 14	53 21	1.45	9.91521	9.75478	9.66899	-12 58	9.3622	15.26	15.248	4.067	8.380											
7 Peru	45 3	52 14	1.29	9.89791	9.78707	9.68498	-9 51	9.2396	14.16	14.154	4.217	8.703											
7 Peru	55 24	53 02	1.33	9.90235	9.77946	9.68181	-10 37	9.2729	14.91	14.404	4.185	8.627											
8 Peru	59 43	40 27	1.85	9.81210	9.88137	9.70347	+1 50	8.5265	11.40	11.392	6.4402	9.9646											
1 Peru 2	59 42	49 07	1.16	9.87855	9.81592	9.69447	-6 44	9.0721	13.25	13.245	6.43119	9.88880											
a Peru 3	15 43	49 24	1.17	9.88040	9.81843	9.69383	-7 01	9.0902	13.33	13.321	4.3055	8.8631											
2 Cam 3	18 34	59 29	1.70	9.93525	9.70568	9.64093	-17 06	9.4880	17.08	17.072	3.7765	9.7856											
o Peru	21 25	47 33	1.09	9.86798	9.82927	9.69725	-5 10	8.9563	12.85	12.843	4.3397	9.0218											
Qu 716	30 54	62 47.5	1.94	9.94904	9.66073	9.60917	-24 24	9.5704	18.97	18.960	3.4089	9.2307											
7 Peru	33 41	47 22	1.09	9.86670	9.83078	9.69748	-4 59	8.9405	12.81	12.800	4.3420	9.0666											
h Peru	36 22	42 10	.91	9.82691	9.86993	9.69684	+0 13	7.5777	11.70	11.696	4.3356	9.9281											
9 Cam	46 4	60 43.5	1.78	9.94065	9.68920	9.62985	-18 20	9.5203	17.74	17.732	3.6657	9.7608											
o Peru 3	59 14	47 22	1.09	9.86670	9.83078	9.69748	-4 59	8.9405	12.81	12.800	4.3420	9.0666											
Campe 4	21 48	53 37.5	1.36	9.90588	9.77310	9.67898	-11 14	9.2980	14.63	14.616	4.1070	9.8098											
4 Camel	27 11	56 31	1.51	9.92119	9.74170	9.66289	-14 08	9.4011	15.72	15.712	3.9961	9.8458											
10 Camel	51 52	60 15	1.75	9.93862	9.69567	9.63429	-17 52	9.5083	17.48	17.470	3.7101	9.7653											
2 Aurigae	52 48	43 38	.95	9.83887	9.85960	9.69847	-1 15	8.3389	11.98	11.977	4.3579	9.3248											
5 Aurigae	53 24	40 53	.67	9.81592	9.87855	9.69447	+1 30	8.4101	11.47	11.466	4.3119	9.5743											
h Aurigae	57 24	41 73	.87	9.81738	9.87745	9.69483	+1 20	8.3669	11.50	11.495	4.3105	9.5703											
a Aurigae	57 25	45 52	1.03	9.85596	9.84282	9.69878	-3 29	8.7844	12.46	12.450	6.4350	9.91570											

	Alt	Stn	Lat	Long	Log tan	Log sin	Log cos	Log sec	i' cos	i' sec	FR	FR
Cloud	51754	62	51	1.96	-20 39	9.5743 _m	9.94969	9.65779	9.60848	19.062	6.34420	9.73017
Muriqui	3550	49	46	1.19	-7 23	9.1125 _m	9.88276	9.81017	9.69293	13.422	4.2965	9.74103
Muriqui	4229	39	6	.81	+3 17	8.7587	9.79981	9.88989	9.68980	11.18	4.2652	9.89341
Muriqui	4849	54	16	1.39	-11 53	9.3231 _m	9.90942	9.76642	9.67584	14.05	4.1256	9.97323
Muriqui	5500	44	56	1.00	-2 33	8.6484 _m	9.84578	9.84999	9.69897	12.25	6.43069	9.84966

2 Lynx
 15 Aurig.
 8 Lynx
 25 Aurig.
 15 Lynx
 64 Aurig.
 19 Lynx
 24 Lynx

Log.

$$\begin{aligned}
 &+4.12 \\
 &+2.06 \\
 &+0.00 \\
 &-2.06 \\
 &-4.12 \\
 &0.61490
 \end{aligned}$$

$$\begin{aligned}
 &2+3+4+5 = 1.03 \\
 &\frac{3+4+5}{3} = 2.06 \\
 &\frac{4+5}{3} = 3.09
 \end{aligned}$$

Index Lines

Intervals between separate lines.

Class Lines	Interval.
50°	3.205
51°	3.273
52°	3.346
53°	3.423
54°	3.505
55°	3.592

	50°	51°	52°	53°	54°	55°
$T_m - T_c =$	4.962	772	788	806	824	844
$T_c - T_f =$	2.460	3.83	3.91	4.00	4.09	4.19
$T_f - T_g =$	2.451	3.81	3.89	3.98	4.07	4.17
$T_g - T_h =$	2.534	3.94	4.03	4.12	4.21	4.31

Reduction of Broken Transits.

	50°	51°	52°	53°	54°	55°
$T_m - T_c$ to $T_m =$	2-3-4-5	1.662	1.688	1.736	1.776	1.811
$T_c - T_f$ to $T_m =$	3-4-5	3.324	3.396	3.472	3.552	3.636
$T_f - T_g$ to $T_m =$	4-5	4.986	5.094	5.208	5.328	5.454
$T_g - T_h$ to $T_m =$		4.807	4.909	5.019	5.135	5.257

Wire Intervals (Grain values)

Between Nov 11 1870 and May 25 1871

$T_m =$ *convoy*
 $T_m - T_e$ 4.962 0.69566
 $T_m - T_1$ 4.426 0.87075
 $T_m - T_2$ 9.877 0.90463
 $T_m - T_h$ 12.411 1.09381
 Mean 6.935 *convoy* 0.84105

49° 50' 1075

Red. to T_m	S	Red. to T_m	S	Red. to T_m	S	Red. to T_m	S	Red. to T_m	S
50° 0' +10.99	51° 0'	+11.02	52° 0'	+11.26	53° 0'	+11.52	54° 0'	+11.80	
1	79	1	02	1	27	1	53	1	80
2	80	2	03	2	27	2	53	2	81
3	80	3	03	3	28	3	54	3	81
4	80	4	04	4	28	4	54	4	82
5	81	5	04	5	28	5	55	5	82
6	81	6	05	6	29	6	55	6	83
7	82	7	05	7	29	7	56	7	83
8	82	8	05	8	30	8	56	8	84
9	82	9	06	9	30	9	56	9	84
10	83	10	06	10	31	10	57	10	85
11	83	11	06	11	31	11	57	11	85
12	83	12	07	12	31	12	58	12	86
13	84	13	07	13	32	13	58	13	86
14	84	14	08	14	32	14	59	14	87
15	85	15	08	15	33	15	59	15	87
16	85	16	08	16	33	16	60	16	88
17	85	17	09	17	34	17	60	17	88
18	86	18	09	18	34	18	60	18	88
19	86	19	10	19	34	19	61	19	89
20	87	20	10	20	35	20	61	20	89
21	87	21	10	21	35	21	62	21	90
22	87	22	11	22	36	22	62	22	90
23	88	23	11	23	36	23	63	23	91
24	88	24	12	24	37	24	63	24	91
25	88	25	12	25	37	25	64	25	92
26	89	26	12	26	37	26	64	26	92
27	89	27	13	27	38	27	64	27	93
28	90	28	13	28	38	28	65	28	93
29	90	29	14	29	39	29	65	29	94
30	91	30	14	30	40	30	66	30	94
31	91	31	14	31	40	31	66	31	95
32	92	32	15	32	40	32	67	32	95
33	92	33	15	33	40	33	67	33	96
34	92	34	16	34	41	34	68	34	96
35	92	35	16	35	41	35	68	35	97
36	93	36	16	36	42	36	69	36	97
37	93	37	17	37	42	37	69	37	98
38	93	38	17	38	43	38	69	38	98
39	94	39	18	39	43	39	70	39	99
40	94	40	18	40	44	40	70	40	99
41	94	41	18	41	44	41	71	41	12.00
42	95	42	19	42	44	42	71	42	00
43	95	43	19	43	45	43	72	43	01
44	96	44	20	44	45	44	72	44	01
45	96	45	20	45	46	45	73	45	02
46	96	46	21	46	46	46	73	46	02
47	97	47	21	47	47	47	74	47	03
48	98	48	22	48	47	48	74	48	03
49	98	49	22	49	48	49	75	49	04
50	99	50	23	50	48	50	75	50	04
51	99	51	23	51	49	51	76	51	05
52	10.00	52	23	52	49	52	76	52	05
53	10.00	53	24	53	50	53	77	53	06
54	11.00	54	24	54	50	54	77	54	06
55	00	55	25	55	51	55	78	55	07
56	01	56	25	56	51	56	78	56	07
57	02	57	26	57	52	57	79	57	08
58	02	58	26	58	52	58	79	58	08
59	02	59	26	59	52	59	80	59	09
60	+11.02	60	+11.26	60	+11.52	60	+11.80	60	+12.09

Wine nitroals Dec 10 1870

	$T_m - T_c$	$T_m - T_f$	$T_m - T_g$	$T_m - T_u$	$\log T$	$\log T$	$\log T$	$\log T$	i_1	i_2	i_3	i_4
<i>Penni</i> 28 9.80382	7.9	11.6	15.5	19.5	0.89763	1.86446	4.19033	1.29053	5.03	7.38	9.87	12.41
<i>Penni</i> 28 9.80382	10.0	15.3	20.3	25.0	1.00000	1.18469	1.18469	1.39794	4.89	7.48	9.92	12.22
<i>Penni</i> 28 9.80382	8.9	13.9	18.0	22.4	0.94939	1.14301	1.25527	1.35025	4.87	7.67	9.93	12.35
<i>Penni</i> 28 9.80382	10.0	14.8	19.7	24.8	1.00000	1.17026	1.29447	1.39445	4.96	7.34	9.98	12.30
<i>Penni</i> 28 9.80382	7.5	11.3	15.0	18.7	0.87506	1.05308	1.19604	1.27184	4.95	7.46	9.90	12.35
<i>Penni</i> 28 9.80382	8.5	13.0	17.2	21.5	0.92942	1.11394	1.23553	1.32244	4.83	7.39	9.78	—
<i>Penni</i> 28 9.80382	8.0	12.0	16.1	20.2	0.90309	1.07918	1.20683	1.30535	4.90	7.35	9.86	12.37
<i>Penni</i> 28 9.80382	10.7	16.1	21.4	26.8	1.02938	1.20683	1.33041	1.42813	4.89	7.36	9.79	12.25
<i>Penni</i> 28 9.80382	7.3	10.9	14.5	17.4	0.86332	1.03743	1.16137	1.26482	4.94	7.38	9.82	12.46
<i>Penni</i> 28 9.80382	8.1	12.3	16.6	20.7	0.88449	1.08991	1.22011	1.31597	4.80	7.30	9.85	12.28

4.910
7.411
9.870
12.333
34.524
8.631

24.524
6.905
8.631
6.905

4.910 7.411 9.870 12.333

Spr Polars 88 34 21 (1871)
Log cos S 8.38093

Log K
00010
7
3
1
—
1
3
7
10

Intervals from Polaris

Date	Nov. 13	Nov. 21	Dec 31	Dec 31	Jan 1	Dec 21	Jan 7	Jan 9	Jan 12	Jan 17	Jan 22	Jan 25
Ton-Tu	5176	5141	5154	5176	588.6	5160	5191	5143	5146	5172	5192	
Ton-Th	4109	4093			4118	4092	4101	4104	4123	4104	4149	
Tu-We	3089	3071			3105	3081	3121	3077	3045	3080	3114	
Th-Fri	2071	2052			2061	2072	2069	2026	2090	2051		
Tu-Th	2051	2086	2044	2070	2073	2071	2044	2098		2058	2083	2076
Tu-Th	3078	3095	3092	3090	3074	3112	3094	3122		3095	3067	3091
Tu-Th	4106	4128	4109	4122	4135	4115	4090			4108	4088	4068
Tu-Th	5162	5159	5157	5176	5179	5191	5182	5214		5158	5129	5176
	3844	3617	3601	3614	3615	3619	3592			3600	3582	3603
Nov 1	271399	71105	—	—	71483	71265	71525	71122	71147	71366	—	—
Nov 2	261374	61204	—	—	61469	61194	61289	61352	61521	61352	—	—
Nov 3	24882	48728	—	—	49206	48869	49429	48873	48344	48555	—	—
Nov 4	231618	31218	—	—	31408	31639	31576	30664	32015	3197	—	—
Nov 5	31194	31931	31112	31594	31660	31597	31112	32181		31345		31723
Nov 6	48824	49066	49024	49443	48874	49304	49052	49443		48785		49010
Nov 7	61342	61574	61374	61511	61648	61437	61172			61363		60938
Nov 8	71282	71257	71240	71399	71425	71357	71071			71248		71399
Nov 1	202292	01998	—	—	02376	02158	02418			02259		
Nov 2	192264	92094	—	—	92362	92097	92182			92245		
Nov 3	177875	77621	—	—	80099	62532	80322			79748		
Nov 4	162511	62111	—	—	62301	62490	62469			62080		
Nov 5	169290	60024	65205	96	62490	6253	80197	62005		62298		62616
Nov 6	177920	77955	77914	80336	77663	92330	77945			77678		77903
Nov 7	192245	92467	92267	92889	92541	02250	92065			92256		91831
Nov 8	202175	02150	02133	02292	02318	01964				02141		02292
Nov 1	06989	06223	69990	67689	69757	80086	80044			69437		69816
Nov 2	88817	87158	87114	87086	86860	87894	87143			86875		87100
Nov 3	99738	99660	99460	99577	99734	99523	99258			99249		99024
Nov 4	09365	09340	09323	09482	09508	09440	07754			09331		09482
Nov 1	4930	5016	4919	4976	4983	4976	4921			4944		4991
Nov 2	8399	7440	7433	7428	7389	7481	7437			7392		7430
Nov 3	9872	9922	9876	9908	9939	9891	9831			9873		9778
Nov 4	12405	12400	12395	12440	12447	12428	12346			12396		12440
Nov 1	4930	7399	9872	12405	3599							
Nov 2	5015	440	922	400	3617							
Nov 3	4918	433	876	395	3601							
Nov 4	4976	428	908	440	3614							
Nov 5	4983	389	939	447	3615							
Nov 6	4976	481	891	428	3619							
Nov 7	4921	437	831	346	3582							
Nov 8	4947	392	873	386	3600							
Nov 1	4991	430	778	440	3603							
Nov 2	44658	3829	7890	3697	5460							
Nov 3	4962	7425	9877	12411	3607	loy 255715						
Nov 4	7426				loy 4838093							
Nov 5	9877				093808							
Nov 6	12411				8.671							
Nov 7	34676											
Nov 8	8.669											

Reading of circles Apr 20 5^h

A

B

b

1870phae.proj

0 5	222 228 233 235 239 247	168 164 164 164 164 164	2314 2330 2346	291 287 288 288 300 1475 2950	289 280 283 291 289 452 2904	2904 2890 29986 2950 3020 30070	40 5	334 180 340 173 337 185 339 180 340 181 190 384 3380188	369 188 368 184 367 183 368 181 360 182 332 188 366 187	3380 343 184 184 184 3664 342 30078
0 0	232 233 230 236 234 15 2330	170 168 163 167 160 162 1774 323 1646	2314 2330 2346	304 308 303 299 298 1512 3024	298 284 291 292 291 445 2890		40 00	350 180 350 188 346 184 345 189 350 182 292 446 3489182	377 194 374 192 376 191 371 190 373 190 371 3742	1778 1892 30004 1876 1926 30050 30064
5 5							45 5			
5 0							45 0			
10 5	208 221 210 205 214 58 2116	178 178 170 180 178 394 1788	2116 2292 30176	295 292 290 284 48 2896	2896 2862 30066 2840 2858 30018	60 5	287 291 293 287 288 486 2912	332 337 330 333 331 18 3386	2912 2972 30060 3336 3380 30044	
10 0	227 228 235 226 230 146 2292	179 180 187 185 188 429 1858	1788 1858 30070	297 295 299 288 292 481 2962	289 283 284 285 280 429 2858	50 0	292 299 294 308 296 1486 2972	339 339 334 338 340 190 3380		
15 5							55 5			
15 0							55 0			

A b				
60 5	238	266	22116	
	210	268	2292	
	229	268	800,46	80 5
	224	264		
	230	262	2292	
	123	28	20	
	2246	2656	2656	
			2750	
			30094	

60 0	232	275		
	227	276		
	238	272	80 0	
	226	277		
	223	275		
	146	25		
	2292	2750		

65 5 85 5

65 0 85 0

70 5	227	288	2266	
	224	288	2399	
	228	287	30128	90 5
	226	284		
	233	282	2858	
	2266	28	2894	
		2858	30236	

70 0	243	292	2	
	232	289		
	230	290	90 0	
	237	288		
	199	288		
	2394	447		
		2874		

75 5 95 5

95 0 95 0

A b				
100 5	360	441	3610	
	365	442	37114	
	358	443	30104	
	370	440		
	352	440	4422	
	305	11	4462	
	3610	442	30040	

100 0	374	450		
	372	442		
	364	450		
	375	442		
	372	444		
	354	28		
	3714	4462		

105 5

105 0

110 5	250	374	2394	
	230	315	2406	
	237	318	30062	
	241	310		
	234	317	3148	
	193	28	3178	
	2394	3198	30040	

110 0	249	323		
	250	322		
	242	312		
	239	314		
	248	318		
	228	89		
	2456	3178		

115 5

115 0

A b				
100 5	220	287	2224	
	214	281	2270	
	223	282	30046	
	225	282		
	230	281		
	112	405	2910	
	2224	2910	2962	
			30052	

100 0	231	300		
	225	284		
	224	288		
	224	287		
	228	282		
	185	1481		
	2240	2962		

105 5

105 0

110 5	232	311	2276	
	232	308	2346	
	222	307	30070	
	223	311		
	229	313	3100	
	138	50	3172	
	2276	3100	30072	

110 0	240	320		
	230	322		
	230	314		
	235	318		
	238	312		
	173	86		
	2346	3172		

115 5

115 0

$$\begin{array}{r}
 120 \text{ } 5 \\
 \begin{array}{r}
 22.9 \\
 23.0 \\
 23.2 \\
 22.8 \\
 \hline
 22.3 \\
 142 \\
 \hline
 2284
 \end{array}
 \end{array}
 \begin{array}{r}
 120 \text{ } 5 \\
 \begin{array}{r}
 315 \quad 2284 \\
 318 \quad 24.66 \\
 320 \quad 301.82 \\
 \hline
 312 \quad 3150 \\
 75 \quad 32.58 \\
 \hline
 3150 \quad 301.08
 \end{array}
 \end{array}$$

$$\begin{array}{r}
 120 \text{ } 0 \\
 \begin{array}{r}
 25.2 \\
 24.5 \\
 24.3 \\
 24.2 \\
 \hline
 25.1 \\
 23.3 \\
 \hline
 2466
 \end{array}
 \end{array}
 \begin{array}{r}
 120 \text{ } 0 \\
 \begin{array}{r}
 330 \\
 324 \\
 330 \\
 323 \\
 \hline
 332 \\
 129 \\
 \hline
 3258
 \end{array}
 \end{array}$$

$$125 \text{ } 5 \quad 145 \text{ } 5$$

$$125 \text{ } 0 \quad 145 \text{ } 0$$

$$\begin{array}{r}
 130 \text{ } 5 \\
 \begin{array}{r}
 130 \\
 118 \\
 124 \\
 120 \\
 \hline
 120 \\
 112 \\
 \hline
 1224
 \end{array}
 \end{array}
 \begin{array}{r}
 130 \text{ } 5 \\
 \begin{array}{r}
 180 \\
 182 \\
 186 \\
 180 \\
 \hline
 188 \\
 426 \\
 \hline
 1852
 \end{array}
 \end{array}
 \begin{array}{r}
 130 \text{ } 5 \\
 \begin{array}{r}
 122.4 \\
 136.6 \\
 \hline
 301.42 \\
 185.2 \\
 19.26 \\
 \hline
 300.74
 \end{array}
 \end{array}$$

$$\begin{array}{r}
 130 \text{ } 0 \\
 \begin{array}{r}
 130 \\
 136 \\
 134 \\
 134 \\
 \hline
 136 \\
 38 \\
 \hline
 1366
 \end{array}
 \end{array}
 \begin{array}{r}
 130 \text{ } 0 \\
 \begin{array}{r}
 194 \\
 190 \\
 198 \\
 190 \\
 \hline
 191 \\
 13 \\
 \hline
 1926
 \end{array}
 \end{array}$$

$$135 \text{ } 5 \quad 155 \text{ } 5$$

$$135 \text{ } 0 \quad 155 \text{ } 0$$

$$\begin{array}{r}
 112 \\
 113 \\
 120 \\
 122 \\
 \hline
 130 \\
 98 \\
 \hline
 1194
 \end{array}
 \begin{array}{r}
 146 \\
 145 \\
 144 \\
 144 \\
 \hline
 150 \\
 235 \\
 \hline
 1490
 \end{array}
 \begin{array}{r}
 1194 \\
 1266 \\
 \hline
 30072 \\
 160 \text{ } 5 \\
 1490 \\
 1552 \\
 \hline
 30082
 \end{array}$$

$$\begin{array}{r}
 125 \\
 124 \\
 122 \\
 129 \\
 \hline
 133 \\
 103 \\
 \hline
 1266
 \end{array}
 \begin{array}{r}
 153 \\
 158 \\
 154 \\
 156 \\
 \hline
 155 \\
 26 \\
 \hline
 1552
 \end{array}$$

$$160 \text{ } 0$$

$$160 \text{ } 5$$

$$165 \text{ } 0$$

$$\begin{array}{r}
 152 \\
 151 \\
 156 \\
 150 \\
 \hline
 158 \\
 17 \\
 \hline
 1534
 \end{array}
 \begin{array}{r}
 184 \\
 182 \\
 188 \\
 187 \\
 \hline
 192 \\
 436 \\
 \hline
 1872
 \end{array}
 \begin{array}{r}
 1534 \\
 1684 \\
 \hline
 30150 \\
 1872 \\
 1922 \\
 \hline
 30150
 \end{array}$$

$$\begin{array}{r}
 164 \\
 168 \\
 171 \\
 171 \\
 \hline
 165 \\
 342 \\
 \hline
 1684
 \end{array}
 \begin{array}{r}
 193 \\
 188 \\
 191 \\
 191 \\
 \hline
 198 \\
 461 \\
 \hline
 1922
 \end{array}$$

$$170 \text{ } 0$$

$$175 \text{ } 5$$

$$175 \text{ } 0$$

$$\begin{array}{r}
 198 \\
 200 \\
 204 \\
 204 \\
 \hline
 211 \\
 1020 \\
 \hline
 2040
 \end{array}
 \begin{array}{r}
 180 \quad 2040 \\
 176 \quad 2158 \\
 174 \quad 301.98 \\
 178 \\
 \hline
 177 \\
 385 \\
 \hline
 1770
 \end{array}$$

$$\begin{array}{r}
 221 \\
 225 \\
 245 \\
 210 \\
 \hline
 223 \\
 94 \\
 \hline
 2188
 \end{array}
 \begin{array}{r}
 193 \\
 184 \\
 191 \\
 190 \\
 \hline
 188 \\
 446 \\
 \hline
 1892
 \end{array}$$

$$\begin{array}{r}
 174 \\
 162 \\
 163 \\
 164 \\
 \hline
 170 \\
 336 \\
 \hline
 1672
 \end{array}
 \begin{array}{r}
 152 \quad 1672 \\
 163 \quad 1844 \\
 159 \quad 172 \\
 161 \\
 \hline
 156 \\
 291 \\
 \hline
 1582
 \end{array}$$

$$\begin{array}{r}
 185 \\
 180 \\
 181 \\
 182 \\
 \hline
 184 \\
 422 \\
 \hline
 1844
 \end{array}
 \begin{array}{r}
 170 \\
 164 \\
 166 \\
 170 \\
 \hline
 169 \\
 339 \\
 \hline
 1678
 \end{array}$$

A b			A b			A b		
180	5	121 98 119 107 121 106 122 101 129 101 112 83 1224 1026 30096	200	5	48 54 58 53 61 277 554	220	5	00 534 03 588 04 30034 00 02 9 18 0.18 84 30066

180	0	136 105 124 111 133 101 132 102 135 104 160 23 1320 1046	200	0	58 59 64 62 51 294 588	220	0	238 152 241 150 250 150 238 154 241 153 208 9 2416 1518
-----	---	--	-----	---	--	-----	---	---

185 5 205 5 225 5

185 0 205 0 225 0

190	5	48 00 462 39 -03 498 50 +02 30036 54 +01 49 -04 47 -088 231 -08 462 30094 462	200	5	53 28 824 84 19 1040 94 20 30116 53 22 95 18 462 104 208 924 208 30068	230	5	149 61 1524 144 60 1534 154 61 30010 154 64 155 68 634 155 68 262 14 1524 634 638 30054
-----	---	---	-----	---	--	-----	---	---

190	0	50 708 52 10 48 08 53 10 46 07 248 43 9880 086	210	0	102 29 101 30 109 29 100 24 108 213 20 18 1040 276	230	0	156 61 158 63 152 63 149 68 152 64 267 19 1584 638
-----	---	--	-----	---	--	-----	---	--

195 5 215 5 235 5

195 0 215 0 235 0

240-5	A 139 141 138 140 141 139 138 1898	B 50 48 51 43 44 239 478 478	1398 1448 300.50	260-5	A 150 145 148 150 151 244 1488 1488	B 19 22 20 18 22 101 202 202	1488 1656 300.68	280-5	A 250 240 245 254 252 24 2482 2482	B 126 121 120 123 129 19 1238 1238	1238 2574 300.32
240-0	143 139 142 151 149 224 1448 1448	54 51 51 52 56 14 528 528		260-0	164 140 161 159 171 328 1656 1656	34 21 25 29 32 154 308 308		280-0	254 245 253 244 255 257 2514 2514	130 122 129 121 130 132 1264 1264	
245-5				265-5				285-5			
245-0				265-0				285-0			
250-5	190 181 185 190 182 428 1856 1856	68 67 80 78 79 372 744 744	1856 1962 300.06	270-5	172 169 170 171 168 350 1700 1700	47 38 42 38 38 204 408 408	1700 1866 300.66	290-5	221 212 217 213 206 69 2138 2138	81 80 80 83 81 399 898 898	898 2138 300.32
250-0	198 198 193 201 192 982 1964 1964	81 88 83 90 90 432 864 864		270-0	186 180 191 192 182 433 1866 1866	50 47 42 49 41 229 458 458		290-0	235 224 227 231 227 144 2288 2288	88 82 87 87 87 415 830 830	
265-5				275-5				295-5			
265-0				275-0				295-0			
265-5				275-5				295-5			
265-0				275-0				295-0			

300 5

A	b
225	40
209	67
210	68
211	62
67	69
2134	336
	672
	<u>430</u>
	30758

320 5

A	b
160	48
159	51
160	49
152	43
156	52
287	243
1574	486
	486
	<u>530</u>
	30744

340 5

A	b
199	126
182	125
180	128
180	114
191	122
42	115
1864	1230

300 0

A	b
218	51
228	71
223	68
229	73
228	72
126	315
2252	430

320 0

A	b
160	50
157	53
169	57
165	55
163	56
314	150
1628	530

340 0

A	b
205	141
194	133
202	135
203	130
208	131
1012	150
2024	1360
20160	30130

310 5

A	b
200	71
189	68
198	68
193	69
196	70
976	346
1952	692
	<u>400</u>
	30078

330 5

A	b
138	27
127	20
129	21
133	22
138	20
160	10
1330	250
	296
	<u>30746</u>

350 5

A	b
127	42
130	43
129	42
121	43
124	48
131	18
1262	436
	1262
	<u>1368</u>
	30076

310 0

A	b
217	71
208	70
199	68
200	70
201	69
1025	70
2000	346
	69700

330 0

A	b
135	35
140	34
148	30
143	27
146	36
232	148
1464	296

350 0

A	b
138	52
133	58
138	50
135	57
130	52
124	18
1348	528
	528
	<u>528</u>
	30102

= 50°

arg.	R	4 Sin	arg.	R	4 Sin	arg.	R	4 Sin	arg.	R	4 Sin
1.0	1.758	.0273	8.0	6.2064	15.0	11.6370	22.0	17.0676			
1.1			8.1		15.1		22.1				
1.2			8.2		15.2		22.2				
1.3			8.3		15.3		22.3				
1.4			8.4		15.4		22.4				
1.5			8.5		15.5		22.5				
1.6			8.6		15.6		22.6				
1.7			8.7		15.7		22.7				
1.8			8.8		15.8		22.8				
1.9			8.9		15.9		22.9				
2.0	1.5516		9.0	6.9822	16.0	13.4128	23.0	17.8434			
2.1			9.1		16.1		23.1				
2.2			9.2		16.2		23.2				
2.3			9.3		16.3		23.3				
2.4			9.4		16.4		23.4				
2.5			9.5		16.5		23.5				
2.6			9.6		16.6		23.6				
2.7			9.7		16.7		23.7				
2.8			9.8		16.8		23.8				
2.9			9.9		16.9		23.9				
3.0	2.3274		10.0	7.7580	17.0	13.1886	24.0	18.6192			
3.1			10.1		17.1		24.1				
3.2			10.2		17.2		24.2				
3.3			10.3		17.3		24.3				
3.4			10.4		17.4		24.4				
3.5			10.5		17.5		24.5				
3.6			10.6		17.6		24.6				
3.7			10.7		17.7		24.7				
3.8			10.8		17.8		24.8				
3.9			10.9		17.9		24.9				
4.0	3.1032		11.0	8.5338	18.0	13.9644	25.0	19.3850			
4.1			11.1		18.1		25.1				
4.2			11.2		18.2		25.2				
4.3			11.3		18.3		25.3				
4.4			11.4		18.4		25.4				
4.5			11.5		18.5		25.5				
4.6			11.6		18.6		25.6				
4.7			11.7		18.7		25.7				
4.8			11.8		18.8		25.8				
4.9			11.9		18.9		25.9				
5.0	3.8790		12.0	9.3096	19.0	14.7402	26.0	20.1708			
5.1			12.1		19.1		26.1				
5.2			12.2		19.2		26.2				
5.3			12.3		19.3		26.3				
5.4			12.4		19.4		26.4				
5.5			12.5		19.5		26.5				
5.6			12.6		19.6		26.6				
5.7			12.7		19.7		26.7				
5.8			12.8		19.8		26.8				
5.9			12.9		19.9		26.9				
6.0	4.6548		13.0	10.0354	20.0	15.5760	27.0	20.9466			
6.1			13.1		20.1		27.1				
6.2			13.2		20.2		27.2				
6.3			13.3		20.3		27.3				
6.4			13.4		20.4		27.4				
6.5			13.5		20.5		27.5				
6.6			13.6		20.6		27.6				
6.7			13.7		20.7		27.7				
6.8			13.8		20.8		27.8				
6.9			13.9		20.9		27.9				
7.0	5.4306		14.0	10.8612	21.0	16.2918	28.0	21.7224			
7.1			14.1		21.1		28.1				
7.2			14.2		21.2		28.2				
7.3			14.3		21.3		28.3				
7.4			14.4		21.4		28.4				
7.5			14.5		21.5		28.5				
7.6			14.6		21.6		28.6				
7.7			14.7		21.7		28.7				
7.8			14.8		21.8		28.8				
7.9			14.9		21.9		28.9				
8.0	6.2064		15.0	11.6370	22.0	17.0676	29.0	22.4982			
8.1			15.1		22.1		29.1				

1870phae.proj...427R
006

$\delta = 51^\circ$ Arg. R ad sid' Arg R ad sid' Arg R ad sid' Arg R ad sid'

79

52

825

095

371

644

917

$$\psi = 52^\circ \&$$

arg. R also arg. B also arg. B also arg. R also

Observations and Reductions for the inclination of the inclined wire.

Note. Observations of Polaris at equal distances from the meridian show that the horizontal wire is nearly if not quite truly horizontal

Designating the first wire in the order of R. H. by T_1
 " " second " " " " T_2
 " " last " " " " T_n
 " " last-but-one " " " " T_{n-1}

Then,

$$T_n - T_1 = 25^m 51^s = 55.85^\circ \text{ sec } 2.44577$$

$$T_n - T_m = 25^m 49^s = 55.82^\circ \text{ sec } 2.44528$$

$$T_m - T_2 = 17^m 14^s = 34.91^\circ \text{ sec } 2.44574$$

$$T_n - T_m = 17^m 13^s = 34.89^\circ \text{ sec } 2.44562$$

Direct observation Jan 17/1871

MR O'Brien 2 33.8 1 23.2 90.60

MR 1. Camel 3 15.0 10.9 2 44.8 40.0 90.53

SM alvirne 3 55.4 5.18 2 25.1 21.7 90.65

SM 19 Lyncis 4 47.0 44.5 3 16.0 14.2 90.65

log 7 3.04656
 " 4 1.95418
 " log 8.91062
 < 4 39 13

From the collimators Jan 17/1871
 Reading of the screw-head at the intersection of the horizontal and inclined wires = 44.90

Y. of T_1	Y. of T_2	Y. of T_n	Y. of T_{n-1}
122 22	272 165	568 407	413 314
123 13	271 194	566 462	411 369
124 22	271 168	572 434	412 341
122 18	270 164	567 464	410 303
123 11	278 168	568 464	408 313
123 22 172	2730 1680	5682 4608	4108 3106
2730	1680	4108	4498
45.02	44.92	40.26	44.98
44.86	44.98		
89.28	89.90		

556.90
 556.24
 13.7
 556.58

1113.17

4 35 08
 4 37 02
 12 10
 4 36 05

log 3.04656 2.04656
 1.95075 1.95376
 8.90419 8.90720

4 35 08 4 37 02

Inclination Jan 20 1871

1st Set of Readings

Foot T_1		Foot T_2	
A	B	A	B
1 2864	1884	2 1204	230
		<u>2864</u>	<u>1884</u>
		4340	4346

Foot T_1		Foot T_2	
A	B	A	B
4 4386	3436	5 2944	1906
		<u>4 4386</u>	<u>3436</u>
		4558	4420
		<u>4390</u>	<u>4396</u>
		8898	8816

This set - to be rejected
on account of bad ill
illumination

2nd Set

1 2820	1816	2 1174	192
2		<u>1 2820</u>	<u>1816</u>
		4354	4376
		<u>4532</u>	<u>4568</u>
		8886	8944

4 4326	3404	5 2858	1972
		<u>4326</u>	<u>3404</u>
		4532	4568

log x	3.04656	3.04656
log y	94871	1.95153
log tan	8.90015	8.90497
L	4 3236	4 3538
		<u>4 3236</u>
		814
		4 34 04

Direct observation	4	39 13
Collimator Jan 17	4	36 05
" Jan 20	4	<u>34 07</u>
		19 25
		4° 36' 28"

Value adopted from Dec 10 1870 to

= 4° 36'

log tan 4° 36'	8.90554	51° 40'	8.90554
cos 50°	9.80804		9.79286
log 15	1.17609		<u>1.17609</u>
	988973		987422
	<u>7758</u>		<u>7485</u>
	7485		
	.0373		= change for 100'

Computation of wave intervals

Star	$\checkmark$	$T_m - T_e$	$T_m - T_f$	$T_m - T_g$	$T_m - T_h$	Star	$\checkmark$	$T_m - T_e$	$T_m - T_f$	$T_m - T_g$	$T_m - T_h$
γ Cass	53 11	8.3	12.3	15.6	20.6	α Persei	49 29	7.5	11.4	15.2	19.0
α Cass	55 49	8.8	13.2	17.6	21.8	α Can	59 29	9.9	14.6	19.5	24.3
η Cass	57 8	9.0	13.8	18.1	22.9	α Persei	47 33	7.4	11.2	14.6	18.6
δ Cass	60 0	9.9	14.8	19.6	24.7	α Aurig.	45 52	7.7	11.6	15.4	19.1
γ Persei	53 0	8.3	12.5	16.6	20.7						
γ Cephei	76 54	21.9	32.6	43.9	54.7						
α Bootis		7.6	11.4	15.5	19.4						
Mean	59 38	11.03	16.53	21.90	27.57	50 35		8.12	12.20	16.18	20.25
Long Do.		1.04258	1.21827	1.34044	1.44094			0.90956	0.8636	1.20898	1.30643
α Cass		70482	70482	70482	70482			9.80274			
					14526			71230	88910	011721	10917
	55 50	8.86	13.32	17.50	22.16						
		0.94743	1.12450	1.24304	1.34557						
ϵ		4.977	7.480	9.828	12.450			5.156			

	5. 50°	5. 51°	6. 52°	5. 53°	5. 54°
1. 5	319	1936	0583	9230	7856
2	404	2760	1401	0020	8627
3	458	3584	2209	0810	9398
4	572	4408	3017	1600	0169
5	657	5232	3825	2390	0940
6	7410	6064	4632	3184	1712
7	8253	6880	5430	3974	2483
8	9056	7716	6238	4764	3254
9	9839	8542	7046	5554	4025
10	0782	9368	7854	6344	4796
11	1625	0194	8662	7134	5567
12	2468	1020	9470	7920	6338
13	3311	1846	0278	8710	7109
14	4154	2672	1086	9500	7880
15	4997	3498	1894	0290	8651
16	5834	4322	2711	1082	9426
17	6677	5148	3519	1872	0197
18	7519	5974	4327	2662	0968
19	8362	6800	5135	3452	1739
20	9204	7626	5943	4242	2510
21	0047	8452	6751	5032	3281
22	0890	9278	7559	5822	4052
23	1732	0104	8367	6612	4823
24	2575	0930	9175	7402	5594
25	3418	1756	9983	8192	6365
26	4260	2580	0790	8980	7140
27	5103	3406	1598	9770	7911
28	5945	4232	2406	0530	8682
29	6788	5058	3214	1320	9453
30	7630	5884	4022	2110	0224
31	8473	6710	4830	2900	0995
32	9315	7536	5638	3690	1766
33	0158	8362	6446	4480	2537
34	1000	9188	7254	5270	3308
35	1843	0014	8062	6060	4079
36	2686	0838	8869	6858	4859
37	3529	1664	9677	7668	5625
38	4371	2490	0485	8458	6396
39	5214	3316	1293	9248	7167
40	6056	4142	2101	0038	7938
41	6898	4968	2909	0828	8709
42	7741	5794	3717	1618	9480
43	8583	6620	4525	2408	0251
44	9425	7446	5333	3198	1022
45	0268	8272	6141	3988	1793
46	1112	9096	6948	4776	2568
47	1955	9922	7756	5566	3339
48	2797	0748	8564	6356	4110
49	3640	1574	9372	7146	4881
50	4482	2400	0180	7936	5652
51	5325	3226	0988	8726	6423
52	6167	4052	1796	9516	7194
53	7010	4888	2604	0306	7965
54	7852	5704	3412	1096	8736
55	8695	6530	4220	1886	9507
56	9538	7354	5027	2674	0282
57	0381	8160	5835	3464	1053
58	1223	8986	6643	4254	1824
59	2066	9812	7451	5044	2595
60	2908	0638	8259	5834	3366
61	3751	1464	9067	6624	4137
62	4593	2290	9875	7414	4908
63	5436	3116	0683	8204	5679
64	6278	3942	1491	8994	6450
65	7121	4768	2299	9784	7221
66	7964	5594	3106	0572	7990
67	8807	6438	3914	1362	8761
68	9649	7264	4722	2152	9532
69	0492	8090	5530	2942	0303
70	1334	8926	6338	3732	1074
71	2177	9752	7146	4522	1845
72	3019	0578	7954	5312	2616
73	3862	1404	8762	6102	3387
74	4704	2230	9570	6892	4158
75	5547	3056	0378	7682	4929
76	6390	3880	1185	8470	5700
77	7232	4704	2000	9258	6471
78	8074	5528	2818	0046	7242
79	8916	6352	3636	0834	8013
80	9758	7176	4454	1622	8784
81	0600	8000	5272	2410	9555
82	1442	8824	6090	3198	0326
83	2284	9648	6908	3986	1097
84	3126	0472	7726	4774	1868
85	3968	1296	8544	5562	2639
86	4810	2120	9362	6350	3410
87	5652	2944	0180	7140	4181
88	6494	3768	0998	7930	4952
89	7336	4592	1816	8720	5723
90	8178	5416	2634	9510	6494
91	9020	6240	3452	0302	7265
92	9862	7064	4270	1092	8036
93	0704	7888	5088	1882	8807
94	1546	8712	5906	2672	9578
95	2388	9536	6724	3462	0349
96	3230	0360	7542	4252	1120
97	4072	1184	8360	5042	1891
98	4914	2008	9178	5832	2662
99	5756	2832	0000	6622	3433
100	6598	3656	0818	7412	4204
101	7440	4480	1636	8202	4975
102	8282	5304	2454	8992	5746
103	9124	6128	3272	9782	6517
104	0000	6952	4090	0570	7288
105	0842	7776	4908	1360	8059
106	1684	8600	5726	2150	8830
107	2526	9424	6544	2940	9601
108	3368	0248	7362	3730	0372
109	4210	1072	8180	4520	1143
110	5052	1896	9000	5310	1914
111	5894	2720	9818	6100	2685
112	6736	3544	0636	6890	3456
113	7578	4368	1454	7680	4227
114	8420	5192	2272	8470	4998
115	9262	6016	3090	9260	5769
116	0104	6840	3908	0050	6540
117	0946	7664	4726	0840	7311
118	1788	8488	5544	1630	8082
119	2630	9312	6362	2420	8853
120	3472	0136	7180	3210	9624
121	4314	0960	8000	4000	0395
122	5156	1784	8820	4790	1166
123	5998	2608	9640	5580	1937
124	6840	3432	0458	6370	2708
125	7682	4256	1276	7160	3479
126	8524	5080	2094	7950	4250
127	9366	5904	2912	8740	5021
128	0208	6728	3730	9530	5792
129	1050	7552	4548	0320	6563
130	1892	8376	5366	1110	7334
131	2734	9200	6184	1900	8105
132	3576	0024	7002	2690	8876
133	4418	0848	7820	3480	9647
134	5260	1672	8638	4270	0418
135	6102	2496	9456	5060	1189
136	6944	3320	0274	5850	1960
137	7786	4144	1092	6640	2731
138	8628	4968	1910	7430	3502
139	9470	5792	2728	8220	4273
140	0312	6616	3546	9010	5044
141	1154	7440	4364	9800	5815
142	1996	8264	5182	0590	6586
143	2838	9088	6000	1380	7357
144	3680	0000	6818	2170	8128
145	4522	0824	7636	2960	8899
146	5364	1648	8454	3750	9670
147	6206	2472	9272	4540	0441
148	7048	3296	0090	5330	1212
149	7890	4120	0908	6120	1983
150	8732	4944	1726	6910	2754
151	9574	5768	2544	7700	3525
152	0416	6592	3362	8490	4296
153	1258	7416	4180	9280	5067
154	2100	8240	5000	0070	5838
155	2942	9064	5818	0860	6609
156	3784	9888	6636	1650	7380
157	4626	0712	7454	2440	8151
158	5468	1536	8272	3230	8922
159	6310	2360	9090	4020	9693
160	7152	3184	0000	4810	0464
161	7994	4008	0818	5600	1235
162	8836	4832	1636	6390	2006
163	9678	5656	2454	7180	2777
164	0520	6480	3272	7970	3548
165	1362	7304	4090	8760	4319
166	2204	8128	4908	9550	5090
167	3046	8952	5726	0340	5861
168	3888	9776	6544	1130	6632
169	4730	0600	7362	1920	7403
170	5572	1424	8180	2710	8174
171	6414	2248	9000	3500	8945
172	7256	3072	9818	4290	9716
173	8098	3896	0636	5080	0487
174	8940	4720	1454	5870	1258
175	9782	5544	2272	6660	2029
176	0624	6368	3090	7450	2800
177	1466	7192	3908	8240	3571
178	2308	8016	4726	9030	4342
179	3150	8840	5544	9820	5113
180	3992	9664	6362	0610	5884
181	4834	0488	7180	1400	6655
182	5676	1312	8000	2190	7426
183	6518	2136	8820	2980	8197
184	7360	2960	9640	3770	8968
185	8202	3784	0458	4560	9739
186	9044	4608	1276	5350	0510
187	9886	5432	2094	6140	1281
188	0728	6256	2912	6930	2052
189	1570	7080	3730	7720	2823
190	2412	7904	4548	8510	3594
191	3254	8728	5366	9300	4365
192	4096	9552	6184	0090	5136
193	4938	0376	7002	0880	5907
194	5780	1200	7820	1670	6678
195	6622	2024	8638	2460	7449
196	7464	2848	9456	3250	8220
197	8306	3672	0274	4040	8991
198	9148	4496	1092	4830	9762
199	0000	5320	1910	5620	0533
200	0842	6144	2728	6410	1304
201	1684	6968	3546	7200	2075
202	2526	7792	4364	7990	2846
203	3368	8616	5182	8780	3617
204	4210	9440	6000	9570	4388
205	5052	0264	6818	0360	5159
206	5894	1088	7636	1150	5930
207	6736	1912	8454	1940	6701
208	7578	2736	9272	2730	7472
209	8420	3560	0090	3520	8243
210	9262	4384			

15.0		12.6390	2520	12.337051	2685	12.118552	2765	12.542053	2760	12.534254	2805
1		7233		4694		1893		9260		6481	
2		8075		5518		2701		8050		7253	
3		8918		6342		3589		0840		8024	
4		9760		7166		4397		1630		8796	
5		0603		7990		5205		2420		9567	
6		1445		8814		6013		3210		0339	
7		2288		9638		6821		4000		1110	
8		3130		0462		7629		4790		1882	
9		3973		1286		8437		5580		2653	
16.0		13.6416	2688	13.2128	2864	12.5264	2896	12.6368	2944	12.3424	2992
1		5659		2952		0072		7158		4196	
2		6501		3776		0880		7948		4967	
3		7344		4600		1688		8728		5739	
4		8186		5424		2496		9528		6510	
5		9029		6248		3304		0318		7282	
6		9871		7072		4112		1108		8053	
7		0714		7896		4920		1898		8825	
8		1556		8720		5728		2688		9596	
9		2399		9544		6536		3478		0368	
17.0		14.3242	2856	14.0366	3043	13.7893	3077	13.4266	3128	13.1138	3179
1		4085		7204		8151		5050		1909	
2		4927		2028		8959		5840		2681	
3		5770		2852		9767		6630		3452	
4		6612		3676		0575		7420		4224	
5		7455		4500		1383		8210		4995	
6		8297		5324		2191		9000		5767	
7		9140		6148		3009		9790		6538	
8		9982		6972		3817		0580		7310	
9		0825		7796		4625		1370		8081	
18.0		15.1668	3024	14.8644	3222	14.5222	3258	14.2164	3312	13.8852	3366
1		2511		4468		6230		2950		9624	
2		3353		5292		7038		3740		0395	
3		4196		1116		7846		4530		1167	
4		5038		1940		8654		5320		1938	
5		5881		2764		9462		6110		2710	
6		6723		3588		0270		6900		3481	
7		7566		4412		1078		7690		4253	
8		8408		5236		1886		8480		5024	
9		9251		6060		2694		9270		5796	
19.0		16.0094	3192	15.7102	3401	15.3501	3439	15.0062	3496	14.6516	3553
1		0937		7726		4309		0882		7337	
2		1779		8550		5117		1642		8109	
3		2622		9374		5925		2432		8880	
4		3464		0198		6733		3222		9652	
5		4307		1022		7541		4012		0423	0423
6		5149		1846		8349		4802		1295	1195
7		5992		2670		9157		5592		2066	1966
8		6834		3494		9965		6382		2838	2738
9		7677		4318		0773		7172		3609	3509
20.0		16.8520	3360	16.5160	3580	16.1530	3620	15.7960	3680	15.4280	3740
1		9363		5984		2888		6750		5852	
2		0205		6808		3096		7540		6642	
3		1048		7632		4004		8330		7432	
4		1890		8456		4812		9120		8222	
5		2733		9280		5620	2501	1910		9012	
6		3575		0104		6428		2700		9802	
7		4418		0928		7236		3490		0592	
8		5260		1752		8044		4280		1382	
9		6103		2576		8852		5070		2172	
21.0		17.6949	3528	17.3418	3759	16.9659	3801	16.5858	3864	16.1954	3927
1		7892		4242		0467		6648		2765	
2		8734		5066		1275		7438		3557	
3		9577		5890		2083		8228		4348	
4		0419		6714		2891		9018		5138	
5		1262		7538		3699		9808		5928	
6		2104		8362		4507		0598		6718	
7		2947		9186		5315		1388		7508	
8		3789		0010		6123		2178		8298	
9		4632		0834		6931		2968		9088	
22.0		18.5372	3696	18.1676	3938	17.7738	3982	17.3756	4048	16.9208	4114
1		6215		2500		8546		4546		0480	
2		7057		3324		9354		5336		1270	
3		7900		4148		0162		6126		2060	
4		8742		4972		0970		6916		2850	
5		9585		5796		1778		7706		3640	

22.5	9585	3696	5796	3938	1778	3982	7706	4048	3566	4114
6	0427		6622		2586		8496		4337	
7	1270		7448		3394		9286		5109	
8	2112		8274		4202		0076		5850	
9	2955		9100		5010		0866		6652	
23.0	1.3798	3864	18.9534	4117	18.5817	4163	18.1654	4232	18.7822	4301
1	4641		0760		6625		2444		8193	
2	3483		1586		7433		3234		8965	
3	6328		2412		8241		4024		9736	
4	7168		3238		9049		4814		0508	
5	0018		4064		9857		5604		1279	4455
6	8853		4890		0665		6394		2051	
7	0696		5716		1473		7184		2822	
8	2538		6542		2281		7974		3594	
9	4380		7368		3089		8764		4365	
24.0	20.2224	4032	19.8152	4296	19.3856	4344	18.9552	4416	18.5136	4488
1	3067		9018		4704		0342		5905	
2	3909		9844		5512		1132		6679	
3	4752		0670		6320		1922		7451	
4	5594		1496		7128		2712		8222	
5	6437		2322		7936		3502		8994	
6	7279		3146		8744		4292		9765	
7	8122		3972		9552		5082		0537	
8	9064		4798		0360		5872		1308	
9	9807		5624		1168		6662		2080	
25.0	21.0650	4200	20.6450	4475	20.1925	4525	19.7450	4600	19.2850	4675
1	1493		7276		2783		8240		3621	
2	2335		8102		3591		9030		4393	
3	3178		8928		4399		9820		5164	
4	4020		9754		5207		0610		5936	
5	4863		0580		6015		1400		6707	
6	5705		1406		6823		2190		7479	
7	6548		2232		7631		2980		8250	
8	7390		3058		8439		3770		9022	
9	8233		3884		9247		4560		9793	
26.0	21.9076	4368	21.4708	4654	21.0054	4706	20.5398	4784	20.0564	4862
1	9919		5534		0862		6138		1336	
2	8761		6360		1670		6928		2107	
3	1604		7186		2478		7718		2879	
4	2446		8012		3286		8508		3650	
5	3289		8838		4094		9298		4422	
6	4131		9664		4902		0088		5193	
7	4974		0490		5710		0878		5965	
8	5816		1316		6518		1668		6736	
9	6659		2142		7326		2458		7508	
27.0	22.7502	4536	22.2966	4833	21.8133	4887	21.3294	4968	20.8258	5049
1	8345		3792		8941		4036		9049	
2	9187		4618		9749		4826		9821	
3	0030		5444		0557		5616		0592	
4	0872		6270		1365		6406		1364	
5	1715		7096		2173		7196		2135	
6	2557		7922		2981		7986		2907	
7	3400		8748		3789		8776		3678	
8	4242		9574		4597		9566		4450	
9	5085		0400		5405		0356		5221	
28.0	23.5928	4704	23.1224	5012	22.6212	5068	22.1194	5152	21.5992	5236
1	6771		2050		7020		1934		6764	
2	7613		2876		7828		2724		7535	
3	8456		3702		8636		3514		8307	
4	9298		4528		9444		4304		9078	
5	0141		5354		0252		5094		9850	
6	0983		6180		1060		5884		0621	
7	1826		7006		1868		6674		1393	
8	2668		7832		2676		7464		2164	
9	3511		8658		3484		8254		2936	
29.0	24.4354	4872	23.9482	5191	23.4291	5249	22.9042	5336	22.3806	5423
1	5197		0308		5099		4832		4477	
2	6039		1134		5907		0622		5246	
3	6882		1960		6715		1412		6027	
4	7724		2786		7523		2202		6792	
5	8567		3612		8331		2992		7564	
6	9409		4438		9139		3782		8335	
7	0252		5264		9947		4572		9107	
8	1094		6090		0755		5362		9878	
9	1937		6916		1563		6152		0650	
30.0	25.2780	5040	24.7940	5370	24.2370	5430	23.1940	5520	23.1920	5610

	50	51	52	53	54
30.0	25.2750	5040 24 7740	5370 24 2370	543023 6940	572023 1420
1	3623	8564	3178	7730	2191
2	4465	9388	3956	8520	2963
3	5308	8212	4794	9310	3734
4	6150	1036	5602	0100	4506
5	6993	1860	6410	0890	5277
6	7835	2684	7218	1680	6049
7	8678	3508	8026	2470	6820
8	9520	4332	8834	3260	7592
9	0363	5156	9642	4050	8363
31.0	26.1206	5208 25.5980	554925.0449	5611 24.4838	5704 23.9139
1	2049	6804	1257	5828	9906
2	2891	7628	2065	6418	0677
3	3734	8452	2873	7208	1449
4	4576	9276	3681	7998	2220
5	5419	0100	4489	8788	2992
6	6261	0924	5297	9570	3763
7	7104	1748	6105	0360	4535
8	7946	2572	6913	1150	5306
9	8789	3396	7721	1940	6078
32.0	26.9632	5376 26.4298	5729 25.8528	5792 25.2736	5888 24.6848
1	0475	5062	9336	3526	7619
2	1317	5886	0144	4316	8391
3	2160	6710	0952	5106	9162
4	3002	7534	1760	5896	9934
5	3844	8358	2568	6686	0705
6	4687	9182	3376	7476	1477
7	5529	0006	4184	8266	2248
8	6372	0830	4992	9056	3020
9	7214	1654	5800	9846	3791
33.0	27.8058	5544 27.2496	5908 26.6607	5973 26.0634	6072 25.4562
1	8901	3320	7415	1420	5334
2	9743	4144	8223	2210	6105
3	0586	4968	9031	3000	6877
4	1428	5792	9839	3790	7648
5	2271	6616	0647	4580	8420
6	3113	7440	1455	5370	9191
7	3956	8264	2263	6160	9963
8	4798	9088	3071	6950	0734
9	5641	9912	3879	7740	1506
34.0	28.6884	5712 28.0754	6087 27.4686	6154 26.8532	6256 26.2276
1	7327	1578	5494	9322	3047
2	8169	2402	6302	0112	3819
3	9012	3226	7110	0902	4590
4	9854	4050	7918	1692	5362
5	0697	4874	8726	2482	6133
6	1539	5698	9534	3272	6905
7	2382	6522	0342	4062	7676
8	3224	7346	1150	4852	8448
9	4067	8170	1958	5642	9219
35.0	29.4910	5880 28.9012	6266 28.2765	6335 27.6430	6440 26.9980
1	5753	9838	3573	7220	0762
2	6595	0664	4381	8010	1533
3	7438	1490	5189	8800	2305
4	8280	2316	5997	9590	3076
5	9123	3142	6805	0380	3848
6	9965	3968	7613	1170	4619
7	0808	4794	8421	1960	5391
8	1650	5620	9229	2750	6162
9	2493	6446	0037	3540	6934
36.0	30.3830	6048 29.7270	6445 29.0844	6516 28.4328	6624 27.7704
1	4179	8096	1652	5118	8475
2	5021	8922	2460	5908	9247
3	5864	9748	3268	6698	0018
4	6706	0574	4076	7488	0790
5	7549	1400	4884	8278	1567
6	8391	2226	5692	9068	2333
7	9234	3052	6500	9858	3104
8	0077	3878	7308	0648	3876
9	0919	4704	8116	1438	4647
37.0	31.1762	6216 30.5528	6624 29.9223	6697 29.2226	6808 28.5408
1	2605	6354	9731	3016	6180
2	3447	7180	0538	3806	6951
3	4290	8006	1347	4596	7723
4	5132	8832	2135	5386	8494
5	5975	9658	2963	6176	9266
6		0484	3771	6966	0037

Reduction to middle wire

Clocks times

1 space = 2.062^s

A		^s
t_1	1	+12.37
	2	+10.31
	3	+8.25

A	1	+9.12
	2	+2.06
	3	+0.00
	4	-2.06
	5	-4.12

A	1	-8.25
-1	2	-10.31
	3	-12.37

$$\begin{aligned} \text{Reduction to Meridian} &= (T_o - T_m) [6.73672 \sin \delta \cos \delta] \\ \text{Reduction to horizontal line} &= (T_o - T_m) [0.8324 \cos \delta] \end{aligned}$$

22

any line

