1877phae.proj.1797w

KG
11366
v.793

L. VV.

Harvard College Observatory

Time Service.

3.

Clock Errors and Russian Transit.

December 13. 1877 to 18

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SMITH & PORTER,
Steam Printers,
Old South Chapel, Spring Lane, BOSTON.
No. 1064 | When another book like this is required, it will be only necessary to send this number.

Astraud's Method. (Astr. Nachrichten, No. 2196).

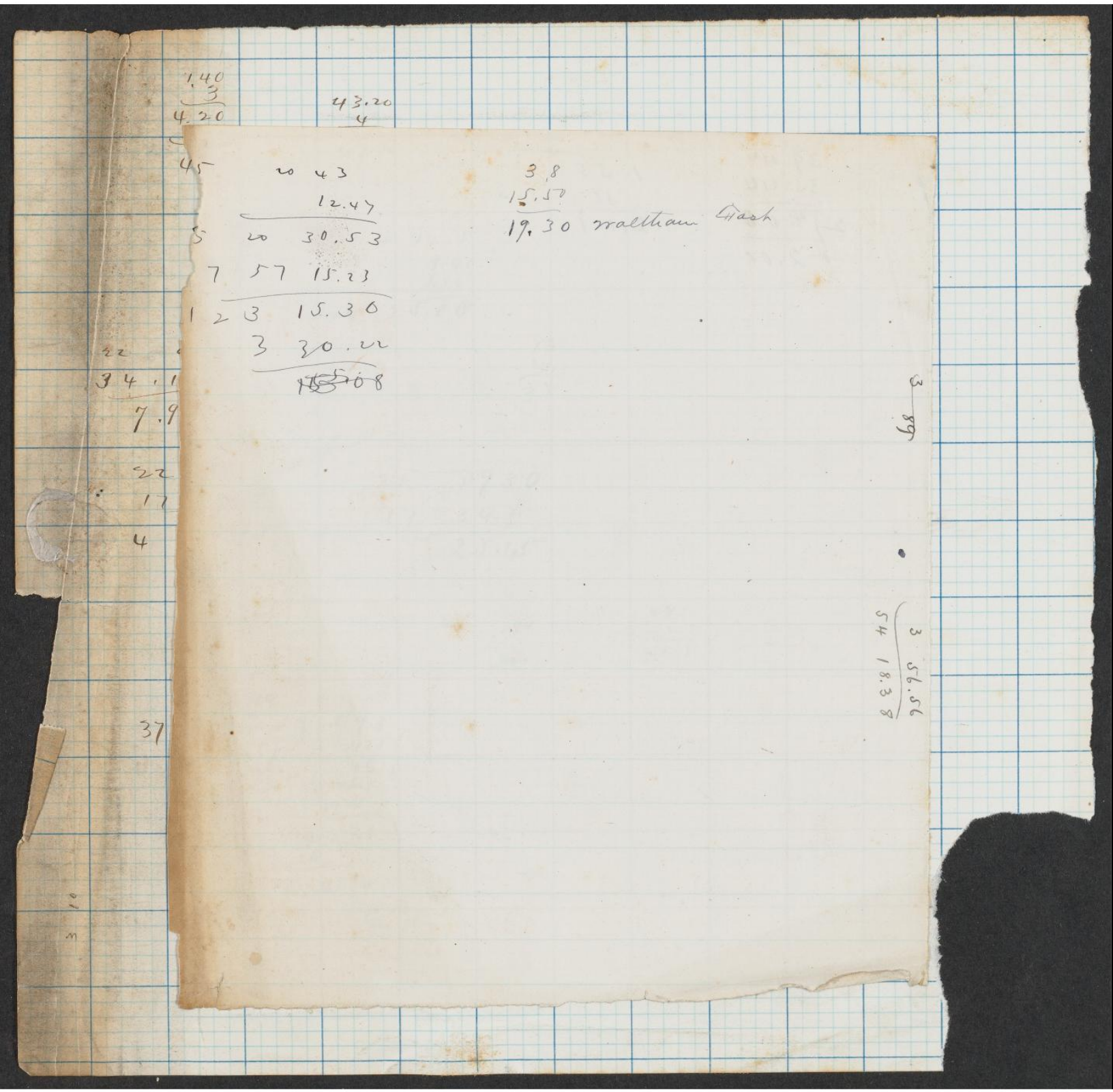
α_1 = R.A. Northern Star. t_1 = Cl. time.
α_2 = " . Southern Star. t_2 = " " .
α_3 = " Zenith Star. t_3 = " " .

$$\frac{(a_1 - t_1) - (a_2 - t_2)}{A' - A''} = Z_1 . \quad \frac{(a_1 - t_1) - (a_3 - t_3)}{A' - A'''} = Z_2 . \quad \frac{C' - C''}{A' - A''} = Z_3 . \quad \frac{C' - C'''}{A' - A'''} = Z_4 .$$

$$c = \frac{Z_1 - Z_2}{Z_3 - Z_4} , \quad a = Z_1 - Z_3 c = Z_2 - Z_4 c .$$

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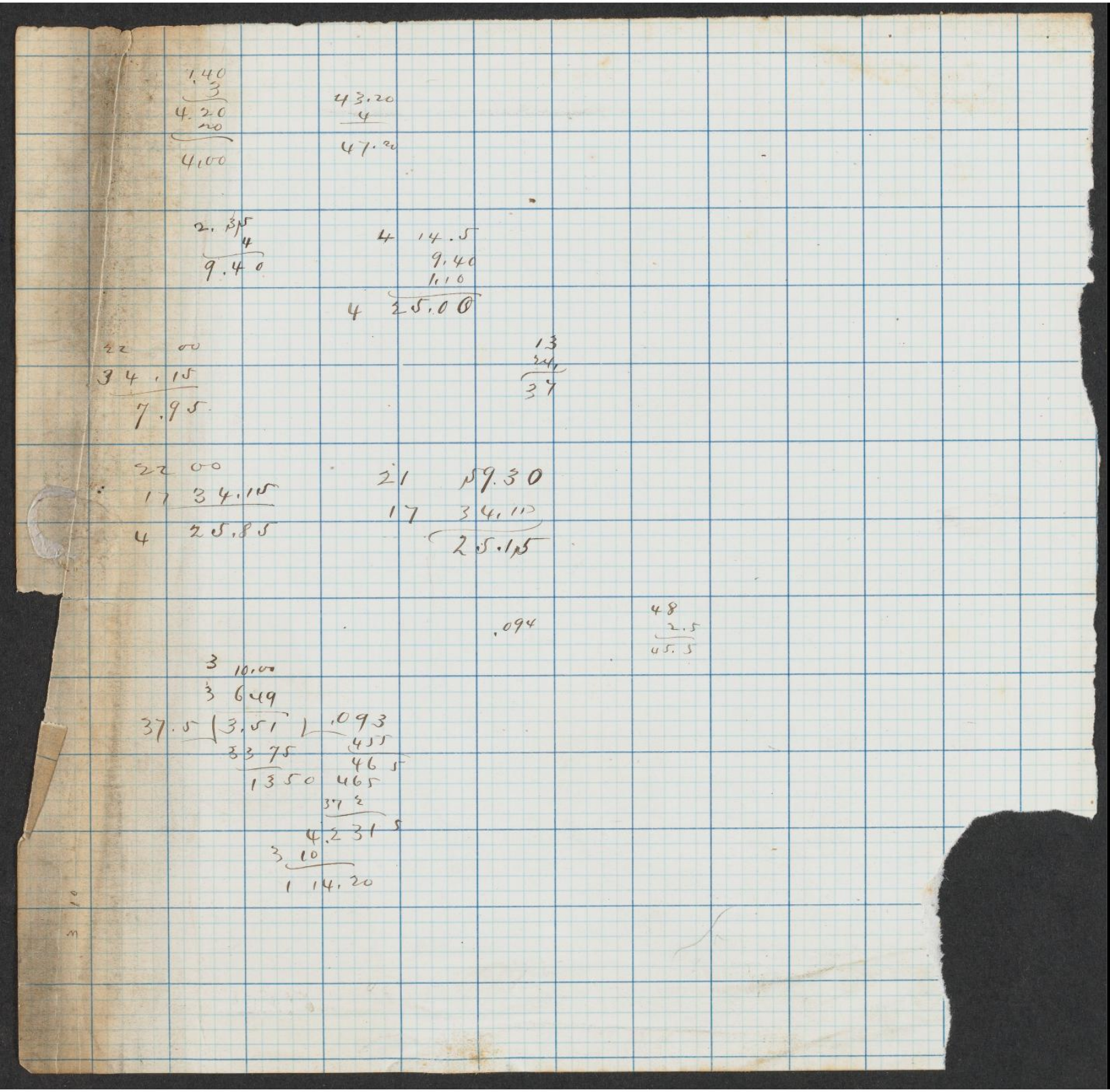
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1.40
3
4.20
20
4.00

43.20
4
47.32

2.35
4
9.40

4 14.5
9.40
1.10
4 25.00

22 00
34.15
7.95

13
24
37

22 00
17 34.15
4 25.85

21 59.30
17 34.15
25.15

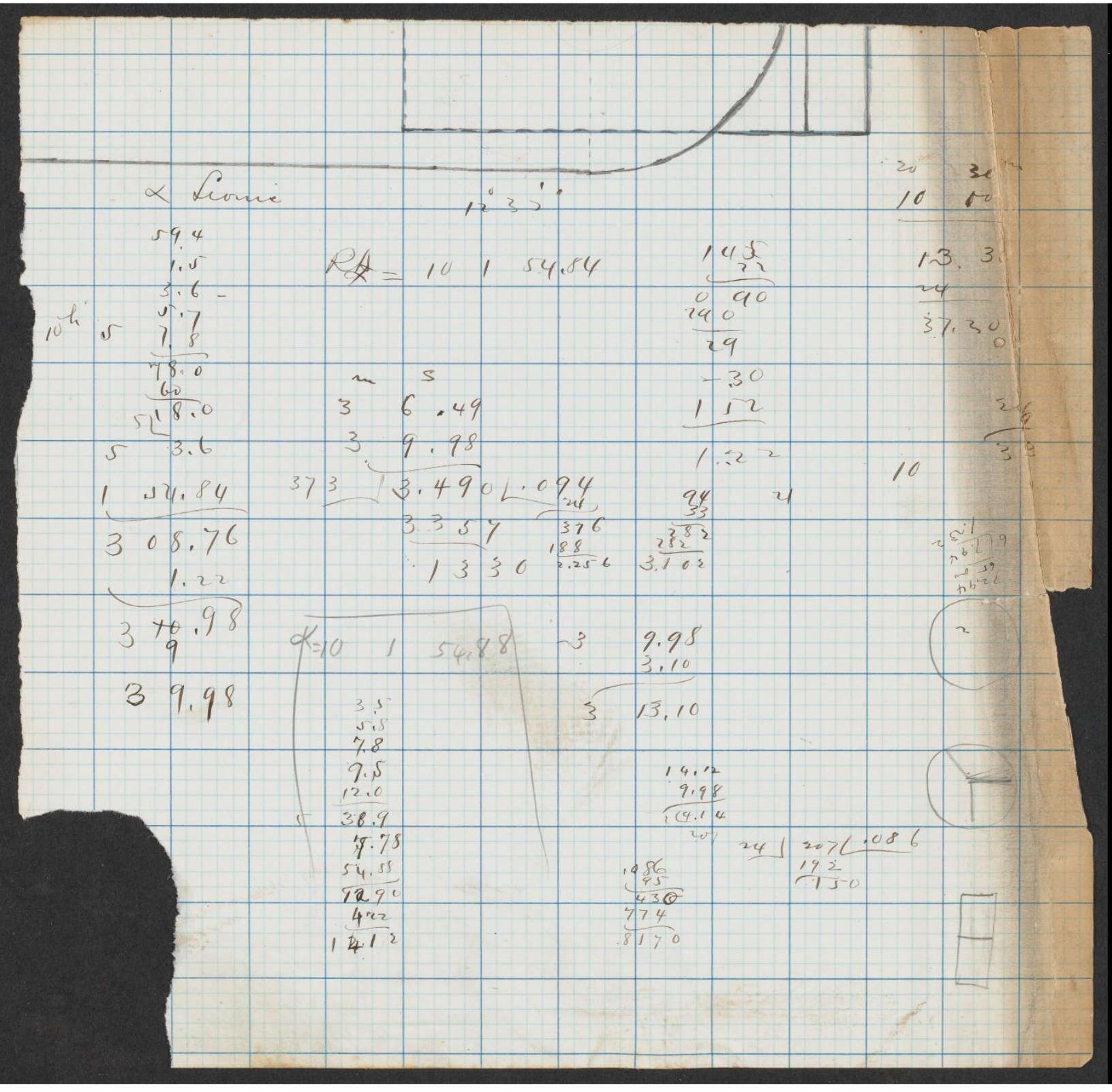
.094

48
2.5
45.5

3 10.00
3 6 49
37.5 | 3.51 | .093
3375 | 455
1350 | 465
375
4.231
3 10
1 14.20

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec 13d 4 1877. Instrument, RT Observer, S.W

Five p.3. Timepiece, 345 Recorder, S.W

Object,	δ Cass.		η Piscium		ν Persei		43 Cass	
Circle,	W		W		E		E	
	w	e	w	e	w	e	w	e
Level Direct,	17.9	18.9	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	17 5	19 1	.	.	.	.	.	.
Difference,	15.4	18.0						
b. = −0ˢ.06		5.4 / 26						
	−0ˢ.06							
c = +0.09 (E)	h m s		h m s		h m s		h m s	
Wire, I.		31.4		17.0		1.7		46.2
II.		13.3		39.0		127.2		4.5
III.		55.6		1.2		33.6		23.1
IV.		37.7		23.0		54.5		41.6
V.	1 19	19.6	1 25	45.0	1 31	5.7	1 34	0.3
Sum,		1576 / 3152 / 24		1252 / 2504 / 24		1077 / 2154		1157 / 2314
Mean,	1 18	55.52	1 25	1.04	1 30	33.44	1 34	23.14
Bb,		−.11		−.05		−.09		−.14
Cc,		−.17		−.09		+.13		+.24
Aa,		55.24 / −.42		0.90 / +.36	30	33.48	34	23.24
	−.58	−.97	+.49	+.82	−.15	−.05	−1.09	−.35
Corr'd Transit,		54.27		1.26 / 1.92		33.43		22.89
R. A.	1 17	51.88	1 24	58.33	1 30	31.59	1 33	20.71
Error of Timepiece,		2.94 / 2.39		2.93 / .39		1.84		+2.18

$107\overline{)1,79}\ \pm 1.67$ (762 / 749 / 410)

$a = +\frac{0.79}{1.07} = +.67$

$107\overline{)79}\ (.74$ (749 / 410)

$+0.74$

$\alpha' - \alpha = 7^m\ 6^s.45$

$\pm\ \delta' - \delta = 9\ 5.66$

$+\ 0.79$

ν Persei

30 33.44
−.09
+.60
+1.00
30 34.95
31.59
+2.36

? 2.94 W
? 2.93 W ∴ Coll. must be in error
? 1.84 E
? 2.18 E
? 2.18 E

295
297
2ˢ.49

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1877phae.proj.1797w

2

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec 13d 4 1877. Instrument, RT Observer, S. W.

Timepiece, 3451 Recorder, S. W.

Object,	o Piscium		50 Cass.		50 Cass.						
Circle,	E		E .330 34		W. 19 26						
	w	e	w	e	w	e			w	e	
Level Direct,	17:5	19:1	18:5	19:2	18:0	18:9					
Reversed,											
Sums,			18 0	18.9							
Difference,			16·5	19·1							
b.			b=−0:06	16.5 / 26							
	h m s		h m s		h m s				h m s		
Wire, I.	60.6 / 60.3 / 1.4	17·1		28·0		3·0				1.6286	
II.		38·5		39·2		14·6			Cos δ =	9.4939	
III.	411209 / 30.25	0·7		50·7		25·7				2.1347	
IV.		21·8		2·0		37·1				136.3	
V.	1 39	43·5	1 51	13·3	1 55	48·5					
Sum,	1 39	121.6 / 24.32		13.32 / 26.64		128.9 / 25.78					
Mean,	1 39	24·32	1 50	50·64	1 55	25·78					
Bb,		−.05		+2		−2					
Ce,		+.09	1 53	13.2 / 16.3 / 3.4	1 53	18.2 / 12.6					
Aa,	39	24.36	1 53	6·9	1 53	7·5 / 6.9			Sug:	.4771	
	+57	+0·18	1 53		7.2	0·6				4939	
Corr'd Transit,	1 39	0.54			½ 0.6 =	0.3				.9710	
R. A.	1 38	58 36								+ 0.09 (E)	
				+ 0s.09 CE							
Error of Timepiece,		+ 2s.18	1 53	6.9	1 53	7.5					
				+ .3		− .6					
			1								

α = 1 38 58.36 t = 39 0.36

α' = 1 32 20.71 t' = 34 23.24

5 37.65 / 37.12 / + 0.53 / .57 + 1.09 = 53/166 = 7248 / 7201 / 5042

32 / 7 / 224 / 166 / 1824

∴ a = +0s.32 0.s319

α = 1 52 64.7 / 58.4 / 6.3 / 6.8 / −0.5 = +0s.132

α' − α =

t' − t =

3.23 / .09 / 0.2907

− 3.2 ~ 57

38)5 1.32 / 38 / 120 / 114 / 60

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1877phaeproj. 1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec 13d.4 1877. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

	δ Cass.		η Pisc		43 Cass		o Pisc	
Object,								
Circle,	W		W		E		E	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		.		.		.		.
II.		.		.		.		.
III.		.		.		.		.
IV.		.		.		.		.
V.		.		.		.		.
Sum,		.		.		.		.
Mean,	1 18 55.52		1 25 1.04		1 34 23.14		1 39 24.32	
Bb,		− 11		− .05		− 09		− 05
Ce,		− .78		− .40		+ 1.04		+ .40
Aa,		54.63		24 0.59		24 09		24 67
	−58	− 27	+49	23	+1.09	− + 44 73	+57	+ 0.76 38
Corr'd Transit,		54.36		0.82		23 36 22 55		1.05 1.43
R. A.	1 17 51.88		1 24 58.33		1 33 20.71		1 38 58.36	
Error of Timepiece,		+ 2s.48		+ 2.49		+ 2.65 1.84		+ 2.69

α'-α =

+ 2.48
· 49
· 36
· 65
· 69

267

+ 2.67 = Sun 345

7h 6s.45
5.96
0.49
1.07 = 0s.47

a = + 0.47 (W)
a = + 0.83 (E)

163 | 1091 | 8
720
774

5 W 37.65
36 56
+ 2.09
1.63

163 | 209 | 1.3
163
460
499
326
340

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec 15 3 1877. Instrument, RT Observer, WEL

Timepiece, 3451 Recorder,

Object, Circle,		TT Androm W		ζ Cassiop W		ζ Andromed W		43 H Aphei W +.12	
		w	e	w	e	w	e	w	e
Level Direct,		18.1	18.2	.	.	.	.	19.0	17.5
Reversed,		17.5	18.5	.	.	.	.	18.3	18.0
Sums,		35.6	36.7	.	.	.	.	37.3	35.5
Difference,			1.1					1.8	
b.			−.04		00		+.02		+.06
		h m	s	h m	s	h m	s	h m	s
Wire,	I.		44.2		37.2		10.4	46	23.0
	II.		1.2		2.3		33.4	47	9.0
	III.		26.3		40.2		56.6	II	55.0
	IV.		51.7		18.0		19.8	48	42.0
	V.	31	8.8		43.5	41	43.2	49	28.0
Sum,			.		.		.	47	55.40
								4	37.63
Mean,		30	26.44		40.24	40	56.68	52	33.03
Bb,		1.19	−.05	1.73	.00	1.04	+.02	9.52	+.57
Cc,		1.20	−.34	1.78	−.50	1.09	−.31	13.06	.
Aa,		+.19	+.13	−.41	−.29	+.36	+.26	−8.94	.
Corr'd Transit,			26.18		39.45		56.65		.
R. A.		30	22.47	33	35.92	40	53.10		.
Error of Timepiece,			3.71 rej.		3.53		3.55		~~51 24.76~~

$0 = 3.92 + .19a + 1.20c$
$= 4.32 - .41a + 1.78c$
$= 3.58 + .36a + 1.09c$
$0 = 3.94 + .05a + 1.36c$
$0 = 13.48 - 8.94a + 13.06c$
$0 = 9.54 - 8.99a - 11.70c$
$= 2.99 - 9.18 + 11.90c$
$0 = 1.06 - a - 1.30c$
$= .33 - a + 1.30c$
$0 = -.73 + 2.60c$
$c = +.28$ E

$0 = 2.92 + .16a + 1.23c$
$= 2.82 + .26 \quad 1.15$
$= 2.91 + .31 \quad 1.11$
$0 = 2.88 + .24 + 1.16c$
$0 = 5.87 - 8.94a + 13.06c$
$0 = 2.99 - 9.18a + 11.90$

Adopted error + 3.44

c is evidently in error – assuming it = +.40 makes more accordant results but mean is as before

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	43 Cephei				β Andromedæ				τ Piscium		υ Piscium	
Circle,	E +.12				E				E		E	
	w		e		w		e		w	e	w	e
Level Direct,	17 .6		16.5		.		.		.	.	17.5	16.5
Reversed,	18 0		18.2		.		.		.	.	17.2	19.0
Sums,	35 6		36.7		.		.		.	.	34.7	37.5
Difference,			1.1									2.8
b.			−.04				−.06		−.07			−.09
	h	m s			h	m s			h	m s	h	m s
Wire, I.		55 31.0				6.2				.		2.1
II.		17.5				32.1				36.0		25.8
III.	TV	3.5				58.1				0.4		49.7
IV.		57 51.0				23.9			5	24.9		13.4
V.		58 37.0			3	50.0				.	13	37.2
Sum,		57 4.0				.				.		.
		4 37.63										
Mean,		52 26.37			2	58.06			5	0.43	12	49.66
Bb,		−38			1.21	−.07			1.13	−.08	1.08	−.10
Ce,		.			1.23	+.34			1.15	+.32	1.11	+.31
Aa,		.			+.16	+.11			+.26	+.18	+.31	+.22
Corr'd Transit,		.				58.44				60.85		50.09
R. A.	0	52 20.12			2	55.07			4	57.53	12	46.65
Error of Timepiece,		.				3 37				3 32		3 44

52 33.60
25.99
2)7.61
38
77
276
27

C = +30

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 16.3 1877. Instrument, R 5 Observer, W.W.

Timepiece, 3451 Recorder,

Object, Circle,	σ Piscium E		υ Piscium E		δ Cassiopeiæ W		η Piscium W	
	w	e	w	e	w	e	w	e
Level Direct,	17·0	17·8	19·0	18·0	17·8	17·5	·	·
Reversed,	16·5	18·4	17·0	18·2	17·5	17·8	·	·
Sums,	33.5	36.2	34.0	36.2	35.3	35.3	·	·
Difference,		2.7		2.2				
b.		−.09		−.07		00		00
	h m s		h m s		h m s		h m s	
Wire, I.		·		2·3		32.7		18·3
II.		36.2		26.2		0.4		40.3 ?
III.		0.7		50.0		28.5		2.4
IV.		5 25.2		13.6		24.6		24.3
V.		·		13 37.5		19 20.7		25 46.5
Sum,		·		·		·		·
Mean,		5 0.70		12 49·92		17 56 59		25 2:36
Bb,	1.13	−.10	1.08	−.08		·		·
Cc,	1.15	+.39	1.11	+.38	1.97	−.67	1.04	−.35
Aa,	+.26	+.15	+.31	+.18	−58	−.34	+.49	+.28
Corr'd Transit,	5	1.14		50.40		55.58		2.29
R. A.	4	57.52	12	46.64	17	51.77	24	58.29
Error of Timepiece,		3.62		3.76		3.81		4.00

$0 = 3.08 + .26^{a} + 1.15^{c}$
$3.20 + .31 + 1.11$
$3.14 + .28 + 1.13$ 3.65
$= 3.50 - 1.58 + 3.20$
$= .36 - 1.86a + 2.07c$
$1.96 - 2.24 - 2.30c$
$.19 - a + 1.11c$
$.88 - a - 1.03c$
$0 = -.69 + 2.14$

$c = +.32$ C.E.
$a = +.54$

$0 = 4.07 + .49^{a} + 1.04^{c}$
$3.95 + .74 + 1.01$
$3.89 + .57 + 1.02$
$3.97 + .60 + 1.02$ 3.95
$= 5.93 - 1.64 + 3.32$

Error +3.85

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1877phad.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	40 Canum				ν Piscium				o Piscium				50 Canum		
Circle,	W				W				W				E		
	w		e		w		e		w		e		w		e
Level Direct,	16·5		17·0		.		.		16·2		17·5		17·8		16·2
Reversed,	17·2		16·3		.		.		16·0		16·0		17·4		18·5
Sums,	35·7		35·3		.		.		36·2		35·5		35·2		36·7
Difference,	4								·7						1·5
b.	+·01								+·02						−·05
	h	m	s		h	m	s		h	m	s		h	m	s
Wire, I.							27·3				19·2				
II.		II	21·0				48·8				40·6			II	37·2
			44·5												59·8
III.			8·2				9·8				2·2				22·5
IV.			31·5				31·3				23·7				
		III	55·5											III	58
V.			18·5			35	52·7		39		45·3				8,2
			42·0												31·0
		IV	5·0												54·0
Sum,			29·0											IV	16·5
		30													39·3
Mean,			55·02			35	9·98		39		2·20				
Bb,	2·87		+·03		·80		+·01		·83		+·02		2·80		8·26
Ce,	3·32		.		1·01		−·34		1·02		−·35		3·20		−·14
Aa,	−1·64		.		+·74		+·43		+·57		+·33		−1·58		.
Corr'd Transit,			.				10·08				2·20				.
R. A.	28	49	12		35		6·04		38		58·33		53		4·62
Error of Timepiece,			.				4·04				3·87				.

Assume C = +.40 (E) a = +.55

Error = 3.81

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 17.3 1877. Instrument, R 5 Observer, Hill

Timepiece, 3451 Recorder,

Object, Circle,	ξ Andromedae 2		μ Andromedae E		ϱ Persei 2		44 H Cephei E −.06	
	w	e	w	e	w	e	w	e
Level Direct,	16.5	18.5	17.2	17.8	+1.5	.	17.5	17.5
Reversed,	16.5	16.8	17.4	17.6	.	.	17.5	17.5
Sums,	33.0	37.3 adj.	34.4	35.4	.	.	.	.
Difference,		4.3		1.0				
b.		−.14		−.03		−.01		0.0
	h m s		h m s		h m s		h m s	
Wire, I.		10.7	3.95 II 1	27.9		58.7		16.0
II.		33.9	3.79	5 46.0		20.0		34.5
III.		57.2	3.70 III 3	3.7		41.4	III	53.0
IV.		20.4	3.78 IV 3	30.7		2.8		12.0
V.	41	43.7	3.83 VI 4	57				
			3.79 5 1	5 6.6	57	24.3	2	31.0
Sum,		.		.		.		.
Mean,	40	57.18	50	3.81	56	41.44	1	53.30
Bb,	1.04	−.15	1.26	−.04	63	−.07	4.22	.
Cc,	1.09	+.45	1.27	+.52	1.02	+.42	5.26	.
Aa,	+.36	+.32	+.11	+.10	+.51	+.46	−3.14	.
Corr'd Transit,		57.50		4.39		42.31		.
R. A.	40	53.09	49	59.54	56	37.56	1	48.42
Error of Timepiece,		4.71		4.85		4.75		.

$0 = 3.94 + 36^a + 1.04^c$
$= 4.23 + .11 + 1.27$
$= 3.87 + .51 + 1.02$

$4.07 + .33 + 1.11$ 4.76
$= 4.88 - 3.14 + 5.26$

$0 = .87 - 2.81a + 4.15c$
$0 = 3.12 - 1.99a - 3.21c$

$0 = .31 - a + 1.48c$
$0 = 1.56 - a - 1.61$

$= 1.25 - 3.09c$

$c = .41$
$a = .90$

$0 = 5.03 + .31^a + 1.11^c$
$= 4.87 + .49 + 1.04$

$4.95 + .40 + 1.08$
$8.07 - 2.39 + 4.29$
$0 = 9.11 - 3.14 + 5.26$
$= 7.03 - 1.64 + 3.32$

4.87 4.71 85 75 65 88 + 4.81

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1977phec.proj.:1707W

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	44 Cephei			υ Piscium			η Piscium			40 Cassiop. −.03							
Circle,	W			W			W			W							
				w		e	w		e	w		e	w		e		
Level Direct,	18.5	16.5	−	.		.	17.2		17.3	16.8		17.5	.		.		
Reversed,	16.0	16.5		.		.	16.2		16.2	16.5		16.0	.		.		
Sums,	36.5	33.0		.		.	adj 33	4	35.5	35	3	33.5	.		.		
Difference,	3.5								2.1			.2					
b.	+.12								−.07			−.01					
			h	m	s	h	m	s		h	m	s	h	m	s		
Wire, I.	3.5				3.8			19.2				33.0			.		
II.	22.0				27.7			41.1				44.5			.		
III.	40.5				51.4			3.4				56.5			.		
IV.	59.0				15.2			25.2				8.0			.		
V.	6 17.5			13	39.1		25	47.2			24	18.7			.		
Sum,					.			.				.			.		
Mean,	3 43.42																
	5 40.50			12	51.44		24	3.22			28	56.14			.		
	1 57.08																
Bb,	+ 54		1.08		+.13	.91		−.06		2.87		−.03			.		
Ce,			1.11		−.46	1.04		−.43		3.32		.			.		
Aa,			+31		+.28	+.49		+.44		−1.44		.			.		
Corr'd Transit,					51.39			3.17				.			.		
R. A.	1 46.48			12	46.54		24	58.29			28	49.08			.		
Error of Timepiece,					4.85			4.88				.			.		

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

must be Dec. 18
Date, ... 187 . Instrument, Ross Tr. Observer, W.H.
Timepiece, 3451 Recorder, ...

Object, Circle,	π Androm. E		ζ Androm E		δ Piscium E +.06		43 H E +.12	
	w	e	w	e	w	e	w	e
Level Direct,	17.5	18.5	17.6	19.2	15.5	19.0	.	.
Reversed,	18.2	18.2	18.5	19.0	18.4	19.4	.	.
Sums,	35.7	36.7	36.1	38.2	36.9	38.4	.	.
Difference,		1.0		2.1		1.5		
b.		−.03		−.07		−.05		−.05
	h m s		h m s		h m s		h m s	
Wire, I.		36.5		11.2		.		4 58 5
II.		1.8		34.4	II 3	5.2		5 44 0
III.		27.2	40	57.7	III 1	19.4		II 17 5
IV.		52.8		21.6	5	33.5		2 20
V.	31	18.0		44.2	IV 34	47.9		3 47 50.0
								4 48 36 5
								5 49 22 5
Sum,		.		.		.		III 1 50 55 0
Mean,	30	27.26	40	57.70	42	26.50		2 51 41.0
								47 49.67
								4 37 63
Bb,	1.19	−.04	1.04	−.07	.83	−.04	9.52	52 27.30
Cc,	1.20	+.54	1.09	+.49	1.01	+.45	13.06	−.48
Aa,	+19	+.12	+.36	+.23	+.58	+.37	−8.54	+ 5.98
Corr'd Transit,		27.88		58.35		27.28		.
R. A.	30	22.43	40	53.07	42	21.96		.
Error of Timepiece,		5.45		5.28		5.32		.

52 21.76 / 30 22.43 / 52 32.72 / 30 27.76 / 22 59.33 / 22 4.96 / 9.13 | 5.63 / +.62

52 21.76 / 40 53.07 / 52 32.72 / 40 58.12 / 11 28.69 / 10 34.60 / 9,30 | 5.91 / +.63

52 21.76 / 42 21.90 / 52 32.72 / 42 26.91 / 9 59.86 / 10 5.81 / 9,52 | 5.95 / +.63

52.21.76 / 64 57.50 / 52 32.72 / 65 2.82 / 12 35.74 / 12 29.60 / 9,20 | 6.14 / +.67

38.60 / 26.82 / 2 | 11.78 / 5.9 / 77 / 413 / 411 / C = +4.5 (E)

a = +.63 E
+.67 W

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer,.....

Timepiece,..... Recorder,.....

Object,	43 1+		σ Piscium		υ Piscium					
Circle,	W		W		W					
	w	e	w	e	w	e	w	e		
Level Direct,	19.5	19.5	.	.	.	.	19.5	19.5		
Reversed,	19.0	19.2	.	.	.	.	[19.5	19.5		
Sums,	38.5	37.7	.	.	.	.	.	.		
Difference,	.8									
b.	+.03						00			
	h m s		h m s		h m s		h m s			
Wire, I.	4 26.0		14.2		4.3					
II.	5 10.5		38.7		28.2					
III.	55 43.0		2.7		52.1					
IV.	56 29.0		27.0		2 15.5					
V.	3 16.0		5 51.5		—					
	4 58 2.5									
	5 48.0									
Sum,	0 21.5									
	1 7.0									
Mean,	57 15.94		5 2.82		2 52.10					
	52 38.31									
	+.29									
Bb,			1.13	+.02	1.08	.00				
Ce,			1.15	−.52	1.11	−.50				
Aa,			+.26	+.17	+.31	+.20				
Corr'd Transit,			62.49		57.80					
R. A.	52 21.88		4 57.50		46.62					
Error of Timepiece,			4.99		5.18					

$0 = 4.79 + .19^a + 1.20^c$
$= 4.56 + .36 + 1.09$
$= 4.50 + .58 + 1.07$
$= 4.62 + .38 + 1.10$ c = .39
$= 4.94 - 5.94 + 13.06$

$0 = 5.34 + .26^a + 1.15^c$
$= 5.48 + .31 + 1.11$
$0 = 5.41 + .28 + 1.13c$ 5.05
$0 = 16.72 - 5.94 + 13.06$
$0 = 11.31 - 9.22^a - 11.93c$
$= .32 - 9.32 + 11.96$
$= 1.28 - a - 1.29c$
$= 0.03 - a + 1.28$
$0 = 1.20 - 2.57c$
$c = +.47$
$a = +.61$

Error 5.47 5.45
29 5.28
32 5.32
4.96 4.99
5.15 5.18
5.24 5.24

If c be assumed = .40

Error = 5.39
5.23
5.27
5.05
5.24
5.24

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 22 and Dec. 23 1877. Instrument, Mer. Circle Observer, J. F. M.

Timepiece, S Clock Recorder,

Object, Circle,	ε Bootis				μ Eridani		9 Cam.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	14 39 17.4	.		.	4.0	.		32.9
II.	19.6	.		.	6.0	.		38.7
III.	22.2	.		.	8.0	.		43.1
IV.	24.5	.		.	10.0	.		48.7
V.	26.8	.		.	12.0	.		53.4
Sum,	110.5	.		.	.	.		216.8
Mean,	22.10	.		.	8.00	.		43.36
m Bb,	+ .53	.		.	+ .55	.		+ .55
Cc,	.	.		.	.	.		.
Aa,	.	.		.	.	.		.
n tan δ	— .42	.		.	+ .05	.		−1.83
Corr'd Transit,	22 23 .	.		.	8.60	.		42.08
R. A.	14 39 39.27	.		.	26.02	.	4 41 59.49	
Error of Timepiece,	17.04	.		.	17.42	.		17.41

1877 Dec. 23.2 Meridian circle level.

W 56.2 E 65.4
56.3 65.0

Reversed level

W 59.6 E 62.4
59.3 62.1

Sums 31.4 54.9

Value of 1 division by a record of last May 29, 0".88

23.5 × 0.11 = 2.585

b = − 0.172

Dec. 23.9

W. 65.6 E 69.0
66.3 68.3

Reversed level

W 65.5 E. 69.6
65.0 69.7

Sums 22.4 36.6

14.2 × 0.11 = 1.562

b = −0.104

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	n^4 Orion.		ι Aurigæ		10 Cam.			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	22.4		42.8		12.8			.
II.	24.3		45.1		16.8			.
III.	26.4		47.5		21.0			.
IV.	28.3		49.9		25.1			.
V.	30.7		52.5		29.1			.
Sum,	132.1		237.8		104.8			.
Mean,	26.42		47.56		20.96			.
m	~~m~~ + .55		+ .55		+ .55			.
Bb,	.		.		.			.
Cc,	.		.		.			.
Aa,	.		.		.			.
n tan φ	— .08		— .52		— 1.42			.
Corr'd Transit,	26.89		47.59		20.09			.
R. A.	44.36	4 49	5.11		37.62			.
Error of Timepiece,	17.47		17.52		17.53			.

n (from μ Eridani & 9 Cam.) = −0.81

− n tan φ = + .81 × .91 = + .737

b (mean of determinations opposite) = −0ˢ.138

b sec φ = − 0.138 × 1.354 = − 0.187

m = b sec φ − n tan φ = +.550

Clock slow 17.47

Present rate (see pp. 12, 13, 14), 0ˢ.7 losing.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 23.9 1877. Instrument, Mer. circle Observer, J. F. M.

Timepiece, S. Clock Recorder,

Object,	α Cor. Bor.		α Serp.					
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	15 29 8.1		15 37 52.8			.		.
II.	11.0		54.5			.		.
III.	13.0		56.8			.		.
IV.	15.1		59.1			.		.
V.	17.6		38 1.0			.		.
Sum,	64.8		284.2			.		.
Mean,	29 12.96		37 56.84			.		.
m		+ .55		+ .55				
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa, n tan δ		− .42		− .10		.		.
Corr'd Transit,	29 13.09		37 57.29			.		.
R. A.	29 30.79		38 15.01			.		.
Error of Timepiece,	17.70		17.72			.		.

Collimation examined this morning to guard against any gross error. It appeared correct; no measurement made. For values of m & n see last page.

F. 3451 compared with S. Clock (F. 1327) by means of mean time clock. Difference between them 26.9. Hence F. 1327 being slow 17.7 F. 3451 is fast 9.2. The observations of Dec 18 made it fast 5.24 (5½ days ago); the resulting rate is about 0.7 a day; the previous rate was about 0.4, so that the actual present rate is probably more than 0.7. A few eye & ear observations taken Dec. 23.3 (before J. F. M.'s sets) made the error of F. 3451 8.85; from this, the present rate seems to be only 0.7.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 24.3 1877. Instrument, Mer. circle Observer, J. F. M.
Timepiece, J. Clock Recorder,

Object,	γ Pegasi		ε Cetι		12 Cetι		12 Cass.	
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	0 6 35.0		12 50.6		23 26.9		25 38.2	
II.	37.0		52.6		28.7		42.7	
III.	39.3		54.7		30.8		47.2	
IV.	41.3		56.8		32.8		51.8	
V.	43.4		59.0		34.9		55.9	
Sum,	196.0		273.7		154.1		235.8	
Mean,	39.20		54.74		30.82		47.16	
m Bb,	+ .45		+ .45		+ .45		+ .45	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
m tan δ	— .18		+ .12		+ .06		— 1.33	
Corr'd Transit,	39.47		55.31		31.23		46.28	
R. A.	6 57.68		13 13.33		49.42		26 4.48	
Error of Timepiece,	18.21		18.02		18.09		18.20	

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 24.3 1877. Instrument, ... Observer, ...
Continued. Timepiece, ... Recorder, ...

Object, Circle,								
	δ Cassiop.		ε And.		21 Cass.			
Level Direct, Reversed,	w	e	w	e	w	e	w	e
	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	0 29 46.1		31 44.0		37 5.1			.
II.	49.9		46.5		12.8			.
III.	53.2		48.8		20.5			.
IV.	56.7		51.3		28.1			.
V.	0.1		53.8		35.8			.
Sum,	266.0		244.4		102.3			.
Mean,	53.20		48.88		20.46			.
m	c + .45		+ .45		+ .45			.
Bb,	.		.		.			.
Cc,	.		.		.			.
Aa,	.		.		.			.
n tan δ	— .93		— .38		—2.49			.
Corr'd Transit,	52.72		48.95		18.42			.
R. A.	30 11.06		32 7.13		37 36.64			.
Error of Timepiece,	18.34		18.18		18.22			.

γ Pegasi 18.21
ι Ceti 18.02
02 " 18.09
ε And. 18.18
.50
Mean 18.13 slow at $0^h\frac{1}{4}$ sid. time.

No value of n will remove discordance.
Adopted value — 0.7
b dec δ assumed as yesterday — 0.187

Rate, losing, 0.s77

Clock comparisons next morning at $16^h\frac{1}{4}$ " "
Clock then slow 18.s6

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1877phae.proj.1797N

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 25.3 1877. Instrument, Mer. Circle. Observer, W. A. R.

Timepiece, ... Recorder, ...

Object, Circle,	Polaris		α Arietis		α Ceti			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	1 12m 48.7		1 59 55.2		2 55 32.0			.
II.	13 31.2		57.4		34.1			.
III.	14 12.6		59.7		36.1			.
IV.	15 2.5		2 0 2.0		38.1			.
V.	45.5		4.3		40.2			.
Sum,	80.5		298.6		180.5			.
Mean,	1 14 16.10		1 59 59.72		2 55 36.10			.
m	+ .54		+ .54		+ .54			.
Bb,	.		.		.			.
Ce,	.		.		.			.
Aa,	.		.		.			.
n tan δ	− 32.74		— .34		— .05			.
Corr'd Transit,	1 13 43.90		1 59 59.92		2 55 36.59			.
R. A.	1 14 2.82		2 0 18.98		2 55 55.57			.
Error of Timepiece,	18.92		19.06		18.98			.

α Ar. 19.06
α Ceti 18.98
Clock slow at 2½ sid. time 19s.02
Loss last 26 hours 18.13
0.89
.07
Rate, losing, 0.82

n = −.80 (Polaris & α Ceti)
b sec δ assumed as before − 0.187
m = +.54

Clock comparison next morning 16½ sid. time; error 19s.50, slow.

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1877phae.proj.1797m

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 26.3 1877. Instrument, Mer. Circle Observer, W. A. R.

Timepiece, S. Clock Recorder,

Object,	ζ Cass.		ζ Cass.		ν Piscium			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	0 29 44.6		1 17 24.0		1 34 41.6			.
II.	47.8		28.0		43.6			.
III.	51.4		32.1		45.4			.
IV.	54.8		36.2		47.6			.
V.	58.3		40.3		49.9			.
Sum,	256.9		160.6		228.1			.
Mean,	51.38		32.12		45.62			.
m	+ .36		+ .36		+ .36			.
Bb,	.		.		.			.
Cc,	.		.		.			.
Aa, n tan δ	− .80		−1.02		− .05			.
Corr'd Transit,	50.94		31.46		45.93			.
R: A.	0 30 11.02		1 17 51.54		1 35 5.99			.
Error of Timepiece,	20.08		20.08		20.06			.

Clock slow at 1h sid. time 20s.07
Loss last 22½ hours 19.0k
1.05
.07
Rate, losing, 1.12
.70
Slow at 16h sid. time, Dec. 26.9, 20.77

b sec φ assumed −0.187 as before
n = −.6
m = +.36

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 27 1887. Instrument, Mer. Circle. Observer, W.A.R.
Timepiece, S. Clock. Recorder,

Object,	α Arietis		α Ceti					
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	1 59 53.6		1 55 30.3			.		.
II.	55.8		32.4			.		.
III.	58.0		34.4			.		.
IV.	0.2		36.2			.		.
V.	2.3		38.3			.		.
Sum,	289.9		171.6			.		.
Mean,	1 59 57.98		34.32			.		.
Bb,	+ .45		+ .45			.		.
Ce,	.		.			.		.
Aa,	.		.			.		.
n tan δ	− .31		− .04		−	.		.
Corr'd Transit,	1 59 58.12		2 55 34.73			.		.
R. A.	2 0 18.96		2 55 55.57			.		.
Error of Timepiece,	20.84		20.84			.		.

m

Clock slow at $2^h\frac{1}{2}$ sid. time 20.84 — $n = -.7$
Loss last $25\frac{1}{2}$ hours 0.77 — b sec φ assumed
Rate losing, 0.72 — −0.187 as before
Slow at 16^h sid. time, Dec. 27.9, 21.25 — $m = +.45$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 28 1877 Instrument, Mer. Circle Observer, A. T.

Timepiece, S. Clock Recorder,

Object, Circle,	σ Persei		f Tauri		ε Eridani		Gr. 716	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b.	.	.	.	.	.	.	.	.
	h m s		h m s		h m s		h m s	
Wire, I.	3 21 33.3		3 23 43.8		3 26 46.1		3 31 7.9	
II.	36.4		~~45.9~~		48.2		12.1	
III.	39.5		48.0		50.3		17.0	
IV.	42.5		.		52.4		21.3	
V.	45.4		52.3		54.5		26.0	
Sum,	197.1		144.1		251.5		84.3	
Mean,	39 42		48.03		50.30		16.86	
m Bb,	+ .50		+ .50		+ .50		+ .50	
Cc,	.		.		.		.	
Aa, n tan δ	− .83		− .17		+ .13		− 1.50	
Corr'd Transit, R. A.	3 22 0.56		3 24 9.89		3 27 12 54		3 31 37.48	
Error of Timepiece,	21.45		21.53		21.61		21.62	

45 / 13 / 61 / 159

clock slow at 3½ sid. time 21.53
loss last 25 hours 20.84 / 0.69 / .03
Rate, losing, 0.66 (0.33)
clock slow at 16h sid. time Dec. 28.9, 21.87

n (ε Eid. & Gr. 716) − .76
b sec δ assumed as before − 0.187
m = .50

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 28.5 1877. Instrument, Mer. Circle Observer, J. 7 M.

Timepiece, S Clock Recorder,

Object,	β Tauri			Lyr. 966			κ Orionis					
Circle,												
Level Direct,	w		e	w		e	w		e	w		e
Reversed,												
Sums,												
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	5	18	10.5	5	22	55.8	5	41	33.7			
II.			13.0		23	4.0			35.8			
III.			15.1			12.3			38.1			
IV.			17.4			20.0			40.1			
V.			20.0			29.0			42.1			
Sum,			76.0			61.1			189.8			
Mean,			15.20			12.22			37.96			
m Bb,			+ .40			+ .40			+ .40			
Cc,												
Aa,												
n tand			— .35			— 2.38			— + .11			
Corr'd Transit,		18	15.25		23	10.24		41	38.47			
R. A.	5	18	37.00	5	23	31.92	5	42	0.14			
Error of Timepiece,			21.75			21.68			21.67			

75
167
142
.71

Clock slow at $5^{h}\frac{1}{2}$ sid. time 21.71
Loss last 27 hours .87

Rate, losing, 0.78

Clock slow at 16^{h} sid. time, Dec. 28.9, 22.05

21.71
21.53
.18

n (Lyr. 966 & κ Ori.) — .64
Error assumed as before — 0.187
m = + .40

$\frac{7}{11}$ Difference Mean for rate between determinations including error in estimation.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 29, 1877. Instrument, Mer. Circle. Observer, J. 7. M.

Timepiece, S. Clock. Recorder,

Object, Circle,								
	η H. Cam.		ε Persei		ξ Persei		λ Tauri	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	3 46 17.0		3 49 14.2		3 50 37.3		3 53 29.9	
II.	21.3		16.9		39.7		32.0	
III.	25.3		19.4		42.2		34.1	
IV.	29.6		22.1		44.9		36.3	
V.	33.9		24.9		47.3		38.4	
Sum,	127.1		97.5		211.4		170.7	
Mean,	3 46 25.42		19 .50		42.28		34.14	
m								
Bb,	+.40		+.40		+.40		+.40	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
mean	−1.16		−.54		−.46		−.14	
Corr'd Transit,	3 46 24.66		19.36		50 42.22		34.40	
R. A.	3 46 47.37		3 49 41.97		3 51 4.91		3 53 57.00	
Error of Timepiece,	22.71		22.61		22.69		22.60	

Clock slow at 4h sid. time, 22s.65
Loss last 22½ hours 0.94
Rate, losing, 1.00
Clock slow at 16h sid. time, Dec. 29.9, 23.15

61, 69, 68, 70 } 260 / 65

m (η H. Cam., λ Tauri) −.65

b as assumed before −.187

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Dec. 31.3 1877. (for ν Tauri, date Dec. 29.3) Instrument, Mer. Circ. Observer, W. A. R.

Timepiece, Recorder,

Object,	ν Tauri				α Arietis				α Ceti			
Circle,												
	w		e		w		e		w		e	
Level Direct,	.		.		.		.		.		.	
Reversed,	.		.		.		.		.		.	
Sums,	.		.		.		.		.		.	
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	3	56	14.4			.	1	59	50.4	2	55	26.8
II.			16.6			.			52.4			29.2
III.			18.6			.			54.8			31.3
IV.			20.8			.			57.1			33.2
V.			22.8			.			59.4			35.5
Sum,			93.2			.			274.1			156.0
Mean,			18.64			.	1	59	54.82	2	55	31.20
Bb, (m)			+.40			.			+.40			+.40
Cc,			.			.			.			.
Aa, (n tand)			−.06			.			−.30			−.04
Corr'd Transit,			18.98			.	1	59	54.92	2	55	31.56
R. A.	3	56	41.68			.	2	0	18.93	2	55	55.56
Error of Timepiece,			22.70			.			24.01			24.00

Dec. 31.3 Clock slow at $2\frac{1}{2}$
sid. time 24.00
loss last $46\frac{1}{2}$ hours 1.35
Rate losing, 0.70
Clock slow Dec. 31.9, $16\frac{1}{2}$ sid. time, 24.41
n = −.7 m assumed +.40 as before

Comparison of 7.3451 with 7.1827 on chronograph
1 47.0 to 47.20
46 34.0
35.4
63.0
7.3451 26.12 fast of 7.1827 37.8 27.5 36.88
23.88 39.9 26.12

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 1.3 1878. Instrument, Mer. Circle Observer, W. A. R.

Timepiece, 7 1327 Recorder,

Object, Circle,	α Cass.				γ Cass.				β Arict.			
Level Direct, Reversed,	w		e		w		e		w		e	
Sums, Difference, b.												
	h	m	s		h	m	s		h	m	s	
Wire, I.	0	33	4.0		0	41	11.7		1	47	25.6	
II.			7.5				15.7				27.8	
III.			11.2				19.6				30.0	
IV.			15.1				23.2				32.1	
V.			18.7				27.1				34.5	
Sum,			56.5				97.3				150.2	
Mean,	0	33	11.30		0	41	19.46		1	47	30.04	
m Bb,			+.40				+.40				+.40	
Cc,												
Aa, n tam S			−1.03				−1.09				−.26	
Corr'd Transit, R. A.			10.67				18.77				30.18	
	0	33	35.54		0	41	43.56		1	47	55.09	
Error of Timepiece,			24.87				24.79				24.91	

m assumed +.40 as before
n " " −.7 "

87
79
4h
257

Clock slow at 1h sid. time 24s.86
Loss last 22½ hours 0.86
Rate losing, 0.92
Clock slow at 16h sid. time, Jan. 1.9, 25s.43

Loss between Dec. 23 & Jan. 1 7s.39
Mean rate losing, 0.82
Clock slow Jan. 3.9 (at this rate) 27.0

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1877phae.proj.1797M

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 4.9 & Jan. 5.3 1878. Instrument, Mer. Circle. Observer, J.Z.M. W.A.R.

Timepiece, Z 1327 Recorder,

Object, Circle,	γ Urs. Min.		α Urs. Min.		o Pisc.		β Ariet.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		13.6		.	1 38	25.0	1 47	22.0
II.		20.6		12 26.0		27.0		23.9
III.		27.6		13 55.9		29.0		26.2
IV.		34.0		15 20.0		31.3		28.5
V.		41.3		.		33.3		30.6
Sum,		137.1		161.9		145.6		131.2
Mean,		27.42		53.97		29.12		26.24
m Bb,		+.40		+.40		+.40		+.40
Cc,		.		.		.		.
Aa,		.		.		.		.
n taus		−2.19		−29.53		−.10		−.25
Corr'd Transit,		25.63	1	13 24.84	1	38 29.42	1	47 26.39
R. A.		54.32	1	13 53.58	1	38 58.10	1	47 55.05
Error of Timepiece,		28.69		28.74		28.68		28.66

Clock slow at $15\frac{h}{2}$ sid. time $28.^{s}69$
Loss last $3\frac{1}{2}$ days 3.83
Rate, losing, 1.09

m assumed +.40 as before
n " −.7 " "

Too uncertain to use as an indication of clock rate with the observations of the following evening. Seems to be 0.5 out.

Clock slow at $1\frac{h}{4}\frac{3}{4}$ sid. time $28.^{s}67$
Loss last 4 days 3.81
Rate, losing, 0.95
Clock slow at $16\frac{h}{4}\frac{3}{4}$ sid. time, Jan. 5.9, 29.26

n = −.69
n assumed .40 as before

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 6.3 1878. Instrument, Mer. Circle Observer, J. F. M.
Timepiece, F. 1327 Recorder, κ Cass. by W. A. R.

Object, Circle, tan δ	κ Cass, 1.90		η Pisc. .26		ν Pers. 1.11		43 Cass, 2.40	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b.	.	.	.	.	.	.	.	.
	h m s		h m s		h m s		h m s	
Wire, I.	0 25 26.0		1 24 23.8		1 29 55.4			
II.	30.4		25.9		58.5			
III.	34.6		28.0		30 1.8		1 32 52.2	
IV.	39.1		30.2		4.9			
V.	44.4		32.1		8.0			
Sum,	174.2		140.0		8.6			
Mean,	34.84		28.00		30 1.72		52.20	
m Bb,	+ .50		+ .50		+ .50		+ .50	
Ce,	.		.		.		.	
Aa, n tan δ	− 1.42		− .19		− .83		− 1.80	
Corr'd Transit,	1 25 33.92		1 24 28.31		1 30 1.39		1 32 50.90	
R. A.	0 26 4.04		1 24 58.09		1 30 31.18		1 33 19.79	
Error of Timepiece,	30.12		29.78		29.79		28.69	

Clock slow at 1½ sid. time 29.79
Loss last 24 hours 1.12
Clock slow Jan. 6.9 at 16½ sid. time 30.49

Adopted value for n −.75 to satisfy η Pisc. & ν Persei; there may be an effect of personal equation in κ Cassiop. which was observed by W. A. R.; 43 Cass. was observed on one wire only. b sec δ assumed as before −.187.
n = +.50

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 7.3 1878. Instrument, Mer. Circle Observer, W. A. R.

Timepiece, F. 1327 Recorder,

Object, Circle,	σ Ric.		β Arict.		36 H. Cassiop.		ν Pers.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	1 38 22.1		1 47 19.0		2 25 46.0		2 35 16.6	
II.	24.5		21.4		53.3		19.5	
III.	26.5		23.8		26 0.2		22.8	
IV.	28.7		26.8		6.6		25.9	
V.	30.7		28.0		13.9		29.0	
Sum,	132.5		119.0		0.0		113.8	
Mean,	1 38 26.50		23.80		2 26 0.0		2 35 22.76	
Bb,	+ .141		+ .141		+ .141		+ .141	
Cc,	.		.		.		.	
Aa,	— .10		— .24		— 2.07		— .75	
Corr'd Transit,	1 38 26.81		1 47 23.97		2 25 58.34		2 35 22.42	
R. A.	1 38 58.08		1 47 55.02		2 26 29.61		2 35 53.69	
Error of Timepiece,	31.27		31.05		31.27		31.27	

31.27
31.05
31.27

Clock slow at 2h sid. time 31.20
Loss last 24½ hours 1.41
Rate, losing, 1.38
Clock slow Jan. 7.9, at 17h sid. time, 32.06

n from σ Ric & 36 H. Cassiop.
— .66
b see φ assumed as before
— .187
m = + .41

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 9 3 1878. Instrument, Mer. Circle Observer, J.M. & W.A.R.

Timepiece, Recorder,

Object,	ν Pisc.		50 Cass.					
Circle, ~~East~~								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								

	h m s	h m s	h m s	h m s
Wire, I.	1 12 7.5	1 52 23.9	.	.
II.	9.7	27.2	.	.
III.	12.0	30.8	.	.
IV.	14.4	34.0	.	.
V.	16.8	37.2	.	.
Sum,	60.4	153.1	.	.
Mean,	12.08	30.62	.	.
m	+ .32	+ .32		
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
n tan δ	− .28	− 1.70	.	.
Corr'd Transit,	1 12 12.12	1 52 29.24	.	.
R. A.	1 12 46.38	1 53 3.50	.	.
Error of Timepiece,	34.26	34.26	.	.

Clock slow at $1^h\frac{1}{4}$ sid. time 34.26 $n = -.56$

Loss last 47 hours 3.06 b sec φ assumed as before

Rate, losing, 1.56 − 0.187

$m = +.32$

Clock slow at 17^h sid. time, Jan. 9.9, 35.30

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 11.8 1878. Instrument, Mer. Circ. Observer, A. J.

Timepiece, Z 1327 Recorder,

Object, Circle,	tau δ			α Serp. .12			β Serp. .28			5 Hrs. Min. 4.76									
Level Direct, Reversed,	w		e	w		e	w		e	w		e	w		e				
Sums, Difference, b.																			
	h	m	s	h	m	s	h	m	s	h	m	s	h	m	s	h	m	s	
Wire, I.				15	37	34.0	15	39	57.9	15	46	17.7							
II.						36.0			54.0			48.4							
III.						38.1			56.0			48.7							
IV.						40.3			58.5			48.6							
V.						42.3			60.3			59.2							
											48	48.9							
											49	18.8							
Sum,						190.7			280.7			340.6							
Mean,				15	37	38.14	15	39	56.14	15	47	48.67							
Bb,	m					+ .26			+ .26			+ .26							
Ce,																			
Aa,	n tau δ					− .06			− .14			− 2.33							
Corr'd Transit,				15	37	38.34	15	39	56.26	15	47	46.60							
R. A.				15	38	15.55	15	40	33.41	15	48	23.82							
Error of Timepiece,						37.21			37.15			37.22							

37.21
37.15
36

n from α Serp. & 5 Hrs. Min. −.49
b sec φ assumed as before −0.17
m = +.26

Clock slow at $15^h\frac{3}{4}$ sid. time 37.18
Loss last $62\frac{1}{2}$ hours 2.92
Rate, losing, 1.12

With value of b afterwards obtained
m = +.47
Clock slow at $15\frac{h}{4}\frac{3}{4}$ sid. time 36.97

Level observations Jan. 12.0, 1878.

W	E	W	E
77.5	54.2	55.4	75.6
55.7	75.4	75.1	55.6
133.2	129.6	130.5	131.2

3.6 .7
3.6
+.396 −.077
+.32
b = +0.021s

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1877phae.proj.1797m

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 12.3 1878. Instrument, Mer. Circle Observer, J. F. M.

Timepiece, F. 1327 Recorder,

Object, Circle,	ι Psc. Fo	α Ars. Min.	η Psc.	ν Pers.
	w / e	w / e	w / e	w / e
Level Direct,	. / .	. / .	. / .	. / .
Reversed,	. / .	. / .	. / .	. / .
Sums,	. .	. .	. .	. .
Difference,				
b.				

	h m s	h m s	h m s	h m s
Wire, I.	1 5 34.7	1 10 36.1	1 24 15.7	1 29 47.5
II.	36.8	11 19.2 / 12 42.4	18.1	50.6
III.	39.0	48.0 / 13 31.0	20.2	53.5
IV.	41.5	14 15.2 / 59.7	22.3	56.6
V.	44.0	15 44.3 / 16 29.2	24.4	59.8
Sum,	196.0	2871	100.7	268.0
Mean,	1 5 39.20	1 13 34.90	1 24 20.14	1 29 53.60
Bb,	.	+ .51	+ .51	+ .51
Cc,	.	.	.	.
Aa,	.	.	.	.
n tan δ	.	−22.89	— .14	— .59
Corr'd Transit,	.	1 13 9.52	1 24 20.51	1 29 53.52
R. A.	.	1 13 47.02	1 24 58.02	1 30 31.05
Error of Timepiece,	.	37.50	37.51	37.53

m

Clock slow at $1^h\frac{1}{2}$ sid. time $37^s.53$

316.97

Loss last 10 hours 0.56

Rate, losing, 1.34

Clock slow at $17\frac{1}{2}$, Jan. 12.9, 38.43

$n = -0.532$

$b \sec\varphi$ (see p. 29) $+0.028$

$m = +.51$

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 13.3 1878. Instrument, Mer. Circle Observer, W. A. R.

Timepiece, 7.1327 Recorder,

Object, Circle, tau S	o Pisc. .15		β Arict .37		50 Cass. 3.04		β Triang. .69	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b.	. .		. .		. .		. .	
	h m s		h m s		h m s		h m s	
Wire, I.	1 38 14.7		1 47 11.6		1 52 19.0		2 1 34.3	
II.	16.7		13.8		22.6		36.9	
III.	18.8		16.0		25.9		39.3	
IV.	21.0		18.1		29.3		41.9	
V.	23.1		20.3		32.5		44.3	
Sum,	94.3		79.8		129.3		196.7	
Mean,	18.86		15.96		25.86		39.34	
m Bb,	+.56		+.56		+.56		+.56	
Cc,	.		.		.		.	
Aa, n tau S	−.09		−.22		−1.79		−.41	
Corr'd Transit, R. A.	1 38 58.02		1 47 54.96		1 53 3.31		2 2 18.10	
Error of Timepiece,	38.69		38.66		38.68		38.61	

$\frac{9}{1}\ \frac{6}{16}\ \frac{16}{5}$

r from o Pisc. & 50 Cass. −.59
b sec φ assumed as before +.028

Clock slow at $1^{h}\frac{3}{4}$ sid. time 38.65
Loss last $24\frac{1}{4}$ hours 1.12
Rate 1.11

Clock slow at $16^{h}\frac{3}{4}$ sid. time, Jan. 13.9, 39.34

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 14.3 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 7.1327 Recorder,

Object, Circle,	α Tauri .129		α Aurigæ 1.03		β Tauri .154		Gr. 966 3.42	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b.	.	.	.	.	.	.	.	.
	h m s		h m s		h m s		h m s	
Wire, I.	4 28 12.7		5 6 57.7		5 17 52.3		5 22 37.0	
II.	14.8		7 0.7		54.6		45.1	
III.	17.0		3.6		57.0		52.8	
IV.	19.0		6.7		59.3		61.0	
V.	21.1		9.5		61.7		69.6	
Sum,	84.6		18.2		284.9		265.5	
Mean,	16.92		3.64		56.98		53.10	
Bb,	+ .142		+ .142		+ .142		+ .42	
Cc,	.		.		.		.	
Aa,	— .12		— .144		— .23		— 1.60	
Corr'd Transit,	4 28 17.22		5 7 3.62		5 17 57.17		5 22 51.92	
R. A.	4 28 57.09		5 7 43.31		5 18 37.03		5 23 31.78	
Error of Timepiece,	39.87		39.69		39.86		39.86	

87
69
86
242
81

Clock slow at 5h sid time 39.81
Loss last 27 hours 1.15
Rate, losing 1.02
Clock slow at 17h 40.32

Jan. 16.2 Value of b mult level W.A.R.

E	W	E	W	E	W
73.7	72.4	60.8	85.0	69.0	75.3
60.8	85.0	76.0	69.8	69.3	75.4
134.5	157.4	136.8	154.8	138.3	150.7

22.9
18.0
12.4
17.8
712
2492

1 div = ".84 = s.056

b = +.249
sec φ = 1.354
b sec φ = +.337

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 16.3 1878. Instrument, Mer. Circle Observer, W.A.R

Timepiece, 1327 Recorder, Chronograph.

Object,	α Ursæ Min		o Piscium		θ Persei		η Persei	
Circle,	42.96		δ ~~48 8~~ 32.7 ~~43~~	.15	48 43	1.14	55 23.5	1.45
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	.		1 38 12.0		6.6		1.8	
II.	.		14.1		9.5		5.5	
III.	1 13 35.5		16.3		12.7		9.1	
IV.	.		18.4		15.8		12.7	
V.	.		20.5		18.9		16.4	
Sum,	.		.		.		.	
Mean,	.		16.26		12.70		9.10	
Bb,	.		m + 1.05		+ 1.05		+ 1.05	
Cc,	.		.		.		.	
Aa,	.		n tan δ − .12		− .89		− 1.13	
Corr'd Transit,	.		17.19		12.86		9.02	
R. A.	1 13 43.7		1 38 58.04		2 35 53.53		2 41 49.70	
Error of Timepiece,	.		40.85		40.67		40.68	

$-8.20 + 42.96\,n$
$-41.78 + .15$
$+33.58 + 42.81\,n$

$n = -.78$
$\log q = .91$
$n \tan q = -.710$
$b \sec q = +.337$
$m = +1.05$

$-8.20 + 42.96\,n$
$-40.83 + 1.14$
$+32.63 + 41.82\,n$

Rate by comparison with Jan. 13 $\frac{-0.83}{+.25}$

Rate by reducing Obs. of Jan. 14 with new values of n & m -0.73

Adopted -0.80

1327 slow 40.73 2^h S.T.

Rate -0.80

Jan. 17.3 The value of n used last night is nearly the value obtained from 50 Cass, 36 Her. and o Piscium It was discovered that α Ursæ was read wrong, the true reading should have been 1 13 26.1 but this gives a value of n far out of the way ∴ it was rejected.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 17.3 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Jan 19.3

Object,	Polaris		o Piscium		Polaris		o Piscium	
Circle,							115	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	.		1 38 11.1		1 10 23.2		38 8.1	
II.	1 12 53.7		13.0		11 8.3		10.3	
III.	13 27.7		15.1		11 51.9		12.4	
IV.	14 8.6		17.2		13 18.6		14.5	
V.	.		19.3		19.8		16.6	
					19.6			
Sum,	9 80.0		.		.		.	
Mean,	1 13 26. 30.00		15.14		1 13 19.33		12.38	
Bb,	.		m +.97		.		+.82	
Ce,	.		.		.		.	
Aa,	.		a tan δ −.10		.		−.08	
Corr'd Transit,	.		16.01		.		13.12	
R. A.	1 13 42.83		1 38 58.03		1 13 40.86		1 38 58.01	
Error of Timepiece,	.		−42.02		.		44.89	

$-12.83 + 42.96\,m$
$-42.79 + .15\,c$
$30.06 + 42.81\,m$
$m = -.70$
$m \tan\delta -.637$
$b\text{-}\sec\delta +.337$
$m +.974$

Rate −1.12

o Pisc.
Jan. 16.3 16.26
17.3 15.14
1.12

1) $-21.53 + 42.96\,m$
2) $-45.63 + .15\,m$
$24.10 + 42.81\,m$

3) $-44.27 + 3.05\,m$
4) $-45.12 + .68\,m$
5) $-44.22 + 3.13\,m$

From 2 − 1 $m = .56$
" 4 − 1 .56
" 3 − 1 .57
3 − 2 .47
5 − 2 .47
3 − 4 .36 } grey
3 − 5 .37 }
Adopted $m = -.53$

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1877phaq.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan. 19.3 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, Recorder,

Object,	50 Cass.			β Trianguli			36 Andr. Cass.			δ Persei			η Persei						
Circle,	71	50.2	3.05	34	24.8	68 3.05	72	17.4	3.13	48	43	1.14	55	23.6	1.45				
				w		e	w		e	w		e	w		e				
Level Direct,				.		.	.		.	.		.	.		.				
Reversed,				.		.	.		.	.		.	.		.				
Sums,				.		.	.		.	.		.	.		.				
Difference,																			
b.																			
				h	m	s	h	m	s	h	m	s	h	m	s				
Wire,	I.	52	5.9		1	27.9		25	31.6		35	2.2		40	57.5				
			9.5						35.1										
	II.		12.4			30.3			38.5			5.5			1.0				
			16.0																
	III.		19.3			32.9			42.0			8.6			4.9				
	IV.		22.6			35.5			45.0			11.7			8.5				
			25.7						48.5										
	V.		29.3			37.8			52.0			14.6			12.1				
			32.4						55.8										
									59.0										
Sum,						.			.			.			.				
Mean,		52	19.23			32.88			45.28			8.52		41	~~5.00~~ 4.80				
Bb,						+ .82			.			+ .82			+ .82				
Cc,						.			.			.			.				
Aa,						− .36			.			− .60			− .77				
Corr'd Transit,						33.34			.			8.74			4.85				
R. A.	1	53	3.50	2	2	18.00	2	26	29.50	2	35	53.47	2	41	49.63				
Error of Timepiece,						44.66			.			44.73			44.78				

n tan q − .482 44.89
b sec q + .337 .66
m + .819 .73
Err − 44.76 .78

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan 22.4 1877. Instrument, Mer. Circ. Observer, W. A. R.

Timepiece, Fr. 1327. Recorder, E. W.

Object, Circle,	o Piscium log δ = 0.15		β Arietis 0.03		50 Cass. 2.95		β Trianguli 0.68	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	37 5.2		46 12.1		51 9.6		1 25.0	
II.	7.3		4.3		12.8		27.4	
III.	9.4		6.6		16.1		29.9	
IV.	11.6		8.8		19.3		32.4	
V.	13.6		11.0		22.6		35.0	
Sum,	47.1		32.8		80.4		149.7	
	9.42		6.56		16.08		29.94	
Mean,	1 37 9.42		1 46 6.56		1 51 16.08		2 1 29.94	
	38 ?		47 ?					
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	1 38 57.98		1 47 54.83		1 53 2.77		2 2 17.96	
	−.15						49.02	
	1 38 57.83							
	48.41							
Error of Timepiece,	.		.		.		.	

$0 = -48.27 + 0.\overset{37}{\cancel{33}}\,x + \Delta t + m$

$0 = -46.69 + 2.95\,x + \Delta t + m$

$0 = -1.58 - 2.92\,x \quad \therefore x = -0.54$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan 23d.4 1878. Instrument, Merid. Cir. Observer, W. A. R.

Timepiece, Frodsham 1327 Recorder, L. W.

Object,	o Persei		η Persei		48 Hercules		α Persei	
Circle,	lgδ = ~~0.05~~ 1.13		lgδ 1.44		4.45		1.16	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		58.2		53.2		0.3		43.2
II.		1.3		57.1		~~5.2~~		46.4
III.		4.2		60.5		9.8		49.4
IV.		7.8		64.3		14.2		52.8
V.		10.4		67.8		19.7		55.9
Sum,		4.38		0.58		9.84		49.54
Mean,		.		.		.		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	2 35 53.39		2 41 49.54		3 4 56.40		3 15 38.68	
Error of Timepiece,		.		.		.		.

$0 = (t-\alpha) + n\,lg\delta + \Delta t + m$.

$\therefore 0 = 49.01 + 1.13n + \Delta t + m$

$0 = -48.96 + 1.44n + \Delta t + m$

$0 = -49.14 + 1.16n + \Delta t + m$

$0 = -49.04 + 1.24n + \Delta t + m$

$\therefore \Delta t + m = +49.04$

$n = +.43$

$\Delta t = +48.57$

$0 = -\overset{49.14}{46.56} + 4.45n + \Delta t + m$.

$0 = -49.04 + 1.24n + \Delta t + m$

-90

$0 = +2.48 + 3.21n$

$\therefore n = -\frac{0.77}{+0.08}$

$\therefore m = +0.40 + .70$

$\therefore m = +1.10$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan 24d.4 187 . Instrument, Mew Ci, Observer, W. A.R.,
Timepiece, 1377 Recorder, C. W.

Object, Circle,	36 + Cass. lg δ 3.13		β Persei +0.85		α Persei +1.19		δ Persei +1.09	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								

	h m s	h m s	h m s	h m s
Wire, I.	33.3	19.3	41.7	.
II.	36.2	22.0	45.0	.
III.	39.8	24.9	48.2	.
IV.	43.2	27.5	51.3	.
V.	46.4	30.3	54.4	.
Sum,	1988	1240	2406	.
	39.76	24.80	48.12	.
Mean,	39.76	24.80	48.12	.
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	3 26 28.67	3 0 15 24.79	3 15 38.63	3 34 16.20
Error of Timepiece,	.	.	.	.

$t - \alpha =$ $-48^s.91$ $-50^s.49$ $-50^s.51$

-0.64 -0.80

-51.13 -51.31

$0 = t - \alpha + n \lg \delta + (\Delta t + m)$

$0 = 50.49 + 0.85 n + \Delta t + m$

$50.51 + 1.19 n + (\Delta t + m)$

$0 = -50.50 + 1.02 n + \Delta t + m$

$0 = -48.91 + 3.13 n + \Delta t + m$

$0 = -1.59 - 2.11 n \quad \therefore n = -0.75$

$-\Delta T = -51.22 + m$

1.08

$\therefore \Delta T = 50.14$

$m = 40 + 0.68$

$m = +1.08$

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·002 | 1.300 / 650

·05 / ·04 / ·0020

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan 19/4 1878. Instrument, Merid. Cir. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,	36 H Cam. 3.13			θ Pers			η Pers			α Ceti.						
Circle,	δ = 72 17				1.14			1.45			0.06					
	w		e	w		e	w		e	w		e				
Level Direct,	.		.	.		.	.		.	.		.				
Reversed,	.		.	.		.	.		.	.		.				
Sums,	.		.	.		.	.		.	.		.				
Difference,																
b.																
	h	m	s	h	m	s	h	m	s	h	m	s				
Wire, I.			19.4			53.0			48.3			56.3				
II.			32.7			56.2			52.0			58.3				
III.			36.2			59.3			55.7			0.3				
IV.			39.7			2.3			59.4			2.5				
V.	2	24	42.8	2	34	5.5	2	40	3.0	2	53	4.6				
Sum,			180 8 36.16			176 3 35.26			218 4 43.68			122 0 24.40				
Mean,	2	24	36.16	2	33	59.26	2	39	55.68	2	53	0.40				
Bb,			.			.			.			.				
Ce,			.			.			.			.				
Aa,			.			.			.			.				
Corr'd Transit,	2	24	36.16	2	33	59.26	2	39	55.68	2	53	0.40				
R. A.	2	26	28.37	2	35	53.28	2	41	49.39	2	55	55.24				
Error of Timepiece,			52.21			54.02			53.71			54.84				

$0 = 54.02 + 1.14m + \Delta t + m$

$53.71 + 1.45m + \Delta t + m$

$54.84 + 0.06 + \Delta t + m$

$12.57 \quad 2.65$

$0 = 54.19 + 0.82m + \Delta t + m$

$0 = 52.21 + 3.13m + \Delta t + m$

$0 = -1.98 - 2.31m$

$\therefore m = -0^s.86$

$0 = -52.21 + 3.13m$ | 2.31 | 1.980 | .86 | 1848 | 1320

−54.02	−53.71	−54.84	52.21
− .98	− 1.25	− .05	− 2.69
55.00	54.96	54.89	54.90
4.89			
4.96			
−54.95			

$m = +1\frac{1}{3} - .9m$

$m = +40 + .77$

$0 = -54.95 - .90 + \Delta t \quad \therefore \Delta t =$

-54.95

$+ 1.17$

$\Delta t = -53.78$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan 29.4 1878 Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,	367+Cass-		θ Pegasi		γ Pegasi		α Ceti.	
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		27.9		51.7		46.9		55.2
II.		31.5		55.0		50.6		57.0
III.		34.9		58.0		54.3		59.2
IV.		38.2		1.0		57.7		1.3
V.	2 25	41.6	2 34	4.2	2 40	1.7	54	3.2
Sum,		17413 / 34.82		16999 / 33.98 / 24		21112 / 42.24 / 12		17599 / 35.18 / 24
Mean,	2 25	34.82	2 33	57.98	2 39	54.24	2 53	59.18
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	~~2 2~~ ~~35~~ 26	28.38	2 35	~~15.38~~ 53.21	2 41	49.31	2 55	55.22
Error of Timepiece,		.		.		.		.

$-55.23 - .93 = -56.16 - .26 - .09 = -56.17$

$-55.07 - 1.19 = -56.26$

$-56.04 - .05 = 56.09$

51

$0 = -56.17 + \Delta t + m$

$\therefore \Delta t = +56.17 - 1.14 = 55.03$

$0 = -55.23 +$

$0 = -55.07 +$ as in last night

$0 = -56.04 +$

$0 = -55.45 + 0.82\,n + \Delta t + m$

$0 = -53.56 + 3.13\,n + " "$

$0 = -1^s.89 - 2.31\,n \quad \therefore n = -.82$

$n = 1\frac{1}{3}6 + .74$

$n = +1.14$

3)1.34
.45

231)1890(82
1848
420
462

$\therefore$ Eun 1327 = $-55^s.03$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Jan 30.4 1878. Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,	η Persei		β Persei		48 Hcph		α Tauri	
Circle,					4.47			0.29
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		45.4		.		52.6		55.0
II.		49.3		.		57.2		57.3
III.		52.7		.		2.0		59.5
IV.		55.3		.		6.3		1.6
V.	2 40	59.9		.	3 4	11.0		3.6
Sum,		262.6		.		129.1 25.82 5		1.7 7 0 3 5.40 5
Mean,		52.52		.		1.82		59.40
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	2 41	49.33	3 0	15.17	3 4	55.83	4 28	56.93
Error of Timepiece,		56.81		.		54.01		57.53

$0 = -56.81 + 1.45x + \Delta t + m$

$-54.01 + 4.42x + \Delta t + m$

$0 = -2.80 - 2.97x \quad \therefore x = -0.94$

$m = +40 + 0.846$

85

$m = +1.25$

$0 = -56.81$

$+ 1.36$

$0 = -55.45$

1.45×94

580

1305

1.3630

$.2652 \times 4.42$

26

4.16

$-56.81 - 1.36 - 58.17 + 1.25 = -56.92$

$-54.01 - 4.16 - 58.17 + 1.25 = -56.92$

$\therefore$ Error 1327 $= -55.45$

From α Tauri 56.62

η Persei 56.88

mean 56.75

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1877phae.proj.1797w

Date,

Object,
Circle,

Level Direc
Rever

Sums,
Difference,
b.

Wire,

Sum,
Mean,

Bb,
Ce,
Aa,

Corr'd Tra
R. A.

Error of

Feb 2d.4

0 = 60.97
60.76
61.41
3.14

0 = -61.05 + 0.75n + Δt + m

0 = -58.63 + 4.42n + Δt + m

0 = -2.42 - 3.67n

4.42
1.47
2.95

∴ n = - 0.66.

- 60.97
- 57
- 61.54
.48
.61

60.76
- 72
-61.48

61.41
- 20
61.61

-58.63
- 2.95
61.58

0 = - 61.54 + Δt + m
- 61.54

∴ Δt = + 61s.54 - m
- 1.07
+ 60.47

Feb 3d.4

3.84) 3.650 (1.68
3804
3460
.9
.612

- 62.41
- 0.58
62.99
.02
- 68.01
+ 1.08
+ 61s.92 = Δt

59.96
3.00
62.96

62.82
.21
63.03

m = + .47 + 61
∴ m = + 1.08

∴ Eun 1327 = - 61s.92

- 58.46

" Eun 1627 = +

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb 2d.4 1878. Instrument, Mer. Cir. Observer, W. A.R.

Timepiece, 1327 Recorder, L. W.

Object,	β Persei	48 + Cephei	γ Persei	γ Tauri
Circle,	δ 0.85	4.42	1.09	.37
	w / e	w / e	w / e	w / e
Level Direct,	. / .	. / .	. / .	. / .
Reversed,	. / .	. / .	. / .	. / .
Sums,	. .	. .	. .	. .
Difference,				
b.				

		h m s	h m s	h m s	h m s
Wire,	I.	38.3	8.7	9.0	50.
	II.	43.2	11.6	12.2	57
	III.	47.6	14.2	15.2	54
	IV.	57.3	16.8	18.4	56.
	V.	57.0 / 01.3	19.4	21.4	58.
Sum,		6.4 / 11.4 / 15.6		7 6 2 / 15 2 4	76 / 4
Mean,		1646 / 3292 / 24 / 6.92		15.74	
Bb,		.	.	.	.
Ce,		.	.	.	.
Aa,		.	.	.	.
Corr'd Transit,		14.14	56.92	15.24	54.
R. A.		3 0 15.11	3 4 53.55	3 24 16.00	4 15 55.
Error of Timepiece,		60.97 / 59.03	58.63 / 61.37	60.76 / 59.24	61.3 / 58.

$0 = -59.03 + .85u + (\Delta t + m)$

$-59.24 + 1.09u$

$-58.59 + .31u$

$.86 \quad 225$

$0 = -58.95 + 0.75u + \Delta t + m$

$-59.03 \quad -59.24 \quad -58.59$

$-.57 \quad -.71 \quad -.20$

$-58.46 \quad -58.52 \quad -58.39$

$\Delta t + m = +58.46$

$m = +1.07$

$\therefore \Delta t = +57.40$

$0 = -61.37 + 4.42u +$

$0 = -58.95 + .75u +$

$\therefore 0 = -2.42 + 3.65u$

$\therefore u = +0.66$

$m = +0.47 + 0.60$

$\therefore m = +1.07$

$\therefore$ Error 1327 = ~~+37.40~~

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ~~Feb~~ Jan 3.4 d 1878. Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,	β Persei		48 H Cephei		δ Tauri		δ Tauri	
Circle,	0.85		4.42		.31		.31	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		7.3		45.8	4 15	~~50.2~~	4 14	48.3
II.		10.0		50.8		3.6		50.8
III.		12.7		55.2		0.7		52.8
IV.		15.4		0.0		10.8		54.7
V.		18.0		4.6		14.2		57.0
Sum,		65.4		156.4		~~38.9~~		136
				31.28		10.8		2.72
Mean,		12.68		55.28		7.19	4 14	52.72
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		12.68		55.28		7.19		52.72
R. A.	3 0	15.09	3 4	55.24	4 15	55.54		55.54
Error of Timepiece,		.		.		.		.

$-62^s.41$ $-59^s.96$ ~~35~~ $-62^s.82$

$0 = -62.41 + 0.85u + (\Delta t + u)$

$= -62.82 + 0.31u + (\Delta t + u)$

$0 = -62.61 + 0.58u$

$0 = -59.96 + 4.42u$

$0 = -2.65 - 3.84u$ $\therefore u = -0.69$

$u = -0.95$

$u = +0.47 + 86$

$u = + 1.33$

$-62.41 - .80 = -63.21$ $-62.82 - .29 = -63.11$

$-63.16 + 1.33$

$\therefore$ Error 1327 = +

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 4 1878. Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,	48 Ophei		δ Tauri		i Aurigae			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		45.4		47.2		56.2		.
II.		50.1		49.4		58.5		.
III.		54.3		51.6		1.0		.
IV.		59.2		53.6		3.4		.
V.		4.2		55.7		5.8		.
Sum,		213.2		257.5		124.9		.
		42.64		51.50		24.98		
Mean,		64.64		51.50		0.98		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	3 4 54.93		4 14 55.53		4 49 4.91			.
Error of Timepiece,		.		.		.		.
		69.29		64.03		63.93		

$0 = -60.29 + 4.42m + \Delta t + w$
$-63.98 + 0.48m + \Delta t + m$
$0 = +3.69 + 3.94m$
$\therefore m = -0.81$

$0 = -64.03 + .31m$
$-63.93 + .65m$
$0 = -63.98 + .48m + \Delta t + m$

$m = .47 + .72 = 1.19$

-64.03
$-\ .24$
64.27

63.93
$.52$
64.45

-64.35
$+\ 1.19$
-63.16

$\therefore$ Error 1327 $= -63^s.16$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 5d 5 1878. Instrument, Mer. Circ. Observer, W. A. R.

Timepiece, 1327 Recorder, L. W.

Object,	β Persei				48 Cephei				δ Tauri			
Circle,		+0.85				+4.47				+.31		
	w		e		w		e		w		e	
Level Direct,	.		.		.		.		.		.	
Reversed,	.		.		.		.		.		.	
Sums,	.		.		.		.		.		.	
Difference,												
b.												
	h	m	s		h	m	s		h	m	s	
Wire, I.			4.9				43.6				46.1	
II.			7.6				48.0				48.3	
III.			10.4				52.9				50.4	
IV.			13.0				58.4				52.5	
V.			15.9				62.5				54.8	
Sum,			51.8				205.4				251.1	
			10.36				53.08				50.42	
Mean,			.				.				.	
Bb,			.				.				.	
Cc,			.				.				.	
Aa,			.				.				.	
Corr'd Transit,			.				.				.	
R. A.	3	0	15.06		3	4	58.32		4	15	55.53	
Error of Timepiece,			.				.				.	

64.70 62.24 65.11

$0 = -64.70 + .85u + \Delta t + w$
$\quad -65.11 + .31$

$0 = -64.90 + .58u$
$0 = -62.24 + 4.42w$

$0 = -2.66 + 3.84$ ∴ $u = -0.69$

$w = +.47 + 0.63 = 1.10$

$-64.70 - .60 = -65.30$

$-65.11 - .21 = 65.32$

$-65.31 + 1.10 = 64.41$ = Error 1327

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 4 1878. Instrument, Merid. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, S.W.

	δ Tauri —		ε Aurigae —		ζ Aurigae —			
Object,								
Circle,	+ .31		+ .65		+.87			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		45.9		55.0		48.9		.
II.		48.1		57.4		51.6		.
III.		50.3		59.8		54.3		.
IV.		52.4		2.2		57.0		.
V.	4 15	54.7	4 48	4.9	4 53	59.8		.
Sum,	4 15	50.28	.	179 3 35.86 2m	4 53	216 54.32		.
Mean,		.		59.86		.		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	4	15 55.51	4	49 4.88	4	53 59.16		.
Error of Timepiece,	4	15 .		.		.		.

+ 5.23 + 5.02 + 4.84

$0 = +5.23 + .31\,u + \Delta t + w,$
$+5.02 + .65\,w + \Delta t + w,$
$+4.84 + .87\,u + \Delta t + w.$

Assume $u = 0.8$

− 5.23	502	4.84
− 24	52	72
− 5.47	−5.54	−5.56
.54		
.56		
157		
− 5.52		
+ 1.15		
4.37		

∴ 1327 = Slow 4.37

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb 7.4 1878. Instrument, Merid. Circ. Observer, W. A. R.

Timepiece, 1327 Recorder, E. W.

Object,	δ Tauri			α Tauri			ζ Aurigæ			δ Ursæ, Min.								
Circle,	+ .31			+ 0.29			+.86			$\lg\delta = 16.82$								
	w		e	w		e	w		e	w		e						
Level Direct,	.		.	.		.	.		.	.		.						
Reversed,	.		.	.		.	.		.	.		.						
Sums,	.		.	.		.	.		.	.		.						
Difference,																		
b.																		
	h	m	s	h	m	s	h	m	s	h	m	s						
Wire, I.			46.2			47.5			49.1		10	27.6						
II.			48.3			49.6			51.7			44.7						
III.			50.5			51.8			54.6			1.8						
IV.			57.6			54.1			57.2			18.7						
V.	4	15	54.8	4	28	56.1	4	53	0.0			37.0						
Sum,			2524 50.48			2591 51.82			2126 42.52			129 8 25.96						
Mean,			.			.			54.52			10m 1.96						
Bb,			.			.			.			.						
Cc,			.			.			.			.						
Aa,			.			.			.			.						
Corr'd Transit,			.			.			.			.						
R. A.	4	15	55.50	4	28	56.84	4	53	59.15	18	11	18.46						
Error of Timepiece,			.			.			.			.						
			5.02			5.02			4.63			−16.50						

$0 = -5.02 + .31u = -5.25$ (21)
$-5.02 + .29u = -5.21$ (19)
$-4.63 + .86u = -5.21$ (54)
$0 = -14.67 + 1.46u$
$u = 1.2$ (6)
5

$u = 0.8$

$0 = -4.89 + .49u$
$0 = -16.50 - 16.82u$
$0 = -11.61 + 17.31u$

$0 = -4.89 + .49u$
$0 = -5.22 + \Delta t + 2w$ (1.01)
$0 = -4.21$

$\therefore u = -0.67$

16.50
11.27
5.23

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 11 & 4 1878. Instrument, Merid. Circ. Observer, L. W. W. aR.

Timepiece, 1327. Recorder, L. W.

Object,	δ Tauri		α Tauri		i aurigae		β Tauri	
Circle,	½δ	+.31		+.29		+.65		+.54
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		48.7		50.0		57.7		30.0
II.		51.0		52.4		0.2		32.2
III.		53.0		54.5		2.9		34.8
IV.		55.2		56.6		5.1		37.0
V.	4 15	57.5	4 28	58.8	4 49	7.7	5 18	39.4
Sum,	4 15	55 4 / 53.08	4 28	223 / 4.46		736 / 14.72		234
Mean,		.		.	4 49	2.72	5 18	34.68
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	4 15	55.46	4 28	56.80	4 49	4.83	5 18	36.82
Error of Timepiece,		.		.		.		.

$0 = -2.38 + .31x + \Delta t + w$ (−.70)

$-2.34 + .29x$ (−.18)

$-2.11 + .65x$ (−.41)

$-2.14 + .54x$ (−.34)

$0 = -2.27 + .45x + \Delta t + w$ (97 / 179)

$-0.20 + 3.72x$

$0 = -2.07 - 3.27x \quad \therefore x = -0.63$

$0 = -0.20 + 3.72x$

$x = +.42 + 56$

$2x = +98$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb 11d 4 1878. Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,			9r. ~~523~~ 966.				
Circle,			+3.72				
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	38.0		14.1			.		.
II.	1.8		18.5			.		.
III.	6.3		22.2			.		.
IV.	9.8		26.4			.		.
V.	13.9		30.0			.		.
Sum,	18 4		3.4 4			.		.
Mean,	22.2		38.2			.		.
	26.4		42.2					
Bb,	30.4		46.8					.
Cc,	.		77.2 8		Mean =	30.31		.
Aa,	.		~~4.56~~			.		.
Corr'd Transit,	.		30.31			.		.
R. A.	.		5 23 20 50			.		.
Error of Timepiece,	.		.			.		.

− 2.58
− 2.52
− 2.52
− 2.46

8

− 2.52 +0.98 = − 1.54 = Eun 1327.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb 130 4 1878. Instrument, Merid. Circ. Observer, W. A. R.

Timepiece, 1327 Recorder,

Object,	51 Cephei		δ Geminor		β Gemini		~~Alhorai Mag~~ α Cam. Maj.	
Circle,	20.7		+.41		+.54		+.10	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	6 43 10.1		7 12 46.6		47.3		51.2	
II.	31.3		48.8		49.7		53.3	
III.	44 14.2		53.0		52.0		55.3	
IV.	35.6		53.3		54.4		57.4	
V.	55.9		55.6		56.6		59.5	
	93.5		.		37		37	
Sum,	6 43 31.2		7h 12m 51s.06		~~3000~~ 6200 46		26 7	
Mean,	42				37 57.00		37 55.34	
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	6 42 17.18		7 12 52.62		7 37 53.62		7 32 57.09	
Error of Timepiece,	.		.		.		.	

+14.0
+14.0

− 1.56

− 1.62
40

− 1.75
2

$0 = +14.0 + 20.7\,w + \Delta t + m$
$\quad - 1.56 + .4\,n + \Delta t + m$

~~$0 = +75.56 + 20.3\,w$~~

$0 = +15.6 + 20.3\,w \;\therefore\; w = -0.77$

$m = .42 + .80$

$0 = +14.0 + 20.7\,w$
$0 = -1.75 + 0.1\,w \;\therefore\; 20.6\,w = 15.75$

−1.56
−.32
−1.88
+ 88
1.28

−1.88
+1.12
−0.76 = Error 1327

−1.88
−2.02
−1.77
5.67
−1.89

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1877phae.proj=1977

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 14.4 1878. Instrument, Mer. Circ. Observer, W. A. R.

Timepiece, 1327 Recorder, E. W.

Object,	δ Ursæ	51 Ceph.	δ Gem.	γ Gem.	ε Gem.
Circle,	L.C.	20.7	+41	+0.29	+.47
	w / e	w / e	w / e	w / e	w / e
Level Direct,	. / .	. / .	. / .	. / .	. / .
Reversed,	. / .	. / .	. / .	. / .	. / .
Sums,	. .	. .	. .	. .	. .
Difference,					
b.					
	h m s	h m s	h m s	h m s	h m s
Wire, I.		42 9.8	47.0	36.3	22.0
II.		30.8	49.2	38.6	24.4
III.	52.3	52.3	51.3	40.7	26.7
IV.	13.5 34.0	13.5	53.7	42.9	28.8
V.	54.4 18.8	43 34.0	55.9	45.1	31.2
Sum,	1730 34.60	14 04 28.08	25 71 51 42	20 36 40.72	12 31 26.62
Mean,		6h 42m 57s 08	51.42	40.72	26.62
Bb,		.	.	.	.
Ce,		.	.	.	.
Aa,		.	.	.	.
Corr'd Transit,		42 34.60	.	.	.
R. A.	18h 11m 6s.27	6 42 16.93	7 12 51.62	6 30 42.00	6 36 27.88
Error of Timepiece,		.	.	.	.

$+17^s.67$ $-1^s.22$ -39 $-1^s.28$ -28 $-1^s.26$ $+.44$

1.61 1.56 1.61 1.70 187

$0 = +17.67u + 20.7z + \Delta t + m$

$0 = -1.28 + 0.29u + \Delta t + m$

$0 = +18.95 + 20.4u$

$\therefore u = \frac{19}{20} = -0.95$

$m = +.39$ $+.86$ 1.25

-1.62 $+39$ $u = 1.25$ $0^s.37$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb 16.4 1878. Instrument, Mer. Circ. Observer, W. A.R.

Timepiece, 1327 Recorder, L. W.

Object,	α Tauri		α Aurigæ		β Tauri		9 yr. 966.	
Circle,		0.29		1.08		.54		3.72
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		51.7		52.8		35.3		19.7
II.		53.8		55.9		33.7		23.7
III.		55.9		59.0		36.0		27.5
IV.		58.0		61.9		38.3		31.7
V.		60.2		64.3		40.8		35.6 39.7
Sum,		2796		2939		1801		1382
		55.92		58.78		36.02		27.64
Mean,		.		.		.		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
								31.64
Corr'd Transit,		55.92		.		36.02	23	29.64
R. A.	4 28	56.72	5 7	43.90	5 18	36.74	√ 23	29.95
Error of Timepiece,		.		.		.		.

-0.80 -0.92 $+2.31$ $+1.69$

$0 = -0.80 + .29u$ (83)

$0 = -0.72 + .54u$

$\therefore 0 = -0.76 + .41u + \Delta t + m$

$0 = +1.69 + 3.72u + \Delta t + m$

$0 = +2.45 + 3.31u$

$\therefore u = +.74$

$m = 27 + .9u \quad 42 + .68$

1.10

80 72 2.31

13 25 +9 1.75

$-80 \quad -92 \quad -76 \quad +1.69$

$-21 \quad -40 \quad -30 \quad -2.75$

1.01 1.12 1.06 1.06

1.06

$\therefore \Delta t + m = -1.06$

$+ m = +1.10$

$\therefore \Delta t = +0.04$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb 18.4 1878. Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, L.W.

Object,	δ Tauri		ε Aurigæ		ζ Aurigæ		β Tauri	
Circle,	+ .31		+ .65		+ .86		+ .54	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m 0 s 0		h m s		h m s	
Wire, I.		50.9		2.4		53.7		32.2
II.		53.0		5.0		56.6		34.6
III.		55.2		7.4		59.2		37.0
IV.		57.6		10.0		2.1		39.3
V.		59.6		.		4.7		41.5
Sum,		26 2 5.26		24 8 4.96		176 3 35.26		184 6 36.92
Mean,		55.26		4.96		59.26		36.92
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	4 15	55.34	4 49	4.70	4 53	59.94	5 18	36.70
Error of Timepiece,		.		.		.		.
		− 0.08		+ 0.26		+ 0.32		+ 0.22

$0 = -0.08 + .31n + \Delta t + m$
$+0.26 + .65n$
$+0.32 + .86n$
$+0.22 + .54n$

88 236

Assume $n = -0.75$

$0 =$
$0 = +0^s.22 + .59n + \Delta t + m.$
$0 = -0.27 + .44n + \Delta t + 1.10$
66
.44
$0 = +0.44 + \Delta t \quad \therefore \Delta t = -0^s.44$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, February 19/4 1878. Instrument, Merid. Circ. Observer, W.A.R.
Timepiece, 1327 Recorder, L.W.

Object, Circle,	ζ Tauri + 0.29		α Aurigae + 1.03		β Tauri + 54		9h. 966. + 3.72	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	.		.			32.2		14.5
II.	.		.			34.7		28.5
III.	.		.			36.9		31.9
IV.	.		.			39.2		36.0
V.	.		.		18	41.7	23	40.2
Sum,	.		.			1847		1611
Mean,	.		.			36.94		32.22
Bb,	.		.			.		.
Cc,	.		.			.		.
Aa,	.		.			.		.
Corr'd Transit,	.		.			.		.
R. A.	4 28 56 68		5 7 42.79		5 18 36.67		5 23 30.06	
Error of Timepiece,	.		.			.		.

+ 0.27 + 2.18

$0 = +0.27 + .54x + \Delta t + m$
$+2.18 + 3.72x$

$0 = +1.91 + 3.18x \quad \therefore x = -.61 \quad m = +.40 + 55 = +.95$

$0 = +0.27 - .33 + \Delta t + .95$

$+.95$
$+1.22$
$-.33$
0.89

$+2.18$
-2.27
-0.09
$+.95$
0.86

$\therefore \Delta t = -0^s.89$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, February 1914 1878. Instrument, Merid. Circ Observer, W. A. R.

Timepiece, 1327 Recorder, L. W.

Object,	ε Orionis			γ Geminorum			ε Orionis					
Circle,			−1° 17′			16° 30′			−1° 17′			
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			4			.			58.9			.
II.			8.7			.			0.9			.
III.			9			.			3.0			.
IV.			8.1			.			5.1			.
V.	5	31	10.3			.	5	30	7.2			.
			29.4						75.1			
Sum,			5.88			.			15.02			.
									48			
Mean,			.			.	5	30	3.02			.
Bb,			.			.			.			.
Ce,			.			.			.			.
Aa,	/		.			.			.			.
Corr'd Transit,	5	30	3.02			.			.			.
R. A.	~~5~~	~~31~~	~~15.44~~	6	30	42.00	5	30	3.02			.
Error of Timepiece,			.			.			.			.
			2.86						0.00			

$0 = 0^s.00 - 0^s.01 + \Delta t + 95$

$\therefore \Delta t = -0^s.94$

$'89$

$\therefore \Delta t = -0^s.93$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, February 24.4 1878. Instrument, Mer. Circ. Observer, W. A. R.

Timepiece, 1327 Recorder, L. W.

Object,	~~α Aquilae~~ α Orionis		β Tauri		gr. 966.		ε Orionis.	
Circle,	+0.13 +1.04		.54		3.72		−0.02	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		33.3		34.1		25.7		0.4
II.		35.5		36.2		30.0		2.5
III.		37.6		38.6		33.8		4.6
IV.		39.7		41.0		37.8		6.6
V.		41.8		43.5	5 23	41.8		8.7
Sum,		1879 / 37.58		1934 / 38.68		1691 / 33.82		228 / 4.56
Mean,		.		.		.		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	5 ~~7~~ 48 ~~42.68~~ 35.38		5 18 36.60		5 23 29.73		5 20 2.95	
Error of Timepiece,		.		.		.		.

$t - \alpha = +1^s.80 \qquad +2^s.08 \qquad +4^s.09 \qquad +1^s.51$

$+4^s.09$ (1.36, 2.73) (3.72, 1.24)

$0 = +1.80 + 0.13 \tan n + (\Delta t + m)$
$+2.08 + 0.54$
$+1.51 - 0.02$

+1.80	2.08	~~4.09~~	~~1.51~~
−.09	−.38	~~−.73~~ −2.47	+.11
1.71	1.70	1.69	1.62

$0 = +5^s.49 + 0.65 \tan n + (\Delta t + m)$.

$\therefore +1^s.70 = \text{Sum } 1327 + m.$

$0 = +1^s.83 + 0.22 n + \Delta t + m$

$0 = +4.09 + 3.72 n + \Delta t + m$

$n = +^s.38 \quad +^s.59 \quad .59 \quad 0^s.97$

$0 = +2.26 + 3.50 n$

$0 = +1.70 + 0.97 + \Delta t$

$\therefore n = -0^s.645$

$\therefore \Delta t = -2^s.67 = \text{Sum } 1327$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 26 & 4 1878. Instrument, Russ. Tr. Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,	23 H. Camelop		23 H. Camelop		23 H. Camelop							
Circle,	W.		E		E							
	w	e	w	e	w	e	w	e	w	e	w	e
Level Direct,	22.3	15.4	.	.	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.	.	.	.	.
Difference,												
b.												
	h m s		h m s		h m s							
Wire, I.	II 55.5		IV 47.5		V 48.3							
II.	15.7		9.4		8.2							
III.	35.7		29.3		28.7							
IV.	55.8		48.7		48.2							
V.	6 25 16.1		8.7		6 31 8.0							
	1787				1414							
Sum,	6 24 35.74		.		28 28							
Mean,	Cc +1m 58.70		.		6 30 − 1 58.70							
Bb,	6 26 34.44		.		6 28 29.58							
Cc,	30.9		.		− 1 58.7							
Aa,	3.54		.		6 26 30.9							
Corr'd Transit,	.		.		.							
R. A.	.		.		.							
Error of Timepiece,	.		.		.							

1.32754 Cc = − 3.54 for C. W.

9.2531

0.5806

2.0744

118.70

237.40

0.5490

9.2531

9.8021

∴ C = + 0s.634 for C. E

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Plmouth 26.4 1878. Instrument, Rev. Dr. Observer, L. M.

Timepiece, 345 Recorder, L. M.

Object,	24 H. Camelop		24 H. Camelop		ζ Geminor		63 aurigæ	
Circle,	E.		W		W.		W	
	w	e	w	e	w	e	w	e
Level Direct,	16.7	21.2	22.9	15.3	.	.	.	.
Reversed,								
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = −0.03								
c = +0.57 (E)								
	h m s		h m s		h m s		h m s	
Wire, I.	III	46.0	V	1.3		52.6		8.6
II.		1.8		17.3		15.7		36.6
III.		17.7		33.5		38.2		4.1
IV.		34.5		49.6		1.0		31.6
V.	6 43	50.2	6 47	5.1	6 58	24.0	7 4	59.2
Sum,		150.2		106.8		131.5		140.1
		30.04		21.36		26.30		28.02
Mean,	6 43	18.04	6 46	33.36	6 57	38.30	7 4	4.02
Bb,			3	10.7		+.03		−.04
			43	22.66		−.60		−.74
Cc,		6h 43m 18.04		.		.		.
		−0.14						
Aa,	+3.37	6 43 17.90		.		57 37.67		+.23
		+1.52			+.59	1.33	+.07	
Corr'd Transit,		43 6 38		.		57 39.00		3.47
		42 21.98						
R. A.	6	25 30.65		.	6	56 54.59	7 3	18.40
						42 21.98		
Error of Timepiece,		+44.40		.		+44.41		+45.07

23 H.
+0.634 cc
+0.510 cc
+0.57 = c.

cn δ = 9.3482
log x = 1.6286
2.2804
190.7
22.66
18.04
Cc = 4.62
2.31
0.3636
9.3482
9.7118
C = +0.51 to (Cc).

ζ Geminin and 24 H. Camelop

α' − α = 14m 32.61
t' − t = 14 19.77
(α' − α) − (t' − t) = +12.84
+.89 + 3.37
4.26
3.76

1.1086
0.5752
0.5334
a = +3.415

18.04
.42
18.46
37.79
19.33
32.61
13.28
13.28
3.76
∴ a = 43.53.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, February 26.4 1878. Instrument, Rms. Dr. Observer, L. M.

Timepiece, 345 Recorder, L. M.

Object,	λ geminor.				Gr 1308										
Circle,	E 25° 38′				E										
	w		e		w		e		w		e		w		e	
Level Direct,	17.2		21.3		.		.		.		.		.		.	
Reversed,					.		.		.		.		.		.	
Sums,	.		.		.		.		.		.		.		.	
Difference,									Level,							
b.									E.				W.			
	h	m	s		h	m	s		h	m	s		h	m	s	
Wire, I.			5.1				8.6		16.7 W		21.2 E		22.3 W		15.4 E	
II.			27.5				7.5		17.2		21.3		22.9		15.3	
III.			49.6				.....		22.3		15.4					
IV.			12.1				4.5		22.9		15.3					
V.	7	12	34.0		7	21	2.8		79.1		73.2					
							23 4				69.1					
Sum,			128.3				5.85				4.1					
			2566		7	19										
Mean,	7	11	49.66		7	19	5.85				d 1.02		∴ b = −0.03			
Bb,			−.03				.				.					
Cc,			+.60				.				.					
Aa,	+.46		+1.57				.				.					
									17.2		21.3					
Corr'd Transit,			51.80				.		22.3		15.4					
R. A.	7	11	~~8.32~~ 7.12				.		39.5		36.7					
									36.7							
									b = 2.8 +0.09							
Error of Timepiece,			+44.68				.				.					

+45.07
+44.41
216

∴ +44.72 = Equ 345 at 26°.4,

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Feb. 28.4 1878. Instrument, Rus. Tr. Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,	ζ Geminor				63 Aurigæ				19 Lyncis Seq.				ι Geminor						
Circle,	E				E				W				W						
	w			e	w			e	w			e	w			e			
Level Direct,	16.2			19.5	.			.	21.0			15.1	.			.			
Reversed,	21.0			15.1	.			.	.			.	.			.			
Sums, 2.6 .03	37.2			34.6	.			.	.			.	.			.			
Difference, 0.078	34.6			.	.			.	.			.	.			.			
	2.6																		
b. = +0.08	+0.08																		
	h	m	s		h	m	s		h	m	s		h	m	s				
Wire, I.			54.1				10.0				23.2				10.2				
II.			17.2				32.5				35.5				34.0				
III.			39.7				55.1				48.1				58.5				
IV.			2.6				32.5				0.6				22.0				
V.	6	58	25.3		7	5	0.2		7	14	13.0		7	19	46.1				
c = +0.57			1389				853				1204				1704				
Sum, b = +0.08			27.78				17.06				24.08				34.08				
							12				24				24				
Mean, a = +3.53	6	57	39.78		7	4	5.06		7	13	48.08		7	18	58.08				
Bb,			+.08				+.10				+.13 / 48.41				+.09				
Cc,			+.61				+.64				−.99				−.64				
Aa,			+1.41				+0.25				−1.41 / 2.40				+0.99				
Corr'd Transit,	6	57	41.88		7	4	6.05		7	13	45.81			18	59.53				
R. A.	6	56	54.57		7	3	18.44		7	12	57.91		7	18	11.41				
Error of Timepiece,			+47.38				+47.61				+47.90				+48.12				

ζ. 47.38
47.61
ι. 47.90
48.12
301
+47.75 = Assumed Error 3451

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, S. W.

Timepiece, ... Recorder, ...

Object,	δ Ursae. min.		α Syrae		α aquilae					
Circle,			W		E					
	w		e		w		e		w		e
Level Direct,	.		.		21.6		15.0		17.3		19.2		.		.
Reversed,	.		.		17 3		19 2						.		.
Sums,	.		.		38.9		34.2		.		.		.		.
Difference,					34.2										
b.					4.7										
					+ 0s.16										
	h	m	s		h	m	s		h	m	s		h	m	s
Wire, I.	R.A. = 18	11	25.40		Wire ast. mn		57.3								
II.		11	16.6		to the end,		6.4		Clouds						
III.	1.2269	22	42.0				[15.5]								
IV.	1.32755						24.6						m 34	hr 15	50.
V.	2.55444						33.7							− 36.28	mean
	358.3						42.6								
	= 5m 58.3													+ .22 Bb	
	11 16.6													− .80 Cc	
Sum,	18	22	42.0	from III	18	34								+ .25 Aa	
			+53.7				122 D								
	18	23	35.7				30.52								
Mean, (E)			− 11.1				15								
	18	23	24.6		18	34	15.50		= 1st wire of V = V.						
Bb,			16.96	22			− 45.35						38m	38.89	
			11.14	46.6			+ 0.10								
Cc,	18	23			Bb =		+ .22		35.430				−37.08		
Aa,		2	24.		Cc =		− .80		1.28				+15.97		
	18	26	10		Aa =		+ .25		28344				− 21.11		
									7086						
									35430						
Corr'd Transit,	1	12	.						45350				38.89		
R. A.			.												
					∴ Transit α Syrae =				18h	33m	38.89				
										32	48.51				
Error of Timepiece,			.							+	50.38				

31.887
3.543
28.344
1.28
22672
5668
2834
36.27552 1.28

1686
2.

21.25

+38 40
42 23
3 43

+38° 40'

1.28

3.543
7.086
1.28
56688
14172
7086
9.070608

3.4538
0.2660

45.35
9.07
36.28

33 13
7 10
42 23
8 32
33 51

+15.50
+ .22
+ .25
+15.97

−45.35
− 80
− 46.15
15.97
− 30.18
60.
+ 29.82
+ 9.07
+ 38.89

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 4th 1878. Instrument, Rms. Tr. Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,	63 Aurigæ			λ Geminor			5			51 Cephei		
Circle,	E			E								
	w		e	w		e	w		e	w		e
Level Direct,	.		.	18 . 5		19 . 8	.		.	.		.
Reversed,	.		.				.		.	.		.
Sums,	.		.	.		.	.		.	For weight. adjustment.		
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			~			11 . 6			.	6	42	.
II.			~			33 . 8			.	44°	51′	.
III.			8 . 7			56 . 0			.	1 . 3163		
IV.			36 . 3			18 . 1			.	1 . 6285		
V.	7	5	4 . 0	7	7	40 . 6			.	2 . 9448		
Sum,	7	4	49 0 16 . 33 36 . 33			16 01 37 . 02 24			.	88 . 06		
Mean,				7	6	86 . 02			.	14m	40s . 6	
Mean b = + 0s . 16												
Bb, a = + 3s . 5			+ . 18			+ 0 . 16			.	Gr. 1308		
Ce, c = + 0 . 6			+ . 74			+ . 60			.	26° 20′		
Aa,			+ . 23			+ 1 . 57			.	7h 18m		
Corr'd Transit,			37 . 48	7	16	58 . 35			.			.
R. A.	7	3	18 . 38 9 . 93	7	11	7 . 06			.			.
Error of Timepiece,			+ 51s . 55			+ 51 . 29			.			.

9 . 8873
0 . 1127
1 . 3275
1 . 4402
27s . 55

37 . 48
27 . 55
9 . 93

+ 51 . 55
84
+ 51s . 42

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Mch 5d.4 1878. Instrument, Observer,

Timepiece, Recorder,

Object,	Gr. 1308		Gr 1308		α gemin		α Can. Min	
Circle,	π 26° 20'		ℓ 333 40		W E 10 14		W E 36 51	
Level Direct,	w	e	w	e	w	e	w	e
Reversed,	~~22.0~~	~~15.8~~	~~23.5~~ 22.8	~~14.6~~ 15.0	18.0	15.0	.	.
Sums,			.	.	.	.	.	.
Difference,								
b. = +0s.26,	Set in Meridian by							
c = +0s.304 (E)	Gr 1308.							
	h m s		h m s		h m s		h m s	
Wire, I.	IV 47.5		Too little time to		53.7		6.5	
II.	57.2		reverse.		19.1		28.3	
III.	7.3				44.0		49.6	
IV.	16.6		S.W.		9.2		11.1	
V.	7 20 26.5				7 28 34.1		7 34 32.3	
Sum,	15 51 31.02				1601 3202		12 7 38 3 5 56	
Mean,	7 20 ~~38.58~~ 7.02				7 27 44.02		7 33 49.56	
Bb,	7 ~~20~~ 19 ~~38.46~~ + .64				+ .30		+ .21	
Ce,	− .84				− .36		− .31	
Aa,	7 ~~20~~ 19 8.26				+ .07		33 49.46	
	−1.22 − 39				+.22		+.60 + 19	
Corr'd Transit,	7 19 7.87				7 27 44.03		7 33 49.65	
R. A.	7 18 15.14				7 26 ~~58.17~~		7 32 56.92	
Error of Timepiece,	+ ~~52~~ 5.73				+ ~~52~~ 5.86		+ ~~52~~ 5.73	

.4409 .4409
5494 9.5599
9903 .8810
~~99.79~~ ~~76.03~~

1.3275 1.3275
9.5599 9.5599
1.7676 .7676
58.56

α−α = 14m 41s.78
t'−t = 14? 41.20
+ 0s.58
+.60 +1.22 =

∴ a = + 0s.319

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 5d.4 1878. Instrument, Rum. Tr. Observer, S. W.

Timepiece, 3451 Recorder, S. W.

Object,	κ Geminor				π Geminor				Gr. 1374.		Gr 1374.	
Circle,	ε				ε				ε		ν 31	57
	w		e		w		e		w	e	w	e
Level Direct,									19.1	19.0	23.0	15.2
Reversed,									23.0	15.2		
									42.1	34.2		
Sums,									34.2			
Difference,									7.9			
b.									∴ b = + 0s.26			
	h	m	s		h	m	s		h	m	s	h m s
Wire, I.			12.7				41.6		I	28.0	III	6.6
II.			35.7				7.0			40.7		19.7
III.			59.1				32.7			53.6		33.0
IV.			22.6				58.6			7.0		45.6
V.	7	38	46.2		7	41	21.1		7	44 19.8	7	46 58.5
			1758				1640			1491		1634
Sum,			35.16				32.80			29.82		32.68
			24							24		
Mean,	7	37	59.16		17	40	32.80		7	43 53.82	7	46 32.68
										2 36.63		30.45
									7	46 30.45		2 | 2.23
Bb,			+ .28				+ .31			∴ c = + 0s.304 (ε)		+ 1.12
Cc,			+ .34				+ .37					
Aa,	7	37	59.78				+ .01		Transit = 7h .46m		31s.57	
	+.33		+ 02		+.19				−1.94	7 46	+ .81	
											32.38	
											4c.09	
Corr'd Transit,		37	59.80			40	33.49			46 32.29		
R. A.	7	37	7.44		7	39	41.00		7	45 39.93		
Error of Timepiece,			+ 52s.36				+ 52s.49			+ 52s.36		

∴ 52.73 W a = +0s.32
52.86 W
52.73 W
52.36 E a = +0s.05
52.49 E
52.36 E

52.73
.86
.36
.49
244

∴ Error 3451 = +52.61

α − a = 8m 32s.49
t − t = 8 32.60
0s.11

∴ a = −0s.11 / −1.94 −.33 = 0.11 / 2.27 = +0s.048

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1877phaa.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 7d 8 1878. Instrument, Rms Dr. Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,	γ Draco				α ~~Cygni~~ Cygni				α Cygni			
Circle,	W 9° 7'				e 8° 43'				e			
	w		e		w		e		w	e	w	e
Level Direct,	20.4		14.5		17.2		18.3		.	.	.	.
Reversed,									.	.	.	.
Sums,	17.2		18.3		.		.		.	.	.	.
Difference,	37.6		32.8									
b.	32.8											
	4.8											
	+0.16											
	h	m	s		h	m	s		h	m	s	h m s
Wire, I.			35.0				20.8				.	.
II.			8.5				40.7				.	a = +0.05 s +1.32 w
III.			43.1				10.6				.	b = +0.16
IV.			17.0				40.5				.	c = +0.30
V.	17	55	51.5		20	39	0.7				.	.
			1551				33					
Sum,			31.02				.66				.	.
Mean,	17	54	43.02		20	39	10.66				.	.
Bb,	1.58		+0.25		1.41		+.23				.	.
Cc,	1.60		−0.48		1.41		+.42				.	.
Aa,	−.25		−.08		−.06		−.00				.	.
Corr'd Transit,	17	54	42.71		20	39	11.31				.	.
R. A.	17	53	46.73		20	37	15.49				.	.
Error of Timepiece,			+55.98				55.82				.	.

55.82

+55.90

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 8d.9 1878. Instrument, Rues. Tr. Observer, S. W.

Timepiece, 3451 Recorder, S. W.

Object,	δ Lyrae		α Cygni		δ Lyrae. Red to meridian.			
Circle,	e		W					
	w	e	w	e	w	e	w	e
Level Direct,	17.3	18.0	21.4	14.3	.	.	.	.
Reversed,					.	.	.	.
Sums,	38.7	32.3	.	.	.	.	.	.
Difference,	6.4							
b. = +0.21	0.21							
	h m s		h m s		h m s		h m s	
Wire, I.		18.0 II		13.5		18.0		.
II.		36.1		43.2		45.2		.
III.		45.3 III		13.1	18 33	45.2		.
IV.	7 33	3.3 IV		43.0		45.3		.
V.	18 34	12.5 V	20 39	13.2		45.5		.
		39.7 VI		10		12		
Sum,		.		.		.		.
Mean,		.	20 38	13.20	18 33	45.24		.
Bb,		.	1.41	+ 30 27	1.28	+ 27		.
Cc,		.	1.41	± .42	1.28	+ .33		.
Aa,		.	−0.86	− .00	+.09	+ .03		.
Corr'd Transit,		.		38 13.08		45.87		.
R. A.	18 32	48.67	20 37	15.51	18 32	48.67		.
Error of Timepiece,		.		+ 57.57		+ 57.20		.

57.57
+ 57.39

71.258
1.28
170064
42516
21258
b | 27.21024
4.535

9.892
1.3275
1.2195
38° 40' N.
Cφ = 9.892554
1.327552
1.43498
27.23
4.54
9.08
13.62

27.23
9.08
54.46
72.5
.1
39.7
54.5
45.2

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 9d 4 1878. Instrument, Russ Tr. Observer, L.W.

Timepiece, 3451 Recorder, L.W.

Object,	α Can. Min.				Tiqeminor.				qr. 1374				qr 1374						
Circle,	W.				W				W				E 328 9						
	w		e		w		e		w		e		w		e				
Level Direct,	.		.		20·6		19·0		.		.		.		.				
Reversed,	.		.		17·2		17·5		.		.		.		.				
Sums,	.		.		37.8		36 5		20		.		.		.				
Difference,					36.5				14										
b. +0ˢ·21					6·3														
	h	m	s		h	m	s		h	m	s		h	m	s				
Wire, I.			40·8				48·1		I		35·7		III		10·0				
II.			.				13·5				48·7				22·5				
III.			55·2				39·0				1·6				35·1				
IV.			.				4·6				15·4				48·7				
V.	7	34	9·3		7	41	30·7			44	28·1			47	2·5				
Sum,			104 5				135 9				129 5				114 8				
			34·83				27·18				25·90				23·76				
Mean,	7	33	54·83		7	40	39·18		7	44	1·90		7	46	35·76				
Bb,	+.80		+ 16				.				36.58		7	46	35·76				
Cc,			— 37				.		7	46	38·48				37.13	+.66			
Aa,	1.01 7h	33m	54ˢ·62				.		Mean = 7h		46m				3.68	+.37			
	+.60															+			
															-1.94				
Corr'd Transit,			.				.				.				.				
R. A.	7	32	56·87		7	39	40·93		7	45	39·72				-1.94				
Error of Timepiece,			.				.				.		7	46	~~35·76~~ 37.13 +.66				
													7	46	37·79				

α − α′

7 45 39.73
32 56.87
2m 42ˢ·86

t − t′

7 46 37.77
33 54.62
12 43·15
42.86
— 0ˢ·29

38.48
35.76
2 12ˢ·72
1.37

0.1367
9.4338
9.5705

74° 14′ 40″
9.43382
1.32752
1.89370 = 78ˢ·29
= 1m 18ˢ·29
2 36·58

∴ a = for C.M. = — 0ˢ·29 / 2·54 = +0ˢ·11

∴ c = +0ˢ·372 (E.)

b = +0.21

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 9d 1878. Instrument, Russ. Tr Observer, L W

Timepiece, 3451 Recorder, L. W.

Object,	Gr. 1374.	Gr. 1374.	6 Cancri	Gr. 1374
Circle,	E	E	E	
	w / e	w / e	w / e	w / e
Level Direct,	. / .	17.2 / 17.5	. / .	. / .
Reversed,	. / .		. / .	. / .
Sums,	. .	. .	. .	. .
Difference,				
b.				
	h m s	h m s	h m s	h m s
Wire, I.	IV 28.1	V 46.5	13.0	.
II.	40.7	59.0	37.1	.
III.	~~54.6~~	12.5	1.0	.
IV.	7.7	25.6	25.5	.
V.	7 20.8	7 49 38.1	7 57 49.7	.
Sum,	9 7 3 / 24.32 / 30 / 524.32 / 1 — 15 1 9 / 30.38 24 — 54.38 — 18 29 — 35.09	18 1 7 / 36.34 24 — 12.34 — 36.58 — 35.76	1 26 3 / 25.26 24 — 1.26	7 46 35.76
Mean,		7 49 ½	7 57	35.76
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	.	.	7 56 3.98	.
Error of Timepiece,	.	.	.	.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 10d 1878. Instrument, Russ. Tr. Observer, S. W.

Timepiece, 3451 Recorder, S. W.

Object,	α Aurigæ	~~40 Orionis~~	ζ Orionis	
Circle,	E	W	W	
Level Direct, w	16.0	19.4		
Level Direct, e	17.4	13.5		
Reversed, w	19.4	19.4		
Reversed, e	13.5	13.5		
Sums, w	35.4	32.9		
Sums, e	30.9			
Difference,	4.5			
a = +0s.11				
C = +0s.372				
b. = +0s.15				
Wire, I.	38.8		54.6	
II.	9.7	46.2	16.1	C
III.	40.2	~~0.4~~	37.0	
IV.	10.6	29.0	58.6	
V.	5h 9m 41.2	5h 7m 29s 51.0	5h 34m 20.0	
Sum,	140.5		186.3	
	28.10		37.26	
	12			
Mean,	5h 8m 40.10		5h 33m 37.26	
Bb,	1.44 + 0.22		.71 + 0.11	
Cc,	1.44 + .54		1.00 − .37	
Aa,	− .01	−	+ .07	
Corr'd Transit,	8m 40.85		33m 37.07	
R. A.	5h 7m 42.40	~~5h 32m 38.63~~	5h 32m 38.63	
Error of Timepiece,	+ 58s.45		+ 48s.44	

∴ Chron 3451 = + 58s.45

Russian Transit dismounted.

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1877phae.proj.1797m

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 15.4 1878. Instrument, Russ. Tr. Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,	Gr. 1408		Gr 1408.		31 Lyncis		30 Monoc	
Circle,	W 326° 15'		W 33° 45'		W		W	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	Russian Transit Mounted.				.	.	.	.
Difference,								
b.	For Meridian III							
	h m s		h m s		h m s		h m s	
Wire, I.	8 4 17.71		V 49.5		37.2		57.5	
II.	+ 3.2		4.4		6.6		18.7	
III.	4 +4.5		18.7		35.8		40.2	
IV.	8h 4m 20.9		34.0		5.7		1.7	
V.	1 28.6		8 7 48.3		8 15 34.7		8 20 23.1	
	8h 2m 52.3							
Sum,	8 5 49.5		~~1516.9~~ ~~309.8~~ 1549		120.0 24.00 12		141.2 28.24 12	
Mean,			8 7 18.98		8 14 36.00		8 19 40.24	
Bb,	3.47		8h 2m 57.18		1.38	+ 06	.70	+ 03
Ce,	4.16		4m 21.80			− .36		− .26
Aa,	.		+ .14		1.38	.	1.00	8h 19m 40.01
	− 2.33		− 1.09			− .01		− .21
			8 4 20.85		-.03		+.72	
			+ 0.69					
Corr'd Transit,	.		4 21.54		.			39.80
R. A.	.		8 4 17.71		8 14 31.94		8 19 4	55.95 17.71
Error of Timepiece,	.		+ 3.83		.			+ 3.85

9.3801
1.3275
8.0526
1.9474

88.59
177.18
2m 57.18

(α'-α) = 15 18.24
(t'-t) = 15 19.16
(α'-α)-(t'-t) = − 0.92

$\frac{-0.92}{+.72 + 2.33} = -\frac{.92}{309} = 0.003$

∴ a = − 0.298

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1077phaeo.prop_1707w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 15.4 1878. Instrument, Rus Tr. Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,			α1446				1446				1446			γ Cancri	
Circle,			W				e				e			e	
Level Direct,		w		e		w		e		w		e		w	e
Reversed,			18.0	16.8										17.3	18.0
			17.3	18.0											
			35.3	34.0											
Sums,			34.0												
Difference,			1.3												
b.	+0.504														
		h	m	s		h	m	s		h	m	s		h	m	s
Wire,	I.	II		33.3		III		6.5		V		23.5				6.0
	II.			46.5				19.5				36.7				28.5
	III.			59.7				32.5				49.4				51.2
	IV.			12.5				45.1				2.3				13.6
	V.	8	25	25.0		8	27	58.2		8	29	15.3		8	38	36.1
Sum,				161.70				161.8				127.2				135.2
				32.40				32.36				25.44				27.04
				24								24				24
Mean,		8	24	59.40		8	27	32.36		8	28	49.44		8	37	51.04
								17.36			2	34.72				
Bb,	3.10	8	26	+1 17.36		8	26	15.00		8	26	14.72		.97		+.04
				16.76				+.12				15.00				
Cc,	3.64			14.91		8	26	15.85		Mean				1.06		+.28
				2 1.85						8	26	14.91				
Aa,	−1.90			6.95				+.57						+.43		−.13
Corr'd Transit,				16.57												.23
R. A.		8	26	13.15										8	37	47.55
Error of Timepiece,				+3.42												+3.68

74° 3' Cos 9.4390
1.3275
1.8885
77.36
154.72

Log .95 = 9.9777
9.4390
9.4167

c + 0.2610 for ce

+3.68 e
+3.85 W
153
+3.77 = Error 3451 at 9h 1.t.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 19.4 1878. Instrument, Trans. Tr Observer, S.W.

Timepiece, 3451, Recorder, S.W.

Object,	~~ζ Cygni~~ ζ Hydrae	ι Ursae Maj	16 Ursae Maj	6² Ursae Maj
Circle,	e	e	e	w
	w / e	w / e	w / e	w / e
Level Direct,	18.7 / 18.2	. / .	. / .	. / .
Reversed,				
Sums,	19.4 / 17.3	. / .	. / .	. / .
	38.1 / 35.5			
Difference,	35.5 / 2.6			
b.	+0.09			
	h m s	h m s	h m s	h m s
Wire, I.	24.1	each 2 lines 1.7	each 2 lines 3.0	I₃ 59.7
II.	45.7	to 12.3	to 12.6	I₅ 18.5
III.	7.2	23.1	22.1	.
IV.	28.3	33.6	32.1	47.5
V.	49.4	IV₅ 8 51 44.5	V 8 53 41.5	IV₅ +26.5
Sum,	15 47 / 30.94	.	.	.
Mean,	8 49 6.94	.	.	.
Bb, +0.09	.90 + .08	.	.	.
Cc, +0.26 (E)	1.02 + .26	.	.	.
Aa, a = −0.30 (W)	+.58 − .18	.	.	.
Corr'd Transit,	49 7.10	.	.	.
R. A.	8 48 58.95	.	.	.
Error of Timepiece,	8.15	.	.	.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 19.4 1878. Instrument, Rec. Tr Observer, L. W.

Timepiece, 3451 Recorder, L. W.

Object,	Θ^2 4 C			36 Lyncis			θ Hydrae			θ Hydrae		
Circle,	W			W			W			W		
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	19.4		17.3	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I. V			24.5			2.1			19.0			.
II. V			43.2			31.3			26.0			.
III. V	9	2	2.0			0.8			33.2			.
IV.			.			30.1			40.5			.
V.			.	9	6	59.5			54.7			.
Sum,			.			1238 2476	9	9	1.5			.
Mean,			.	9	6	0.76			.			.
Bb,			.	1.38		+0.13			.			.
Cc,			.	1.38		##.36			.			.
Aa,			.	-.03		+.01			.			.
Corr'd Transit,			.		6	0.54 ~~59.64~~			.			.
R. A.			.	9	5	52.56			.			.
Error of Timepiece,			.			+7.98 V +7.98 +8.15 3)41			.			.

in Circ 3451 = + 8.03

1877phae.proj.1797w

74

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 20.4 1878. Instrument, Rms. Tr. Observer, E W

Timepiece, 345 Recorder, E. H.

Object,	σ^2 Ursæ Maj		θ Hydræ		1 H. Draco		11 Draco	
Circle,	e		w		w		w	
	w	e	w	e	w	e	w	e
Level Direct,	18.5	19.1	17.6	20.0	.	.	.	.
Reversed,					.	.	.	.
Sums,	17 6	20 0	.	.	.	.	.	.
Difference,	36.1	39.1						
		36.1						
b.	−0.5.10	3.0						
	h m s		h m s		h m s		h m s	
Wire, I.		14.3		30.8	I	4.5	II	34.2
II.		33.0		52.0		28.5		58.5
III.		51.6		13.1		54.0		24.5
IV.		10.5		34.5		18.5		48.5
V.	9 0	28.7	9 8	56.0	9 15	43.2	9 18	13.5
Sum,		1381		1864		.		.
		37.62		37.28				
Mean,	8 59	51.62	9 8	13.28		.		.
Bb,		+.24		+.08		.		.
Cc,	2.62	+.68	1.02	+.27		.		.
Aa,	11.11	+.66	9 8	13.09		.		.
			+57	−34				
Corr'd Transit,		53.20		12.75		.		.
R. A.	8 59	43.53	9 8	3.27		.		.
Error of Timepiece,		+9.67		+9.48		.		.
		8.35						

+9.67
11 5
+9.58

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Mch. 20, 4 1878 Instrument, Run. Tr Observer,

Timepiece, Recorder,

Object,	1 H Draco			1 H Draco			1 H Draco.				
Circle,	W										
Level Direct,	w	e		w	e		w	e		w	e
Reversed,	3 18.7	19.8		.	.		.	.		.	.
Sums,	.	.		.	.		.	.		.	.
Difference,											
b.											
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	III		4.0			.			.			.
II.			29.0			.			.			.
III.			54.3			.			.			.
IV.			19.7			.			.			.
V.	9	20	44.5			.			.			.
			151.5									
Sum,			30.30			.			.			.
Mean,	9	19	54.30			.			.			.
Bb,			+ .52	$\alpha' - \alpha =$		11	m 42.80		.			.
Ce,			− 1.76	$t' - t =$		.	11	39.97	.			.
Aa, −4.20	9	19	53.06									
			+ 2.49									
Corr'd Transit,			55.57	$(\alpha' - \alpha) - (t' - t) =$		.	+ 2.83			$a =$		
R. A.	9	19	46.07			.	−4.20−57		= 283 / −477		= −0.594	
Error of Timepiece,			+9.50			.			.			.

+81° 52'

9	8	3.27
11		42.80
19		53.06
8		13.09
11		39.97

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Mch 21.9 1878. Instrument, Russ. Tr. Observer, L. W.

Timepiece, 3451 Recorder, L. W. Mch 23.4

Object,	α Aquilae			α Cygni					ι Ursæ maj			
Circle,	W 326 10			E					W 6 8			
	w		e	w		e	w		e	w		e
Level Direct,	19.0		19.0	28.8		18.9	.		.	.		.
Reversed,				21.0		18.3	.		.	.		.
Sums,	20.9		18.6	20.9		18.6	.		.	.		.
	39.9		37.6	.		.						
Difference,	37.9											
	2.0											
b. +0.07												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			19.7			6.6			.	1.50		45.0
II.			41.0			16.7			.			55.6
III.			2.6			26.6			.	1.50		6.6
IV.			24.0			36.3			.			17.1
V.	19	45	45.6	20	37	46.6			.	+17 9	51	28.0
Sum,			102.9			29 56			.			152.3
			26.58									30.46
Mean,	19	45	2.58	20	37	26.56			.	9	51	6.46
Bb, +0.07			+.06			+.10			.			−.04
Cc, +0.26			−.26			+.36			.			−.39
Aa, −0.60			−.34			+.03			.			−.20
												63
Corr'd Transit,			2.04			27.05			.		51	5.83
R. A.	19	44	50.53	20	37	15.87			.	8	50	54.25
Error of Timepiece,			+11.51			+11.18			.			+11.84
												+11.58

.18
69
+11.35

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Mch 23d.4 1878. Instrument, Russ. Tr. Observer, S. W.

Timepiece, 345 Recorder, S. W.

Object, Circle,	9r 1446 e				γ Cancri e				Ethydrae e				ζ Hydrae W			
	w		e		w		e		w		e		w		e	
Level Direct, Reversed,	. .		. .		18.7 17.0		17.4 19.0		. .		. .		17.0		19.0	
Sums,	.		.		35.7		36.4		.		.		.		.	
Difference,							35.7									
b. = − 0s.03							0.8									
	h	m	s		h	m	s		h	m	s		h	m	s	
Wire, I.	~~III~~		.				14.5				50.6				29.0	
II.	3.10		55.0		.97		36.8		.82		12.0		.83		50.3	
III.	3.64		8.7				59.2		1.02		33.5		1.02		11.6	
IV.			21.5		1.06		21.8				54.6				33.0	
V.	−1.90		34.8		+.43		44.3		+.58		16.0		+.57		54.6	
	8	26	47 5		8	38			8	41			8	49		
Sum,			167 5				176 6				166 7				178 5	
			33.50				35.32				33.34				35.70	
Mean,			12.													
	8	26	21 50		8	37	59.32		8	40	33.34		8	49	11.70	
Bb,			− 09				− 03				− 02				− 02	
			+ .95				+ .28				+ .27				− .27	
Ce,	8	26	22.36		8	37	59.57		8	40 26	33.59 22 36					
Aa,			+ 2.24				− .51				− .68				− .67 9/6	
Corr'd Transit,			24.60				37 59.06				40 32.91				~~17~~ 66 16.74	
R. A.	8	26	12.77		8	37	47.41		8	40 26	21.07 12.77		8	48	58.90	
Error of Timepiece,			+ 11.83				+ 11.65				+ 11.84				+ 11.84	

11.58
11.83
11.65
11.84
11.84
37 4
11.5748

11 34.67 α′−α =
11 37.21 t′−t =
2.54
2 3 3

14m 8.30
14 11.23
−2.93
+.58+1.90

$\frac{-2.93}{+2.48} = -1.18$

∴ +11.75 = Error 2m 5

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 26d.9 1878. Instrument, ... Observer, ...

Timepiece, Mch 26d.4 Recorder, ...

Object,	α Cygni		θ Leonis		γ Ursæ Maj		ζ Leonis	
Circle,	W		E		E		W	
	w	e	w	e	w	e	w	e
Level Direct,	20.3	19.0	.	.	20.3	17.2	.	.
Reversed,	21.9	17.3	.	.	19.0	18.4	.	.
Sums,	42.2	36.3	.	.	39.3	35.6	.	.
	26.3	.			35.6	.		
Difference,	5.9				3.7			
b. = +0s.20					+0s.12			
	h m s		h m s		h m s		h m s	
Wire, I.		31.5		25.1		21.0		10.6
II.		1.7		47.2		46.6		22.2
III.		31.6		9.3		12.1		53.6
IV.		1.5		31.7		37.8		15.7
V.	20 38	31.4	11 8	53.6	11 12	3.4	11 18	36.8
Sum,		97.7		166.7		120.9		149
		19.54		33.34		24.18		29.78
		12		24				24
Mean,	20 37	31.54	11 8	9.34	11 11	12.18	11 17	53.78
Bb,		+.28		+.10	1.19	+0.14		+.10
Cc,		−.35		+.22	1.20	+.25		−.21
Aa,		+.03		9.66		12.57		53.67
			+.46	−.51	+.19	−.21	+.53	−.59
Corr'd Transit,	20 37	31.50		9.15		12.36		53.09
R. A.	20 37	15.99	11 7	53.00	11 11	56.39	11 17	36.54
Error of Timepiece,		+15.51		+16.15		+15.97		+16.55
		+17.81						

16.15 e
15.97 e
16.55 w
16.54 w
4)64.21
+16.30

∴ Eqn 3h57 Mch 26d.4 = +16.30

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 26 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	χ Draco		λ Draco								
Circle,	W 27 37		E 332° 23'								
	w	e	w	e	w	e			w	e	
Level Direct,	19.4	18.4	20.3	17.2	.	.			.	.	
Reversed,					.	.			.	.	
Sums,	.	.	.	.	.	.			.	.	
Difference,											
b.											
	h m s		h m s		h m s				h m s		
Wire, I.	I 5.2		IV 10.0		150.6 7.2						
II.	15.6		21.1		12264						
III.	26.0		31.3		124147						
IV.	37.0		41.7		62.07						
V.	11 22 47.3		11 25 52.0		24 30.36						
Sum,	11 131 1		11 25 156 1		24 29.15		C =				
	27 26.22		31.22		21.21						
	1 64 14		62.07		05.60 = +0.207 CE.						
Mean,	11 24 30.36		11 24 31.15								
	0.61										
	11h 24m 29.75										
Bb,	2.57 + .31		.		.						
Cc,	[2.92] 24 30.06		.		.						
Aa,	53 .67		.		.						
	-1.35 + 1.50										
Corr'd Transit,	31 56		.		.						
	~~55~~ +9										
R. A.	11 24 15.02		.		.						
Error of Timepiece,	+ 16.54		.		.						

17 36.54

α'-α 6m 38.48

τ'-τ 6 36.39

α'-α-τ'+τ = + 2.09

a = $\frac{2.09}{-1.35 - .53}$ = $\frac{2.09}{1.88}$ = -1.11 for cuda wel

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, March 29d 8 1878. Instrument, R.T. Observer, Ris.

Timepiece, 3451 Recorder,

Object, / Circle,	α Cygni e		ιL Cancri W		36 Lyncis W		θ Hydrae W 320 27	
	w	e	w	e	w	e	w	e
Level Direct,	20.3	16.7	March	30.93	.	.	.	.
Reversed,	19.0	18.1			.	.	.	.
Sums,	39.3	34.8	.	.	.	.	.	.
	34.8	.						
Difference,	4.5							
b.	+0.15							
	h m s		h m s		h m s		h m s	
Wire, I.		37.3		.		16.8		44.0
II.		7.2		12.0		45.7		.
III.		37.1		33.7		—		.
IV.		7.2	9 1	55.6		—		.
V.	20w 38	37.2		.		—		.
		1.0		99.3				
Sum,		.	9 1	33.10		.		.
Mean,	20 37	37.20		.		.		.
Bb, +0.15		+.21	+.87	+.26		.		.
Cc, +0.21		+.26	+1.02	−.30		.		.
Aa, −1.00		+.06	+.53	−.45		.		.
Corr'd Transit,	20 37	37.73	1	32.60		.		.
R. A.	20 37	16.13	9 1	10s.55		.		.
Error of Timepiece,		+21s.60	+	22s.05		.		.
			+					

+ 22.05 W
+ 22.53 e
+ 22.68 e
1.26

∴ Error 3451 = + 22.42

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Mch. 30d.3 1878 Instrument, Rms. Tr Observer, Leo

Timepiece, 3451 Recorder, Leo

Object,	1 Draco				1 Draco				θ Ursae maj				ο Leonis					
Circle,	W				E				E				E					
	w		e		w		e		w		e		w		e			
Level Direct,	19.5		16.2		20.8		15.(		.		.		20.7		15.3			
Reversed,																		
Sums,	20 8		15.2		.		.		.		.		.		.			
Difference,	40.3		31.4															
b.	31.4																	
	8.9																	
	+0s.30																	
	h	m	s		h	m	s		h	m	s		h	m	s			
Wire, I.	II		44.0		IV		40.5				41.6				20.0			
II.			9.7				6.0				43.0				41.5			
III.			34.7				30.8				6.0				3.0			
IV.			59.5				55.7				29.5				25.0			
V.		18	24.5		9	23	22.0		9	25	41.2		9	35	46.5			
			17 24				154 0				124 3				136 0			
Sum,	9	18	34.48		9	23	30.80				24.86				27.20			
		+2	23 49			−2	23 49				78 5				24			
Mean,	9	20	57.97		9	21	07.31		9	25	26.17		9	35	33.20			
Bb,	Cir. Transit 9h				20m 2s.64				+1.61		+.48		+.87		+.26			
	+ 5.30				+ 1.59													
Cc,			9h		20m 4s.23				+1.63		+.49		+1.02		+.31			
Aa,					+ 3.61				−.28		+.24		+.52		35 3.77			
	−4.30														20 4.23			
															44			
Corr'd Transit,		20	7.84							25	7.38			35	3.33			
R. A.	9	19	45.07						9	24	44.85		9	34	40.65			
Error of Timepiece,			+22s.77								+22s.53				+22s.68			

21.258

14174150
1434.9150

1.327552
9.15069
2.17683
15026

as 9.15069
0.8492
42 23
11 10
31 13

9 18 34.48
3 30.76
9 22 4.74
0.54
21 4s.20
2.10

9 23 3080
3 30.26
9 20 00 4.54
5.28
2.64

∴ Circle E

Log 2.10 = 0.3222
Log cos δ = 9.1507
9.4729 0.29

Cll = +0s.30

7.07

9 34 40.65
19 45.07
α!α = +4m55s.58
t!t = +4 59.54
− 4.04

∴ a = −4.04 / +4.82 = −0s.84

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, ...

Timepiece, ... Recorder, Wood Phil 35

Object,	6 Cancri		27 Lyncis		36 Lyncis		38 Lyncis	
Circle,	e		w 9° 28′		w		w	
	w	e	w	e	w	e	w	e
Level Direct,	20.1	15.0	18.6	17.1	.	.	.	.
Reversed,					.	.	.	.
Sums,	18.6 / 38.7	17.1 / 32.1	.	.	.	.	.	.
Difference,	32.1 / 6.6							
b. = +0.5 26								
	h m s		h m s		h m s		h m s	
Wire, I.	39.0		9.1		21.0		52.0	
II.	3.1		20.8		50.6		19.1	
III.	27.6		43.6		19.7		46.2	
IV.	51.7		6.6		49.6		12.6	
V.	7 57 14.5		8 0 18.0		9 7 19.1		9 12 39.3	
Sum,	135.9 / 27.38		98.1 / 19.62		160.0 / 32.00		169.2 / 33.84	
Mean,	7 56 27.38		7 59 43.62		9 6 20.00		9 11 45.84	
Bb,	+1.10	+ .33	1.58	+ .47	1.39	+ .41	+1.26	+ .38
Cc,	+1.13	+ .34	1.61	− .48	1.39	− .46	+1.26	− .42
Aa,	+.28	− .24	−.26	+ .22	−.03	+ .05	+.11	−.16
Corr'd Transit,	7 56 27.81			43.83		20.00		45.84
R. A.	7 56 3.64		7 59 19.30		9 5 52.30		9 11 17.65	
Error of Timepiece,		+24.17	e	+24.53		+27.70		+28.19

24.53 W
70

∴ 3451 = +24.35

27.70
28.19
27.92
23.81
+27.97 = Sum 3451

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 3d.4 1878. Instrument, Rms. Tr Observer, S.W.

Timepiece, 3451 Recorder, S.W.

Object,	1 Draco	1 Draco	δ Ursae maj	σ Serpis
Circle,	W	e 320 31 29 29	e	E
Level Direct, w	20.0	.	.	21.5
Level Direct, e	15.0	.	.	14.0
Level Reversed, w		.	.	18 6
Level Reversed, e		.	.	17 1
Sums,	. .	. .	. .	40.1 31.1
Difference,				9.0
b. = +0s.30		Middle = 9h 20m 2s.8		+0s.30
Wire, I.	II 46.5	IV 42.3	25.0	25.1
II.	12.7	6.8	48.1	46.8
III.	36.5	33.5	11.1	8.6
IV.	1.5	58.0	34.5	30.3
V.	9h 18m 27.0	9 23 23.5	9 25 57.6	9 35 51.8
Sum,	9 18½ 124.2 24.84 1.8 36.84 23.49	9 22 164.82 32.82 2 23.49	176.3 35.26 24	16.26 3.252 24 5
Mean,	9 20 0.33	9 20 9.33	9 25 11.26	9 35 8.52
Bb,	+5.30 .	. .	+1.61 +.48	+.87 +.26
Ce,	. .	. .	+1.63 +.54	+1.02 +.33
Aa,	−4.30 9 .20	6.40	−.28 +.42	35 9.11 +.52 −.78
		+6.49		
Corr'd Transit,	.	12.89	9 25 12.70	35 8.33
R. A.	9 19	45.16	9 24 44.78	9 34 40.62
Error of Timepiece,	.	+27.63	+27.92	+27.71

Cos δ = 9.1507
6.6532
9.8039
6366
4s.50

t 9 17 36.84 30.26
9 20 7.10 2.56 4.54 2.27

0.3560
9.1507
9.5067

9 22 32.82 30.26
9 20 2.56 2.27
Mean 9h 20m 4s.81
+ 5.30 .3 + 1.59
+ 15.90

Call + 0s.321 for C2.

de+bb 9 to 6.40

α'−α 9 34 40.62
9 19 45.16
14 55.46

t'−t = 35 9.11
20 6.40
15 2.71

α'−α−t'+t = 7s.25

.52 + 4.

− 7.25 / 4.82 = −1s.51

476
44.5

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 7th 9 1878. Instrument, Rev. Tr. Observer, ...

Timepiece, 3451 Recorder, ...

Object,	α Cygni							
Circle,	E		W					
	w	e	w	e	w	e	w	e
Level Direct,	21·0	15·2	19·1	17·0	·	·	·	·
Reversed,	19·1	17·0			·	·	·	·
	40·1	32·2						
Sums,	32·2	·	·	·	·	·	·	·
Difference,	7·9							
b.	+0ˢ·26				3451		394	
	h m s		h m s		h m s		h m s	
Wire, I.		41·5		·	20 44 57·0	= 19 38 0·0		
II.		1·5		·	− 35 11			·
III.		21·7		·	20 44 15 89			·
IV.		51·5		·		·		·
V.		21·6		·		·		·
	20 39	41·5		·		·		·
Sum,		1·5		·		·		·
Mean,	20 39	51·54		·		·		·
Bb, +0·26		+·36		·		·		·
Cc, +0·32		+·46		·		·		·
Aa, −1·51		+·09		·		·		·
Corr'd Transit,	39	51·54		·		·		·
R. A.	20 39	16·43		·		·		·
Error of Timepiece,		+35ˢ·11		·		·		·

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 8.9 1878. Instrument, Rms. To. Observer, Leo.
Timepiece, 3451 Recorder, Leo.

Object,	σ Leonis				λ Draco				λ Draco				ν Leonis						
Circle,	♈				♈				e				e						
	w		e		w		e		w		e		w		e				
Level Direct,	19.8		15.8		.		.		.		.		21.2		14.5				
Reversed,	21.2		14.5		.		.		.		.								
Sums,	41.0		30.3		.		.		.		.		.		.				
Difference,	30.3		.		.		.		.		.		.		.				
b.	10.7																		
	+0.36																		
	h	m	s		h	m	s		h	m	s		h	m	s				
Wire, I.			48.1		I		25.0		V		31.6				39.6				
II.			9.2				35.3				42.0				0.5				
III.			31.3				45.5				52.3				22.0				
IV.			52.5				58.0				3.0				45.3				
V.	11	16	13.7		11	23	6.8		11	27	13.0		11	32	4.6				
Sum,			154.8				168.3				141.9				110.0				
			30.96				33.66				28.38				22.00				
							12				24								
Mean,	11	15	30.96		11	22	45.66		11	26	52.38		11	31	22.00				
Bb,	.82		+.29		2.59		+2 4.15		.74		−2 4.15		.74		+.27				
							24 49.81/76				24 48.23								
Cc,	1.01		−.32		2.92		24 49.05		1.00				1.00		+.32				
Aa,	+.50		−.62		−1.35		+1.05		.67				+.67		−.82				
	11	15	30.93				24 50.10							31	22.59				
							+1.66												
Corr'd Transit,		15	30.31			24	51.76							31	21.97				
R. A.	11	14	53.29		11	24	14.76						11	30	44.76				
Error of Timepiece,			+37.02				+37.00								+37.01				

α − α'

11 30 44.76
24 14.76 6m 30.5 00
14 53.29 9m 21.47

31 22.59
24 50.10 6m 32.49
15 30.93 9m 19.17

150672
12264
124.14672

49.81
48.23
2|1.58
.76

42 22
−0 8
42 31

c = +0.32 for Ce.

−2.49 / .67+1.35 = −2.49 / 2.02 = −1.23

−+2.49
+2.30

+2.30 / −1.35−.50 = 2.30 / 185 = −1.24

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 12, 1878 Instrument, Runs. Tr. Observer, S.W.

Timepiece, 3451 Recorder, S.W.

Object,	α Cephei		ε Pegasi					
Circle,	W		E					
	w	e	w	e	w	e	w	e
Level Direct,	19.6	16.0	21.1	14.1	.	.	.	.
Reversed,	21.1	14.1			.	.	.	.
Sums,	40.7	30.1	.	.	.	.	.	.
Difference,	30.1							
b.	10.6							
	+0.351							
	h m s		h m s		h m s		h m s	
Wire, I.		53.0		.		.		.
II.		8.5		.		.		.
III.		23.7		58.0		1.3275		.
IV.		38.8		19.3	Cos 9°19' =	9.9942		.
V.	21 16	53.9	21 39	41.2		1.3333		.
				118.5		21:54		
Sum,		177.9		39.5		.		.
		3 5 5.8	21	19.5		.		.
Mean,	21 16	23.58	21	38 57.96		.		.
Bb, +0.35	2.00	+.70	.85	+.30		.		.
Ce, +0.32 e.	2.13	−.81	1.02	+.33		.		.
Aa, a = −1.23	-.91	+.87	+.53	−.65		.		.
Corr'd Transit,	16	24.34	38	57.94		.		.
R. A.	21	15 38.92	21	38 12.39		.		.
Error of Timepiece,		+45.42		+45.55		.		.
				+45.42				
				.97				

Err 3451 = +45.48

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 16d 1878. Instrument, Russ. Tr. Observer, E.W.

Russ. Tr. Moved out to bed. Timepiece, 3451 Recorder, E.W.

Object,	1 H Draco	q Her 54	o Leonis	ε Leonis
Circle,	W	W	W	W
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	18.0 | 18.0
Sums,	2m 23.49			15 0 20 8 / 33.0 38.8
Difference,				33.0
b.	4 46.98			5.8
			Assumed = +0.32	
			∴ b = −0.193	
	h m s	h m s	h m s	h m s
Wire, I.	9 19 43.4	0.0	51.3	45
II.	+51.5	21.2	13.2	28.2
III.	9 20 34.9	41.0	34.7	51.6
IV.	−4 46.9	1.6	56.2	14.6
V.	9 15 48.0	9 33 22.1	9 36 17.6	9 40 38.0
Sum,		859 / 17.18	173.0 / 34.60	136.9 / 27.38 / 24
Mean,	9 18 19.5 / 2 3 5	9 32 41.18	9 35 34.60	9 39 51.38
Bb,	~~+5 56.0~~	2.56 −.49	.87 −.17	1.04 −.21
Cc,	9 20 43.0	2.89 −.92	1.02 −.33	1.08 −.35
Aa,		32 39.77	35 34.50	−0.56
	9 20 34.9 −1.33	+3.64	+.52 34.10	50.82 +.35 −.96
		~~32~~ ~~39.77~~		
Corr'd Transit,	2 23.5	32 49.41	32.68	49.86
R. A.	22 58.49	31 ~~50.04~~ 51.42	9 34 40.48	9 38 57.89 / 31 51.42
	19.5	+ 0 52.99		
Error of Timepiece,		~~+48.35~~	+ 52.20	~~+~~ 51.97
	9 20 34.9			

4 46.9

9 25 21.8

100

1.41

2 23.5 / 120 / 6) 163.5 / 27.6

9 25 51.5 / 27.6 / 9 25 23.9

2c.

+51.99
+52.20
+51.97

9 39 50.82
32 39.77
t'-t = 7 20 11.05
α'-α = 7 6.47
α'-α-t'-t = −4.58
.35+1.33
= 1.68
∴ a = −2.74

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 16d.4 1878 Instrument, Rms. Tr. Observer, S. W.

Timepiece, 345 Recorder, S. W.

Object,	ν Leonis			April 17d.4 ζ Leonis			April 17.4 46 Leo. Min			Pr 1508 17d.4		
Circle,	e			e			e			e		
	w		e	w		e	w		e	w		e
Level Direct,	15.0		20.8	.		.	.		.	21.3		15.0
Reversed,				.		.	.		.	22.8		14.9
Sums,	.		.	.		.	.		.	44.1		29.9
Difference,										29.9		.
b.										3 | 14.2		
										i = +0s.47		
										c = +0.32		
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			.			1.2			32.2			40 3
II.			.			22.7			58.0			+ 58 3
III.	9	46	44.6			44.2			24.0			15 5
IV.			.			6.1			49.7			33 5
V.			−.67	10	44	27.8	10	48	15.8	10	51	51 5
Sum,						101 8 20.36 24			179 7 35.94 12			199 1 39.82 24
Mean,	9h	46m	43s.9	10	43	44.36	10	47	23.94	10	51	5.82 15.82
Bb,	1.09		1.03 −.21	~~53~~.84		+.39	~~.15~~ 1.22		+.57	4.04		+1.90
Cc,	1.12		+.36	~~84~~ 1.02		+.33	1.24		+.40	5.01		+1.60
Aa,	+.30		−.82	~~402~~.53		+1.47	+.15		+.42	−2.94		−8.17
Corr'd Transit,		46	43.9			46.55			25.38			11.15
R. A.	9	45	51.84	10	42	53.10	10	46	32.08	~~10~~ ~~24~~ 10		~~48.38~~ 50 17.69
Error of Timepiece,			+52s.1			+53s.45			+53s.30			+53s.46

∴ adopted Error 345 = 52s.10

from e & w. values.

+19.32
−8.17
11.15

∴ a = +2s.78

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 19d 4 1878. Instrument, Rec. Tr. Observer, E. W.

Timepiece, 3451 Recorder, E. W.

Object,	β Leonis			γ Ursae Maj							
Circle,	E			W							
	w		e		w		e		w		e	
Level Direct,	16·3		16·0		13·0		19·5		·		·	
Reversed,	13·0		19·5						·		·	
Sums,	29·3		35·5		·		·		·		·	
Difference,			29·3									
b. = − 0ˢ·21			6·2									
	h	m	s		h	m	s		h	m	s	
Wire, I.			3·2				12·1				·	
II.			25·3				48·6				·	
III.			47·3				25·7				·	
IV.			9·3				1·6				·	
V.		44	31·5		11	49	38·0				·	
Sum,			11·6 6 / 23·32				196 0 / +4·20 / 25·20				·	
Mean,	11	43	47·32		11	48	25·20				·	
Bb,	~~48~~ 1·04 92		−·20		1·68		− 36				·	
Cc,	~~92~~ 48 1·04		+·33		1·71		− 55				·	
Aa,	11ʰ 43ᵐ		47ˢ·45		11ʰ	48ᵐ	24ˢ·29				·	
	Log ~~94~~ 1·48		+·73		−·36		−·55					
Corr'd Transit,			48·18			48	23·74				·	
R. A.	11	42	52·91		11	47	28·48				·	
Error of Timepiece,			55ˢ·27				55ˢ·26				·	

$11^h\ 43^m\ 47^s.45 + .48a + \Delta t = 11\ 42\ 52.91$

$11\ 48\ 24.29 - .36a + \Delta t = 11\ 47\ 28.48$

$4^m\ 36^s.84 - .84a = 4^m\ 35^s.57$

$4\ 35.57$

$+ 1^s.27 = .84a \quad \therefore a = +1^s.52$

∴ Assume Error 3451 = +55ˢ.27.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 21d 4 1878. Instrument, Russ. Tr Observer, E. W

Timepiece, 3451 Recorder, E. W.

Object,	d Ursæ Maj		d Ursæ Maj		d Ursæ Maj		o Leonis	
Circle,	e		e		e		e	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	11 . 3	20 . 1	11 . 7	20 . 2
Reversed,	.	.	.	.				
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								

		h	m	s	h	m	s	h	m	s	h	m	s
Wire,	I.	III		.	IV		23 . 6	V		26 . 8			58 . 6
	II.			.			34 . 0			37 . 3			18 . 0
	III.		III 4	51 . 7			44 . 6			48 . 1			39 . 7
	IV.		III 5	2 . 5			55 3			58 . 5			1 . 2
	V.			.			5 . 7	9	27	9 . 2	9	36	23 . 1
Sum,				.			163 2			1799			1386
							32 . 64			35 98			27 72
Mean,				.			12			12 .			12 .
			m.	1	1		44 . 64	9	26	47 . 98	9	35	39 72
Bb,				.			.			.			.87
Cc,				.			.			.			.
Aa,				.			.			.			1.02
													+52
Corr'd Transit,				.			.			.			.
R. A.		9	23	44 . 71			.			.			.
Error of Timepiece,				.			.			.			.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 9d 4 1878 Instrument, Pass. Tr. Observer, S. W.

Timepiece, 3451 Recorder, S. W.

Object,	ε Leonis		19 Leo. Min.		π Leonis		30 H Camelop.	
Circle,	e		W		W		W 40 48	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	12.9	19.8	.	.	.	.
Reversed,	.	.	11 5	20.1	.	.	.	.
Sums,	.	.	24.4	39.8	.	.	.	.
Difference,				24.4				
b. = −0s.51				15.4				
	h m s		h m s		h m s		h m s	
Wire, I.		10.1		18.0		5.2		13.2
II.		33.5		46.3		26.6		42.3
III.		57.1		15.3		48.0		12.8
IV.		20.6		43.5		9.5		43.2
V.	9 40	43.6	9 52	12.1	9 55	31.1	10 12	12.9
Sum,		1649		1348 52		120.4		1244
		32.98		3604		24.08		24.88
Mean,	9 39	56.91	9 51	15.04	9 54	48.08	10h 11m	12.88
Bb,	1.04	−.53	1.33	−.68	.83	.		
Cc,	1.08	+.29	1.33	−.36	1.02	.		
Aa,		.		.		.		
	+.35		+.03		+.56			
Corr'd Transit,	9 39	56.67	51	14.00		.		
R. A.	9 38	57.82	9 50	15.33		.		
Error of Timepiece,		+58s.85		+58.67		.		

+58s.76 = Eww 3451

+20° 28′
42 23
γ Leo. 21° 55′

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, April 21d 4 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

	30 H Camelop W		30 H Camelop e 319 12		γ Leonis		30 H Camelop e	
Object, Circle,								
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	12.3	20.7
Sums, Difference, b.	.	.	.	.	.	.	.	.
	h m s		h m s		h m s		h m s	
Wire, I.	II 11.5		III .		II 12.1		IV 4.6	
II.	41.2		.		III 17.2		34.3	
III.	11.0		(3) 5.0		.		4.5	
IV.	40.8		(4) 34.3		IV 10 14 39.8		34.5	
V.	10 18 9.5		(5) 10 21 4.2		.		10 24 5.5	
Sum,	1140 32.80 12		.		1008 33.6 20		834 1668 12	
Mean,	10 17 10.80		.		.		10 23 4.68	
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	.		.		.		.	
Error of Timepiece,	.		.		.		.	

30 H Camelop.

I (W) 10h 5m 58.20
III (W) 11m 12.88
V (E) 17 10.80
23 4.68

1.628 55
9.07442
2.55413
358.20

2.30

0.3617
9.0744
9.4361

W. 17m 11.08
W. 17 10.80
E. 17 6.48

2 | 4.60
2.30

c = + 0.273 (E)

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 1st 4 1878. Instrument, Rev. Tr. Observer, S. W.

Timepiece, 345 Recorder, S. W.

Object,	47 Draco.		2 Comae		8 Cen. Venat.		γ Virg	
Circle,	W.		W		W		E	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	11.1	23.5			11.3.	23.7	10.0	25.0
Sums,			11.2 / 10.0 / 21.2	23.6 / 21.0 / 44 6 / 21.2 / 27.4				
Difference,								
b. = −0.91								
	h m s		h m s		h m s		h m s	
Wire, I.		6.0		38.1		57.5		31.8
II.		22 0		42.3		2.4		35.3
III.		41.0		46.0		7.0		38.8
IV.		59.8		50 0		12.0		42.5
V.	12 9	16.5		53.7		17.0		46.0
Sum,		143 3 / 2866 / 12 / 47.99		230 1 / 46.02 / −1.21		969 / 19.38		194 4 / 38.88
Mean,	12 8	40.66		46.02		7.38		38.88
Bb,		−3.64		−.92	1.35	−1.23 (1.61)		−.66
Cc,		−1.35 / 35.67		−.29 / 44.81	1.35	−.36		+.27
Aa,	−2.90	+6.26	+.39	−.84	.01	−.02	+.68	−1.47
Corr'd Transit,	8	41.93		43.97		5.77		37.02
R. A.	12 6	36.47	12 23	38.50	12 27	60.11	12 35	31.43
Error of Timepiece,	1m	5.46	1	5.47	1	5.66	1	5.59

C = +0.273 (E)

b = −0.91

44.81 / 35.67 / 9.14

6 36.47

α′−α = 17 2.03

t′−t = 9.14

−7.11

+39 +2.90 =

∴ a = −2.16

3.29) 7.11 (2.16

658

530

329

2010

658

721

659

65.46 / .66 / .59 / 65.57

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 1st & 4 1878 Instrument, Observer,

Timepiece, Recorder,

Object,	32 Camel			32 Camel					4 Ursae Min.			
Circle,	E			W					(N)			
	w		e	w		e	w	e	w		e	
Level Direct,	11 : 5		23 : 5	11 : 5		23 : 5	.	.	.		.	
Reversed,	.		.	.		.	.	.	.		.	
Sums,	.		.	.		.	.	.	.		.	
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	I		29.0			22.5			.	V		26.1
II.			2.0			57.5			.			43.2
III.			36.5			31.5			.			0.0
IV.			12.0			4.5			.			17.2
V.			45.5	12h	50m	40.5			.			35.2
Sum,			.			156.5			.			124.4
						31.30						24.96
Mean,			.	12	49	31.30			.			0.36
Bb,			.			.			.	3.95		-1.44
Ce,			.			.			.	4.86		1.77
Aa,			.			.			.	-2.83		4.95
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
Error of Timepiece,			.			.			.			.

0.E
0.00

4 Ursae. I-III 206.60

60.36
26.60
33.76

(W)
(E) 30.22
2 | 3.54
1.78

2.83 | 1.58

1.78

0.1489
9.3137
9.4626
9.5617

1495

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 3d 4 187 . Instrument, Observer,

Timepiece, Recorder,

Object,	α Draco		δ Bootis		κ Virginis		4 Ursae Min.	
Circle,	(E)		(E)		(E)		(E)	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	15.1	15.1
Reversed,	.	.	.	.	.	.		
Sums,	.	.	.	.	.	.	.	.
Difference,							3.3 5.2	
b. = +0ˢ.00								
	h m s		h m s		h m s		h m s	
Wire, I.	58.8		53.1		28.0		III 55.7	
II.	7.3		56.9		31.6		14.3	
III.	15.7		1.2		35.2		29.3	
IV.	23.6		5.2		38.8		47.5	
V.	32.2		8.9		42.6		4.3	
Sum,	137 6 / 27.52		125 3 / 25.06		176 2 / 35.24		151 1 / 30.22	
Mean,	15.52		1.06		35.24		Ce + 1.77 = 31.99	
Bb,	2.18	+0.74	1.06	+.39	.62	+.33		+.44
Cc,		Ce +.86 = 16.38		+.40	1.02	+.57 = 35.81		+4.95
Aa,	2.37 / -.91	+1.59	1.11 / .33	−.58		−1.42		
Corr'd Transit,		17.97		0.88		34.19		36.94
R. A.	14 1	9.90	4	53.21	14 6	26.31	14 9	29.09
Error of Timepiece,		68ˢ.07		67ˢ.67		67ˢ.88		67ˢ.85

1.3775 / 9.3137 / 2.0138

67.67 / 68.0 / 15.67

α 1 α

3ᵐ 2.78 / 2 56.38 / +6ˢ.40 / −2.83 −.81

686

$\alpha_2 = -1^s.75 + 67^s.83 = 34\,51.$

3.64

3.64) 6440 (1770 / 364 / 2760 / 2609 / 1520

103.2

60.36 / 43.2 / 17.1

α = −1ˢ.75 / β = 0.00ˢ / ∴ C = +0.364

(E).

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 3.9 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,				? Φ Vng.								
Circle,				W								
	w		e	w		e		w		e	w		e
Level Direct,	.		.	.		.		.		.	.		.
Reversed,	.		.	.		.		.		.	.		.
Sums,	.		.	.		.		.		.	.		.
Difference,													
b.													
	h	m	s	h	m	s		h	m	s	h	m	s
Wire, I.			.	14	33	21.0				.			.
II.			.			25.4				.			.
III.			.			30.0				.			.
IV.			.			33.0				.			.
V.			.			36.3				.			.
Sum,			.	4)15.3		145.7 29.14				.			.
Mean,			.	14	3.56	29.14				.			.
Bb,			.	73		.37				.			.
Cc,			.	1.00		− .37				.			.
Aa,			.	+.68		−1.19				.			.
						−1.56							
Corr'd Transit,			.			27.58				.			.
R. A.			.	14	21	58.03				.			.
Error of Timepiece,			.			9.55				.			.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 4d.4 1878. Instrument, Russ. Tr. Observer, L.W.

Timepiece, 3451 Recorder, L.W.

Object,	Ylm. Mg			Sirius							
Circle,	W. I II III IV E										
Level Direct,	w		e	w		e	w		e	w		e
Reversed,	16.0		13.2	15.1		14.0	.		.	.		.
							.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			.			.			.			.
II.			.			.			.			.
III.			.			.			.			.
IV.			.			.			.			.
V.			.			.			.			.
Sum,			.			.			.			.
Mean,			.			.			.			.
Bb,			.			.			.			.
Cc,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
Error of Timepiece,			.			.			.			.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 4d 4 1878. Instrument, Merid Circ. Observer, W. A. P.

Timepiece, 1327 Recorder, S. W.

Object, Circle,	δ Leonis Merid		λ Draco.		χ Ursæ Maj		β Leonis	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	11 8 11.8			47.6		10.9		25.0
II.		14.0		50.7		13.9		27.1
III.		16.2		53.6		17.0		29.3
IV.		18.6		56.6		20.2		31.4
V.		20.7	11 24	59.7		23.4	11 43	33.6
Sum,		81.3		3.2		85.4		146.4
						17.08		29.28
Mean,	11 8	16.26	11 24	53.64		17.08	11 43	29.28
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa, n tan δ		−.55		−3.88		−1.54		−.38
Corr'd Transit,	11 8 15.71		11 24	49.76		15.49		28.90
R. A.	11 7 39.78		24	13.84	11 39	39.64	11 42	52.82
Δt + m		−35.93		−35.92		−35.85		−36.08
Error of Timepiece,		.		.		.		.

Mean of δ Leonis, χ Ursæ Maj. & β Leonis

Δt + m = − 35.95

m = + 1.410

Δt = − 37.35

n tan δ Leonis χ Draco. − 1.41

b = + .09 b sec φ + .12

n tan φ − 1.28

m + 1.40

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 5.4 1879. Instrument, Russ. Tr II Observer, S.W.

Sup. 110. Timepiece, 34 J1 Recorder, S.W.

Object,	α Virg			α Ursae min 2.C			α Ursae min S4				
Circle,	(W) I III V			(W) IV 4.5.			(E) V 2.3.			—	
	w		e	w		e	w		e	w	e
Level Direct,	.		.	17:6		15:7	16:7		16:7	.	.
Reversed,	.		.				17:6		15:7	.	.
Sums,	.		.	Rattle follows.		.	34.3		32.4	.	.
Difference,	.		.	Each wins.		.	32.4		.	.	.
b. = +0ˢ.063							3|1.9				
							+ 0ˢ.063				
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.	III		53.9			.			.		.
II.			57.5			.			43 21.0		.
III.			1.0			.5			45 52.0		6.3
IV.			4.7		32ᵐ	56.0			.	IV	24.3
V.	13ʰ	20	8.2	13ʰ	35	22.0			.		.
Sum,			125.3	13ʰ	15ᵐ	40ˢ.89	13ʰ	16ˢ	9ᵐ.26	14ᵐ	48ˢ.95
			2506	13ʰ	15ᵐ	40ˢ.73	13	14	14.10	2	26.16
Mean,	13	20	0.06	13	15	40ˢ.8			14.36	4	52.82
						+ 15.8	13	16	09.08		
Bb,	+.61		+ .04			− 1.77			15 40.8	29	37.90
Ce,	1.02		− .37			.			2|30ˢ.8	2	26.16
Aa,		19	59.72		13	15 54.8			15ˢ.8		.
	+.82								.		.
Corr'd Transit,			.			.	Log 15.8		1.1987	A = +32.02	
R. A.	13	18	48.88	1	13	8.08			8.36894	B = −27.86	
									9.56776		
							+ (CE)		0ˢ.370		
Error of Timepiece,			.			.			.		.

1ʰ 13 8.08
1 18

13 18 48.88
13 8.08

α′−α 5ᵐ 40ˢ.80

4 4.9

α′−α−τ′+τ = + 1ᵐ 35ˢ.9

− 32.25 + .82

19 59.72
15 54.8

τ′−τ = 4ᵐ 4ˢ.9

88° 39′ 33″ 1° 20′ 27″
42 22 48
46° 16′ 45″ = 2δ
2 40 54
(φ−δ) 48° 57′ 39″

sin ζ 9.87752
cos ζ 9.81732
8.36894

log = 1.50858 A = 32.25
log = 1.44838 B = 28.08

620ˢ.063

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 5d 4 1878. Instrument, Merid Cir. Observer, W.A.P.

Timepiece, 1327 Recorder,

Object, Circle,	κ Draco		ε Ursæ Min		η Ursæ Maj		η Bootis	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								

	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	12	28	49.5	12	56	41.9	13	43	19.6	13	49	28.5
			52.8									
II.			55.8			44.0			22.7			30.6
III.			59.0			46.1			25.9			32.7
			21									
IV.			5.1			48.2			29.1			35.0
V.			8.0									
			11.2			50.4			32.3			37.2
		75	14.0									
		51.50				230 6			129 6			140
Sum,		28.61	.			46.12			25.92			28.00
Mean,	12	29	1.94	12	56	46.12	13	43	25.92	13	49	32.80
Bb,	2.81		~~3.06~~	.205		~~.35~~	1.19		~~2.01~~	0.344		~~.57~~
			− 3.37			− .25			− 1.43			− .41
Cc,			.			.			.			.
Aa,												
Corr'd Transit,			~~58.88~~			~~45.87~~			~~23.91~~			~~32.73~~
			58.57			45.77			24.49			32.39
R. A.	12	28	21.69	12	56	9.02	13	42	47.60	13	48	55.51
Δt 4m			36.88			36.85			36.89			36.88
Error of Timepiece,			~~37.19~~			~~36.75~~			~~36.31~~			~~36.77~~

× $0 = +40.25 + 2.81\,n + \Delta t + m$

×× $+37.10 + .21\,n$

× $+38.32 + 1.19\,n$

×× $+37.29 + .34\,n$

$m = \begin{cases} +0.52 \\ +1.52 \\ \hline +1.63 \end{cases}$

× $0 = 78.57 + 4.00\,n$

×× $0 = 74.39 + .55\,n$

$0 = 39.28 + \frac{2.00}{1.50}\,n + \Delta t + m$

$0 = 37.20 + 0.27\,n + \Delta t + m$

$0 = 2.08 + 1.73\,n$

$\therefore n = -1.69$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 6d.4 1878. Instrument, Merid. Cir. Observer, ~~S. W.~~ W. A. R.

See page 108. for Photog. Tel. Results. Timepiece, 1327 Recorder,

Object, for Transit of L. W.
Circle,

	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								

	h m s	h m s	h m s	h m s
Wire, I.	.	.	.	.
II.	.	.	.	.
III.	.	.	.	.
IV.	.	.	.	.
V.	.	.	.	.
Sum,	.	.	.	.
Mean,	.	.	.	.
Bb,	.	.	.	.
Ce,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	.	.	.	.
Error of Timepiece,	.	.	.	.

Assume Run

$6^d.4$ 1327 = +36.73
1.83
~~38.56~~

$\Delta t = +38.08$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 6d 11 187 . Instrument, Merid Cir. Observer, W. A. R.

Timepiece, 1327 Recorder,

Object,	δ Leonis		41 Draco.		η Virg. 12h 13h ?		κ Draco	
Circle,								
Level Direct,	w	e	w	e	w	e	w	e
Reversed,								
Sums,								
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	8 13.4		12 6 59.0		12 14 15.8		12 28 50.6	
II.	15.5		40 / 9.0		18.0		53.8	
III.	17.7		14.0		20.3		56.7	
IV.	19.9		19 0 / 24.3		22.3		59.8	
V.	22.1		29.0 / 34.7		24.2		3.0	
			39.6				6.0 / 9.3	
Sum,							12.2	
Mean,	11 8 17.72		12 7 19.18		17 14 20.12		12 28 59.96	
Bb,	− .45		− 5.76		.00		+ ~~0.48~~	
Cc,							~~3.72~~ 3.3	
Aa,								
	log 0.387		4.54		0.00		2.81 log − 11.24	
Corr'd Transit,	8 17.27		12 6 13.82 / 36.25		20 12 / 25		~~0.44~~ / 4.24	
R. A.	11 7 39.66		~~11~~ ~~59~~ ~~9.42~~		12 13 42.43		12 28 21.52	
Error of Timepiece,	+ 37s.61		+ 37s.57		+ 37s.29		+ 37.41 / ~~38.92~~	

$0 = +38^s.06 + 0.387\,n + \Delta t + m$

$0 = +37^s.69 + 0.00 + \Delta t + m$

$0 = +0.37 + 0.39\,n$

$0 = +42^s.93 + 4.54\,n + \Delta t + m$

$+37.87 + 0.19\,n + \Delta t + m$

$0 = +5.05 + 4.35\,n \;\therefore\; n = -1.16$

58.99
11.52
37.47

37.61
.57
.29
147
37.49
+ .15
+1.04
~~+38.68~~

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 6d 4 187 . Instrument, Observer,

Timepiece, Recorder,

Object,	ε Urs. maj		ε Ursæ									
Circle,												
	w		e		w		e		w		e	
Level Direct,	.		.		.		.		.		.	
Reversed,	.		.		.		.		.		.	
Sums,	.		.		.		.		.		.	
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	12	49	15.7	12	56	42.7			.			.
II.			19.3			44.8			.			.
III.			23.2									
			26.8			46.9			.			.
IV.			30.5			49.1			.			.
V.			.			51.1			.			.
Sum,			11 55 23.10			.			.			.
Mean,	12	49	23.10	12	56	46.92			.			.
Bb,			~~+.26~~			~~0.5~~			.			.
Ce,			− 2.29			− .31			.			.
Aa,			.						.			.
	lyd	1.518			0.205	46.61			.			.
Corr'd Transit,			~~23.36~~			~~46.95~~			.			.
R. A.			20.81			.			.			.
	12	48	43.46	12	56	9.02						
Error of Timepiece,			$+37^s.35$			$+37^s.59$			.			.

$0 = +39^s.64 + 1.52 + \Delta t + m$

$0 = +37.90 + \omega.20$

$0 = +38.77 + 0.86 + \Delta t + m$

$0 = +\cancel{38.44}\ 41.71 + 2.81 +$

$0 = +\cancel{0.33} - 1.95n \quad \therefore n = +0.17$

$0 = +2.94 + 1.95n \qquad -1.51$

$b = +0^s.12$

Recap-nights.

$37.47 + .35 + .59 = 37.47$

$37.47 + 1.15 + 1.36 = 38.98$

assumed error

$b\,d\,4 = 38^s.83$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 8d.4 1878. Instrument, Mer. Cir. Observer, W. A. R.

Timepiece, 1327 Recorder, S. W.

Object,	β Ursae maj.		δ Leonis.		β Leonis.		47 Draconis.	
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		5.7		15.1		28.4		11.5
II.		9.3		17.3		30.4		16.2
III.		13.2		19.6		32.6		21.3
IV.		17.0		21.7		34.7		26.4
V.	10 55	20.4	11 8	24.0	11 43	36.8	11 7	31.2
Sum,		65.6		97.7		162.9		106.6
		13.12		19.54		32.58		21.32
Mean,	10 55	13.12	11 8	19.54	11 43	32.58	11 7	21.32
Bb,		2.02		.		.		.
Cc,		.		.		.		.
Aa,	1ph 1.54	.	0.39	.	0.27	.	4.54	.
Corr'd Transit,		.		.		.		.
R. A.	10 54	31.78	11 7	39.64	11 42	52.75	12 6	35.42
Error of Timepiece,		.		.		.		.

39.32
39.39
39.48
11 9
+ 39.40
+ .15
+ 1.18
+ 40.73

+ 41.34 + 2.02 + 39.90 + 39.83 + 45.40

39.90 − .51
39.83 − .35
1.07
+ 40.36

1.54
.39
.27
3 | 2.10
0.70

0 = + 40.36 + .70 n + Δt + m
= 45.40 + 4.54 n

0 = + 5.04 + 3.84 n ∴ n = − 1.31

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 10d 24 1878. Instrument, Pass Tr. Observer, E. W.
Timepiece, 3451 Recorder, E. W.

Object,	τ Serpis		λ Draco		λ Draco.		ν Serpis	
Circle,	E		E		W		W	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	13.0	12.4	.	.	14.9	16.1
Reversed,	.	.	14.9	16.1	.	.		
			27.9	28.5				
Sums,				27.9				
Difference,	42 23			0.6				
b. = −0s.02	+30 32				Cos δ =			
	38° 51′							

	h m s	h m s	h m s	h m s
Wire, I.	14.2		I 13.5	17.3
II.	35.6		24.0	38.7
III.	56.8	III 25.0?	34.2	0.0
IV.	18.6	35.2	44.5	21.2
V.	11 22 39.5	11 24 46.3	11 26 54.8	11 31 42.5
Sum,	1647 / 32.94 / 24	10655 / 35.50 / −10.36	−2 17108 / 34.20 / 4.32	11977 / 23.94 / 24
Mean,	11 21 56.94	11 24 25.14	11 23 29.88	11 30 59.94
Bb,	.77	2.57	−0.5	−0.1
Cc,	−0.1 / +.74	−0.5 / +2.37	−2.37	−0.74
Aa,	1.00	2.92	1.00	1.00
	11 21 57.67	11 24 27.46	11 24 27.46	11 30 59.19
	+.63 −.51	−1.35 +1.09	+.90 +.50	+.67 −.45
Corr'd Transit,	21 57.16	24 28.55 / 46	24 28.36 / 27.96	30 58.92 / 58.94
R. A.	11 21 42.19	11 24 13.57 / 21 42.19	24 13.57	11 30 44.56 / 24 13.57
Error of Timepiece,	+14s.97	+14s.98 / 138 / 2)137 / .69	+14s.39	+14s.39

Set Tr. in Meridian by 8 Gruis.

9.5341

α′ − α = 31s.38 / 29.79 / +1.59 = 159/198
+ − t
−1.35 − .65

30.99 / 31.73 / −0.74 = −74/202 = −.366
67 + 1.35

−0s.896 / −0.367 / 2)1.173 / −0s.587

4099

0.46599 / 1.6256 / 2.0945

124.s53

0.4659 / 0.5494 / 1.0153 / 10s.36 / 12 / 12432

29.88 / 25.14 / 2)4.74 / 2.37 = 0.3365

Log 0.4659 / 9.8706

C = +0s.742 (E).

−0° 8′ / 42 23 / 42° 31′

Eun 3451 = +14s.68

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 13.4 1878. Instrument, Rum. Tr. Observer, S. W.

Timepiece, 3451. Recorder, S. W.

Object,	43 Comae		20 Can. Ven.		α Virginis.		Gr 2001.	
Circle,	W		e		e		e II	
	w	e	w	e	w	e	w	e
Level Direct,	15.2	19.8	15.0	20.1	.	.	.	.
Reversed,	15.0	20.1	.	.	.	.	.	.
	30.2	39.8	.	.	.	.	.	.
Sums,	.	30 2	.	.	.	.	.	.
Difference,	.	9.6	.	.	.	.	.	.
b. = −0s.32								
	h m s		h m s		h m s		h m s	
Wire, I.		0 5 0		47.6		23.6	III	0.5
II.		16.6		8.0		44.7		12.8
III.		32.6		25.1		6.6		24.8
IV.		48.7		43.8		28.3		37.0
V.	13 7	4.6	13h 13m	2.7	13 19	49.7	13 23	48.5
Sum,		102 5		125 2		1529		123 6
		20.50		20.04		30.58		24.72
Mean,	13 6	32.50	13 12	25.04	13 19	6.58	13 23	24.72
								1.37
Bb,	1.13	−.36	1.32	−.42	+.82	−.20	2.95	−.94
Ce,	1.14	−11.46	1.32	+.53	1.02	+.41	3.42	+1.37
Aa,	+27				4.82	6.79	−1.74	25.13
			+04			19	23h	
Corr'd Transit,		6 32.60		25.15		6.79		
R. A.	13 6	13.76	13 12	7.51	13 18	48.87	13 23	07.22
Error of Timepiece,		18.84		17.64		17.92		17.83
		=+17.92						

+17.92 . W
17.64 . e
17.92 . e
2)1.56
+17.78

α − A = +18.35
t − t = +18.36

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 13.4 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	Gr. 2001							
Circle,	W							
Level Direct,	w	e	w	e	w	e	w	e
Reversed,	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	V 28 7		Gδ = 9.46511		.		.	
II.	41 3		1.62355		.		.	
III.	53 0		2.16344		.		.	
IV.	5 2		145.69		.		.	
V.	13 26 17 6		.		.		.	
	1458							
Sum,	29.16		.		.		.	
	24							
Mean,	13 25 52.16		.		.		.	
	2 25.69							
Bb,	13h 23m 27s.47		.		13 23 27.47 (m)		.	
Ce,	3.42		.		24.72 (e)		.	
Aa,			.		2 12.75			
Corr'd Transit,			.		Log = 1.s37 = 0.1367			
R. A.	13 23 07.22		.				9.46511	
							9.6018	
Error of Timepiece,			.		∴ C = + 0s.40 (e)			

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 6d.4 1878. Instrument, Russ. Dr, Observer, L. W.
Timepiece, 345. Recorder, Chronogr.

Object, Circle,	θ Virg. e		43 Camelop. e		α Ursae. Min. e III, 123		α Ursae. W III 45.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	15.2	17.8	.	.	16.0	17.1
Reversed,	.	.	16.0	17.1	.	.		
Sums,	.	.	31.2	34.9	.	.	.	.
			.	31.2				
Difference,				3.7				
b.	−0s.123							
	−0.090							
	h m s		h m s		h m s		h m s	
Wire, I.		45.2		16.8	9 10.0			.
					4 52.32			
II.		48.8		20.4	11 37.5			.
					2 36.16			
III.		52.0		24.5	13 14 9.0			.
IV.		55.7		28.6	4 56.5		16 27.5	
					+20 19.83		2 36.16	
V.	13 3	59.3	13 6m	32.4	13 11 38.83		13 18 55.0	
							4 57.32	
Sum,		261.0		172.7	14 2.32		13 17 38.75	
		57.20		24.54	14 3.66		13 61.34	
					14 9.00		14 3.68	
Mean,	13h 3m	57s.20	13h 6m	24s.54	14 4.99		13 59.51	
Bb,	.68	−.83		3.4	Corr. for =	13h 14	13.8	
						.	+3.46	
Cc,	1.01	+.11		.		.	14 5.3	
Aa,		3m 51s.47		.		.		
	+.74	−1.08			+32.25		−47.2	
Corr'd Transit,		3m 50s.39		.		13 18.1		.
R. A.	13 3	40.86		.	1 13 8.61			.
					3 40.86			
Error of Timepiece,		+9s.53		.		+9s.5		.

α′−α = 9m 27s.75
t′−t = 10 13.8
(α′−α)−(t′−t) = −0m 46s.0
32.25 − .74

Log 46.0 = 1.6628
38.51 = 1.4984
0.1644
∴ a = −1s.460

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 6.4 1878. Instrument, Rev. Dr. Observer, L. N.

Timepiece, 2451. Recorder, L. N. Chron.

Object,	69 H Ursae ?		ζ Virg.					
Circle,	W		W					
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		59.1		36.6		.		.
II.		6.2		40.2		.		.
III.		13.4		43.7		.		.
IV.		20.7		47.3		.		.
V.	13 24	28.1	13 ~~29~~ 28	50.5		.		.
Sum,		127.5 / 25.50		243 / 43.66		.		.
Mean,	13 24	13.50	13 ~~29~~ 28	43.66		.		.
Bb,		.	.74	− .66		.	δ =	.
Cc,		.	1.00	− .11		.		.
Aa,		.	13h 28 14	42.80 5.3		.		.
			.67			α′−α =		15m 22.89
Corr'd Transit,		.		.		t′−t =		37.5
R. A.		.	13 28 13	31.50 8.61		:		.
						(α′−α)−(t′−t) =		45.5
Error of Timepiece,		.		.	Log 45.4 31.45	1.6571 1.5076 0.1495	+45.5 .67 − 32.25	1.6571 − 1.5 41

3° 42′ 14″.3

~~45~~ m 7′

12m

3m 2.8s

~~15m 28s .95~~

~~15m 28s.95~~

1° = 4m

1′ = 4s

1° = 1/15′

6) 14m 48s.95 (120, 20)

2m 26s.16

Log 1.32752

152 1.17609

Log 2.50361 in (11)

318″.56

300″ s = 4.68557

2.50361

7.18918

~~+.32752~~

α Ursae, Min 1 13 7.82

8.36 0.54

8.87 0s.51

May 5d.4 1h 13m 8s.08 8s.08

6.4 1 13 8.61

Cos δ = 8.36894

Sin I = ~~7~~.18918

~~5598 12~~

Sin ζ = 8.81024

= 3° 42′ 14.″3

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 5d 4 1878. Instrument, Rues. IV Observer, Leo

fm page 99. Timepiece, 2451 Recorder, Chron.

Object,	α Virg	α Ursae Min.	α Ursae Min	
Circle,	W.	W	e	
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b. +0s.063				
	h m s	h m s	h m s	h m s
Wire, I.	.	.	.	.
II.	.	.	.	.
III.	.	.	.	.
IV.	.	.	.	.
V.	.	.	.	.
Sum,	.	.	.	.
Mean,	13 20 ~~0.06~~	13 15 ~~28~~ 26.7	.	.
Bb,	.61 + .04	28.08 − 1.77	.	.
Cc, c = +.108 e.	1.02 − .11	13 15 .	26.9 .	.
Aa,	19 59.99		.	.
	.82 2α' 1.77	+32.25 α 1.	9.8 .	.
Corr'd Transit,	19 58.22	13 17.1	.	.
R. A.	13 18 48.88 / 13 8.08	1 13 8.08	.	.
Error of Timepiece,	1 9s.3	9s.0	.	.

α L α
+ − +

5m 40s.80
4 33.1
+ 1m 7s.7

13 19 59.99
15 26.9
4 33.1

+ 67s.7

Log = 67.7 = 1.8306
31.43 = 1.4973
0.3333 w

.82 − 32.25
31.43

2.s156

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer,.....

Timepiece,..... Recorder,.....

Object, Circle,								
Level Direct, Reversed	w	e	w	e	w	e	w	e
	. .	. .	. .	. .	. .	. .	. .	. .

May 5.4 Collimation.

6.4 α Virginis

tr.	13h	20	0.06						
				IV4	13	32	56.0	V2	43m 21.0
						−17	24.7		27 47.6
						13	15m 31s.3		15m 33s.4
				IV5	13	35	22.0	V3	45 52.0
						−20	0.4		30 23.40
						13	15m 21s.6		15m 28s.6
						3° 42′	14″.3		7° 35′ 51″
						12m			
						2	48s.95		
						14m	48s.95		30m 23s.40
						2	35.74		14m 48.95
						17	24.69		6/15 34.45
						20	0.43		2m 35s.74
									30 23.40
May 5d.4	w	13	15	26.4					27 47.66
	e	13	15	31.0 − 4.3	>	+ 4.6	ce		
		13	15	29.7					
May 6d.4	w	13	13	59.5					
	e	13	14	54.0 − 2.2	>	+ 4s.5	ce		
		13	14	1.8					

Log 4.6 = 0.6628

Cis δ 4.5 = 0.6532

8.3689

9.0317 0s.108

9.0221 0.105

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 16d.4 1878. Instrument, Runs. Tr. Observer, E. W.

Timepiece, 3451 Recorder, E. W

Object,	b Can. Ven.		20 Comae		K Draconis			
Circle,	W.		W		E			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	16.0	17.0	15.8	14.0	.	.
Reversed,	.	.					.	.
Sums,	.	.	15.8 / 31.8 / 31.0 / .8	14.0 / 31.0	.	.	.	.
Difference,								
b. +0s.03								
	h m s		h m s		h m s		h m s	
Wire, I.		47.8		14.6		.		.
II.		57.3		37.5		.		.
III.		15.8		0.6		.		.
IV.		33.5		23.2		.		.
V.	12 20	43.4	12 24	46.1		.		.
Sum,		197.8 / 39.56 (24)		122.0 / 24.40 (24)		.		.
Mean,	12 20	15.56	12 24	0.40		.		.
Bb,	1.30	+ .04	1.01	+ .03		.		.
Cc,	1.30	− .52	1.08	− .44		.		.
Aa,		− .48		.		.		.
	+.07		+.39					
Corr'd Transit,	E	15 08		24 0.00		.		.
R. A.	12 19	58 29	12 23	38 40		.		.
Error of Timepiece,		+ 21s.79		+ 21s.60		.		.

Sum 24 T = + 21s.70

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 17D.4 1878. Instrument, Rms. Tr. Observer, SW

Timepiece, 3451 Recorder, SW

Object,	ε Virg.				θ Virginis				43 Comae				69 Humae						
Circle,	e				W				W				W						
	w			e	w			e	w			e	w			e			
Level Direct,	14.2			18.1	.			.	15.2			17.4	.			.			
Reversed,	15.2			17.4	.			.					.			.			
Sums,	29.4			35.5	.			.	.			.	.			.			
Difference,				6.1															
b. = −0s.20																			
	h	m	s		h	m	s		h	m	s		h	m	s				
Wire, I.			48.1				21.6				.				12.1				
II.			9.7				42.5				.				19.0				
III.			31.7				4.2		13	6	37.2				26.3				
IV.			53.3				25.7				.				33.5				
V.	12	57	14.8		13	4	46.6				.			24					
Sum,			15 5 76 / 3 1.52				14 0 6 / 28.12				.				7 8 8 / 26.3				
Mean,	12	56	31.52		13	4	4.12		13	6	37.2		13h	24m	26s.3				
Bb,	.89		− .18		× 68		− .44		1.13		− .2		-1.93		− .38				
Cc,	1.02		+ .40		1.01		+ .40		1.14		− .45		2.03		− .81				
Aa,	12	56	31.74								.		12	24	25.11.9				
	+1.52				+.74		+ .74		+.27				−.63						
Corr'd Transit,		56	31.74				+ 3.68				36.6				25.1				
R. A.	12	56	8.99		13	3	40.79		13	6	13.74		13	23	62.51				
Error of Timepiece,		+	22s.75			+	22s.89				+22s.9				22.6				

56 8.99
6 53.52
6 53.4

22.9
22.75
165

∴ 3451 = + 22s.83

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 19d.4 187 . Instrument, Rms. Dr Observer, Lw

Timepiece, 3451 Recorder, Lw.

Object,			α Draconis				κ Draco.			κ Ursæ Min.		
Circle,			W				e			e		
	w		e		w		e		w		e	
Level Direct,	.		.		15 . 0		18 . 5		.		.	
Reversed,	.		.						.		.	
Sums,	.		.		.		.		.		.	
Difference,												
b.												
	h	m	s		h	m	s		h	m	s	
Wire, I.			46 . 0	III			19 . 0	V			.	
II.			3 . 2				28 . 2				.	
III.			.				36 . 7				.	
IV.			.				45 . 1	④			23 . 6	
V.			.		14	1	53 . 5	⑤	14	3	31 . 7	
Sum,			.				18 2 5 36 . 50				.	
Mean,			.		14	1	36 50				.	
Bb,			.		2.18		− . 63				.	
Ce,			.		2.37		+ . 95				.	
Aa,			.		−.91		.				.	
Corr'd Transit,			.				.				.	
R. A.			.		14	1	8 . 68				.	
Error of Timepiece,			.				.				.	

Wire, V.	14	7	34 . 7
Sum,			13 8 5 27 . 70 24
Mean,	14	6	51 . 70
Bb,			− . 18
Ce,			+ . 41
Aa,			.
			+.81
Corr'd Transit,			.
R. A.	14	6	26 . 89 37
Error of Timepiece,			.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 19d.4 1878. Instrument, Russian Observer,

Timepiece, 345 Recorder,

Object,	α Bootis			θ Bootis							
Circle,	E			W							
	w		e	w		e	w		e	w	e
Level Direct,	14 5		19 3	15 0		18 8	.		.	.	.
Reversed,							.		.	.	.
Sums,	.		.	14 5 / 29.5		19 8 / 38.1 / 29.5 / 8.6	.		.	.	.
Difference,											
b. −0s.29											
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			48.3			23.1			.		.
II.			11.2			58.0			.		.
III.			33.7			33.0			.		.
IV.			56.4			8.0			.		.
V.	14	11	19.1	14	22	42.3			.		.
			1689			1644					
Sum,			33.94			32.88			.		.
Mean,	14	10	33.74	14	21	32.88			.		.
Bb,	.97		−.28	1.62		∓.47			.		.
Cc,	1.06		+.42	1.64		−.66			.		.
Aa,			.			.			.		.
	+.42			−.29							
Corr'd Transit,			.			.			.		.
R. A.	14	10	8.80	14	21	6.24			.		.
Error of Timepiece,			.			.			.		.

33.88
8.80
25.08
25.51
59
25s.30

31.75
6.24
25.51

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 23.99 1878. Instrument, Pass. Tr Observer, Leo

Timepiece, 3451 Recorder, Lew.

Object,	☉			☉			☿			☿		
Circle,	e			W			W			W		
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	r_1		37.5	IV_5	5	1.5	I_{III}	6	0.5	IV_1		1.5
II.	I_3		45.5	V_1		8.5	II_{III}		23.5	IV_{II}		9.0
III.	I_5	3	53.0	V_3		16.0	III_{III}	6	47.5	IV_5		16.5
IV.										V_1		24.3
V.	II_1		60.5			24.0				V_3		32.0
Sum,	3	4	8.0	V_5	5	50.0				V_5		39.5
Mean,	5	4	1.60							4	7	
Bb,			4.1965									
Cc,												
Aa,			49.12			12.50						
Corr'd Transit,			7 1 120 2205									
R. A.			7 1 340.5									
			48.6									
Error of Timepiece,			.			.			.			.

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1877phaa.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Pua: observatório Instrument, Observer,

Timepiece, Recorder,

Object,	01		10					
Circle,	e		W					
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.					Os pontos			
	h m s		h m s		h m s		h m s	
Wire, I.		37.5		9.0				
II.		45.5		16.5	4h 5m 13.89		10.083	
III.		53.0		24.3	— 3.98		0h 23m 41s.4	
IV.		60.5		32.0	4h 5m 9.91		60	
V.	4 3	68.0	4 7	39.5			1380	
		2645		1213			41.	
Sum,		5290		2426			1421.4	
Mean,	4h 3m 52.90		4h 7m 24.26				3600.	
							Log 1421.4 = 3.1527	
							3600 3.5563	
Bb,		.	4 3 52.90				9.5964	
Ce,		.	10 77.16				39.49 Jamboin	
Aa,		.	4 5 38.58				.3949	
			5 9.91				9.5964	
Corr'd Transit,		.					.0034	
R. A.		.					9.5998	
							3.979	
Error of Timepiece,		.	+ 28.67					

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 25th 4 1878. Instrument, Rev. Tr. Observer, S.W.

Timepiece, 345 Recorder, S.W.

Object,	20 Cam. Ursæ.			α Virginis			Ar 2001			17 H Cam. Ursæ.		
Circle,	W			E			E			E		
	w		e	w		e	w		e	w		e
Level Direct,	13 : 2		14 : 6	.		.	.		.	13 · 0		16 · 0
Reversed,				.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			42 · 9			36 1			47 · 5			.
II.			11 · 5?			57 · 6			12 · 0			.
III.			39 · 4			19 · 2			36 · 3			.
IV.			7 · 6			41 · 3			0 · 8			.
V.	13h	13m	35 · 7	13h	20m	2 · 5	13	24	35 · 0	13	30	48 3
Sum,			.			.			.			.
Mean,			.			.			.			.
Bb,			.			.			.			.
Cc,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
Error of Timepiece,			.			.			.			.

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1877phaa.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 26.4 1878 Instrument, Russ, Tr Observer, S.W.

Timepiece, 3451 Recorder, S.W.

Object,	20 Cam ven.				x Virginis				gr 2001				gr. 2001						
Circle,	e				e				e				W 30°39'						
	w		e		w		e		w		e		w		e				
Level Direct, Reversed,	11.3		16.4		11.2		17.0		.		.		.		.				
Sums,	.		.		13.1		15.9		.		.		.		.				
Difference,					24.3		32.9												
b. −0.29							24.3												
							8.6												
	h	m	s		h	m	s		h	m	s		h	m	s				
Wire, I.			42.6				37.2		III		13.7		V		43.5				
II.			10.8				58.6				26.0				55.3				
III.			38.9				20.6				38.5				7.5				
IV.			7.5				42.3				50.0				19.5				
V.	13	13	35.5		13	20	4.3		13	24	2.5		13	26	31.7				
Sum,			136.3 27				1630 32.60				130 26.14 12				157.5 31.50 24				
Mean,	13	12	39.06		13	19	20.60		13	23	38.14		13	26	31.50				
Bb,	1.32		−.38		1.81		−.47		2.95		−.85		13	23	41.95				
Ce,	1.32		+.74		1.03		+0.57		3.42		+1.96				−1.91				
Aa,	+.04		−.01		−.82		+.24		1.74		−.50		13h	23m	40.04 −.85				
Corr'd Transit,			39.41 38.91				20.94			23	38.69								
R. A.	13	12	7.89		13	18	48.84		13	23	6.59								
Error of Timepiece,		+	32.02 31.52			+	32.10			+	32.10								

13 23 39.19
19 20.70
$t'-t =$ 4m 18.49

$\alpha'-\alpha =$ 4 17.75
0.74
26

$$a = \frac{-0.74}{+1.74+1.82} = \frac{74}{256} = -0.29$$

+73° 11'
cos δ 9.4655
1.6285
2.1630

145.55

41.95
38.14
2 | 3.81
1.905

log = .2799
cos δ = 9.4655
9.7454

+0.556 (ce)

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 24 1878. Instrument, Rum. Observer, ...

Timepiece, ... Recorder, ...

Object,	17 H Can. Ven.										
Circle,	W										
	w		e	w		e	w		e	w		e
Level Direct,	13.1		15.9	.		.	.		.	.		.
Reversed,				.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			3.6			.			.			.
II.			30.5			.			.			.
III.			57.1			.			.			.
IV.			24.0			.			.			.
V.	13	30	51.1			.			.			.
Sum,			16 6 3 33.26 24			.			.			.
Mean,	13	29	57.26			.			.			.
Bb,	1.26		− 36			.			.			.
Cc,	1.29		− .71			.			.			.
Aa,	+.11		− .03			.			.			.
Corr'd Transit,			56.16			.			.			.
R. A.	13	29	23.95			.			.			.
Error of Timepiece,			+ 32.21			.			.			.

+ 32.02
23
+ 32.12

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, May 28.7 1878. Instrument, Rms Tr. Observer, L.W.

Timepiece, 3451 Recorder, L.W.

Object,	η Bootis				ring.			α Draco			α Draco.	
Circle,	W				e			E			E	
	w		e		w		e	w		e	w	e
Level Direct,	13	.0	16	.1				12	.9	16 .7		
Reversed,												
Sums,								13.0		16.1		
								25.9		32.8		
Difference,										25.9		
										6.9		
b. = − 0.23												
	h	m	s		h	m	s	h	m	s	h	m s
Wire, I.			46.2		Wire			I 3		2.6		9.5
II.			8.7					II 1 I 5		36.0 19.0		26.6
III.			31.2					II 3		53.0	III 3	43.5
IV.			53.6									59.8
V.	13	50	16.3					cloud			14 2	16.5
Sum,			156.2									155.9
			31.20									31.18
Mean,	13	49	31.20								14 1	43.18
Bb,	.98		− .24					2.18		.6		− .50
Cc,	1.06		− .59					2.37				+ 1.32
Aa,	+.42		− .12					-.91				+ .26
Corr'd Transit,	13	49	30.25								14 1	44.26
R. A.	13	48	55.48								14 1	9.46
Error of Timepiece,			+ 34.77									+ 34.80

a = − 0.29

b = − 0.23

c = + 0.35 (E)

34.80 E

34.77 W

1345 = + 34.78

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 14 1878. Instrument, Russ Jr. Observer, S. W.

Timepiece, 3451 Recorder, S. W.

Object,	η Virginis	Ursae Maj.	ε Virginis	α Ursae Minoris
Circle,	E	E	W	W
	w | e	w | e	w | e	w | e
Level Direct,	12.6 | 12.0	. | .	. | .	14.2 | 16.8
Reversed,				12.8 | 12.8
				27.0 | 29.6
Sums,	. | .	. | .	. | .	. | 27.0
Difference,				2.6
b. = −0.09				
	h m s	h m s	h m s	h m s
Wire, I.	.	4.4	5.3	I 1 3 30.0
II.	56.3	43.5	27.2	.
III.	10.0	21.5	49.1	III 1 8 35.5
IV.	12 36 24.5	0.6	10.5	+4 52.32
V.	.	12 50 39.1	12 57 32.6	IV 1 11 4.5
				+2 26.16
Sum,	9.0 8 / 30.26	109.1 / 21.82	1247 / 24.94	1h 13m 27s.8 2 / 13 30.16
Mean,	12 36 10.26	12 49 21.82 +.88	12 56 48.94	1h 13m 29s.24
				C + 26.22
Bb, −0s.09	.73 −.06	1.75 −0.157	+.89 −.08	−27.86 −2.60
Cc, c = +0s.62 (E)	1.00 +.62	1.82 +1.13	1.02 −.63	1h 13m 52.84
Aa,	+.68 +.29	−.45 −.19	+.52 +.22	56m 48s.23 +32.02 +13.7
Corr'd Transit,	36 11.11	49 22.90	56 48.45	13 66 5
R. A.	12 35 31.78	12 48 42.97	12 56 8.90	1 13 26.9
Error of Timepiece,	+39s.83	+39s.73	+39s.55	+39s.6

39.73 E
39.55 W
128

∴ Error 3451 = +39s.64

α′ − α: 56 8.90 / 17m 18s.0

13 52.84
56 48.23
t′ − t: 17m 4s.61
α′ − α − t′ + t: + 13s.39
+32.02 − 62
= + 13.39 / 31.50

∴ a = +0s.425

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ... 187 . Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	α Ursae Min										
Circle,	e										
	w		e		w		e		w		e
Level Direct,	13.1		13.6		.		.		.		.
Reversed,	12.6		12.0		.		.		.		.
Sums,	25.7		25.6		.		.		.		.
Difference,	12.8		12.8								
b.											
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	1	14	16.5			.			.			.
II.			.			.			.			.
III.	1	16	49.5			.			.			.
		2	26.16									
IV.			.			.			.			.
V.	1	19	17.5			.			.			.
		4	52.82	14	21.67							
				13	29.24							
Sum,		14	16.50	2	52.43				.			.
		14	23.34									
		14	25.18									
Mean,	1h	14m	21.67	42.44	26.22	1.62			.			.
					25	4	64					
							7560					
Bb,			.			.			.			.
Cc,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
Error of Timepiece,			.			.			.			.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 30.4 1878 Instrument, Observer,

Timepiece, Recorder,

Object,	α Draco		δ Bootis		ι Bootis		θ Bootis	
Circle,	e		e		e 9° 53′		W	
	w	e	w	e	w	e	w	e
Level Direct,	13.1	12.1	.	.	.	.	13.8	12.0
Reversed,			.	.	.	.	13.1	12.1
Sums,	.	.	.	.	.	.	26.9	24.1
Difference,							24.1	.
b. +0s.09					Neglect		2.8	
	h m s		h m s		h m s		h m s	
Wire, I.		34.0		20.5		.		39.5
II.		.		35.5		.		14.3
III.		50.0		50.5		.		49.6
IV.		.		5.7		.		24.5
V.	14 2	7.0	14 11	20.6		.	14 22	59.3
Sum,		91.0		132.8		.		187.2
		30.30		26.56				37.44
								12.5
Mean,	14 1	50.30	14h 10m	50s.56		.	14h 21m	49.44
Bb, +0.09 (3)		.	.97	+.08		.	1.62	+.14/68
Ce, +0.62 (2)		.	1.06	+.66		.	1.63	−1.01
Aa, a = +0s.425		.	+.42	+.18		.	−.29	−.12 1.13
Corr'd Transit,		.	10	51.48		.		48.45
R. A.		.	14 10	8.75		.	14 21	6.05
Error of Timepiece,		.		+42s.73		.		+42.40

P 3451.=.. H 191.

14 20 46.5 = 9 38 44.0

14 39 22.5 = 9 39 20.0

42.57

14h 28m 39.s93 = 9h 39m 20s.0

4 48 0.43

9h 40m 39.s50

135.11

9h 39 34.39

4.39

15.61

+42.73

+42.40

113

+42s.57

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 1. 1870. Instrument, R.T.v. Observer, Lw

Timepiece, 3451 Recorder,

Object,	β Bootis				μ Bootis										
Circle,	W.				W										
	w		e		w		e		w		e		w		e
Level Direct,	.		.		.		.		.		.		.		
Reversed,	.		.		.		.		.		.		.		
Sums,	.		.		.		.		.		.		.		
Difference,															
b.															
	h	m	s		h	m	s		h	m	s		h	m	
Wire, I.			14.5				.				.				
II.			.				.				.				
III.	Clouds		.				.				.				
IV.			.				.				.				
V.			.				.				.				
Sum,			.				.				.				
Mean,			.				.				.				
Bb,			.				.				.				
Ce,			.				.				.				
Aa,			.				.				.				
Corr'd Transit,			.				.				.				
R. A.			.				.				.				
Error of Timepiece,			.				.				.				

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 5.4 1878. Instrument, Mer. Circ. Observer, W.A.R.

Timepiece, 1327 Recorder, Chronogr.

Object,	κ Draco.		ε Urs.		α Draco		θ Bootis	
Cirele,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	54.80			15.1		13.0		11.2
II.	57.3			17.2		17.8		14.7
III.	0.1			19.3		22.7		18.0
IV.	3.2			21.3		27.4		21.5
V.	6.4			23.5		32.3		25.0
	12 29	28.1 31.1 34.2	13 57		14 2		14h 22m	
Sum,		57.3 29m 40.1 17.08		96.4 19.28		113.2 22.64		90.4 18.08
Mean,	12 29	34.16	13 57	19.28	14 2	22.64	14 22	18.08
Bb,		2.64 -.66	+.89	-.22	2.18	-2.04 -.55	1.64	+.88 +.41
Cc,		33 50 -2.33	57	19.06 +.85		-1.49		-.47
Aa,		-1.42 +.52 +.60	+.52	+.59	-.91	+1.03	-.29	-.33
Corr'd Transit,	29	31.17 31.90	57	19.91 19.85	2	20.60 21.06	22	17.20 17.34
R. A.	12 28	20.11	12 56	8.86	14 1	9.24	14 21	6.04
Error of Timepiece,	+1m	11.99 11.06	+1m	10.99 11.05	+1m	11.36	+1m	11.16

α'-α 27m 48.75

ε'-ε 27 45.56

+3.19

·52 +1.42 = 3.19 / 1.94 = +1.64

11.16
11.36
11.05
11.06
4)53
+1m 11.13

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1877phae.proj.:17974

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 6 1878. Instrument, Mer. Circ. Observer, W. A. R.

Timepiece, Recorder,

Object,	κ Drac.		ε Virg.		α Ursæ Min.		η Bootis		α Bootis		
Circle,	tan δ +2.81		tan δ +.21		tan δ +42.68		tan δ +.34		tan δ +.36		
			w	e	w	e	w	e	w	e	
Level Direct,			.	.	.	.	.	.	.	.	
Reversed,			.	.	.	.	.	.	.	.	
Sums,			.	.	.	.	.	.	.	.	
Difference,											
b.											
	m	s	h m	s	h m	s	h m	s	h m	s	
Wire, I.	29	23.3	57	16.5			50	3.1	11	16.6	
II.		26.3		18.6	3	27.0		5.4		18.7	
III.		28.5		20.8	4	12.0		7.6		21.0	
IV.		32.5		22.8	4	57.3		9.8		23.1	
V.		35.6		24.9	5	39.1		12.0		25.4	
		38.7			6	24.6					
		41.9			7	7.0					
Sum,		44.6		103.6		219.0		37.9			
		~~47.8~~			7	52.0					
		~~370.2~~			~~8~~	~~35.0~~					
Mean,	29	~~36.49~~	12 57	20.72	5	39.9	13 50	7.58	11	20.96	
					5	4.9					
Bb,	m.			+.86	13	44.8		+.86		+.86	
Ce,	n tan δ			−.28		+.9		−.45		−.48	
Aa,				.		+56.9		.		.	
Corr'd Transit,			57	21.30	14	42.6	50	7.99	11	21.34	
R. A.	28	20.15	12 56	8.86	1 13	30.49	13 48	55.43	14 10	8.74	
Error of Timepiece,				72.44		.		72.56		72.60	

Sec φ 1.36 b sec φ = −.34
tan φ .91 −n tan φ = +1.20
+.86

log red. of group 1.05538
" circ δ 8.369753
" Rate 2.685563
8m 4.9

72.44
56
60
+72.53 = Error 1327

0 = 71.86 + .21n
= 72.15 + .34n
= 72.22 + .36n
0 = 72.08 + .30n
0 = 14.31 − 42.68n
0 = 57.77 + 42.98n
n = −1.34
1.30
−1.32
1188
120

57.77
4238
1539
12714
2676

12 Draconis
0 = 75.34 + 2.81n
72.08 + 30n
0 = 3.26 + 2.51n
n = −1.30

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 7.4 1878. Instrument, Mer. Circle Observer, Will.

Timepiece, 1327 Recorder, Chronograph

Object,	109 Herculis			3 Serpentis								
Circle,	tan δ +.04			tan δ +.09								
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.	Outer group.											
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	14	41	39.7	15	10	19.5			.			.
						20.8						
II.			41.8			21.9			.			.
						22.9						
III.			43.8			23.9			.			.
						25.0						
IV.			46.0			25.9			.			.
						26.9						
V.			48.0			28.0			.			.
Sum,		41	43.86		10	23.87			.			.
Mean,			22.72			.			.			.
Bb,		41	21.14		10	23.87			.			.
Cc,	m		+.86			+.86			.			.
Aa,	Mend		−.05			−.12			.			.
Corr'd Transit,		41	21.95		10	24.61			.			.
R. A.		40	7.98		9	10.70			.			.
Error of Timepiece,			+73.97			+73.91			.			.

1.35605 log eq. Int (109 Herculis)
9.99962 log sin δ
1.35643 log Red
22.72

Assume m = +.86
n = −1.32

Error of 1327 = +73.94

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1877phae.proj.17974

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 8 1878. Instrument, Rus. Tr Observer, WCW

Timepiece, 3451 Recorder,

Object,	Sun prec. limb										
Circle,	W										
	w		e		w		e		w		e	
Level Direct,	19.8		12.1		.		.		.		.	
Reversed,	7.3		14.5		.		.		.		.	
Sums,	27.1		26.6		.		.		.		.	
Difference,	.5											
b.	+.02											
	h	m	s		h	m	s		h	m	s	
Wire, I.	9.4		23.3				.				.	
II.	9.6	5?	46.5				.				.	
III.							.				.	
	6	9.5	50									
IV.	1	8.7	5				.				.	
V.	7	18.2	5				.				.	
Sum,			.				.				.	
Mean,			18.25				.				.	
Bb,	+1.02		+.02				.				.	
Cc,	1.08		−.67				.				.	
Aa,	+.37		+.16				.				.	
Corr'd Transit,	7		17.76				.				.	
R. A.	6		30.51				.				.	
Error of Timepiece,			+47.25				.				.	

1.62855 1.32752
9.96438 9.96438
1.66417 1.36314
46.15 23.07

Assume $a = +.42^{s}$
$c = -.62$

10.331 = Hourly rate
23
20662
30993
60 | 237.613
3.96
34.47
30.51

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 9th 1878. Instrument, Mer Circle. Observer, W.A.R.

Timepiece, 1327 Recorder, Chronograph

Object, Circle,	ε Ursae Maj.		ε Virginis.		η Boötis		α Draconis	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b.	.	.	.	.	.	.	.	.
	h m s	h m s	h m s	h m s	h m s	h m s	h m s	h m s
Wire, I.	12 49 53.5		12 57 27.2		13 50 7.9		14 2 18.5	
II.	57.3		25.3		10.0		23.5	
III.	50 1.2		25.4		12.2		28.6	
IV.	4.8		27.5		14.4		33.0	
V.	8.5		29.6		16.6		38.1	
Sum,	55.3		27.0		61.1		141.7	
Mean,	12 50 1.06		12 57 25.40		13 50 12.22		14 2 28.34	
Bb,	+.86		+.86		+.86		+.86	
Cc,	−2.06		−.28		−.47		−2.91	
Aa,	12 49 59.86		12 57 25.98		13 50 12.61		14 2 26.29	
Corr'd Transit, R. A.	12 48 42.77		12 56 8.84		13 48 55.42		14 1 9.14	
Error of Timepiece,	1 17.09		17.14		1 17.19		1 17.15	

Error of 1327 = 77.14 Sec

n = −1.36 α Draco. & ε Virg.

m assumed +.86

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 11.4 1878. Instrument, Mer. Circle Observer, J.E.M.

Timepiece, 1327 Recorder, Chronograph

Object,	μ Bootis				β Coronae												
Circle,	tan δ +.78				+.57												
	w		e		w		e		w		e		w		e		
Level Direct,	.		.		.		.		.		.		.		.		
Reversed,	.		.		.		.		.		.		.		.		
Sums,	.		.		.		.		.		.		.		.		
Difference,																	
b.																	
	h	m	s		h	m	s		h	m	s		h	m	s		
Wire, I.		21	11.5			24	7.0				.				.		
II.			14.0				9.2				.				.		
III.			16.7				11.5				.				.		
IV.			19.3				14.0				.				.		
V.			22.2				16.5				.				.		
Sum,			.				.				.				.		
Mean,		21	16.74			24	11.64				.				.		
Bb, m			+.86				+.86				.				.		
Cc, m tan δ			−1.06				−.78				.				.		
Aa,			.				.				.				.		
Corr'd Transit,		21	16.54			24	11.72				.				.		
R. A.		19	56.07			22	57.14				.				.		
Error of Timepiece,		1	20.47			1	20.58				.				.		

m assumed +.86

n " −1.36

Adopted error of 1327 $+1^m\ 20^s.52$

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 15. & 18 1878. Instrument, Rev. T. Observer, Lew

Timepiece, 345 Recorder, Lew

Object,	μ Bootis				ι Draco				ν Bootis				[ι Draco]			
Circle,	e				W 17° 1′				W							
	w		e		w		e		w		e		w		e	
Level Direct,	13	1	17	2					13	0	17	9				
Reversed,																
Sums,	13 0		17.9													
	26.1		35.1													
Difference,			26.1													
b. = −0ˢ.30			9.0													
	h	m	s		h	m	s		h	m	s		h	m	s	
Wire, I.			13.6				.				34.0				24.5	
II.			31.0				.				2.3				43.5	
III.			49.5				.				30.6				57.8	
IV.			7.3				.				58.7				11.7	
V.		21	25.2				.		15	28	27.2				25.6	
Sum,			126				.				152		1882		39 6	
			253								306		364			
			24												53.2	
Mean,	15h	20m	49.82				.		15h	27m	30ˢ.56		15	23	11.64	
											−1.21					
Bb, 1.27	1.27		−.32				.		1.33		−0.40		1.87		−1.56	
			+.51													
Cc, 1.27	1.27		+.79				.		1.33		−.82		1.97		−1.22	
Aa, .10	.10		+.04				.		+.03		+.01		−.58		−.18	
Corr'd Transit,		20	49.83				.			27	29.35			23	9.68	
R. A.	15	19	46.06				.		15	26	36.02		15	22	16.61	
Error of Timepiece,			+53ˢ.77				.				+53ˢ.33				+0 53ˢ.07	

53.33
110
+53ˢ.55

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 15.4 1878. Instrument, Rues Tr. Observer, E. M.

Timepiece, 3451 Recorder, E. M.

Object, Circle,	ρ Bootis W		5 Ursae Min W		5 Ursae Min e		π Bootis pr. e	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b. = − 0.s95	.	.	.	.	.	.	.	.
	h m s		h m s		h m s		h m s	
Wire, I.		44.6	IV	.		.		13.9

1878. June 26. Time 25d 22h.5 Corr = − 2m 49.s8
on H.C.O. Time Signals.

Arnold 1678. Vertical and Caird on pocket
rate = losing 9.s3 pr day.
Leonard Waldo.

Error of Timepiece,	+ 56.s11	.	.	+ 56.s29

0.s43 / 24 / 47 / 43 / 141 / 188 / 2021

34.41 − 56 = 33 44

76 15 / 42 23 / 33 52

∴ Corr 3451 = + 56.s20

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 15.4 1878. Instrument, Repsold Tr. Observer, E. M.

Timepiece, 345.1 Recorder, E. M.

Object,	ρ Bootis				5 Ursae Min				5 Ursae Min				π Bootis for.					
Circle,	W				W				e				e					
	w		e		w		e		w		e		w		e			
Level Direct,	.		.		.		.		.		.		.		.			
Reversed,	.		.		.		.		.		.		.		.			
Sums,	.		.		.		.		.		.		.		.			
Difference,																		
b. = −0.s25																		
	h	m	s		h	m	s		h	m	s		h	m	s			
Wire, I.			44.6		IV		.				.				13.9			
II.			9.7				.				.				36.0			
III.			34.3		③		22.0				.				58.0			
IV.			59.1		④		36.5		V		.				20.5			
V.	14	28	23.8		14	30	51.5		14	32	16.0		14	36	42.8			
Sum,			171 5 / 34.30				.				.				171 2 / 34.24			
Mean,	14	27	34.30		~~14~~	~~30~~	~~1~~				.		14	35	58.24			
Bb,	1.14		− .28				.				.		.93		− .23			
Ce,	1.16		− .69				.				.		1.04		+ .62			
Aa,	+ .24		+ .11				.				.		+ .47		+ .20			
Corr'd Transit,	14	27	33.44				.				.		~~14~~	35	58.83			
R. A.	14	26	37.38				.				.		14	34	62.54			
Error of Timepiece,			+ 56.s11				.				.				+ 56.s29			

76 15
42 23
33 52

0.s43
24
47
43
141
188
2021

34.41
47
− 56
33 44

∴ Error 3451 = + 56.s20

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1877phae.proj.1797N

Date

Objec
Circl

Level

Sum
Diff
b.

Wire

Sum
Mea

Bb,
Ce,
Aa,

Corr'
R.

Erro

κ Oph.

16 52 57.76
+.05
+.54
16h 52m 58s.35
+.59
52 58.94

16 54 34.84
51 56.89
6 37.95

ε Uns. min.

16 59 43.06
+36
+2.86
−3.93
−1.07
16h 59m 42s.00
52 58.35
+1+ 6m 43s.65
α−α 6 37.95
− 5s.70

59 42.0
− 5.13
59 36.87

∴ a = $\frac{-5^s.70}{-4.746-.55} = \frac{5.70}{5.30} = +1^s.08$

− 5s.13

+ .59

52 58.94
57 56.89
1m 2s.05

59 36.87
58 34.84
1m 2s.03

16 59 42.35

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 16d.4 1878. Instrument, R.T. Observer, S.W.

Timepiece, 345 Recorder, S.W.

Object,	α pr Bootis						Ellm. mag			W	
Circle,	e						ω				
	w		e		w		e		w		
Level Direct,	13.5		15.2		12.1		16.8		June 19d.4		
Reversed,											
	12.1		16.8								
Sums,	25.3		32 0								
Difference,			25.3								
b. = −0s.22			6.7								
	h	m	s		h	m	s		h	m	s
Wire, I.			29.5						III	48.3	IV
II.			44.5							8.5	
III.			59.3							34 6	
IV.			13.9							1.6	
V.	14	36	24.0							28.0	17h 3
			17 6 2							11 6 0	
Sum,			3524							23.20	
			24							12	
Mean,	14	35	59.24							35.20	17h − 3
Bb,			−.23				A = −4.746				
Cc,			+.62				B = 5.685				
Aa,			+.20				C = 7.406			+3.93	
Corr'd Transit,	14	35	−59.83								16 5
R. A.	14	35	59.73						16	58 34.84	16
		34	62.54								
Error of Timepiece,			+ 57s.89								+1m

Log cn δ = 9.13078

Log III−IV = 1.32752

2.19674 − 157.1

3.93
36
− 3.57

16 59 43.06

Aa+Cc 16h 59m39.s49
+ 2.86
16 59 42.35

0.59
9.13
9.7

c = +0s

Z = +0s.

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1877phae.proj.1797w

Date

Objec

Circl

Level

Sum

Diff

b.

Wire

Sum,

Mea

Bb,

Cc,

Aa,

Corr

R.

Erro

κ Oph.

16 52 57.76

+.05
+.54
16h 52m 58s.35
+.59
52 58.94

16 54 34.84
51 56.89
6 37.95

ε Uns. min.

16 59 43.06
+36
+2.86
−3.93
−1.07
16h 59m 42s.00
52 58.35
+1+ 6m 43s.65
2+2 6 37.95
− 5s.70

59 42.0
− 5.13
59 36.87

∴ a = $\frac{-5^s.70}{-4.746-.55} = \frac{5.70}{5.30} = +1^s.08$

− 5s.13

+ .59

52 58.94
51 56.89
1m 2s.05

59 36.87
58 34.84
1m 2s.03

16 59 42.35

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1877phae.proj.1797N

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 19d.4 1878. Instrument, Trans. Observer, E.W.

Timepiece, 3451 Recorder, E.W.

Object,	η Herculis				49 Herculis				~~ε Herculis~~ κ Ophiuchi		ε Herculis	
Circle,	W				W				E		E	
	w		e		w		e		w		w	
Level Direct,	.		.		15.1		15.1		16.1		.	
Reversed,	.		.		16.1		14.2		14.2		.	
					31.2		29.3					
Sums,	.		.		29.3				.		.	
Difference,					1.9							
b.					+0.06							
	h	m	s		h	m	s		h	m	s	
Wire, I.			53.6				52.9				14.6	51.6
II.			20.8				15.1				36.1	16.6
III.			48.3				37.0				57.6	41.2
IV.			15.6				59.0				19.7	6.1
V.	16	40	43.1		16	48	20.8		16	53	40.8	16 57 31.1
			181.4				184.8				168.8	146.6
Sum,			36.28				36.96				33.76	29.32
Mean,	16	39	48.28		16	49	36.96		16	52	57.76	16 56 41.32
Bb,	1.29		+.08		.92		+.06		+.85 +.15		+.05	1.15 +.07
Cc,	1.29		+.68		1.04		−1.55		+.97 1.02		+.54	1.17 +.62
Aa,	+.08		+.09		+.48		+.52		+.55 +.23		−.37	+.23 +.25
											58.35	
Corr'd Transit,		39	47.78				36.99				58.03	42.26
R. A.	16	38	45.85 46.05		16	47 46	36.47 34.86		16	51	56.89	16 55 40.53
						1m	1s.61					1 1.48
Error of Timepiece,			1m 1.73		+1m		1.75		+1m		2.05	+1m 1.73

$\log 319 = 0.5038$
0.7235
9.7803

$\therefore a = -0.^s603$

$\frac{+3.78}{+3.19} = \frac{3.19}{-5.29} =$
$-4.74 - .55$
-5.29

$+ 61.73$
1.61
2.05
1.73
$+ 61^s.78$

$58^s.35$

$16\ 59\ 39.49$
$51\ 56.89$
$7^m\ 42.60$

$16\ 59\ 39.49$
$16\ 52\ 58.35$
$+ 6^m\ 41.14$
41.14 $41^s.14$

$16\ 58\ 34.84$
$51\ 56.89$
$6\ 37.95$ 37.95
$+3^s.78$ $+3^s.19$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 19.4 1878. Instrument, Rms. Tr Observer, E. W.

Timepiece, 3451 Recorder, E. W.

Object,	κ ophiuchi				Eus. Maj.							
Circle,	e.											
	w		e		w		e		w		e	
Level Direct,	.		.		.		.		.		.	
Reversed,	.		.		.		.		.		.	
Sums,	.		.		.		.		.		.	
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			.			.			.			.
II.			.			.			.			.
III.			.			.			.			.
IV.			.			.			.			.
V.			.			.			.			.
Sum,			.			.			.			.
Mean,	16	52	57 76			.			.			.
Bb,			.			.			.			.
Cc,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
Error of Timepiece,			.			.			.			.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 20.4 1878. Instrument, R.T. Observer, SW

Timepiece, 3451 Recorder, SW

Object,	γ Serpentis		ε Cornae		θ Draco.						
Circle,	W		e 15° 9'		e						
	w	e	w	e	w	e			w	e	
Level Direct,	13.6	14.9			14.7	13.1					
Reversed,					13.6	14.9					
Sums,					28.3	28.0					
Difference,					28.0						
b. = +0.01					0.3						
	h m s		h m s		h m s				h m s		
Wire, I.	26.0					18.6					
II.	40.6					59.7					
III.	55.7		37.1			40.8					
IV.	10.7		1.0			22.2					
V.	25.1		15 57 25.0		16 2	3.5					
Sum,	158.1		3163.1			1448					
	31.62		21.03			28.96					
	74		41.03			12					
			23.91								
Mean,	55.62		37.124		16 1 40.96						
Bb, b = +0.08	.94	+.01	1.09	37.12 +.01	1.85	+.44 +.02					
Ce, c = +0.53 (E)	1.04	−.55	1.13	+.60	1.93	+1.03					
Aa, a = +1.08	+46	+.50	+29	+.32	−58	−.61					
Corr'd Transit,		55.58	17 53	38.05		1 41.40					
R. A.	15 50	52.32		35.45	15 59	39.61					
Error of Timepiece,		63.26		62.60		61.79					

1.93 · 53 = 579, 965, 10229

108 · 46 = 648, 432, 4968

108 · 56 = 648, 540, .6048

9.94904 + 1.32752 − .37848 = 33.91

62.60 + 63.26 − 5.86 = 62.93

Eun 3451. + 62.93

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 23d 4 1878. Instrument, Rum. IV Observer, SW

Timepiece, 3451 Recorder, SW.

Object,	φ Bootis				γ Coronae				ε Serpentis				12 H Draco		
Circle,	e				W				W				W.		
	w		e		w		e		w		e		w		e
Level Direct,	11 : 5		16 : 2		.		.		.		.		10 : 8		17 : 0
Reversed,	10 8		17 0		.		.		.		.				
Sums,	22 3		36 2		.		.		.		.		.		.
			22 3												
Difference,			13 9												
b. = − 0ˢ.45															
	h	m	s		h	m	s		h	m	s		h	m	s
Wire, I.			58.7				32.0	IV 1			40.3				.
II.			17.6	4.4			45.5	IV 5			15.2				.
III.			36.5	4.9			48.3				.				.
IV.			55.8	8.8			56.1								clouds.
V.	15	35	14.0	8.7			4.3	V 1			2.3				.
								V 3			9.2				.
								V 5	40		16.7				.
Sum,			182.6				181.2				.				.
			36.42				36.24				.				.
Mean,	15	34	36.52				48.524				.				.
Bb, b = −0ˢ.45			−.60				−.48				.				.
Cc, = +0ˢ.60 (Σ)			+.80				−.66				.				.
Aa, = +1ˢ.08			+.05				+.34				.				.
Corr'd Transit,		34	36.67				48.60				.				.
R. A.	15	33	29.87		15	37	40.35				.				.
Error of Timepiece,	+ 1ᵐ 6ˢ.80				+ 1ᵐ 8ˢ.25						.				.

N 191 = 3451

9 41 42.0 = 15 57 27.5

B594 3447

9 45 0.0 = 15 54 19.5

11.4
54
.60

66.80
68.25
215.05
+67ˢ.52

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 24.4 1878 Instrument, Rev. Tr. Observer, S.W.

Timepiece, 3451 Recorder, S.W.

Object,	α Virginis				β Serpentis				ε Serpentis			
Circle,	W				W				e			
	w		e		w		e		w		e	
Level Direct,	.		.		10.3		17.0		12.5		15.1	
Reversed,	.		.									
Sums,	.		.		12.5 / 22.8		15.1 / 32.1		.		.	
Difference,							22.8 / 3 | 9.3					
b.							−0.31					
	h	m	s		h	m	s		h	m	s	
Wire, I.			59.0				16.0				26.6	
II.			13.7				31.2				40.6	
III.			27.8				45.6				55.1	Clouds again
IV.			42.1				0.7				9.2	prevent
V.	15	39	56.3		15h	42m	15.1		15h	46m	23.5	observation
Sum,			198.9 / 39.78 / 12				108.6 / 24 / 72				155.0 / 31.00 / 24	
Mean,	15h	39m	27.978		15h	41m	45.872		15h	45m	55.800	
Bb,	81		−19/25		93		−31/30		840		−94/25	
Cc,	1.07		−.53/78		1.04		−.53/83		1.01		+1.19 / +.53	
Aa,	+54		+59		47		+52		60		+66	
Corr'd Transit,		39	27.59			41	45.41			45	54.04	
R. A.	15	38	18.75		15	40	36.61		15	44	47.38	
Error of Timepiece,		1m	8.84			1m	8.80			1m	6.66	

α = +1.51
β = −0.31
ε = +0.53

1 6.66
1 8.84
15.50

3451 394 191 + 1m 7.75

16 0 19.0 = 9 47 0.0

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 25d.4 1878. Instrument, Russ. Tr Observer, E.W.

Timepiece, 3451 Recorder, E.W.

Object,	Gr 2415		½ Draco		½ Draco		x Ursulus	
Circle,	e		e		m° 29' W		W	
	w	e	w	e	w	e	w	e
Level Direct,	13.4	16.1	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	—		III .		V 7.5			39.8
II.	—		.		16 3			12.0
III.	0.2		38.0		25.0			44.0
IV.	28.1		46.5		33 5			16.6
V.	17 5 56.3		17 9 55.5		17 11 42.5		17 25	48.0
	846		1300					
Sum,	28.20		43.33		.			.
Mean,	.		.		.			.
Bb, b = − 0s.14	.		.		.			.
Ce, c = + 0s.501 (E)	.		.		.			.
Aa, a =	.		.		.			.
Corr'd Transit,	.		.		.			.
R. A.	.		.		.			.
Error of Timepiece,	.		.		.			.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer,.....

Timepiece,..... Recorder,.....

Object,	ρ Ophiuchi	ψ Draco	ψ Draco	ψ Draco
Circle,	W	W 29 50	E 33 09	E
Level Direct,	w 14.0 | e 16.9	w . | e .	w . | e .	w 14.8 | e 16.2
Reversed,	14.8 | 16.2	. | .	. | .	
Sums,	28.8 | 33.1	. | .	. | .	. | .
Difference,				
	4.3			
b. = −0.s14				
Wire, I.	h m s III 3 40.5 40.s5	h m s I 39.8	h m s III 2 6.5	h m s V 14.3
II.	IV 1 54.5	51.0	3 18.0	26.5
III.	123 1	2.5	4 45 m 29.5	37.5
IV.	IV 5 61.5 8.6	14.5	.	49.5
V.	V 1 16.1	17 43 26.3	.	17 h 48 m 1.3
	V 2 23.5			
	V 5 39 m 30.0			
Sum,	3 | 12 5 2	134 1	Gr. mean	129 1
		26.82		25 82
				12
Mean,	41.40	17 h + 43 2.82	17 h 45 m 20.s32	17 47 m 57.82
		19.14		19.14
Bb,	.80 17 h 39 m 1.s40	17 45 21.96	2.84 −.40	17 45 18.68
	−.11			
Cc,	1.01 −.50		3.28 17 h 45 19.92	
Aa,	17 39 +0.79		−1.62 −.26	
	+61 +24.33			
	25.42			
	39.46			
Corr'd Transit,	+ 0.40		45 19.66	
	39.56		19.49	
R. A.	17 37 30.71		17 44 10.22	
Error of Timepiece,	+1 m 9.s37 9.s25		+ 1 m 9.s38	
	9.35		+ 9.24	
	9.41			

17 44 10.22
37 30.21
α′−α = 40.01

45 19.92
39 0.79
t′−t = 19.13
21.33
40.46

α′−α − t′−t = −0.s46

a = +0.s20

$\frac{-0.46}{-1.62 \mp 61} = +\frac{46}{223}$

a = +0.s265

9.99860
1.32752
1.32892

21.96
18.68
2|3.28
1.64

0.2148
9.4851
9.6999
+0.s501

9.48509
1.62854
2.14346
13944

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 26d.4 1878 Instrument, R.T. Observer, Lw.

Timepiece, 9451 Recorder,

Object,	♀ Hercules		ω Herculis								
Circle,	E		W								
	w	e	w	e	w	e			w	e	
Level Direct,	13.5	15.8	12.6	17.0	.	.			.	.	
Reversed,	12.6	17.0			.	.			.	.	
Sums,	26.1	32.8	.	.	.	.			.	.	
	.	26.1									
Difference,		6.7									
b. −0s.22											
	h m	s	h m	s	h m	s			h m	s	
Wire, I.		48.3		32.5		.				.	
II.		58.5		47.1		.				.	
III.		8.5		1.6		.				.	
IV.		18.7		16.3		.				.	
V.	16 6	44.0	16 21	31.0		.				.	
Sum,		30 / 660		128.5 / 2570		.				.	
Mean,	16 6	8.60	16 21	1.70		.				.	
Bb, −0.22	1.42	+.31	.91	−.20		.				.	
Cc, +0.501 ①	1.42	+.71	1.04	−+.52		.				.	
Aa, +0s.20	−.07	−.01	+.47	+.09		.				.	
Corr'd Transit,	6	9.61	21	2.11		.				.	
R. A.	16 4	58.53	16 19	50.29		.				.	
Error of Timepiece,	+1m	11s.08	+1	10.78 / 1+8 2		.				.	

10.78
1.86

∴ 8451 = +1m 10s.93

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1877phae.proj.1797N

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 28.4 1878. Instrument, Rus. TN Observer, S. W.

Timepiece, 3451 Recorder, S. W

Object,			ℓ Coronae —				ε Serpentis				β Serpentis				κ Serpentis —	
Circle,			W				e				e				e	
Level Direct,			w		e		w		e		w		e		w	e
Reversed,			10.3		13.3		.		.		.		.		12.2	12.5
Sums,			12.2 / 22.5		12.5 / 25.8		.		.		.		.		.	.
Difference,					12.5 / 3.3											
b.																
			h	m	s		h	m	s		h	m	s		h	m s
Wire,	I.				10.5				.				.			45.1
	II.				37.4				.				26.6			7.7
	III.				4.0				30.8				48.5			30.0
	IV.				31.0				52.3				11.0			52.6
	V.		15	36	57.1		15	40	13.6		15	42	33.1		15	45 15.0
Sum,					140.0 / 28.00				.				29.80 / 59.80 / 119.2 / 23.84			150.4 / 30.08
Mean,			15	36	4.00				.		15	41	48.70		15	45 30.08
Bb,	− 0.11		1.25		−.14				.		.93		−.10		.97	−.11
Ce,	+ 0.50		1.26		−.62				.		1.04		+.52		1.06	+.50
Aa,	+ 0.20		+12		+.02				.		.47		+.09		+.43	+.08
Corr'd Transit,			15	36	3.36				.			41	49.21		15 (45)	36.53
R. A.			15	34	50.10				.		15	40	26.60		15	43 18.06
Error of Timepiece,				+1m	13.16				.			+1m	12.61			2m 12.47

3451 191 3451 394

15 56 37.0 = 9 26 56 . 15 54 26.0 = 9 25. 20.0

1 13.16
12.61
25.77

+ 1m 12.89

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, June 30 1878. Instrument, RT Observer, Lw

Timepiece, 345 Recorder,

Object,	η Serpentis				109 Herculis				β Draco			
Circle,	e				e				W			
	w		e		w		e		w		e	
Level Direct,	14 : 7		10 : 7		:		:		13 : 8		11 : 0	
Reversed,												
Sums,									14.2	10 2		
									28.0	21.2		
Difference,									21.2			
b. = + 0s.23									6.8			
	h	m	s		h	m	s		h	m	s	
Wire, I.			3.5				1.7				32.5	
II.			11.3				25.0				0.7	
III.			18.1				47.5				28.0	
IV.			25.0				10 3				54.6	
V.	18	16	32.0		18	20	53.6		18	24	22.3	
Sum,							118.1				138.1	
							23.62				27.62	
Mean,					18	19	47.62		18	23	27.62	
Bb,							+ .23				+ .43	
Ce, +.50							+ .55		29.05 1.08		− .97	
Aa, + .20							+ .08				+ .11	
Corr'd Transit,						19	48.48			23	26.97	
R. A.					18	18	33 .28		18	22	10.73	
Error of Timepieee,						1m	15s.20			1m	16.24	

1 15.20
16.24
11.44
+4 15.72

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1877phae.proj.17974

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 1, 40 1878. Instrument, Russian Transit Observer, Frank Waldo

Timepiece, Chron 3451 Recorder, F W.

Object, Circle,	δ Ophiuchi E.	γ Herculis W	η Draconis sup. W	H Draconis E
	w | e	w | e	w | e	w | e
Level Direct,	12.5 | 11.1	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
	13 5 | 11.0			
Sums,	25.0 | .	. | .	. | .	. | .
Difference,	22.1			
b.	3 | 2.9			
	+ .08 -3°22'	19°26'	61°47'	69°2'
	h m s	h m s	h m s	h m s
Wire, I.	34.8	17 7.5	22 11.5	.
II.	9 56.1	30.0	56.7	.
III.	17.5	52.5	23 41.3	30.5
IV.	38.8	18 15.0	26.5	30 30.3
V.	10 00.1	18 37.5	25 11.1	31 29.5
Sum,	14 7.3	142.5	147.1	.
	5 87.3	5 262.5	5 291.1	.
Mean,	9 17.46	17 52.5	41.42	29 30.5
Bb,	~~+~~ .71 +.07	.99 .08	1.94 .	2.49 .
Cc,	~~.70~~ 1.00 .	1.06 .	2.04 .	2.79 .
Aa,	~~1.00~~ .70 ~~+.35~~	.41 ~~+.35~~	-1.10 .	-1.25 .
Corr'd Transit,	9 17.88	17 52.78	.	.
R. A.	.	.	.	.
	16 8 00.60	16 16 35.50	16 22 23.95	16 28 17.10
Error of Timepiece,	+ 1 17.28	1 17.28	.	.

16 22 23.95
16 8 00.60
14 23.35

23 41.58
9 17.53
14 24.05 wrong
23.35
-1.10 - .70 +.50 = a.
702
a = +.50

1 17.28 17.28
17.28 17.28
14.68 14.68
14.98 14.68
4.22.68 24.32
+ 1 5.67 16.08

Error 3451.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 1.40 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object, ~~3 Hercules~~	3 Hercules	χ Ophiuchi					
Circle, ~~E.~~	E	E					
	w	e	w	e	w	e	w	e
Level Direct,	13.5	11.00	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.	31° 49		9°34'					
	h m s		h m s		h m s		h m s	
Wire, I.	9.4		29.5		.		.	
II.	34.5		58 50.6		.		.	
III.	59.5		5 3 12.6		.		.	
IV.	38 24.5		33.8		.		.	
V.	38 49.5		53 55.6		.		.	
Sum,	177.4		182.1		.		.	
	~~59.4~~		~~60.7~~					
	59.5							
Mean,	37 59.5		12:42		.		.	
Bb,	1.16	+.09	.86	+.07	.		.	
Cc,	1.18	.	1.07	.	.		.	
Aa,	22	−:23	.54	−.57	.		.	
Corr'd Transit,	59.36		53 11.92		.		.	
R. A.	.		.		.		.	
	16 36 44.48		16 51 56.94					
Error of Timepiece,	+ 1 14.88		+ 1 14.98		.		.	

16 51 56.94 — 36 44.48 = 15 12.46

53 12.49 — 37 59.59 = 15 12.90 − 12.46 = 0.44 (36) 80 → −.44

16 51 56.94 − 28 17.10 = 23 39.84

53 12.49 − 29 30.70 = 23 41.79 − 39.84 = 1.95

1.80 | 1.95 | 1.08 @ 1.95

1.80

150

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer,.....

Timepiece,..... Recorder,.....

Object,												
Circle,												
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			.			.			.			.
II.			.			.			.			.
III.			.			.			.			.
IV.			.			.			.			.
V.			.			.			.			.
Sum,			.			.			.			.
Mean,			.			.			.			.
Bb,			.			.			.			.
Cc,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
Error of Timepiece,			.			.			.			.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer, ...

Timepiece,..... Recorder,.....

Object,															
Circle,															
	w		e		w		e		w		e		w		e
Level Direct,	.		.		.		.		.		.		.		.
Reversed,	.		.		.		.		.		.		.		.
Sums,	.		.		.		.		.		.		.		.
Difference,															
b.															
	h	m	s		h	m	s		h	m	s		h	m	s
Wire; I.			.				.				.				.
II.			.				.				.				.
III.			.				.				.				.
IV.			.				.				.				.
V.			.				.				.				.
Sum,			.				.				.				.
Mean,			.				.				.				.
Bb ,			.				.				.				.
Ce,			.				.				.				.
Aa,			.				.				.				.
Corr'd Transit,			.				.				.				.
R. A.			.				.				.				.
Error of Timepiece,			.				.				.				.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 6.+ 1878. Instrument, E. Transit Observer, H. M.

Timepiece, Chron 3451 Recorder, Chronograph.

Object,	γ Herculis Ophiuchi	ε. Herculis	ε Urs (min	ε Urs. min
Circle,	I. M.	I. M.		
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b. = + .23	~~+7°31'~~ +9° 34'	31° 6'	82° 14'	
	h m s	h m s	h m s	h m s
Wire, I.	53 14.2	56 57.1	III 59 ~~23~~ 23.8	V 8 16.6
II.	16.3	59.3	37.6	33.8
III.	18.2	1.7	53.3	49.0
IV.	20.4	3.8	6.2	02.9
V.	22.4	6.1	23.0	17.9
Sum,	91.5	128.0	143.9	120.4
		120.	120	120.
		8 0	263:9	240.4
Mean,	18.3	1.6	52.78	48.08
Bb,	.85 +.21	1.14 +.28	5.685 +1.30	
Ce,	1.02 −1.12	1.16 −1.28	7.406	
Aa,	.55	.23 +.07	−4.746	
Corr'd Transit,	.	00 67	.	.
R. A.	.	.	.	.
	16 51 56.92	16 55 40.51	16 58 37.80	
Error of Timepiece,	.	+ 1 20.16	.	.

53 18.3
51 59.92
1 18.38

59 1.6
55 40.51
1 21.09

54 52.78
58 37.80
1 14.98

5.685
.23
17055
11370
1.307 55

(0 = 1 18.17 + .55 a + 1.02 c)

0 = 1 21.37 + .23 a + 1.16 c + Δt

0 = 1 21.77 + .49 a + 1.04 c + "

mean 0 = 1 21.57 + .36 a + 1.10 c + Δt

0 = 1 18.28 − 4.746 a + 7.406 c + Δt

dif = 0 = 5.29 + 5.106 a − 6.306 c

m: 23, 31, 23, 69, .071

102, 102, 1.12, 116, 116, 1.27

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer,.....

Timepiece,..... Recorder,.....

Object,	α Herculis	α Ophiuchi	i Herculis	ψ Draconis
Circle,	I. M.	I. E.		
Level Direct, Reversed,	w e	w e	w e	w e
Sums, Difference, b.	14° 32′	12° 39′	46° 4′	72° 41′

	h m s	h m s	h m s	h m s
Wire, I.	10 25.9	30 36.9	37 19.0	I 4 4 58.7
II.	27.9	38.8	21.9	4.7
III.	30.0	40.8	24.8	12.6
IV.	32.0	42.8	29.9	18.5
V.	34.0	44.7	30.8	24.6
Sum,	149.8	204.0	124.4	119.1 (60) 59.1
Mean,	29.98	40.80	24.88	11.82
Bb,	.91 +.23	.89 +.22	.44 +.36	2.90 +.73
Cc,	1.04 −1.14	1.03 +1.13	1.44 +1.58	3.36 .
Aa,	.49 +.15	.51 +.16	−.09 −.23	−1.69 .
Corr'd Transit,	29.22	41 31	26.79	.
R. A.	17 9 8.44	17 29 19.68	17 36 4.74	17 44 10.04
Error of Timepiece,	1 20.78	1 21.63	22.05	.

31 21 21 62 .06 — 123 123 135

+10 104 104 114 — 49 31 49 147 1519

10 29.98 / 9 8.44 / 1 21.54

30 40.8 / 29 19.68 / 1 21.12

37 24.88 / 36 4.74 / 1 20.14

44 11.82 / 45 28.92 / 46 45.88 / 86.62 / 45 28.87 / 44 10.04 / 1 27.83

1 20.92 / +.06 / 1.33 / 1 22.31

$0 = 1\ 21.34 + .51a + 1.03c + \Delta t$

$0 = 1\ 20.50 \pm .09a + 1.44c + \text{''}$

Mean. $0 = 1\ 20.92 + .21a + 1.23c$ e

$0 = 1\ 27.83 - 1.69a + 3.36c$

$0 = -6.91 + 1.90a - 2.13c$

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1877phae.proj.:1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 6.4 1878. Instrument, E. Transit Observer, F. M.

Timepiece, 3451 Recorder, Chase.

Object,	γ Draconis		γ Draconis					
Circle,			I E.					
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	III 45 17.0		V 46 33.0					
II.	21.9		39.3					
III.	28.7		45.6					
IV.	35.0		52.9					
V.	42.0		58.6					
Sum,	144.6		229.4		1327.		345-1.	
Mean,	28:92		45:88		17 51 00		17 5-2 41.5	
Bb,	.		.		.		1 20.44	
Cc,	.		.		.		51 21.06	
Aa,	.		.		.		51 00.	
							Error 24.06	
Corr'd Transit,	.		.		.		.	
R. A.	.		.		.		.	
Error of Timepiece,	.		.		.		.	

1.44
1.1
144
144
1.584

.279
103
103
1.133

31
57
35
155
1585

$0 = 5.29 + 5.10\,a - 6.306\,c$ m.

$0 = -6.91 + 1.90\,a + 2.13\,c$ E. ch.

$0 = 1.04 + a - 1.23\,c$

$0 = 3.63 + a + 1.12\,c$

$0 = -2.59 - 2.35\,c$

$c = -1.10$ c.m.

$0 = 1.04 + a - 1.35$

$0 = a - .31$

$a = +.31$

123
1.1
123
123
1.353

5-10 | 5.29 | 1.04
5-10
1900

5.10 | 6.306 | 1.23
5-10
1206

2.35 | 2.59 | 1.10
235
240
235
1020
1560

190 | 6.91 | 3.63
570

199 | 2.13 | 1.12
190
230
190
40
1210
1140
700

Error 345-1
+1 20.44

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer, ...

Timepiece,..... Recorder,.....

Object,								
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	.		.		.		.	
II.	.		.		.		.	
III.	.		.		.		.	
IV.	.		.		.		.	
V.	.		.		.		.	
Sum,	.		.		.		.	
Mean,	.		.		.		.	
Bb ,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	.		.		.		.	
Error of Timepiece,	.		.		.		.	

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1877phae.proj.:1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 8.4 1878. Instrument, Meridian Circle Observer, W. A. R.

Timepiece, 1327 Recorder, Chron. A. M. Comp.

Object,	γ² Urs. Min.		β Herculis ε Coronae		ζ Herculis			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.	72°15′		27°14′ (27°45′)		14°32′			
	h m s		h m s		h m s		h m s	
Wire, I.	32.4		13.5		46.5	58.8		.
	36.0							
II.	38 3		15.8		49.8	0.5		.
	42 7							
III.	20 46.0		52 18.0		51.0	2.8		.
IV.	49.3		20.5		53.2	4.9		.
	52.9							
V.	56 3		22.8		8 55.2	7.0		.
	59.5							
Sum,	9[411.4		90.6		4.9			.
Mean,	45.28		18.12		50.98		122 / 52 / 244	.
Bb,	3.12		+.52				610 / −.6344	.
Cc,							1.13 / +.50	.
Aa,							16.77	.
Corr'd Transit,							26 / 122 / 52 / 24	.
R. A.	15 20 59.30		15 52 35.39		17 9 8.45		.3172 / 1.13	.
Error of Timepiece,							+.81 / −17.47 / 16.66	.

P

$0 = -14.02 + 3.12 x + (\Delta t + n)$.

$0 = -17.37 + .39 x + $ "

$0 = +3.35 + 2.73 x$

$x = -1.22$

$0 = -17.27 + .52 x + \Delta t + n$

$0 = -17.47 + .26 x + \Delta t + n$

$0 = -17.37 + .39 x + \Delta t + n$

273 | 335 | −1.22 (x)

220 / 556 / 640

Sec φ = 1.35

tan φ = .91

122 / 182 / 162 / 91 / 1.1102

$0 = -17.37 + (-.49) + \Delta t + .02 + 1.11$

$0 = -17.8737 + .64 + \Delta t$

$\Delta t = +16.73$

Error 1327 = −16.73

−16.54 rate +2.10

m. a. R.

1327 3451

18 50 28 18 52 7.5

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 9.4 1878. Instrument, Meridian Circle Observer, W.A.P.

Timepiece, 1327 Recorder, Chron. 4 W. comp.

Object, Circle,	β Herculis		ε Urs. Min.		α Herculis		α Ophiuchi.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.	~~7.29~~ 7.40 21° 45′		7.29 82° 14′		+.26 14° 32′		.22 12° 39′	
	h m s		h m s		h m s		h m s	
Wire, I.		42.1		1.5 9.7		49.0		0.1
II.		44.2		16.9		51.0		2.2
III.	24	46.4		24 0 32.4		53.1		4.3
IV.		48.7		39.1		55.2		6.5
V.		50.9		47.5 54.8		57.4		8.7
			58	2.3				
Sum,		232.3		228.2 60 288.2		265.7		21.8
Mean,		46.46		~~32.24~~ 32.24		53.14		4.36
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	16 25 1.71		16 58 36.14		17 9 8.45		17 29 19.70	
Error of Timepiece,		.		.		.		.

$0 = -3.90 + 7.29n + \Delta t + m$

-14.35

-14.18

-14.15

Loss of 1327 -14.23

$0 = -15.25 + .40n + \Delta t + m$

$0 = -15.31 + .26n + ''$

$0 = -15.34 + .22n + ''$

$0 = -15.30 + .29n + ''$

$0 = -3.90 + 7.27n + ''$

$0 = -11.40 - 6.98n$

$n = -1.63$

6.98 | 11.40 | 1.63

698

4420

4188

2320

Error of Clock − Watch

1.35 .05 .07

.63 .91 163

1467

1.48

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 10.4 1878. Instrument, Meridian Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chronog. H. M. Comp

	~~δ Bootis~~ ε Serpentis	γ Ursæ Min.	α Coronæ	ε Serpentis
Object,				
Circle,	.09	3.12	.57	.12
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b.				
	h m s	h m s	h m s	h m s
Wire, I.	44 29.7	14 57 20 36.8 17.5 40.0 20.6 43.5 24.1 47.0 27.4 -50.3 30.9 53.9 34.6 57.4 38.0 0.8 41.2 4.0	16.8	1.
II.	31.7		19.0	3.
III.	33.8		21.3	5.2
IV.	35.9		23.7	7.2
V.	38.0		29 26.1	9.2
Sum,	49.1	3303.7 120 4537	106.9	25.6
Mean,	33.82	20 50.41	21.38	5.12
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	15 44 47.34	15 50 59.18	15 29 34.34	15 38 18.69
Error of Timepiece,	.	.	.	.

P.

$0 = -8.77 + 3.12n + \Delta t + n.$

$0 = -13.52 + .09n + ''$

$0 = -12.96 + .57n + ''$

$0 = -13.57 + .12n + ''$

1.05 72

$0 = -13.35 + .24n + ''$

$0 = -8.77 + 3.12n + ''$

$0 = -4.58 - 2.88n$

$n = -1.60$

288 | 4.58 | 1.60

288

1700

1728

1.35
.10
+.13

1.6
.91
16
144
1456
135

$n = +1.59$

16
1.6 1.6 .12
.09 .57 192
-.144 16 140
80
-.82
.77

12.08
12.19
12.17
44
-12.15

Error of 1327

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 13.4 1878. Instrument, Meridian Circle. Observer, MAR.

Timepiece, 1327 Recorder, Chas. H. Cowles.

Object,	γ² Urs. Min.		ζ Coronae		ζ Serpentis		ε Serpentis	
Circle,	3.12		.51		.12		.09	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								

	h m s	h m s	h m s	h m s
Wire, I.	42.4 45.9	23.0	7.5 19.0	36.0
II.	49.2 52.7	25.5	9.5 21.0	38.1
III.	56.4 00 3.3 6 5	27.8	11.5 23.1	40.2
IV.		30.1	13.5 25.2	42.1
V.	21 10.0	29 32.4	15.8 27.2	44.3
Sum,	266.4 240 9|506.4	5|138.8 .	5|57.8 11.54 .	0.7 .
Mean,	56.27	27.76	.	40.14
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	15 20 59.00	15 29 34.31	15 38 18.67	15 44 47.341
Error of Timepiece,	.	.	.	.

P $0 = -2.73 + 3.12u + \Delta t + m$

$0 = -6.95 + .24u + \ldots$

$0 = 4.22 + 2.88u$

$u = -1.46$

584 292 .3504

+1.46

+1.11

$0 = -6.55 + .51u + \Delta t + m$

$0 = -7.13 + .12u + \Delta t + m$

$0 = -7.17 + .09u + \Delta t + m$

3\|20.85 3\|17.2 4

$0 = -6.95 + .24u + \Delta t + m$

$0 = -6.95 - .35 + 1.46 + \Delta t$

$0 = -5.84 + \Delta t$

$\Delta t = 5.84$

.10 .91 1.35 1.46 +.13 1.314 +1.33 1.33 +1.46

12.15 5.84 3\|6.31 +2.10 rate.

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1877phae.proj.1797b

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, 15.4 1878. Instrument, ... Observer, ...

Timepiece, 1327 Recorder, ...

Object,	½ Ursæ min.				ε Coronæ				ε serpentis				E serpentis			
Circle,	3.12				.51				.12				09			
	w		e		w		e		w		e		w		e	
Level Direct,	.		.		.		.		.		.		.		.	
Reversed,	.		.		.		.		.		.		.		.	
Sums,	.		.		.		.		.		.		.		.	
Difference,																
b.																
	h	m	s		h	m	s		h	m	s		h	m	s	
Wire, I.			47.9				27.5				12.0				40.4	
			50.9													
II.			54.6				29.7				14.0				42.5	
			57.8													
III.			1.1				32.0				16.0				44.7	
			4.3													
IV.			7.5				34.6				18.1				46.8	
			11.1													
V.		21	14.5			29	36.8			38	20.2				48.8	
Sum,			249.7				160.6				80.3				23.2	
			249.7													
Mean,											16.06				44.8	
		21	1.08			29	32.12									
Bb,			.				.				.				.	
Cc,			.				.				.				.	
Aa,			.				.				.				.	
Corr'd Transit,			.				.				.				.	
R. A.	15	20	58.87			29	34.30				18.66				47.30	
Error of Timepiece,			.				.				.				.	

P $0 = +2.21 + 3.12n + \Delta t + m$

$0 = -2.43 + .24n + \Delta t + m$

$0 = +4.64 + 2.88n$

$n = -1.61$

288 | 464 | 1.61
288
1760
1728
320

131.94
33.25
+1.31

$0 = -2.18 + .51n + \Delta t + m$

$0 = -2.60 + .12n + \Delta t + m$

$0 = -2.50 + .09n + \Delta t + m$

1.28 31.72

$0 = +2.43 + .24n + \Delta t + m$

$0 = -2.43 - .39 + .13 + 1.46 + \Delta t$

$0 = -1.23 + \Delta t$

$\Delta t = 1.23$

47 18
45 41.23
1 31.77

17 47 .13 ch.
17 45 40 el.

1.61
24
644
322
.3864

1.61
91
161
1449
1.6051
13
1.59
51
1.20

5.84
1.23
24.61
2.30

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 16. 4 1878. Instrument, Mer. Circle Observer, W.A.K.

Timepiece, 1327 Recorder, Chas. H. M. Cowles.

Object,	ζ Serpentis		ε Serpentis		3 Ursæ Minoris		ε Coronæ.	
Circle,	.12		.09		4.76		.52	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		13.7	0	42.4		15.3		30.5
II.		15.9		44.6		20.0 26.0		32.8
III.		18.0		46.6		30.8 35.8		35.2
IV.		20.0		48.7		40.6 45.8		37.6
V.	38	22.1	1'	50.7		55.5 55.7	52	39.7
Sum,		89.7		233.0		321.5		25.8
Mean,		17.94		46.60		35.72		35.16
Bb,		.		.	87 97 104	10 7 3 .		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	15 38	18.65	15 44	47.30	15 48	30.04	15 52	35.31
Error of Timepiece,		.		.		.		.

$0 = -.71 + .12n + \Delta t + m$

$0 = -.70 + .09n + \Delta t + m$

$0 = -.15 + .52n + \Delta t + m$

$0 = -1.56 + .73$

mean $0 = -.52 + .24n + \Delta t + m$

P. $0 = +5.67 + 4.76n + \Delta t + m$.

$0 = +5.67 + 4.76n + \Delta t + m$

$0 = -6.19 - 4.52n$

$n = -1.37$

4.52 | 6.19 | 1.37

452

1670

1356

3140

$0 = -.52 - .33 + .13 + 1.24$

$+ .52$ Error 1327

1.27 .24 548 274 3288

1.37 91 137 1238 1.24

1.23 .52 24 | 1.75 | .073 168 070

52 20 .75

56 | 37.50 4.25 561 | 33.25

18 56 55 | 37.5 5 | 34.51 1327

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 17.45 1878. Instrument, Mer. Circle Observer, J. H. M.

Timepiece, 1327 Recorder, Chas. H. W. Coups.

Objeet,	72 Ophiuchi			η Serpentis.								
Circle,	+.16			−.05								
	w		e	w		e	w		e	w		e
Level Direct,												
Reversed,												
Sums,												
Difference,												
b.	+9°32′			−2°55′								
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			34.8			0.8						
II.			37.0			3.0						
III.			39.1			5.0						
IV.			41.1			7.1						
V.			43.3			9.2						
Sum,			195.3			25.1						
Mean,			39.06			5.02						
Bb,												
Cc,												
Aa,												
Corr'd Transit,												
R. A.	18	1	37.47	18	15	3.56						
Error of Timepiece,												

Assume $\pi = -1.49$.

1.4 × 16 = 84, 14 → −.224

1.4 × .05 = +.070

$0 = +1.63 - .22 + .13 + 1.27 + \Delta t$

$0 = +2.81 + \Delta t$

$\Delta t = -2.81$

1.40 × 16 = 91, 14 → 126 → 1.27

1.40 × .5 = .070

$0 = +1.44 + .07 + .13 + 1.27 + \Delta t$

$0 = +2.91 + \Delta t$

$\Delta t = -2.91$

mean = 2.86

26.5) 2.38 (.09 (.52)

23.85 (20)

+2.16

rate 1327

.087 (24) 348 (174) 2.088 (18) 1.90

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 19. 46 1878. Instrument, Mer. Circle Observer, J.A.M.

Timepiece, 1327 Recorder, Oliver A. M. Comp.

Object,	α Lyrae		26 Groombridge		ε Lyrae pri.		β Lyrae.	
Circle,	+.80		+2.18		+.82		+.65	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		53.1		33.8		22.6		39.4
II.		55.8		43.5		25.3		42.0
III.		58.5		53.3		28.0		44.5
IV.		1.1		2.6		30.7		46.9
V.		3.7		11.8		33.4		49.5
Sum,		172.2 120 292.2		145.0 120 265.		140.0 .		222.3 .
Mean,		58.44		53.0		28.00		44.46
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.		.		.		.		.
	18 32 51.71		18 35 52.98		18 40 21.02		18 45 37.77	
Error of Timepiece,		.		.		.		.

P. $0 = +.02 + 2.18\,m + \Delta t + m$.

$0 = +6.80 + .76\,m + \ldots$

$0 = -6.78$

$0 = +6.73 + .80\,m + \Delta t + m$

$0 = +6.98 + .82\,m + \Delta t + m$

$0 = +6.69 + .65\,m + \Delta t + m$

2.40 227

mean $0 = +6.80 + .76\,m + \Delta t + m$

Assume $m = +1.0$

91 .76
14 1.4
364 302
91 76
1.274 − 1.06
13 1.40
+1.40 + 34
6.80
Grof 1327 = 7.14
2.86
2 | 14.28
2.14
rate. + 2.12

m 2.12 1.088
192
200
192

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 20 & 21 1875. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	δ Bootis	γ Urs. Minoris	δ Bootis pr.	κ Coronae.
Circle,	.67	3.12	.87	.51
Level Direct,	w | e	w | e	w | e	w | e
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b.				
	h m s	h m s	h m s	h m s
Wire, I.	41.3	57.4	39.0	38.0
		0:6		
II.	43.8	4.1	42.0	40.1
III.	46.4	7.1	44.6	42.6
		10:2		
IV.	48.8	14.2	47.2	44.8
		17.5		
V.	10 51.4	21.0	26 58.0	29 47.1
		21 25 0		
	31.7	157.1	22[illegible].8	212.6
Sum,	.	60	.	.
		97.1		
Mean,	46.34	10:79	44.56	42.52
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	15 10 37.85	15 20 58.85	15 26 35.56	15 29 34.22
Error of Timepiece,	.	.	.	.

P.O = + 11.94 + 3.12n + Δt + m

0 = 8.60 + .68n + ''

0 = + 3.34 + 2.44n + Δt + m

244 | 334 | 1.37 n = - 1.37

244
900
732
1680

0 = + 8.49 + .67n + Δt + 2m

0 = + 9.00 + .87n + '' + ''

0 = + 8.30 + .51n + '' + ''

25.79 + 2.05

Mean 0 = 8.60 + .68 + '' + ''

0 = 8.60 − .93 + .13 + 1.25 + Δt

0 = 9.05 + Δt

Δt = − 9.05

+9.05 = Sum of 1327 .91

364
182
+2.1814 rate,

1.37 137
.68 .91
137
109 6 1233
822 1.25
931 6 13
1.38
93
.45

9.05
7.14
20.8 | 1.91 | .091
1872
0380

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 21.4 1878. Instrument, E Transit Observer, H W.

Timepiece, 34 51 Recorder, Chas.

Object, Circle, Ill.	η Serpentis 21° 02' −2° 55' E 2		109 Herculis 21° 42 E		γ Draconis (25) 72°40' E 1		α Lyrae 38° 40' E 3	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	23.0 29.2 35.2 42.0 48.9	.	.
Difference,						1.4 8.6 15.1		
b. = + .54								
	h m s		h m s		h m	21 s 4 28.7 41.1 48.5	h m	s
Wire, I.		39.3		8.3		55.0 1.9 8.6		25.4
II.		41.3		10.3		21.1 27 8 34.4 41.6 48.0		27.8
III.		43.0		12.5		0.7 7.6 14.0		30.4
IV.		45.1		14.7		20.9 27.1		33.0
V.		47.0		16.9		651.8 720 1371.8 4 54872		35.6
Sum,		15.7		12.7				2.2
Mean,		43.14		12.54				30.44
Bb,	70	+.37	1.01	.54	2.90	+1.56	1.28	.69
Cc,	1.00	.	1.08	.	336	.	1.28	.
Aa,	.71	.	.38	.	1.69	.	9	.
Corr'd Transit,		.		.		.		.
R. A.	18 15 3.56		18 18 33.35		18 23 18.29		18 32 51.70	
Error of Timepiece,		.		.		.		.

19 11 29.5 3451 } 1327 / 30 } 394

19 30 35

19 34 28 3451

19 33 00 1327

2.90 .54 116 145 1.566 128 57 512 640 6912 123 54 492 675 564

0 = +1 39.98 + 1.00 c + .71 a + Δt 2

0 = +1 39.73 + 1.08 c + .38 a + Δt

0 = +1 39.43 + 1.28 c + .09 a + Δt. 3

2.11 38 118

Mean. 0 = +1 39.70 + 1.130 + .39 a + Δt.

Polar 0 = +1 37.14 + 3.36 c − 1.69 a + Δt 1

0 = − 7.44 / 2.56 + 2.23 c − 2.08 a + Δt Ill. E

0 = +1 39.70 + .79 − 1.18 a + Δt

Δt = −1 41.49

Δt = −1 40.30

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 21.4 1878 Instrument, E. Transit Observer, H. W.

Timepiece, 3451 Recorder, Chase.

Object, Circle, Ill.	ξ aquilae		ι Lyrae		T Draconis (25)		β Cygni.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	59.5	.	.
Difference,						6.2		
b.						13.0		
						20.0		
						26.3		
						39.5		
						46.7		
						53.5		
	h m s		h m s		h m s		h m s	
Wire, I.		27.3		42.4		7.0		33.0
						20.4		
II.		29.4		45.0		27.4		35.3
						34.3		
III.		31.3		47.6		41.3		37 37.7
						48.0		
IV.		33.4		50.1		1.6		40.0
						8.5		
						14.9		
						21.9		
V.		35.4		52.6		28.0		42.4
						42.0		
						49.3		
Sum,		6.8		237.7		55.5		188.4
						3.0		
						9.9		
Mean,		31.36		47.54		678.4		37.68
						180		
						858.4		
						4		
						34.336		
Bb,	.90	.48	1.23	.66	2.97	1.60	1.10	+.59
Cc,	1.03		1.24		3.45		1.13	
Aa,	.50		.14		−1.76		.28	
Corr'd Transit,								
R. A.	18 59 51.66		19 3 00.21		19 17 56.50		19 25 51.49	
Error of Timepiece,								

$0 = +1\ 40.18 + 1.03\ \sigma + .50\ a + \Delta t$

$0 = +1\ 37.99 + 1.14\ \sigma + .14\ a + \Delta t$

$0 = +1\ 38.78 + 1.13\ \sigma + .28\ a + \Delta t$

116.95 3.40 .92

Mean $0 = +1\ 38.98 + 1.39\ \sigma + .31\ a + \Delta t.$

Polar $0 =$

$139.43 + 3.45\ \sigma + 1.76\ a + \Delta t$ Ill.

$0 = +0.45 + 2.06\ \sigma - 2.07\ a.$

$0 = +138.98 - .98 - .15 + \Delta t$

$0 = +137.75 + \Delta t$

$\Delta t = -137.75$

$0 = -2.56 + 2.23\ \sigma - 2.08\ a$ (1)

$0 = +.45 - 2.06\ \sigma - 2.07\ a$ (2) changes.

$0 = -1.14 + \sigma - .93\ a$

$0 = +.21 - \sigma - 1.00\ a$

$0 = -.93 - 1.93\ a$

$a = -.48$

$0 = -1.14 + .44 + \sigma.$

$0 = -.70 + \sigma$

$\sigma = +.70$ Ill. E.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 22. 4 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. H. W. Comp.

Object,	ε Serpentis		ξ Urs. Minoris		φ Herculis		β Herculis	
Circle,	.09		4.74		1.00		.40 +1.06 2.045	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		55.7		29 1 34.0 39 0 43.8 49 0- 54.0		6.5		10.3
II.		57.6				9.5		12.6
III.		59.8				12.3		14.9
IV.		1.8		59 4 4.3		15.2		17.0
V.		4.0		9.1		18.2		19.2
Sum,		178.9 120 298.9		321.7 120 441.7		61.7		.
Mean,		59.78		49.08		12.34		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		25 1.60 +6 7.02
R. A.	15 44 47.24		15 48 29.45		16 4 58.15		16	
Error of Timepiece,		.		.		.		.

4.20 | 6.27 | 1.49
4.20
20.70
16.80
3900
mean

4.74 | 6.32 | 1.49 P
4.74
2080
1696
3840

0 = + 12.54 + .09 n + Δt + m (13.30, .40)
0 = + 14.19 + 1.00 n + Δt + m
39.73 1.49
mean 0 = + 13.36 + .54 n + Δt + m
0 = + 19.63 + 4.74 n + Δt + m
0 = − 6.27 − 4.20 n + Δt + m
n = − 1.49

.91
1 49
1341
1.355-9
+ 1.36
.13
1.49
−84
463

54
1.5
270
54 270
.567 56
.56 .81
.14

12.54 .13 .14 −.01 1.35 13.89
14.19 .13 1.36 1.49 1.49
mean 0 = +13.31 + .50 n + Δt + m
0 = 19.63 + 4.74 n + "
0 = − 6.32 − 4.24 n
n = −1.49
0 = +13.31 − .75 + .13 + 1.36 + Δt
0 = + 14.05 + Δt
Δt = − 14.05.

13.36
.68
Δt = − 14.04
Error of 1327 = +14.04

9.05
2 | 5.00
2.50

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 23.4 1878. Instrument, E. Transit Observer, H. M.

Timepiece, 9457 Recorder, Chron.

Object,
Circle,

Level Direct,
Reversed,

Sums,
Difference,
b. = +.50

Wire, I.
II.
III.
IV.
V.

Sum,
Mean,

Bb,
Cc,
Aa,

Corr'd Transit,
R. A.

Error of Timepiece,

Blank No. 1.

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A. R. BREWER, Sec'y. WILLIAM ORTON, Pres't.

Dated Fort Worth Sep 19 1878

Received at Camb

To Frank Waldo

READ THE NOTICE AT THE TOP.

Mail clock error
for July twelfth
to me all safely
arrived

Leonard Waldo

11 & H, Eclipse
Via Dallas

-1.21 + 1.27
C = -.9 / +.6 = -1.50. Q.

H. M.

a = -.49 + 1.21 (-1.50)
a = -2.30

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1877phae.proj.1797u

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 23.4 1878. Instrument, E. Transit Observer, H. M.

Timepiece, 9457 Recorder, Chas.

Object,
Circle,
Level Direct,
Reversed,
Sums,
Difference,
b. . = + .
Wire, I.
II.
III.
IV.
V.
Sum,
Mean,
Bb,
Ce,
Aa,
Corr'd Transit,
R. A.
Error of Timepiece

E. Tus. Mer.

	w	e
	.	.
	.	15.9
	.	31 1
	.	45.1
	.	59.4
	1	13.9

	h	m	
			4 28 3
			57.6
			12.2
			27 0
			41.1
			10 5
			25.0
			39.7
			53.3
	2		8.7

4 8 2,8
3 60
9 8
15 12.8
12.19

5.685 + 2,84
7.406
4.746

6 58 34.40

17 52
17 55

-1' 40.68
= -49 2'

= 7'''' 121 / 12 / 605 / 121 / 1.81 / .49 / 2,30

-1.21 + 1.27
C = -.9 / +.6 = -1.50. ϕ.

1036 / 540

4 52 / 1290 / 964 / 3260

a = -,49 + 1,21 (-1,50)
a = -2.30

Ill. m.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 23.4 1878. Instrument, E. Transit Observer, H. W.

Timepiece, 9457 Recorder, Chas.

Object, Circle,	ξ Herculis Mk. W.		ζ Herculis		χ Ophiuchi		E Urs. Min.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	15.9
Sums,	.	.	.	.	.	.	.	31 1
Difference,								45.1
b. = +.50			3		2		1	59.4
								13.9
	h m s		h m s		h m s		h m	428 3
Wire, I.	38 21.7		40 22.4		53 35.8			57.6
II.	24.2		25.3		37.8			12.2
III.	26.3		27.7		39.6			27.0
IV.	29.0		30.3		41.7			41.1
V.	31.3		32.9		43.6			10.5
								25.0
								39.7
							2	53.3
								8.7
Sum,	13 2.5		38.6		48.5			482.8
Mean,	26.50		27.72		39.70		15	12.19
Bb,	1.16	.58	1.29	.64	.86	.43	5.685	+2.84
Cc,	1.18	.	1.29	.	1.02	.	7.406	.
Aa,	.22	.	.08	.	.54	.	-4.746	.
Corr'd Transit,		.		.		.		.
R. A.	16 36 44.28		16 38 45.79		16 51 56.87		16 58 34.40	
Error of Timepiece,		.		.		.		.

17 52 11.5 (3451)
00.0 (394)

17 55 16.0 (1327)
30 (394)

$-1\ 42.57$ $-1\ 43.26$ $-1\ 40.68$

$+1.90 = -40\,Z''$ $+2.59 = -49\,Z'$

$4.82 \overline{)1.90}\ .40$ $5.28 \overline{)2.59}\ .49$

$-5.28 \overline{)6.39}\ 1.21\ Z''$ $-4.82 \overline{)6.11}\ 1.27 = Z'''$

$C = \frac{-.49 + .40}{-1.21 + 1.27}$

$C = \frac{-.9}{+.6} = -1.50.$ Ch.

$a = -.49 + 1.21(-1.50)$

Mk. W. $a = -2.30$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 23 4 1878. Instrument, E. Transit Observer, H. M.

Timepiece, 3451 Recorder, Chas.

Object, Circle,	π Herculis Dll. E.		β Draconis		β Ophiuchi		γ Drac. Aust.	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	59.1
								5.6
Difference,								12.0
								18.4
b.			3		2		1 45	24.5
	h m s		h m s		h m s		h m s	
Wire, I.		28.0		18.3		8.2		35.8
								42.4
II.		30.1		21.5		10.7	45	48.9
								55.5
III.		32.6		24.8	39	12.7	46	2.0
								16.0
IV.		35.0		28.0		14.7		23.2
								29.3
V.	12	37.7		31.2		16.5		35.8
								42.3
Sum,		13.4		23.8		12.8		1184.6
		.		.		.		60
								244.6
Mean,		32.68		24.76		12.56	45	48.92
Bb,	1.25	.62	1.62	.81	.70	+.85	2.85	1.42
		.		.		.		.
Cc,	1.26	.	1.64	.	1.01	.	3.27	.
Aa,	.12	.	+.29	.	.69	.	-1.63	.
Corr'd Transit,		.		.		.		.
R. A.		.		.		.		.
	17 10	51.01	27	43.51	37	30.27	44	9.48
Error of Timepiece,		.		.		.		.

$C = \frac{-1.22 + 1.61}{-1.01 + 1.22}$

$\alpha = \frac{+.39}{+21} = +1.85$ Dll. E.

21 | 39 | 1.85
21
180
168
120

3.27 | 1.01 | 2.23 | 2.26 | 1.01 = 2'''
223
300
-1.34 | 1.63 | 1.25
134
290
268
220

$C = +1.85$ Dll. E

$a = -1.22 + (1.01)(1.85)$

$a = -1.22 + 1.87$

$a = +.65$

$-1\ 42.29 \quad -1\ 42.06 \quad -1\ 42.64 \quad -1\ 39.92$

$+ \frac{2.14}{-1.34} = -1.61 = Z''$ $\quad + \frac{2.72}{2.23} = -1.22 = Z'$

1.34 | 2.14 | 1.61
134
800
784
160

223 | 272 | 1.22
223
490
446
440

Z''''

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 23d. 3. 1878. Instrument, Mural Cir. Observer, W.A.R.

Timepiece, 132 Recorder, Chm. & W. Comp.

Object, Circle,			γ Draconis 51° 30′		α Herculis 28° 44′		β Ursæ Min. 86° 36′	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		59.7		59.7		1.4	11	16.7 =
II.		3.0		3.6		3.6		35.3
III.		6.2		6.2		6.0		51.3
IV.		.		9.6		8.4	13	7.9
V.		.		13.0		10.9		26 0 -
								44.0
								2.8
								18.7
								35.7
Sum,		.		91.5		30.3		9)238.4
				60.		.		26.50
				31.5				
Mean,		.		6.30		6.06		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.		.	17 53	49.56	18 2	50.27	18 11	45.07
Error of Timepiece,		.		.		.		.

P $0 = +41.43 + 16.83u + \Delta t + u$

$0 = +16.31 + .92u + \ldots$

15.91] 25.12] 1.58
15 91
9210
7955
12550

$0 = +25.12 + 15.91u$

$u = -1.58$

158
91
158
1422
1.4378

1.58
92
316
1422
−1.4536
+.13
+1.44
+.12

$0 = +16.74 + 1.30u + \Delta t + u$

$0 = +15.88 + .55$

1.62 85

$0 = +16.31 + .92u + \ldots$

$0 = +16.43 + \Delta t$

$\Delta t(132) = -16.43.$

16.43
14.05
26) 2.38) .091 dt.
234
40

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 24-14 1878. Instrument, Merid. Cir. Observer, W. A. R.

Timepiece, 1327 Recorder, Chas. H. M. Comfs.

Object,	T Herculis		ϕ Herculis		β Herculis		E. Hrs. Mill.	
Circle,	1.06		1.01		1.40		7.29	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.10			45°,4'		21°45'			

	h m s	h m s	h m s	h m s
Wire, I.	19.5	11.0	14.8	32.0 39.1
II.	22.7	13.7	17.0	47.3 54.7
III.	25.8	16.7	19.0	2.1 10.0
IV.	28.7	19.6	21.3	17.1 25.5
V.	16 31.7	5 22.5	23.5	32.9
Sum,	128.4	83.5	95.6	260.7 240
Mean,	25.68	16.7	19.12	20.7 2:30
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	16 16 7.08	16 4 58.11	16 25 1.60	16 58 34.22
Error of Timepiece,	.	.	.	.

P. $0 = +28.08 + 7.29n + \Delta t + n$.

$0 = +18.24 + .82n + \ldots$

$0 = 9.84 + 6.47n$

$n = -1.52$

$0 = 18.60 + 1.06n + \Delta t + n$

$0 = 18.59 + 1.01n + \ldots$

$0 = 17.52 + .40n + \ldots$

$0 = 18.24 + .82n + \ldots$

$0 = 17.00 + 1.60 = 18.60$

$0 = 17.06 + 1.60 = 18.66$

$0 = 16.92 + 1.60 = 18.52$

Sum of 1227 = + 18.59

16.43

2.16

.097

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1877phae.proj.17974

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 25.45 1878. Instrument, Mer. Circle Observer, J. F. M.

Timepiece, 1327 Recorder, Chas. H. M. Coffin.

Object,	13 R Lyrae		ν Draconis		ζ Aquilae			
Circle,	.95		2.92		.24			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.10	43°46′		71°7′		13°40			
	h m s		h m s		h m s		h m s	
Wire, I.		55.2		12.9 67		6.7		.
II.		58.0		19.4		9.0		.
III.		0.8		25.7		11.1		.
IV.		3.8	56	32.1		13.2		.
V.	18 52	6.6		.	0	15.5		.
Sum,		124.4 120 4.4		96.8		55.5		.
Mean,	52	0.88		19.36		11.10		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	18 51	40.50	18 55	56.25	18 59	51.66		.
Error of Timepiece,		.		.		.		.

P $0 = +23.11 + 2.92n + \Delta t + n$.

$0 = 19.91 + .59n + \ldots$

$0 = +3.20 + 2.33n$

$n = -1.38$

$0 = 20.38 + .95n + \Delta t + n$

$0 = 19.44 + .24n + \ldots$

$0 = 19.91 + .59 + \Delta t + n$

$0 = 20.38 - 1.31 + 1.38 = 20.45$

$0 = 19.44 - .33 + 1.38 = 20.49$

Sum 1327. $= +20.47$

$0 = 19.91 - .83 + 1.38$

$0 = 20.45$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 25.4 1878. Instrument, E. Transit Observer, F. W.

Timepiece, 345. Recorder, Chas.

Object,	γ Draconis		72 Ophiuchi		χ Draconis		~~Dlt. 2655 Gr.~~ Dlb. M.	
Circle,	L. E.				E.			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.50	3		3		1			
	h m s		h m s		h m s		h m s	
Wire, I.		26.9		18.3		26.7		7.~
						33.9		16.0
II.		30.0		20.3		46.8		24.8
						53.6		
III.		33.1		22.3		0.2~		
						6.9		33.0
IV.		36.3		24.2		13.7		
						26.3		42.9
V.	55~	39.6	3	26.3		32.9		
Sum,		165.9		111.4		241.0		123,9
		.		.		240		.
Mean,		33.18		22.28		1.0		24.72
						0.11		
Bb,	1.58	+.78	.86	.43	2.90	1.45	3.77	+1.88
		.		.		.		.
Cc,	1.60	.	1.02	.	3.36	.	4.60	.
Aa,		.		.		.		.
	-.26		.54		-1.69		-2.65	
Corr'd Transit,		.		.		.		.
R. A.		.		.		.		.
	+17 53	49.45	18 1	37.45	18 23	18.11	18 35~	41.36
Error of Timepiece,		.		.		.		.

$0 = 1\ 43.73$

$3 \cdot 0 = 1\ 44.51 - .26\,a + 1.60\,c$

$\not{3}\ 0 = 1\ 45.26 + .54\,a + 1.02\,c$

$0 =$ (17, 28)

Mean $0 = 1\ 44.88 + .14\,a + 1.31\,c$

$1\ \mathbf{P} \quad 0 = 1\ 43.45 - 1.69\,a + 3.36\,c$

$0 = +1.43 + 1.83\,a - 2.05\,c$ L.E.

L.E. $0 = 1\ 44.88 - .07 + .30 = 1\ 45.11$

L.M. $0 = 1\ 45.95 - .17 - .27 = 1\ 45.51$

Mean $1\ 45.31$

131 23 393 262 30 1.16 23 348 202 27

$0 = +1.43 + 1.83\,a - 2.05\,c$ (1).

$0 = +.71 + 2.98\,a + 3.44\,c$ (2)

$0 = .70 + .90\,a - c$ (3)

$0 = .21 + 86\,a + c$

$0 = .91 + 1.76\,a$

$a = -.52$

$0 = .70 - .468 - c$

$c = +.23$ L.E.

$c = -.23$ L.M.

86 52 172 430 1.45 .21 .24 312 104 1.13 16 23 48 37 28

$a = -.34$

$c = +.45$ (E).

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 25 1878 Instrument, E. Transit Observer, H. M.

Timepiece, Chron 3+51 Recorder, Chron.

Object,	ε Lyrae pr.		Vanpantis pr.					
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		3.4		54.7		.		.
II.		6.0		56.7		.		.
III.		8.8		58.6		.		.
IV.		11.5		0.5		.		.
V.		.		2.6		.		.
Sum,		30.8		173.1 (293.1)		.		.
Mean,		6.16		58.62		.		.
Bb,	1.30	+.65	.70	+.35		.		.
Cc,	1.30	.	1.01	.		.		.
Aa,	7	.	.60	.		.		.
Corr'd Transit,		.		.		.		.
R. A.	18 40 21.00 (18 35 41.36)		18 50 12.87			.		.
Error of Timepiece,		.		.		.		.

$0 = 1\ 45.81 + .57a + 1.30c$

$0 = 1\ +6.10 + .60a + 1.01c$

1.91 .67 7.31

Mean $0 = +1\ 45.95 + .33a + 1.16c$

$1\ 45.24 = 2.65a + 4.60c$

$0 = +.71 + 2.98a - 3.44c$

L. W.

205 | 1.43 | 1.70

205 | 1.83 | 1.80

1640

90

3.44 | 1.71 | 1.21

688

220

344 | 2.98 | 1.86

2752

2280

176 | 910 | 5.2

880

300

R. E.

$1\ 44.51 + .13 + 37 = 1\ 45.01$

$1\ 45.26 - 28 + 24 = 1\ 45.20$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 27 & 1878. Instrument, Mer. Circle. Observer, J. A. M.
Timepiece, 1327. Recorder, Chase. & M. Comps.

Object,	δ Ursæ. Min.	109 Herculis	χ Draconis	α Lyræ.
Circle,	16.94	.40	72	.80
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b. +.10		21° 42'	72° 40'	38° 29'
	h m s	h m s	h m s	h m s
Wire, I.	55.0	52.5	31.4	10.7
II.	12 12.8	54.8	35.2	13.5
III.	12 29.0	57.0	38.8	15.9
IV.	48.6	59.3	45.8	18.7
V.	13 05.6	19 01.5	49.4	21.5
			52.8	
			56.3	
			23 59.8	33
Sum,	151.0	225.1	9[411.6	80.3
		60		
		285.		
Mean,	30.20	18 57.02	23 45.73	16.06
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	18 11 43.90	18 18 33.29	18 23 18.05	18 32 51.63
Error of Timepiece,	.	.	.	.

P. $0 = +46.80 + 16.94\,m + \Delta t + m$

$0 = 24.08 + .60\,m + \Delta t + m$

$0 = 22.22 + 16.34\,m$

$m = -1.35$

16.34 | 22.22 | 1.35
1634
5880
4902
7780

135
91
135
1215
1.2285
13
1.36

$0 = +23.73 + .40\,m + \Delta t + m$

$0 = 24.43 + .80\,m + \Delta t + m$

$0 = 24.08 + .60\,m + \Delta t + m$

$0 = 23.73 - .54 + 1.36 = 24.55$

$0 = 24.43 - 1.08 + 1.36 = 24.71$

136
54
82
128
.28

1.26

24.63
20.43
4.06
+ 2.10
rate

+ 24.63
Error 1327

24.54
20.68

24 | 2.10 | .087
192
180

1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 28. + 1878. Instrument, Mer. Circle Observer, W. A. R.

Timepiece, 1327 Recorder, Chron. F. W. Comp.

	~~ζ Herculis~~ / Draconis	δ Urs. Min	109 Herculis	α Lyrae
Object,				
Circle,	1.26	16,94	40	.80
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. | .	. | .	. | .	. | .
Difference,				
b.				
	h m s	h m s	h m s	h m s
Wire, I.	.	27.0	55.0	13.2
		43 9		
II.	.	2.5	57.3	15.8
III.	.	19 0	59.5	18 3
		37.0		
IV.	.	53.7	1.8	21.0
		11.6		
V.	.	28.8	19 4.0	33 23.7
		13 45.2		
Sum,	.	268.7	177 6	92.0
		60	120	
		328.7	297.6	
Mean,	.	12 36.52	59.52	18.40
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	.	.	.	.
	17 53 49.48	18 11 43.60	18 18 33.29	18 32 51.66
Error of Timepiece,	.	.	.	.

P = 0 = 52.92 + 16.94 + Δt + m.

0 = 26.48 + .50 n + ..

0 = 26,44 + 16.34 n

16.34 | 26.44 | 1.62

1634

1010

4804

2963

n = −1.62

1,62

91

162

1458

1,47

13

150

0 = 26.23 + 40 n + Δt + m

0 = 26.74 + .80 n + ..

,97

0 = 26.48 + .60 n + ..

0 = 26.23 + .65 + 1.50 = 27.08

0 = 26.74 − 1.30 + 1.50 = 26.94

3451 = 5 44 55.5

344 =

Mean. 27.01

24.63

Comp 1327 + 2.38

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 28.4 1878. Instrument, E. Transit Observer, W. M.

Timepiece, 3451 Recorder, Chas.

Object, Circle,	~~δ Her. Min.~~, γ Draconis Ill. M.		109 Herculis M.		ε Lyrae M		ζ Lyrae M	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.50								
	h m s		h m s		h m s		h m s	
Wire, I.	33.2		18.6		35.8		22.8	
II.	52.8							
	59.0		20.6		38.1		24.9	
III.	25 06.0		22.7		40.7		27.1	
IV.	11.5		24.7		43.2		29.7	
	19.3							
V.	38.2		20 27.0		34 45.5		47 31.9	
Sum,	7220.0		13.6		3.3		36.4	
	80							
	40.							
Mean,	25 5.71		22.72		40.66		27.28	
	7.16							
Bb,	2.90	+1.45	1.01	.50	1.28	.64	1.18	.59
Cc,	3.36		1.08		1.28		1.20	
Aa,	-1.69		.38		9		19	
Corr'd Transit,								
R. A.	18 23 17.93		18 18 33.29		18 32 51.66		18 45 37.73	
Error of Timepiece,			1 49.39		1 49.26		1 49.64	

P. $0 = 1\ 49.23 \overset{+}{-} \frac{1.69}{3.36}a + \frac{3.36}{1.69}c$

$0 = 1\ 49.90 + 1.19a + .22c$

$0 = -.67 - 2.68a + 3.14c$

$0 = .67 + 2.68a - 3.14c$

assume $c = +.26$ C.C.

1 18 33.29 — 25 6.95

23 17.93 — 20 22.96

4 44.64 — 4 43.33

43.33

2.07 | 1.31 | -.63 (a)

$0 = 1\ 49.93 + 1.05a + .38c$

$0 = 1\ 49.64 + 1.28a + .9c$

$0 = 1\ 50.14 + 1.20a + .19c$

2.71 — 56 — 66

$0 = 1\ 49.90 + 1.19a + .22c$

$0 = 1\ 49.23 + 3.36 - 1.69a$

$0 = +.67 - 2.17c + 1.91a$

1 49.64 Cw.

1 49.12 CC.

2|52

+.26 LL.

assume c.

Then $0 = .67 + .43 + 1.91a$

$a = -.57$

Cw. 1 49.43

Cl. 1 49.51

+ 1 49.47

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 28 1877. Instrument, E. Transit Observer, H.P.

Timepiece, 3451 Recorder, Chron.

Object,	ν Draconis	ϑ Lyrae	χ Cygni	ϑ Aquilae
Circle,	E.	E	E	E
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b.				

	h m s	h m s	h m s	h m s
Wire, I.	57 11.7	55.0	4.3	19 21 4.9
	17 9			
II.	30.0	57.1	8.1	12.0
III.	38 0	59.9	11.6	13.9
	42.7			
IV.	48.4	2 1	16 14.6	15.9
	55 0			
V.	6.7	14 4.7	.	17.9
	12 9			
Sum,	261.3	178.8	40.0	19.6
	120	120		
	381.3	298.8		
Mean,	42.37	59.76	8.0	13.92

Bb,	2.71 1.35	1.27 .63	1.64 .82	78 .39
Ce,	3.08 .	1.27 .	1.66 .	1.00 .
Aa,	.	.	.	.
	-1.48	10	-.31	63
Corr'd Transit,	.	.	.	.
R. A.	.	.	.	.
	18 55 56.11	19 12 11.27	19 14 19.95	19 19 24.59
Error of Timepiece,	.	1 49.37	1 49.62	1 49.53

P $0 = 147.61 + 3.08c - 1.48a$.

$0 = +149.12 + 1.27c + 10a$

$0 = 148.97 + 1.66c - .31a$

$0 = 149.72 + 1.08c + .63a$

.81 .93 .42

$0 = 149.27 + 1.31c + .14a$

$0 = 147.61 + 3.08c - 1.48a$

$0 = 149.27 + 1.31c + .14a$

$0 = 1.66 - 1.77c + 1.62a$

$a = -.75$ cE,

$a = .62$ cW.

assume $a = .70$

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, July 31.5 1878. Instrument, Mer. Circle Observer, F. W. A. R.

Timepiece, 1327. Recorder, Chron. F. N. Comp

Object, Circle,	ε Ursæ Min. 7.29 .22		α Ophiuchi .22		ι Herculis 1.04		γ Draconis 1.26	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.10								
	h m s		h m s		h m s		h m s	
Wire, I.	+5.5 51.9 53.8 0.2		47.5		31.5		16.5	
II.	2.5 15.5 9.2		49.7		34.5		20.0	
III.	17.1 24.4		51.9		37.5		23.3	
IV.	32.8 40.2		54.0		40.5		26.6	
V.	59 47.0		29 56.0		36 43.5		29.7	
Sum,	272.5 120 152.5		9.1		.		16.1	
Mean,	16.94		51.82		36 37.5		23.22	
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	16 58 33.38		17 29 19.62		17 36 4.48		17 53 49.44	
Error of Timepiece,	.		.		.		.	

P. $0 = 43.56 + 7.29\,m + \Delta t + m$

$0 = 33.00 + .84\,m + \text{''}$

$0 = 10.56 + 6.45\,m$

$6.45 \mid 10.56 \mid 1.64$ $m = -1.64$

645
4110
3870
2400

164
104
656
1640
1.7056

126
164
504
756
126
20664

$0 = 32.20 + .22\,m + \Delta t + m$

$0 = 33.02 + 1.04\,m + \Delta t + m$

$0 = 33.78 + 1.26\,m + \text{''} + \text{''}$

$0 = 33.00 + .84\,m + \text{''}$

$0 = 32.20 - .36 + 1.49 = 31.84 + 1.49 = 33.33$

$0 = 33.02 - 1.70 + 1.49 = 31.32 + 1.49 =$

$0 = 33.78 - 2.06 + 1.49 = 31.72 + 1.49 = 33.36$

54

Emf 1827 = 33.27
69
Emf 1877 33.44

1.64 164
22 91
328 164
328 1476
3608 1.492

24 | 211.088
192
190

33.27
27.01
3 | 6.26
3 | 6.33
+2.11
rate of 1827

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 2 1878. Instrument, Observer,

Timepiece, Recorder,

Object,	χ Draconis			α Lyrae			110 Herculis			β Lyrae		
Circle,	Mk. M.			M.						M.		
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			.			.			.			.
II.			.			.			.			.
III.			.			.			.			.
IV.			.			.			.			.
V.			.			.			.			.
Sum,			.			.			.			.
Mean,			.			.			.			.
Bb,	2.90		.	1.28		.	99		.	118		.
Cc,	3.36		.	1.28		.	1.06		.	120		.
Aa,	-1.69		.	9		.	41		.	20		.
Corr'd Transit,			.			.			.			.
R. A.			.			.			.			.
	18	23	17.77	18	32	51.60	18	40	28.18	18	45	37.71
Error of Timepiece,			.			.			.			.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 3d 1878. Instrument, E Transit Observer, F. W.

Timepiece, 1327 Recorder, Chum.

Object, Circle, Ill.	α Herculis E.		α Ophiuchi		ζ Herculis		γ Ophiuchi	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. Assume b = +.50								
	h m s		h m s		h m s		h m s	
Wire, I.		44.4		55.9		37.9		26.5
II.		46.3		57.8		40.9		28.5
III.	17 9	48.4	17 29	59.9		44.0	42	30.4
IV.		50.4		2.0		46.8		32.5
V.		52.4		4.0		49.6		34.5
Sum,		.4		179.7		19.2		2.4
				120				
				299.7				
Mean,	17 9	48.38		59.94		43.84		30.48
Bb,	92	+.46	89	.45	144	+.72	72	+.36
Cc,	1.04	−.26	1.03	−.26	146	−.37	1.00	−.25
Aa,	48	−.57	.51	−.60	−09	+.11	63	−.26
Corr'd Transit,		48.01		59.53		4 50		29.73
R. A.	17 9	8.29	17 29	19.59	17 36	4.44	17 41	49.98
Error of Timepiece,		39.72		39.94		40.06		39.75

18 11 41.98
41 49.98
29 52.00
33 55.47
57.53
4 3.47
243.47

16 26.46
42 30.59
33 55.47
48
12
.576
63
12
.756

17 41 49.98
17 36 44.44
5 45.54

42 30.59
36 44.19
5 46.40
5 45.54
.72 | −.86 | −1.20
72
140
14

α'−α

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 3 1878. Instrument, E. Transit. Observer, W. M.

Timepiece, 1327 Recorder, Chow.

Object,	δ Ursæ Min			δ Ursæ Min			110 Herculis			β Lyræ		
Circle,	E			W			W			W.		
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.	86° 36' 37"			7~31.68								
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.	III	15	7.6	V		—.			3.8			12.5
II.		15	47.0		23	12.2			5.9			15.0
III.		16	.		23	46.2			8.2			17.6
IV.		17	3.2		24	26.5			10.3			19.8
V.		17	40.1		25	3.2			12.4			22.3
Sum,			97 9			84.9			40.6			88.2
			.			60			.			.
Mean,		16	24.48		23	48.30		41	8.12		46	17.64
						144.9						
Bb,	12.09		+6.04	12.09		+6.04	.99		+.50	1.18		+.59
Cc,	16.86		−4.06	16.86		.	1.06		+.26	1.14		+.30
Aa,	−11.66		.	−11.66		.	40		−.48	20		−.24
Corr'd Transit,			.			.			8 40			38 29
R. A.			.			.			.			.
	18	11	41.98	18	11	41.98	18	40	28.18	18	45	37.72
Error of Timepiece,			.			.			40.22			40.57

39.72
39.94
40.06
39.76
347
39.87
40140
40.27
+=40.14 mof Cl. 1327. at 17h 50m

40.22
40.57
79
40.36

24 | 223 | 1093
216
70

13.44
3 | 16.70
+2.23 rate of 1327.

16 24.48
6.04
16 30.52
16 22.66
2 | −7.86
| −3.93
.066
2358
2358
−.25938 = C. C. E.

23 48.30
7 31.68
16 106.62
F 6.04
16 22.66 a.r.

17 9
18 42
54
21
2114
57

99
93
93
192

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 7 1878. Instrument, E Transit Observer, FW.

Timepiece, 1327 Recorder, Chm

Object, Circle,	ι Herculis W		γ Ophiuchi W		ε Ophiuchi W		35 Draconis W	
	w	e	w	e	w	e	w	e
Level Direct,	57.0	42.4	.	.	.	.	.	.
Reversed,	62.0	37.0	.	.	.	.	.	.
Sums,	119.0	79.4	.	.	.	.	.	.
Difference,	79.4	.						
b. Assume b = +.50	40.6	.67					76 58 39	
	15 10.15							
	90							
	175							

	h m s	h m s	h m s	h m s
Wire, I.	46.0	34 9 .	.	31.0 40.7 48.0 56.8
II.	49.0	36.8 5 .9	5.9	6.8 23.9 32.2 42.2 51.0 59.6
III.	51.8	38.7 8 .9	8.9	16.2 25.6 34.1 43.0 51.9
IV.	54.6	40.6 11 .8	11.8	
V.	57.5	42.6 .	.	
Sum,	8.9	43.6 .	26.6 .	563.0 6 6 6 23.0
Mean,	51.78	42 38.72	8.87	41.53

Bb,	1.44	+.72 +.93	77	+.38 +.50	80	+.40 .52	3.16	+.83 2.38
Cc,	1.44	+.12	1.00	+.09	1.01	+.08	4.44	. .
Aa,	-09	+.05	63	-.32	60	-.30	-2.52	.
Corr'd Transit,		52 88 .		38 99 .		+9.17 .		.
R. A.	17 36	4:36	17 41	49.96	17 37	30.19	17 54	56.37
Error of Timepiece,		+ 48.52		+9.03		48.98		.

144 65 720 864 936 — 27 65 435 500 — 65 8 520 — 366 65 1830 2196 23790 — 65 86 430 516 559 — 1209 65 6045 7254 7.85

38.72 .50 .09 39.31 — 42

17 54 56.37 41 49.96 13 06.41 5.00 1.41 — 1.41 1260 150 — .45 (a)

55 41.53 +2.38 +.39 55 44.30 42 39.31 13 05.00 — 4.44 108 3552 3552 39072

129 65 645 774 83 — 118 65 590 708 73

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,.....187 . Instrument,..... Observer,.....

Timepiece,..... Recorder,.....

Object,	72 Ophiuchi				δ Ursæ Min.				δ Ursæ Min				δ Ursæ Min						
Circle,													IV V						
	w			e			w			e			w			e			
Level Direct,	.			.			.			.			.			.			
Reversed,	.			.			.			.			.			.			
Sums,	.			.			.			.			.			.			
Difference,																			
b.							86° 36' 29"												
	h	m	s				h	m	s				h	m	s				
Wire, I.			22.0					4	27.4			III		11	7.2			14	29.8
II.			23.9						59.3					11	43.4				51
III.			26.0						34.2					12	16.6				35.5
IV.			28.0						8.4						51.6				7.8
V.			30.0						44.2						23.0				46.6
																		18	49.0
																			24.9
																			54.4
																			29.0
																		20	2.0
Sum,			29.9						1735						141.8				159.3
			.						.						60				1.20
Mean,			25.98					45	34.70					12	16.36			15	36.92
Bb,	86		+.43				12.09		16.04						16.04				6.44
			.56						7.85						7.85				.
Cc,	1.02		+.09				16.86		.						-1.48				.
Aa,	54		-.27				-11.76		.						.				.
Corr'd Transit,			26 36						.						.				.
R. A.			.						.						.				.
	18	1	37.40				18	11	40.73										
Error of Timepiece,			+8.96						.						.				.

18 40 28.16
18 11 40.73
28 47.43

12 16.36
7.85
12 24.21
1.48
12 22.73
41 17.25
28 54.52
28 47.43
+12.16 | -7.09 | -.58
60 80
101

12 13.40
16.86
088
13488
134888
1.4836 8
41 14.70

12 16.36
12 13.40
24.96
1.48
+.08 8 8
0.π.

18 55.86
12 16.36
6 39.50
15 36.92
3 18.94
2
6 37.88
6 39.50
2 | 77.38
6 38.80
5 34.70
12 13.40

-.50
Assume a = -.50

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 7 1878 Instrument, 6 Transit Observer, A.W.

Timepiece, Recorder, Chem.

Object,	α Lyrae		110 Herculis		β Lyrae			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		34.3		12.5		21.2		.
II.		37.0		14.6		23.9		.
III.		39.6		16.7		26.0		.
IV.		42.1		18.8		28.4		.
V.		44.8		20.9		30.8		.
Sum,		47.8		33.5		30.3		.
		.		.		.		.
Mean,		39.56	41	16.70		26.06		.
Bb,	1,29	+ .63	1.00	+ .00	1,18	+ .89		
		.84		.65		+.76		.
Cc,	1.30	-.11	1.06	-.09	1.20	-.11		.
Aa,	7	-.04	40	-.20	19	-.10		.
Corr'd Transit,		40 25		17 06		26 61		.
		.		.		.		.
R. A.	18	32 51.56	18	40 28.16	18	45 37.68		
Error of Timepiece,		48.78		48.90		48.93		.

+49.03
48.98
48.96
48.70
48.90
48.93
5.50
+48.92 Error of 132γ. at 18h10m

18 45
17 36
.81
21
18 10

48.92
40.14
+48.78
2.19 rate of 132γ.
+2.20 1.092
216
40

+48.15

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 8. 1878. Instrument, E. Transit Observer, H. M.

Timepiece, 1327 Recorder, Chaw.

Object, Circle,	67 Ophiuchi L, E.		72 Ophiuchi E		0 Hercules E		δ Ursæ Min. E	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference,	. .	. .	. .	. .	. .	. .	. .	. .
b. assum b = +.64	assume c = -.09 C.E.							
	h m s		h m s		h m s		h m s	
Wire, I.		22.9		24.3		36.4		8.8 —
II.		24.8		26.3		38.6		42.9
III.		26.8		28.4		40.9		17.5
IV.		28.6		30.4		43.1		49.2
V.	55	30.7	2	32.4	3	45.5		.
Sum,		33.8		41.8		45		109.6 60 49.6
Mean,	55	26.76	2	28.36	3	40.90	12	16.53
Bb,	77	+ .51	.86	+ .57	1.11	+ .75	12.09	+ 7.85
Cc,	1.00	- .09	1.02	- .09	1.13	- .10	16.86	- 1.48
Aa,	64	- .46	54	- .39	27	- .19	- 11.76	+ 8.46
Corr'd Transit,		55 26 .72		28 .45		41 .36		3# .38
R. A.	15	54 35.65	18	1 37.39	18	2 50.13	18	11 40.37
Error of Timepiece,		+ 51.07		+ 51.06		+ 51.23		+ 51.01

18 11 40.37
1 37.39
10 02.98
9 54.06
- 12.30 8.92 .72
86
310

12 16.53
7.85
12 24.38
1.48
12 22.90
2 28.54
9 54.06

2 28.36
48
2 28.84

a = -.72

51.07
51.06
51.23
.36
+ 51.12 Error of 1327 at 17h 55m
48.92
+ 2.20 12 = 2.22
rate

67 11 67 67 746 7 5-16 5762

86 67 602 469 5159

77 67 469 5159

64 72 128 448 4608 1

54 72 108 378 38.88

27 72 54 189 194

1176 72 2352 8232 8.467

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 11 N 3 1878. Instrument, E. Transit Observer, H. M.

Timepiece, 1327 Recorder, Chron

Object,	35 Draconis	72 Ophiuchi	α Herculis	Groom. 25 33
Circle, L. E.				
	w | e	w | e	w | e	w | e
Level Direct,	56.3 | 41.1	. | .	. | .	. | .
Reversed,	57.8 | 39.2	. | .	. | .	. | .
assume e = +.09	1.14.1 | 80.3			
Sums, CW.	50.3 / 4 | 33.8	. | .	. | .	. | .
Difference,	15 | 8.45 | .56			
b. = +.56	2 | 90			
	h m s	h m s	h m s	h m s
Wire, I.	58 2 7.9	31.7	43.5	.
II.	55 16 7 33.8	33.6	45.7	.
III.	42 0 52.1	35.7	48.0	.
IV.	0 8 9.0	37.7	50.1	.
V.	26 5 34.6 43 8	2 39.6	52.2	.
Sum,	325.4 +40 565.4	28.3 .	39.5 .	.
Mean,	51.40	35.66	47.90	.
Bb,	3.66	+2.05	86	+.48	1.11	+.62	.
Cc,	4.44	−.40	1.02	−.09	1.13	−.10	.
Aa,	−2.52	.	54	−.30	27	−.15	.
Corr'd Transit,	.	.	2 35.75 .	48 27 .	.
R. A.	19 54 56.05		18 1 37.37	18 2 50.09	.
Error of Timepiece,	.		+ 58.38	+ 58.18	Mean = +58.28

3.66 / 56 / 2.196 / 1830 / 2.0496

86 / 56 / 516 / 430 / 48

56 / 56 / 336 / 421

18 1 37.37
17 54 56.05
α − α. 6 41.32

2 36.05
55 53.05
6 43.00
41.32
3.06 | −1.68 | = .55 @
15 30
15 00

5 1.12
3 | 7.16
+ 2.38
Ralo
of 1327.

1327 = 3451
19 43 48 = 19 45 00

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 12-3 1878. Instrument, Mer. Circle. Observer, W. A.K.

Timepiece, 1327 Recorder, Chas. H. M. Comfs.

Object,	α Herculis		~~α Ophiuchi~~ 109 Herculis.		ζ Herculis		δ Lus. Min					
Circle,	.26		.22		1.05		16.94					
	w	e	w	e	w	e	w	e				
Level Direct,	.	.	.	.	.	.	.	.				
Reversed,	.	.	.	.	.	.	.	.				
Sums,	.	.	.	.	.	.	.	.				
Difference,												
b. assumed = +.10												
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			0.3			28.6			58.8			54.7
II.			5.7			30.9			1.8			11.5
III.			8.0			33.1			4.6			29.4
IV.			9.8			35.4			7.6			48.1
V.		10	15.2			37.6			10.7		13	4.9
												21.0
												37.9
												55.8
												14.8
Sum,			39.0			.			83.5			278.1
			.			.			60			240
									23.5			38.1
Mean,			7.80			33.12			4.70		13	4.23
						10						
Bb,			.			33.02			.			.
Cc,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.	17	9	8.19	18	18	33.19	17	36	4.24	18	11	38.97
				~~17~~	~~29~~	~~19.49~~						
Error of Timepiece,			.			.			.			.

P. $0 = 1\ 25.26 + 16.94m + \Delta t + m.$

$0 = 59.98 + .65m + ..$

$0 = 25.28 + 16.29m$

$m = -1.55$

$0 = 59.61 + .26m + \Delta t + m$

$0 = 60.36 + 1.05m + \Delta t + m$

$119.97 + 1.31$

$0 = 59.98 + .65m + ..$

$0 = 59.61 - .40 + 1.54 = 60.75$

$0 = 60.36 - 1.62 + 1.54 = 60.28$

(omit Hi) $0 = 59.83 - .62 + 1.54 = 60.75$

~~$0 = 59.98 - 1.00 + 1.54 = 60.52$~~

$\Delta t = .10 + 60.60$

$+ 2.32$

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 13, 14 1878. Instrument, Mer. Circle. Observer, W. A. R.

Timepiece, 1327 Recorder, Chase. F.M. comp.

	109 Herculis		α Lyrae		K Cygni		β Cygni.	
Object,								
Circle,	,40		,80		1.28		.52	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.	21°42'		38°39'		53°08		27°45'	
	h m s		h m s		h m s		h m s	
Wire, I.		31.2		49.2		.		49.8
II.		33.3		52.0		.		52.0
III.		35.7		54.7		.		54.2
IV.		38.0		57.1		.		56.6
V.	19	40.0	33	59.8		.	26	59.0
Sum,		28.2		22.8		.		21.6
Mean,		35.64		54.56		.		54.32
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	18 18	33.19	18 32	51.48	19 14	19.75	19 25	51.45
Error of Timepiece,		.		.		.		.

Assume π = 1.155.

1.155 / .620 / 1.775 / .80

1327 = 20 41 54.85

3451 = 43 45

0 = 62.45 − .62 + 1.54 = 63.37

0 = 63.08 − 1.24 + 1.54 = 63.38

0 = 62.77 − .80 + 1.54 = 63.47

1.22

63.41

60.70

+2.71

10

24 | 2.60 +1.11 = Δt.

24

20

1877phaet.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, August 14. 1878. Instrument, Mer. Circle. Observer, W.A.R.

Timepiece, 1327 Recorder, Chron. F.W. Comp.

Object, Circle,	κ Cygni 53° 8′		β Cygni 27°42′		γ Aquilae 10°19′			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.10	1.33		.52		.18			
	h m s		h m s		h m s		h m s	
Wire, I.		19.1		51.9		31.7		.
II.		23.0		54.3		33.8		.
III.		26.4		56.7		36.0		.
IV.		29.8		59.0		38.1		.
V.	15	33.3		1.3		40.2		.
Sum,		131.6		223.2 (283.4)		29.8		.
Mean,		26.32		56.64		35.96		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	19 14	19.76	19 25	51.44	19 40	31.26		.
Error of Timepiece,		.		.		.		.

Assume $u = 1.55$.

1.55 × .52 = 310 + 775 = .806

133 × 4.65 = 46.5 + 15.5 = 2.06.15

155 × 18 = 1240 + 155 = .279

0 = 66.56 − 2.06 + 1.54 = 66.04

0 = 65.20 − .80 + 1.54 = 66.94

0 = 64.70 − .28 + 1.54 = 65.96

274 + 65.98 = Emof 1327.

63.41 + 2.57 = 2.47 rate. At. 1327 31 40

3451 20 32 48.65

247 × 2 = 5.94 + 65.98 = 70.92

16.94

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 17th.4 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas F. W. Loupe.

Object,	α aquilae			
Circle,				
	w / e	w / e	w / e	w / e
Level Direct,	. / .	. / .	. / .	. / .
Reversed,	. / .	. / .	. / .	. / .
Sums,	. .	. .	. .	. .
Difference,				
b.	+ 8° 32′			
	h m s	h m s	h m s	h m s
Wire, I.	1.4	.	.	.
II.	3.6	.	.	.
III.	5.8	.	.	.
IV.	8.0	.	.	.
V.	9.9	.	.	.
Sum,	28.7 .	.	.	.
Mean,	46 5.74	.	.	.
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	19 44 53.58	.	.	.
Error of Timepiece,	+ 73 .43	.	.	.

0 = + 72.16 − .22 + 1.49 = +73.43 = Ω

Assume n = −1.50

15

22

15
91
15
135
136
13
149

1 3 27 = 20 22 00

34 51 = 20 20 26

22 00
1 23.53
20 36.47
26.00
10.47

65.98
3 | 7.45
2.48

73.43
1.85
75.28

73.43
2.48
1.07
76.98

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 18.4 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,			β Aquilae					
Circle,			.11					
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	.			33.5	.		.	
II.	.			35.5	.		.	
III.	.			37.6	.		.	
IV.	.			39.85	.		.	
V.	.		50	41.85	.		.	
Sum,	.			38.3	.		.	
Mean,	.		50	37.66	.		.	
Bb,	.			.	.		.	
Cc,	.			.	.		.	
Aa,	.			.	.		.	
Corr'd Transit,	.			.	.		.	
R. A.	.		19	49 22.98				
Error of Timepiece,	.			.	.		.	

0 = 1 14.68 − .15 + 1.49 = 76.02 73.43 76.02

73.43 1.13 1.13

+ 2.59 74.56 77.15

25

2.34

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 20 187 . Instrument, Observer,

Timepiece, Recorder,

Object,	δ Ursæ min.		α Lyræ		κ Cygni		γ aquilæ	
Circle,			.80		1.33		.18	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	20 5		6.8		34 5		47.0	
II.	38.3		9.4		37.8		49.1	
III.	56.0		12.1		41 3		51.4	
IV.	13.0		14.8		44.8		53.4	
V.	31.2		17.4		48.1		55.6	
	48.7							
	7.0							
	23.1							
	41 5							
	.							
Sum,	.		10 5		6.5		6.5	
	.		.		.		.	
Mean,	.		12.1		41.3		51.30	
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	.		.		19 14 19 63		.	
			18 32 51,37		~~19 40 31.23~~		19 40 31 22	
Error of Timepiece,	.		.		.		.	

Odoms w = −1.50

8
1.20

1.5
33
45

45
15
1.95

15
18
120
15
270

0 = 1 20.73 + .80 m + H+ m

0 = 1 21.67 + 1.33 m + "

0 = 1 20.07 + .18 m + "

1 20.73 − 1.20 + 1.49 = 1 21.02 +11=,13

1 21.67 − 2.00 + 1.49 = 1 21,16

1 20.07 − .27 + 1.49 = 1 21.29

58

Ens(1327 + 1 21.19

1 16.02

2 | 5.17

+ 2.58

Salt

32
74
100
2 | 206
89

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug. 22. 1878. Instrument, Mer. Circle Observer, W. A. R.

Timepiece, 1327 Recorder, Chron. F. W. Coupe

Object,	δ Ursæ min.	γ Aquilæ	α Aquilæ	β Aquilæ
Circle,	16.83	.18	.15	11
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b. Assume +.10	86° 36′ 41″	10° 19′	8° 33′	6° 6′
	h m s	h m s	h m s	h m s
Wire, I.	.	52.0	14.5	43.85
II.	6.1	54.25	16.5	45.95
III.	18 13 25.5	56.1	18.65	48.0
IV.	44.4	58.3	20.6	50.6
V.	.	42 0.25	46 22.9	50 52.0
Sum,	76.0	220.9 / 6 / 280.9	43.15	39.8
Mean,	13 25.33	42 56.18	18.63	47.96
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	18 11 35.53	19 40 31.22	19 44 53.55	19 49 22.96
Error of Timepiece,	.	.	.	.

P. $0 = 1\ 49.80 + 16.83n + \Delta t + m$.

$0 = 1\ 25.01 + .15n + \text{''}$

$0 = 24.79 + 16.68n$

$n = -1.50$

1668 | 24.79 | 1.50
1668
8110
8340

91/15
135
1.36
.13
1.49

1327 − 20 54 55
3457 − 20 53 16

54 55
1 26.38
20 ° 53 28.62
53 16
−12.62 Error of 3457
10.47
52.15
−.43 rate of 3457

$0 = 124.96 + .18n + \Delta t + m$
$0 = 125.08 + .15n + \text{''} + m$
$0 = 125.00 + .11n + \text{''} + \text{''}$
10 4 14

$0 = 125.01 + .15n + \text{''} + \text{''}$

$0 = 125.01 + .25 + 1.49 = 126.25$ Error.

121.19
5.06
rate +2.53

−12.62
86
13.48

26.25 26.25
4.54 3.75
31.19 29.00

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug. 25 h 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. F. W. Comp.

Object,	α Lyrae.	ε Lyrae	χ Cygni	
Circle,	38°40'	35°55'	53°9'	
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b. Assume = +.10	,80	,72	1.33	
	h m s	h m s	h m s	h m s
Wire, I.	18.8	.	46.6	.
II.	21.5	.	50.1	.
III.	24.2	4 32 .70	53.5	.
IV.	26.8	.	56.8	.
V.	34 29.4	.	16 0.3	.
	20.7	.	17.3	.
Sum,	.	.	.	.
Mean,	34 24.14	4 32 .70	15 53.46	.
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	18 32 51.28	19 2 59.92	19 14 19.52	.
Error of Timepiece,	.	.	.	.

Assume n = −1.50

8
1.20
15
72
30
105
1.08

133
15
665
133
2.015

1327 = 19 58 0,15

3457 = 19 56 18.00

0 = 132.86 + −1.20 + 1.49 = 93.15

0 = 132.78 − 1.08 + 1.49 = 93.19

0 = 133.94 − 2.02 + 1.49 = 93.41

3 | 7 5

93.20
86.25
3 | 6.95
+2.32 rate.

+ 93.25 Error of 1327.

32
62
74
3 | 6 8
56

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19370phee.0003.47074

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 26.~~25~~ 1878. Instrument, Mer. Cir. Observer, Mark.

Timepiece, 1327 Recorder, Chas. H. W. Cook.

Object, Circle,	ι Lyrae		κ Cygni		β Cygni 27°041'		λ Ursæ min	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = + 10 Assumed								
	h m s		h m s		h m s		h m s	
Wire, I.		30.3		49.1		22.0		.
II.		32.8		52.5		24.2		.
III.		35.4		55.95		26.5		.
IV.		37.9		59.5		29.0		.
V.	4	40.5	16	2.9	27	31.2		.
Sum,		26.9		29.95		32.9		.
Mean,		35.38		55.99		26.58		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	19	2 59.89	19	14 19.49	19	25 51.34		.
Error of Timepiece,		.		.		.		.

Assume n = −1.50

52
30
75
.78

0 = 135.49 − 1.08 + 1.49 = 1 35.90
0 = 136.50 − 2.02 + 1.49 = 1 35.97
0 = 135.24 − .78 + 1.49 = 1 35.95

12
1 35.94
1 33.25
2.69

rate of 1327 2.66

20 51 56.5 = 3451
20 53 40 = 1320

133 17 91 172
17 17
9 31 17 50 4
133 153 +72
−2.61 −1.54 −1.224
+.15 −.7 +.15

2.66 266 1.1
24
.26

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1877phae.proj.1797w

w 46 c3

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 27.3 1878. Instrument, Mer. Ci. Observer, Mak.

Timepiece, 1327 Recorder, Chas. H. W. Penfs.

Object,	δ Ursæ Min		ι Lyrae		K Cygni		β Cygni	
Circle,	16.83		.72		1.33		.52	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. +10 assumed	86°36							
	h m s		h m s		h m s		h m s	
Wire, I.	22 6		33.0		51.7		24.7	
	41.7							
II.	58 6		35.5		55.2		27.0	
	16.0				58.8			
III.	34.1 - 51 3		38.0		2.0		29.3	
IV.	8.8 25 9		40.5		.		31.7	
V.	13 43.4		3 43.1		56 .		34.0	
Sum,	302.4		40.1		43.3		46.7	
Mean,	37.60		38.02		58.66		29.34	
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	18 11 33.53		19 2 59.88		19 14 19.47		19 25 51.33	
Error of Timepiece,	.		.		.		.	

$0 = -00.07 + 16.83n + \Delta t + n$

$0 = 138.45 + .52n + n$

$0 = +21.62 + 16.31n$

$n = -1.33$

16.31 | 21.61 | 1.33
1631
5310
4893
4170

72
926
9316
9576

133
91
133
1197
1,2103
13
1.34

133
133
399
399
133
17789

133
52
266
665
.6916

$0 = 138.14 + .72n + \Delta t + n$

$0 = 139.19 + 1.33n + n$

$0 = 138.01 + .52n + n$

1.34 1.57

$0 = 138.45 + .52 + n$

$0 = 138.14 + .96 + 1.34 = 138.52$

$0 = 139.19 - 1.78 + 1.34 = 138.75$

$0 = 138.01 - .69 + 1.34 = 138.66$

1.93

138.64
135.94
2.70

n 1270 1.113
240
30
24
60
1915

270
10
4100
42.64

24 | 1270 | 1.113
240
30
24
60

1327 2044 45
3451 w 43 . 00.3

rate 1327.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 29.3 1878. Instrument, Mer. Circle. Observer, M.A.K.

Timepiece, 1327 Recorder, Chas. A. W. Goups.

Object,	δ Ursæ min	ε Lyrae	K Cygni	β Cygni
Circle,	16.94	.72	1.33	.52
Level Direct, w	.	.	.	.
Level Direct, e	.	.	.	.
Reversed, w	.	.	.	.
Reversed, e	.	.	.	.
Sums,	.	.	.	.
Difference,				
b. = +.20				
	h m s	h m s	h m s	h m s
Wire, I.	12 6.6	38.0	57.0	29.8
II.	22.5	40.8	0.6	32.0
III.	12 41.3	43.2	4.0	34.5
IV.	57.7	45.9	7.3	36.8
V.	15.8	48.3	10.7	39.1
Sum,	143.9 / 60 / 203.9	16.2 / k.	79.6 / 60 / 19.6	22.2 / .
Mean,	40.78	43.24	3.92	34.44
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	18 11 32.78	19 2 59.86	19 14 19.43	19 25 51.31
Error of Timepiece,	.	.	.	.

Waltham.
48.40
50.42
52.42
54.44
56.43
58.44
0.45
2.47
4.48
6.48
18 53 8.50
Aug 28 D.M.

P. $0 = 208.00 + 16.94n + \Delta t + m$
$0 = 143.67 + .86n + "$
$0 = 24.33 + 16.08n$
$n = -1.51$
$n = -1.51$

$0 = 143.38 + .72n + \Delta t + m$
$0 = 144.49 + 1.33n + "$
$0 = 143.13 + .52n + "$
$0 = 143.67 + .86n + "$
$0 = 143.38 - 1.09 + 1.64 = 143.93$
$0 = 144.49 - 2.00 + 1.64 = 144.13$
$0 = 143.13 - .80 + 1.64 = 143.97$
1 44.01
Error 1327

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Aug 31st 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. A. M. Camp.

Object, Circle,	β Cygni .52		γ Aquilae 18		α Aquilae 15			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.20	27°42′		10°19′		8°33′			
	h m s		h m s		h m s		h m s	
Wire, I.		33.6		13.6		36.0		.
II.		36.0		15.7		38.0		.
III.		38.3		17.8		40.1		.
IV.		40.7		19.8		42.2		.
V.		43.9		22.0		44.2		.
Sum,		42.8		38.9		0.5		.
Mean,		38.56		17.78		40.1		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		201 .083
R. A.	19 25 51.29		19 40 31.14		19 44 53.48			192
Error of Timepiece,		.		.		.		90

Assume n = -1.50

.52 .30 .75 .78 .15 .91 .15 .135 1.36 .26 1.62

.15 .18 .120 .5 .27 .64 .37 .15 .15 .75

0 = 1 47.21 − .78 + 1.64 = 1 48.07

0 = 1 46.64 − .27 + 1.64 = 1 48.01

0 = 1 46.62 − .25 + 1.64 = 1 48.01

9

148.03

144.01

2|4.02

2.01

Error of 1327.

53 25.15

1 40.15

51 41.00

51 37

4.

51 37 = 3451

20 53 25.15 = 1321

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 1st 1878. Instrument, ... Observer, ...

Timepiece, ... Recorder, ...

Object,	δ Ursæ Min		ι Lyræ		κ Cygni		β Cygni	
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.20								
	h m s		h m s		h m s		h m s	
Wire, I.		10 .1		44 .5		3 .2		.
II.		26 .6		47 .0		6 .6		.
III.		44 .4		49 .6		10 .3		.
IV.		2 .1		52 .0		13 .6		.
V.		18 .7		54 .6		17 .0		.
Sum,		101 .9 (120 / 221)		47 .7		00 .7		.
Mean,		44 .38		49 .54		10 .14		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	18 11 31 .67		19 2 59 .87		19 14 19 .35		19 25 51 .26	
Error of Timepiece,		.		.		.		.

P. $0 = +72.71 + 16.94\,n + \Delta t + n.$

$0 = 150.21 + 1.02\,n + ''$

$0 = 22.51 + 15.92\,n$

$n = -1.42$

15.92 ⟌ 22.51 (1.42
15 92
6 590
6 368
2300

142 × 72 = 284, 994, 1024
142 × 91 = 1278, 1292, 26, 1.55
142 × 133 = 426, 426, 142, 18886

$0 = 149.63 + 1.72\,n + \Delta t + n$

$0 = 150.79 + 1.33\,n + ''$

14.2 2.05

$0 = 150.71 + 1.02\,n + ''$

$0 = 149.63 - 1.02 + 1.55 = 150.16$

$0 = 150.79 - 1.89 + 1.55 = 150.46$

150.37

Emf 1329.

2.35

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 2 1878. Instrument, Mer Circle Observer, W.A.K.

Timepiece, 1327 Recorder, Chas. A. W. Cobb.

Object,	ι Lyrae		κ Cygni		β Cygni			
Circle,	.72		1.33		.52			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.20								
	h m s		h m s		h m s		h m s	
Wire, I.		46.9		5.8		.		.
II.		49.4		9.3		.		.
III.		52.0		12.7		.		.
IV.		54.5		16.1		.		.
V.		57.1		19.6		.		.
Sum,		09.9		13.5		.		.
Mean,		51.98		12.7		.		.
Bb,		.		.		.		10 50 42.57
Cc,		.		.		.		3.89
Aa,		.		.		.		10 50 43.68
Corr'd Transit,		.		.		.		.
R. A.		19 2 59.80		19 14 19.33		17 25 51.25		.
Error of Timepiece,		.		.		.		.

Assume n = -1.45

145 / 91 / 145

145 / 133 / 435 / 435 / 1928

1015 / 1044

1305 / 1.32 / 26 / 1.58

$0 = 1\ 52.18 - 1.04 + 1.58 = 1\ 52.72$

$0 = 1\ 53.37 - 1.93 + 1.58 = 1\ 53.02$

1.74

1 52.87

1 50.32

+2.55 Dec.

5.10 / 17 / 5.23

190

15.287 / 1.21 / 154.13

1 52.87 / 2.65 / 1 55.52

22 6 0.3 = 1327

22 4 9.5 = 2457.

6 0.3 / 6 0.08

6 0.3 / 1 53.09 / 4 9.91 / 4 9.50 / 4 07.21 / 4 9.5 / 7.3

1 52.87 / 5.23 / 1 58.10

255 / 3 / 7.65 / 52.87 / + 60.52

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 16 1878. Instrument, Mer. Circle Observer, J. F. M.

Timepiece, 1327 Recorder, Chas. H. H. Cowp

Object,	109 Herculis			α Lyrae.			α Ophiuchi					
Circle,	.40			.80			.22					
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.							12°39'					
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			30.9			48.5			17.0			.
II.			33.0			57.3			19.0			.
III.			35.3			54.0			21.2			.
IV.			37.5			56.5			23.3			.
V.	20		39.8	34		59.2			25.4			.
Sum,			26.5			19.5			5.9			.
Mean,	20		35.3	34		53.9			21.18			.
Bb,			.			.			.	20	47	25.15
Cc,			.			.			.		23	.64
Aa,			.			.			.	20	45	21.51
											45	29.50
												+8.00
Corr'd Transit,			.			.			.			.
R. A.	18	18	32.81	18	32	51.02	17	29	19.12			.
Error of Timepiece,			.			.			.			.

assumen = 1.45 $0 = 2\ 2.50 - .58 + 1.56 = 2\ 3.48$

$0 = 2\ 2.88 - 1.16 + 1.56 = 2\ 3.32$

$0 = 2\ 2.06 - .32 + 1.56 = 2\ 3.30 + .10 = 2\ 3.40$

2 3.48
2 3.32
2 3.30
1.10
+2 3.37

2 3.37 Error 3.27
1 5 2.87
4 10.50 2.63
8 rate 1.327
25
24
1.0

1.45 1.327
145 3451
91
145
1805
1.3195
1.32
26
156
1.45
22
290
24
.31

20 47 25.15
20 45 29.50

24 2.6 #1.11
11
26

27
32
.64
3.

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 7.3 1878. Instrument, New Circle Observer, J.F.M.

Timepiece, 1327 Recorder, Chron. W.W. Soule.

Object,	109 Herculis		α Lyrae.					
Circle,	.40							
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.20								
	h m s		h m s		h m s		h m s	
Wire, I.		33.4		51.7		.		.
II.		35.7		54.3		.		.
III.		38.0		56.6		.		.
IV.		40.3		59.3		.		.
V.		42.5		1.9		.		.
Sum,		39.9		223.8 (60) 273.8		.		.
Mean,		37.98		56.76		.		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	18	18 32.80	18	32 51.00		.		.
Error of Timepiece,		.		.		.		.

assume. n = -1.45

0 = 2 05.18 − .58 + 1.56 = 2 06.16

0 = 2 05.76 − 1.16 + 1.56 = 2 06.26

+ 2 06.21 Eq of 1327

2 3.37

+ 2.84 dat.

24 | 2.84 | 1.12

6 24

44

1327 21 3 10

3457 21 1 13.3

3 10
2 6.48
1 3.52
1 13.30
9.88

12
14
48
12
168
1.90
6.53
.8 34.3
2 8.23

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 8.3 1875. Instrument, Mer. Circle Observer, J.H.M.

Timepiece, 1327 Recorder, Chas. H. Rockwell.

Object, Circle,	109 Herculis		α Lyrae				
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.20								
	h m s		h m s		h m s		h m s	
Wire, I.		36.0		53.8		.		.
II.	20	38.3		56.3		.		.
III.		40.5		59.0		.		.
IV.		42.7		1.5		.		.
V.		45.0		4.5		.		.
Sum,		2,5		175.1		.		.
		.		120				
				295.1				
Mean,		40.50		59.02		.		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.		.		.		.		.
	18	18 32.79	18	32 50.58				
Error of Timepiece,		.		.		.		.

Assume $u = -.145$

$0 = 2\ 07.71 - .58 + 1.56 = 2\ 08.69$

$0 = 2\ 08.44 - 1.16 + 1.56 = 2\ 08.88$

157

$2\ 08.78$

206.21

$+ 2,57$ dat.

21 2 42 = 3451

21 4 40 = 1327

2 9.03

21 2 30.97

420

11.03

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 9. 4 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas.

Object, Circle,	α Cygni 1,00		ν Cygni .86		ξ Cygni .57			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +.20	14° 50′		40° 42′		29° 43′			
	h m s		h m s		h m s		h m s	
Wire, I.	25.0		46.8		54.2			.
II.	28.0		49.6		56.6			.
III.	30.9		52.3		59.0			.
IV.	33.8		54.9		1.3			.
V.	36.6		57.6		3.8			.
Sum,	4.3		11.2		174.9			.
Mean,	30.86		52.24		58.98			.
Bh,	.		.		.			.
Ce,	.		.		.			.
Aa,	.		.		.			.
Corr'd Transit,	.		.		.			.
R. A.	20 37 19.45		20 52 40.75		21 7 48.13			.
Error of Timepiece,	.		.		.			.

assume n = -1.45

$0 = 2\ 11.41 - 1.45 + 1.56 = 2\ 11.52$

$0 = 2\ 11.49 - 1.25 + 1.56 = 2\ 11.80$

$0 = 2\ 10.85 - .81 + 1.56 = 2\ 11.60$

1.92

$\Delta t + 2\ 11.64 = $ Em of 1327.

22 12 45
2 11.82
22 10 33.18
45.15
12.33 Em of 3451

2 8.78
263 | 12.86 | 1.11
263
230
263

10 45.5 = 3451
22 12 45 = 1327

1.10
5
1.15
11.64
2 12.79

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1877phae.proj.1797N

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 10th 1878. Instrument, Mer. Cir. Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. H. Smith.

Object,	α Herculis			ζ Serpentis			γ Lyrae				
Circle,	.55 E			.05			.72				
	W		E	W		E	W		E	W	E
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b. = +.20	28°44			−2°56′			31°34				
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			57.9			11.1			7.6		.
II.			0.2			13.2			10.1		.
III.			2.5			15.3			12.8		.
IV.			4.8			17.4			15.2		.
V.			7.3			19.4			18.0		.
Sum,			12.7			26.4			13.7		.
Mean,			2.54			15.28			12.74		.
Bb,			.			.			.		60.00
Cc,			.			.			.		2 13.90
Aa,			.			.			.		46.10
Corr'd Transit,			.			.			.		59.5
R. A.	18	2	49.57	18	15	3.10	19	2	59.62		+13.40
Error of Timepiece,			.			.			.		2.15
											+15.55

2 = −1.45 55 725 725 .7975 145 72 290 1015 1.0440

0 = 2 12.97 − .80 + 1.56 = 2 13.73

0 = 2 12.18 − .07 + 1.56 = 2 13.68

0 = 2 13.12 − 1.04 + 1.56 = 2 13.62 23

20 31 59.5 = 3451 +2 13.67 Error of 1327

20 60 = 1327

2 13.9 0 23

2.30 1.25 3.55 2 13.67 2 17.22

1.15 10 1.25

2 13.67 2.30 2 15.97

2 13.67 2 11.64 2.03 +.27 2.30

15 62 3179 18 .26 22

110 110 3 1.13 26

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 12. 1878. Instrument, Mer Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. F. McCoy.

Object,	θ Herculis			η Serpentis			109 Herculis				
Circle,	.55			.05			.40				
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b.	28°45'			−2°56'			21°43'				
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.		5	2.7			16.0			46.0		.
II.			5.0			18.1			48.1		.
III.			7.4			20.2			50.5		.
IV.			9.6			22.2			52.7		.
V.			12.0			24.3			54.8		.
Sum,			36.7		0	0.8		0	2.1		.
Mean,			7.34			20.16			50.42		.
Bb,			.			.			.		46 5.1
Ce,			.			.			.		2 19.06
Aa,			.			.			.		43 46.04
											2
											75.96
Corr'd Transit,			.			.			.		.
R. A.	18	2	49.53	18	15	3.05	18	18	32.73		.
Error of Timepiece,			.			.			.		.

13.5
1.35
2 18.61
2 19.96

0 = 2 17.81 − .80 + 1.56 = 2 18.57
0 = 2 17.11 − .07 + 1.56 = 2 18.60
0 = 2 17.69 − .58 + 1.56 = 2 18.67
14
+ 2 18.61 Error of 1327.
2 13.67
4.9 4
2 4.92
value +2.46
1327

1327 = 22 46 5.1
3451 = 44 2

2 18.61
.44
2 19.05

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1877phae.proj.1797N

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 13th 1878. Instrument, Mer. Circle. Observer, J. F. M.

Timepiece, 1327 Recorder,

		w	e	w	e	w	e	w	e
Object,									
Circle,									
Level Direct,		.	.	.	.	.	.	.	.
Reversed,		.	.	.	.	.	.	.	.
Sums,									
Difference,									
b.									

		h	m	s
Wire,	I.			.
	II.			.
	III.			.
	IV.			.
	V.			.
Sum,				.
Mean,				.

Bb,	.	.	.	20	31	31	.			
Ce,	.	.	.		2	21.47				
Aa,	.	.	.	29	9.53					
						2700				
Corr'd Transit,						17.47				
R. A.	18	18	.	.						
Error of Timepiece,	.	.	.	.						

Scale for Chron Sheets



Mr Frank Walds
Harvard Observatory
Cambridge.
Mass.

0 = 2 20.27 −.58 +1.56 = 2 24.25 Error 1327

2 18.61

2.64 260

+ 2.60

rate of 1327 130

11

1.41

2 21.25

2 22.66

1327 = 20 31 31

3001 = 20 29 27

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 13th 1878. Instrument, Mer. Circle. Observer, J. F. M.

Timepiece, 1327 Recorder,

Object,								
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,							.	.
Difference,								
b.								
							h m	s
Wire, I.								.
II.								.
III.								.
IV.								.
V.								.
Sum,								.
Mean,								.
Bb,	.		.		.		20 31 31	.
Ce,	.		.		.		2 21.47	
Aa,	.		.		.		29 9.53	
Corr'd Transit,								17.47
R. A.	18 18 3							
Error of Timepiece,	.		.		.			.

6.00
26
25.84
2.92

1 2 3 4 60
1.2.3.4.5.6.7.8.9.0.
2 45
1.23

0 = 2 20.27 − 28 + 1.56 = 2 24.25 Err of 1327

2 18.61

2.64 260

+ 2.60

rate of 1327 130
11
1.41

2 21.25

2 22.66

1327 = 20 31 31
1327 = 20 29 27

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 14 1878. Instrument, Observer,

Timepiece, Recorder,

Object,	δ Ursae Min.		ο Herculis		η Serpentis		109 Herculis	
Circle,	16.94		.55		.05		.40	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. +.20								
	h m s		h m s		h m s		h m s	
Wire, I.	13 3.5		8.0		21.3		51.3	
II.	37.7		10.3		23.6		53.5	
III.	56.4 / 12.6		12.8		25.6		55.8	
IV.	28.5 / 47.9		15.0		27.7		58.0	
V.	~~46~~ 22.5		17.5		29.8		0.3	
Sum,	209.1 / 120 / 89.1		13.6 / 60 / 73.6		28.0		218.9 / 60 / 198.9	
Mean,	12.74		12.72		25.60		55.78	
Bb,	.		.		.		.	
Cc,	.		.		.		.	
Aa,	.		.		.		.	
Corr'd Transit,	.		.		.		.	
R. A.	18 11 26.28		18 2 49.49		18 15 3.02		18 18 32.69	
Error of Timepiece,	.		.		.		.	

P. $0 = 2\ 46.46 + 16.94m + \Delta t + n$.

$0 = .2\ 22.97 + .33m + n$

16.6 | 23.49 | 1.41
1661
6880
6644
2360

$0 = 23.49 + 16.61m$

$m = -1.41$

91
141
1269
1.2831
26
1.54

$0 = 2\ 23.23 + .55m + \Delta t + n$

$0 = 2\ 22.58 + .05m + n$

$0 = 2\ 23.09 + .40m + n$

8.90 100

$0 = 2\ 22.97 + .33m + n$

$0 = 2\ 22.97 - .47 + 1.54 = 2\ 24.07$

Adopt 1327 = 2 24.07

1327 = 22 49 40
3451 = 22 47 34.5

22 49 40
2 24.57
22 47 15.43
7 34.50
19.07
Err. 3451

2 24.07
2 21.85
+2.22
Δt
ΔT = T.10

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 15 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, Recorder,

Object,	∂ Herculis		η Serpentis		109 Herculis.			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		10.8		24.1		54.0		.
II.		13.3		26.3		56.2		.
III.		15.6		28.4		58.5		.
IV.		17.8		30.3		0.7		.
V.		20.2		32.4		2.8		.
Sum,		27.7		41.5		172.2		.
		.		.		120		
						292.2		
Mean,		15.54		28.30		58.44		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.	(2451)	13.5
R. A.	18 2	49.47	18 15	3.05 2.99	18 18	32.68	(1327) 21 8	20.2
Error of Timepiece,		.		.		.		.

u = − 1,40
55
70 91
78 1.4
,77 364
91
1,274
26
14 1.53
4
,56

0 = 2 26.07 * − .77 + 1,53 = 2 26.83
0 = 2 25.25 − .07 + 1,53 = 2 26.71
0 = 2 25.76 − .56 + 1,53 = 2 26.73
17
+2 26.76 Emf 1327
= 24.07
2.70 vali

24 | 270 | 1.113
240
30
24
60

1327.
21 8 20.2
2 27.10
21 5 53.10
6 13.5
+20.4
Em. 3451

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 16th 1878. Instrument, Mer. Circle Observer, D.A.K.

Timepiece, 1327 Recorder, Chas. D.W. Comp.

Object,	α Herculis			η Serpentis			109 Herculis				
Circle,											
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b. = +.20											
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			13.3			26.8			56.6		.
II.			15.7			28.9			58.8		.
III.			17.9			30.9			0.9		.
IV.			20.5			33.0			3.3		.
V.			22.9			35.0			5.6		.
Sum,			40.3			4.6			125.2		.
			.			.			5.2		
Mean,			18.06			30.92			1.04		.
Bb,			.			.			.		.
Ce,			.			.			.		.
Aa,			.			.			.	20 16 5	
										229.54	
										13 35.46	
										57	
										21.54	
Corr'd Transit,			.			.			.		.
R. A.	18	2	49.45	18	15	3.07	18	18	32.64		
Error of Timepiece,			.			.			.		.

0 = 228.61 − .77 + 1.53 = 229.37

0 = 227.85 − .07 + 1.53 = 229.31

0 = 228.37 − .56 + 1.53 = 229.34

12

+ 229.34 error of 1327

226.76

+ 2.58 ratio of

3451 = 20 13 57

1327 = 20 16 5

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 17.3 187 . Instrument, ... Observer, MAR.

Timepiece, ... Recorder, ...

Object,	β Lyrae			ζ Lyrae			γ Aquilae				
Circle,	.65			.72			.18				
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b. = +.20	33° 12'			35° 55'			10° 19'				
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.		3	.2			25.7		57	.9		.
II.		5	.8			28.3		59	11.1		.
III.		8	.2			30.9		1	13.2		.
IV.		10	.9			33.3		3	15.3		.
V.		13	.2			35.8		5	17.4		.
Sum,		41	.4			4.0		123	.2		.
		.				.		3	.2		.
Mean,		8	.28			30.80		1	.64		.
Bb,			.			.			.	21	5 40
Cc,			.			.			.		2 32.10
Aa,			.			.			.	21	3 07.90
											308.
											2 29
Corr'd Transit,			.			.			.		.
R. A.	18	45	37;01	19	2	59.48	19	40	30.96		.
Error of Timepiece,			.			.			.		.

Assume = -1.40

65

70

14 72 28

84

91

98

1.008

14 48 112 14 25

0 = 2 31.27 − .91 + 1.53 = 2 31.89

0 = 2 31.32 − 1.01 + 1.53 = 2 31.84

0 = 2 30.68 − .25 + 1.53 = 2 31.96

.29

+ 2 31.90 = Error of 1327

2 31.78

2 29.34

+2.44 rate 1327

1.00 62 45 27 76 .16

1327 = 21 5 40

3451 = 30.8

1.22 10 1.32 2 31.90 2 33.22

1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 18 3 1878. Instrument, Mer. Cir. Observer, Mak.

Timepiece, Recorder, Chas. P.W.

Object,	β Lyrae		ε Lyrae		γ Aquilae			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		5.8		28.2		.		.
II.		8.2		30.7		.		.
III.		10.6		33.2		.		.
IV.		13.1		35.9		.		.
V.		15.6		38.3		.		.
Sum,		53.3		16.3		.		.
		.		.		.		.
Mean,		10.66		33.26		.		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	18 45	36.99	19 2	59.46	19 40	30.94		.
Error of Timepieee,		.		.		.		.

0 = 2 33.67 − .81 + 1.53 = 2 34.29

0 = 2 33.80 − 1.01 + 1.53 = 2 34.32

61

+2 34.30 Err of 1327

2 31.90

+2.40

+3

+2.43 = rate of 1327

63
47
110
55
18

1327 = 20 42 30

3451 = 20 40 19.55

4 2 30

2 34.48

39 55.52

19.55

24.00

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 19, 13 1878. Instrument, Mer. Ci. Observer, Mark

Timepiece, Recorder, Chron. D.H.

Object,	i Lyrae	K Cygni	β Cygni	
Circle,	.72	1.33	.52	
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. | .	. | .	. | .	. | .
Difference,				
b. = +.20		85°9'	27°42'	
	h m s	h m s	h m s	h m s
Wire, I.	30.5	49.2	22.3	.
II.	33.0	52.6	24.5	.
III.	35.5	55.9	27.0	.
IV.	38.2	59.2	29.2	.
V.	40.7	2.8	31.5	.
Sum,	279	219.7 / 60 / 279.7	34.5	.
Mean,	35.58	55.94	26.90	.
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	19 2 59.46	19 14 18.84	19 25 50.98	.
Error of Timepiece,	.	.	.	.

25
30.81
48.16
13.6
25.44

n = −140
72
28
98 133
1.008 14
532
133
1.862
14
52
28
70
.73

0 = 2 36.12 − 1.00 + 1.53 = 2 36.65
0 = 2 37.10 − 1.86 + 1.53 = 2 36.77
0 = 2 35.92 − .73 + 1.53 = 2 36.92
12
2 36.71 Error of 1327.
34.30
2.41 +
4
2.45 = value of 1327

2 36.71
2.45
17
2 39.33

1327 =
3451 = 20 24 13.6
3

25
30
132
2 34.71
2 38.03

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 22nd 1878. Instrument, ... Observer, N.A.R.

Timepiece, ... Recorder, ...

Object,	Vaquilae			ϰ aquilae			βaquilae				
Circle,	,18			,15			,10				
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b. = +,20											
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			9.3			31.8			.		.
II.			11.5			33.9			.		.
III.			13.6			35.9			.		.
IV.			15.8			37.9			.		.
V.			17.9			40.2			.		.
Sum,			18.1			29.7			.		.
Mean,			13.62			35.940			.		.
Bb,			.			.			.		.
Cc,			.			.			.		.
Aa,			.			.			.		.
Corr'd Transit,			.			.			.		.
R. A.	19	40	30.86	19	44	53.21	19	49	22.64		
Error of Timepiece,			.			.			.		.

u = −1.40
18
11.2
14
25

14
15
210

42.73
1.31
44.04

0 = 2 42.76 − .25 + 1.53 = 2 44.04

0 = 2 42.73 − .21 + 1.53 = 2 44.04

2 44.04
36.71
17.33
5
317.28
2.43

13 27 21 57 35.0
34 51 55 20.5

57 35.0
− 2 44.25
50.75
5 20.5
29.75

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 23.3 1878. Instrument, ... Observer, mark

Timepiece, ... Recorder, ...

Object,	i Pegasi		ζ Aquilae					
Circle,	.72		.15					
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		39.7		34.0		.		.
II.		42.2		36.2		.		.
III.		44.8		38.3		.		.
IV.		47.5		40.3		.		.
V.		50.0		42.3		.		.
Sum,		24 2 .		41 .1 .		.		.
Mean,		44.84		38.22		.		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	19 2 59.36		19 44 53.23			.		.
Error of Timepiece,		.		.		.		.

1.40
.72
.28
9 8
1.01

0 = 2 45.48 − 1.01 + 1.53 = 2 46.00

0 = 2 44.99 − .21 + 1.53 = 2 46.31

assume the 2 46.31 to be right. Error 1327.

2 44.04

+ 2.27 rate

1327 = 20 15 00

3451 = 12 44.1

15 00
2 46.35
12 13.65
44.1
30.45

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 23.3 1878. Instrument, M.E. Circle. Observer, W.A.R.

Timepiece, 1327 Recorder, Chron. D.W. Coup.

Object,	ν Cygni		ξ Cygni		τ Cygni		β Cephei	
Circle,	.86		.57		.77		2.75	
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b. = +w	140° 41′		29°43′		37°31		70°2′	
	h m s		h m s		h m s		h m s	
Wire, I.		21.2		29.0		39.3		44.2 / 49.1
II.		23.9		31.2		42.0		53.5
III.		26.6		33.6		44.5		56.1 / 59.5
IV.		29.5		36.0		47.1		2.5 / 8.4
V.		32.0		38.5		49.6		
Sum,		33.2		18.3		22.5	27 3.3	273.3
Mean,		26.64		33.66		44.56	7 193 3.3 / 56.19	7 378.3 / 5
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.	21 7 48;10			.		.
R. A.	20 52	40.58	~~21 0 32.66~~		21 9	58.54	21 27	7.45
Error of Timepiece,		.		.		.		.

P 0= 2 48.74 + 2.75 u + Δt+m.

0 = 2 45.86 + .73 u + "

0 = 2.88 + 2.02 u + "

2.02 | 2.88 | 1.45

202

860

808

520

u = − 1.45

.91

145

1305

1.31

26

1.57

145

73

435

1015

1.0585

86

47

.33

0 = 2 46.06 + .86 u + Δt+m

0 = 2 45.56 + .57 u + "

0 = 2 45.96 + .77 u + "

2.58 220 73

0 = 2 45.86 + .73 u + "

0 = 2 45.86 − 1.05 + 1.52

+2 46.33 = Error ~~chr~~ 1327.

2 46.23

2 44.84

+2.19 rate

2412.20 | 0.0917

216

40

160

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 25.3 1878. Instrument, Observer,

Timepiece, Recorder,

Object,	ν Aquii			ξ Aquii			ε Pegasi				
Circle,							16				
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b.							9°18'				
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			24.6			32.6			0.2		.
II.			27.6			35.0			2.3		.
III.			30.3			37.4			4.6		.
IV.			32.8			39.8			6.6		.
V.			35.6			42.1			8.6		.
Sum,			0.9			36.9			22.3		.
			.			.			.		.
Mean,			30.18			37.38			4.46		.
Bb,			.			.			.		.
Cc,			.			.			.		.
Aa,			.			.			.		51 40.
											2 50.35
Corr'd Transit,			.			.			.		48 53.35
											27 .
R. A.	20	52	41;00	21	7	48;12	21	38	15.45		33.35
Error of Timepiece,			.			.			.		.

1 45 / 86 / 8 7 0 / 11 6 0 / 1.2 4 7 0

0 = 2 49.18 − 1.24 + 1.52 = 2 49.46 Ky.

0 = 2 49.26 − .82 + 1.52 = 2 49.96

1 45 / 57 / 10 1 5 / 4 2 5 / 8 2 6 5 ·1.29

0 = 2 49.01 − .23 + 1.52 = 2 50.30

.26

+ 2 50.13 Err of 1327

46.33

2 3.80

+ 1.90

2 46 / 4 5 | 11 9 0 | 1.08 / 19 2

23 51

2 50.13 / 22

27 34.57

44 13.27

96 / 50.13 / 55.09

51.09

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date,..... 187 . Instrument,..... Observer, ...

Timepiece,..... Recorder,.....

Object,								
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	13 27 .			.		.		.
II.	15.2 .		57.5	.		.		.
III.		.		.		.		.
IV.		.		.		.		.
V.		.		.		.		.
Sum,		.		.		.		.
Mean,		.		.		.		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.		.		.		.		.
Error of Timepiece,		.		.		.		.

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 27 1878. Instrument, Mer. Circle Observer, J.F.M.

Timepiece, 1327 Recorder, F.W. Coup.

Object,	η Serpentis				109 Herculis				ε Lyrae.						
Circle,		.05				.40				.80					
	w		e		w		e		w		e		w		e
Level Direct,	.		.		.		.		.		.		.		.
Reversed,	.		.		.		.		.		.		.		.
Sums,	.		.		.		.		.		.		.		.
Difference,															
b.	−2°55′				21°42′										
	h	m	s		h	m	s		h	m	s		h	m	s
Wire, I.			51.7				21.5				39.0				.
II.			53.8				23.8				41.5				.
III.			55.8				26.0				44.3				.
IV.			57.8				28.2				47.0				.
V.			60.0				30.3				49.7				.
Sum,			29.1				29.8				21.5				.
Mean,			55.82				25.96				44.3				.
Bb,			.				.				.				.
Ce,			.				.				.				.
Aa,			.				.				.				.
Corr'd Transit,			.				.				.				.
R. A.	18	15	02.85		18	18	32.44		18	32	30.52				.
Error of Timepiece,			.				.				.				.

u = −1.145
5
.0725
1.45
4
.580

0 = 2 52.97 − .07 + 1.52 = 2 54.42
0 = 2 53.52 − .58 + 1.52 = 2 54.46
0 = 2 53.78 − 1.16 + 1.52 =

u 8
u 4
55.92

8

+ 2 54.44 Error of 1327
2 50.13
4.31
39
4.60
+ 2.30 rate of 1327.

1327 = 2 35 45
3451 = 2 33 26.15

35 45
2 54.62
50.38
26.15
35.77
33.35
2.42
10
2 (2.52
1.26

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, September 28 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chronograph. U.S. Coast.

Object,	ι Lyrae			σ² Cygni			β Delphini					
Circle,	.72			1.05								
	w		e	w		e	w		e	w		e
Level Direct,	.		.	.		.	.		.	.		.
Reversed,	.		.	.		.	.		.	.		.
Sums,	.		.	.		.	.		.	.		.
Difference,												
b.				46° 21'								
	h	m	s	h	m	s	h	m	s	h	m	s
Wire, I.			50.4			40.7			.			.
II.			53.0			43.6			.			.
III.			55.5			46.6			.			.
IV.			58.0			49.7			.			.
V.			0.5			52.6			.			.
Sum,			27.4			33.2			.			.
Mean,			55.48			46.64			.			.
Bb,			.			.			.			.
Ce,			.			.			.			.
Aa,			.			.			.			.
Corr'd Transit,			.			.			.			.
R. A.	19	2	59.33	20	9	49.81			.			.
Error of Timepiece,			.			.			.			.

145 72 350 290 1015 1044 — 105 105 425 1450 15225

0 = 2 56.25 − 1.04 + 1.52 = 2 56.73

0 = 2 56.83 − 1.52 + 1.52 = 2 56.83

1327 20 59 35
3451 20 57 14.7

59 35
2 56.90
56 38.10
14.70
36.10
−7

2 56.83
2 56.83
+ 2 56.83
Error 1327 at 20h 9m (S.T.)

2 56.83
2.24
1.12
3 00.19

12 43 36 108 111.6 — 24 | 2.24 | 1.0 98 — 216 — 80

2 54.44
2.39
15
2.24

2 56.83
2.36
2 59.19

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept 30. 1878 Instrument, Mer. Circ. Observer, WAR.

Timepiece, Recorder, D.W. Coupe.

Object,	ε Cygni		ζ Cygni					
Circle,	.57		.77					
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.	+29°43'		37°31'					
	h m s		h m s		h m s		h m s	
Wire, I.		43.5		54.0		.		.
II.		46.0		56.6		.		.
III.		48.4		59.2		.		.
IV.		50.8		1.8		.		.
V.		53.2		4.3		.		.
Sum,		41.9		175.9 / 120 / 295.9		.		.
Mean,	+29°	48.38		59.18		.		.
Bb,		.		.		.		.
Ce,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	21 7	48.60	21 9	58.42		.		.
Error of Timepiece,		.		.		.		.

145 / 57 / 1015 / 725 / .8265 / 29 / 12

0 = 3 00.38 − .82 + 1.52 = 3 00.08

0 = 3 00.96 − 1.12 + 1.52 = 3 01.16

3 01.12

2 56.83

14.69 / 10

2(4.60) / 2.30

21 27 52.65 ch / 15 cl.

15 / 3 * 1.15 / 3 13.85 / 52.65 / 38.8

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 1st 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. D.W. Coolidge.

Object,	α Cygni	ν Cygni	ε Cygni	β Cephei.
Circle,	1.00	.86	.57	2.75
	w | e	w | e	w | e	w | e
Level Direct,	. | .	. | .	. | .	. | .
Reversed,	. | .	. | .	. | .	. | .
Sums,	. .	. .	. .	. .
Difference,				
b. = +.20	44° 50′	40° 41′	29° 44′	70° 2′
	h m s	h m s	h m s	h m s
Wire, I.	16.0	37.7	45.4	0 3
II.	19.0	40.2	47.9	3.5
III.	22.0	43.0	50.2	6.4
IV.	24.9	45.6	52.5	9.5
V.	27.7	48.6	55.0	12.5
				15.3
				18.5
				21.8
				24.5
Sum,	9.6	15 1	1.0	112.3
	.	.	.	.
Mean,	21.92	43.02	50.2	12.53
Bb,	.	.	.	.
Cc,	.	.	.	.
Aa,	.	.	.	.
Corr'd Transit,	.	.	.	.
R. A.	20 37 19.01	20 52 40.37	21 7 47.88	21 27 7.08
Error of Timepiece,	.	.	.	.

P. 0 = 3 5.45 + 2.75 n + Δt+n.
0 = 3 2.63 + .81 n + "
0 = 2.82 + 1.94 n
n = − 1.45

0 = 3 2.91 + 1.00 n + Δt+n
0 = 3 2.65 + .86 n + "
0 = 3 2.32 + .57 n + "
1.88 + 2.43

0 = 3 2.63 + .81 n + Δt+n
0 = 3 2.91 + 1.45 + 1.52 = 3 2.98
0 = 3 2.65 − 1.25 + 1.52 = 3 2.92
0 = 3 2.32 − 0.83 + 1.52 = 3 3.01
2.91
3 2.97
3 2.97
3 2.88

36.2 (Ch
21 21 59.0 (Cl)
3 3.
56
36.2
40.2

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, ~~Sept.~~ Oct. 2nd 1878. Instrument, Mer. Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chron. A.W. Comp.

Object, Circle,	α Cygni		ν Cygni		ξ Cygni			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		17.5		39.0		46.9		.
II.		20.2		41.7		49.4		.
III.		23.2		44.5		57.6		.
IV.		26.0		47.1		53.9		.
V.		29.0		49.9		56.3		.
Sum,		15.9		22.2		7.1		.
		.		.		.		.
Mean,		23.18		44.44		51.54		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.		.
R. A.	20 37	18,99	20 52	40.35	21 7	47.86		.
Error of Timepiece,		.		.		.		.

(Ch (Cl)

3 04.19 + .07 = 3 04.26
3 04.09 + .27 = 3 04.36
3 03.68 + .70 = 3 04.38
10
+3 4.33 Error 1327.
3 2.97
+1.36

22.2 Ch
2139 45.
3 4.38
3 40.62
22.2
41.58

.57
11.5
5
63
.66

41.58
63
8
42.21

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HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Oct. 3, 3 1878 Instrument, Rus Zenith Observer, A.W.

Timepiece, 3451 Recorder, A.W.

Object,	α Cephei		ε Pegasi		ε Pegasi			
Circle,	reading							
	w	e	w	e	w	e	w	e
Level Direct,	49.0	19.5	48.0	18.2	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.	62°4'				9°19			
	h m s		h m s		h m s		h m s	
Wire, I.	17 18 37.0			.		.		.
	18 07.0							
	22 5							
II.	18 52.5		III	9.5		.		.
	19 8 0							
III.	19 23.0		IV	31.5	35 9.5			.
	19 38 5							
IV.	19 53.5			.	35 31.5			.
	20 23 5			5				
V.	20 38.5		V		35 52.8			.
	21 09 0							
Sum,	313.0			.		.		.
	60							
	253.0							
Mean,	19 2 3.0			.		9.5		.
Bb,	200	+8.72		.	86	+3.75		.
Cc,	2.13	.		.	1.02	.		.
Aa,	.71	+50.90		.	54	+255.60		.
Corr'd Transit,	15 40.82			.	3 59.35			.
R. A.	21 15 42.46			.	21 38 15.38			.
Error of Timepiece,		.		.		.		.

49
19.5
2|68.5
34.2
33.1
1.3
33.6
13
1008
336
b = +4.368
4.368
26
16
3488
3.74496

480
18.2
2|66.28
33.1
C.W.

assume C = 0.
α − α
38 15.38
15 42.46
22 32.92
15 46.50
6 46.42
360
12.5 |406.42 +32.52 (a)
375 5 25.2
314
200
6 42
5
2 22

35 9.5
19 23.0
15.46.5

325.2
71
3252
2764
230.89
−3 50.9
325.2
54
3008
1626
175608
2 55.6 6

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1877phae.proj.1797M

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Oct 3 1878 Instrument, Mer Cir Observer, Mak.

Timepiece, 1327 Recorder, Olson T.W. Cary

	Object, Circle,											
		α Cygni 1.05		β Delphini ~~1.05~~ 1.25		α Cygni 1.00						
		w	e	w	e	w	e	w	e			
	Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .			
	Sums, Difference, b.	.	.	.	.	.	.	.	.			
		46 2 21										
		h m s		h m s		h m s		h m s				
Wire,	I.	50.2		54.2		19.5		.				
	II.	.		56.2		22.5		.				
	III.	56.1		58.3		25.5		.				
	IV.	.		0.4		28.3		.				
	V.	2.0		2.5		31.3		.				
	Sum,	108.3		171.6		27.1		.				
		60 / 168 3		120 / 291 6		.		.				
	Mean,	56.10		58.32		55.42		.				
	Bb,	.		.		.		43.20				
	Ce,	.		.		.		1.35				
	Aa,	.		.		.		44.58				
	Corr'd Transit,	.		.		.		.				
	R. A.	20 9 49.68		20 31 52.94		20 37 18.97		.				
	Error of Timepiece,	.		.		.		.				

1.45
1.05
2.25
1.45 0
1.52 25
.36

3 6.42 − 1.52 + 1.52 = 3 6.42
3 5.38 − .36 + 1.52 = 3 6.54
3 6.45 − 1.45 + 1.52 = 3 6.52
1.48
3 6.49 Err. of 1327
3 4.33
2.16
4
2.20 rate

3 6.29
2.20
1.52
3 9.81

16.55 (345)
21 54 40.00 (1327)
3 6.64
21 51 33.36
16.55
43.19

3
3 6.49
2.20
3 8.68
1

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Oct 4.9 1878. Instrument, Mer. Observer, J.E.M.

Timepiece, Recorder,

Object, Circle,	α Leonis				Oct. 6.9 α Leonis			
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.		59.4		.		3.5	~~1327~~ 3451 = 10	46 00
II.		1.5		.		5.8	1327 = 10	48. 27
III.		3.6		.		7.8		.
IV.		5.7		.		9.5		.
V.	10 5	7.8		.		12.0		.
Sum,		.		.		.		.
Mean,	.5	3.6		.	5	7.78		.
Bb,		.		.		.		.
Cc,		.		.		.		.
Aa,		.		.		.		.
Corr'd Transit,		.		.		.	10 48 27	
R. A.	10 1	54.84		.	10 1	54.88	3.14.15 10 45	12.85
							46 00	
Error of Timepiece,		.		.		.	47.15 43.19 35 4.40 35	1.20

5 3.6
1.54.84
3 0 8.76
1.22
309.98
Err of 1327

5 7.78
1 54.88
12.90
1.22
314.12
Err of 1327
42
314.94

150

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1877phae.proj.1797

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Oct 8.5 1878. Instrument, Mer Circle Observer, W.A.R.

Timepiece, 1327 Recorder, Chron D.W. Comp.

Object,	02 Cygni			β Delphini			α Cygni				
Circle,	105			.25			100				
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b.											
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			0.4			4.5			29.9		.
II.			3.5			6.8			32.8		.
III.			6.2			8.8			35.8		.
IV.			9.3			11.0			38.8		.
V.			12.4			13.2			41.6		.
Sum,			31.8			44.3			178.3		.
Mean,			6.36			8.86			35.66		.
Bb,			.			.			.		.
Cc,			.			.			.		.
Aa,			.			.			.		.
Corr'd Transit,			.			.			.		40 35 3 17.08
R. A.	20	9	49.55	20	31	52.87	20	37	18.86	37	17.92 7.05 5.87
Error of Timepiece,			.			.			.		9.13 .

0 = 3 16.81 − 1.52 + 1.52 = 3 16.81

0 = 3 15.99 − 36 + 1.52 = 3 17 25

0 = 316.80 − 1.45 + 1.52 = 3 16.87

50.93

3 16.98 Error 1327 341 2.86 1.08

16.98 14.12

16.48 20 19.03

84 24 336 178 216

84 12 1.08 16.98 18.06

3457 − 2138 7.05

1327 = 35

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Sept. 10th 1878. Instrument, Mer. Circle. Observer, W.A.R.

Timepiece, 1327 Recorder, Chas. H. Goulp

Object, Circle,	α Cygni 1.00		ν Cygni .86		ξ Cygni .57		β Cephei 2.75	
	w	e	w	e	w	e	w	e
Level Direct, Reversed,	. .	. .	. .	. .	. .	. .	. .	. .
Sums, Difference, b. = +.w	.	.	.	.	.	.	.	.
	h m s		h m s		h m s		h m s	
Wire, I.		34.0		55.6		3.6		18 0
II.		37.0		58.5		6.0		21.5
III.		39.8		1.0		8.4		24 1
IV.		42.8		3.8		10.8		27.5
V.		45.7		6.5		13.0		30 6
								33.5
								36 5
								39 4
								42.6
Sum,		49.3		125.4		41 8		273.7
				5.4				
Mean,		39.86		1.08		8.36		30.41
Bb,								10 28 5
								3 2 1.56
								3 43.44
Cc,								36.00
Aa,								52.66
Corr'd Transit, R. A.		20 37 18.80		20 52 40.19		21 7 47.74		21 27 6.65
Error of Timepiece,								1327 = 0 28 5
								3451 = 0 36

P 0 = 3 23.76 + 2.75m + Dt + m.

0 = 3 20.86 + .81m + "

0 = 2.90 + 1.94m

194 | 290 | 1.49

194 − 1.50m

960 91 15

776 135

1840 136 26

1.62

150 57

86 10

90 285

120 57

1.290 .85

162 162

33 .77

0 = 3 21.06 + 1.00m + Δt + m

0 = 3 20.89 + .86m + "

0 = 3 20.62 + .57m + "

2.57 2.43

0 = 3 20.86 + .81 + "

0 = 3 21.06 − 1.50 + 1.62 = 3 21.18

0 = 3 20.89 − 1.29 + 1.62 = 3 21.22

0 = 3 20.62 − .85 + 1.62 = 3 21.39

99

3 21.26

Emf 1327

21.26

16.98

4.28

4.24

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1877phae.proj.17974

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, October 13.3 1878. Instrument, Mer Circle Observer, J.W.M.

Timepiece, Recorder, J.W.

Object,	δ Aquilae			β Cygni			ε Cygni				
Circle,		E4			E2			E5			
	w		e	w		e	w		e	w	e
Level Direct,	.		.	.		.	.		.	.	.
Reversed,	.		.	.		.	.		.	.	.
Sums,	.		.	.		.	.		.	.	.
Difference,											
b.	2°30′			27°41′			51°27				
	h	m	s	h	m	s	h	m	s	h	m s
Wire, I.			46.2			13.1			0.6		.
II.			48.5			15.5			4.0		.
III.			50.5			17.8			7.4		.
IV.			52.5			20.1			10.7		.
V.			54.8			22.5			14.0		.
Sum,			02.5			39 0			36.7		.
Mean,			50.50			17.80			7.34		.
Bb,			.			.			.	23	30 30
Ce,			.			.			.		3 28.46
Aa,			.			.			.		27 1.55
											57.30
											55.75
Corr'd Transit,			.			.			.		.
R. A.	19 19		23.85	19 25		50.49	19 26		39.10		.
Error of Timepiece,			.			.			.		.

$\alpha = -1.50$
125
625
125
1.875

$0 = 3\ 26.65 - .06 + 1.62 = 3\ 28.21$
$0 = 3\ 27.31 - .78 + 1.62 = 3\ 28.15$
$0 = 3\ 28.24 - 1.87 + 1.62 = 3\ 28.00$
36
$+ 3\ 28.12$ Error of 1327.
21.16
8.96
16
$3\ 8.80$
$24\ 2.27$ 1.095
216 9
110 $.855$

$1327 = 23\ 30\ 30$
$3451 = \ \ \ \ 57.3$

$23\ 30\ 30$
$3\ 28.45$
$27\ 01.55$
573
55.75
1.00
$+ 56.75$

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1877phae.proj.1797w

HARVARD COLLEGE OBSERVATORY TIME SERVICE.

Date, Oct. 14 1878. Instrument, Observer,

Timepiece, Recorder,

Object,	α Cygni		ν Cygni		ξ Cygni			
Circle,								
	w	e	w	e	w	e	w	e
Level Direct,	.	.	.	.	.	.	.	.
Reversed,	.	.	.	.	.	.	.	.
Sums,	.	.	.	.	.	.	.	.
Difference,								
b.								
	h m s		h m s		h m s		h m s	
Wire, I.	43.1		4.8		12.8 59.6			.
II.	46.0		7.5		15.0 2.0			.
III.	49.0		10.2		17.4 4.4		17.5	.
IV.	51.8		13.0		19.8 6.9		47.67	.
V.	54.7		15.7		22 9.1		29.83	.
Sum,	44.6		1.2		372 2 8 2 0			.
	.		.		22.0			.
Mean,	48.92		10.24		17.44 4.40			.
Bb,	.		.		.		1 17 15	.
Cc,	.		.		.		3 30.81	.
Aa,	.		.		.		13 44.19	.
							41.4	
Corr'd Transit,	.		.		.		57.21	
R. A.	20 37 18.70		20 52 40.09		21 7 47.67		1.45	
							58.66	
Error of Timepiece,	.		.		.		.	

α = 3 30.22 − 1.50 + 1.62 = 3 30.34

ν = 3 30.15 − 1.29 + 1.62 = 3 30.48

ξ = 3 29.79 − .85 + 1.62 = 3 30.56

126

+ 3 30.47 Error 1327

15

3 30.32

3 28.12

+2.20 rate.

41.4 3451

1 17 15 1327

3 30.80

13 44.20

41.4

57.2

11 2 5 − 8.5

4

116

30.41

+31.57

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1877phae.proj.1794W

1878. No. 1327. 3451. Constants Howard 191 A.W.

August.	Error.	Rate.	Error.	Rate.	Meridian Circle
3.3	+ 40.14				
3.4	+ 48.92	+ 2.17			
8.3	+ 51.12	+ 2.20			
11.3	+ 58.28	+ 2.38	+ 2 10.50		
12.3	+ 60.60	+ 2.32	+ 2 11.82	+ 1.32	
13.4	+ 63.41	+ 2.60	+ 2 13.20	+ 1.35	
14.4	+ 65.98	+ 2.47	+ 2 14.65	+ 1.45	
17.4	+ 73.43	+ 2.48	+ 20.50		
18.4	+ 76.02	+ 2.59			
20.4	+ 81.19	+ 2.58			
22.4	+ 86.25	+ 2.53	− 12.65	+ 1.57	
25.35	+ 93.25	+ 2.32	− 11.20	(	
26.4	+ 95.94	+ 2.65	− 7.90	+ 1.25	
27.4	+ 98.64	+ 2.70	− 5.90	+ 2.00	
29.4	+ 1.04.01	+ 2.68			
31.4	+ 1.48.03	+ 2.01	0.00	+ 1.48	
September.					
1.4	+ 1 50.32	+ 2.35	1.8 + 1.9	+ 1.35	
2.4	+ 1 52.87	+ 2.55	2.4 + 2.30	+ 1.15	
6.4	+ 2 3.37	+ 2.62	6.4 + 8.00	+ 1.42	
7.3	2 6.21	+ 2.84	7.4 + 9.88	+ 1.88	
8.3	2 8.78	+ 2.57	8.4 11.03	+ 1.15	
9.4	2 11.64	+ 2.63	9.4 12.32	+ 1.27	
10.3	2 13.67	+ 2.30	10.4 13.40	+ 1.18	
12.3	2 18.64	+ 2.46	12.5 15.96	+ 1.23	
13.3	2 21.25	+ 2.60	13.4 17.47	+ 1.60	
14.3	2 24.07	+ 2.82	14.4 19.07	+ 1.50	
15.3	2 26.76	+ 2.70	15.4 20.40	+ 1.39	
16.3	+ 2 29.34	+ 2.58	16.3 21.54	+ 1.20	
17.3	2 31.90	+ 2.44	17.4 22.90	+ 1.29	
18.3	2 34.30	+ 2.45	18.3 24.00	+ 1.10	
19.3	2 36.71	+ 2.45	19.3 25.44	+ 1.40	
22.3	2 44.04	+ 2.43	22.3 29.75	+ 1.44	
23.3	2 46.31	+ 2.27	23.3 30.45	+ 0.70	
25.4	2 50.13	+ 1.90	25.4 33.35	+ 1.20	
27.3	2 54.46	+ 2.30	27.4 35.11	+ 1.26	
~~28.3~~	~~2 56.82~~	~~+ 2.24~~	~~27.4 35.11~~	~~+ 1.26~~	
28.3	2 56.82	+ 2.24	28.3 36.01	+ .90	
30.3	3 01.12	+ 2.30	30.3 38.80	+ 1.08	
October.					
1.3	3 2.97	+ 1.90	1.3 40.2	+ 1.40	
2.3	3 4.33	+ 1.36	2.3 41.58	+ 1.38	
3.3		+ 2.20	3.3 43.19	+ 1.63	
4.8	3 9.98	+ 2.25	~~47.25~~	~~+ 1.20~~	
6.8	3 14.12	+ 2.07	44.15	+ 1.20	
8.3	3 16.98	+ 2.11	44.15	+ 1.33	
10.3	3 21.26	+ 2.12	52.66	+ 1.75	
13.3	3 28.12	+ 2.27	55.75	+ 1.03	
14.3	3 30.4	+ 2.24	57.21	+ 1.46	
16.3	3 34.67	+ 2.12	59.92	+ 1.36	
20.3	3 43.66	+ 2.25	20.4 65.00	+ 1.27	
22.3	3 48.04				
			26.3 72.94	+ 1.32	F.W. obs.
26.3	+ 3 56.95	+ 2 23.	~~26.~~ ~~26.3~~		
28.4	+ 3 1.62	+ 2.21			F.W. obs.
29.3	4 3.02				m.aR. obs.

		Error.	Rate.	Rate
Aug.	2.9	− 1 54.1		
	5.9	2 00.5	− 2.15	
	7.9	2 05.3	− 2.40	− 2.25
	8.9	2 07.7	− 2.40	− 2.40
	11.9	2 15.0	− 2.43	− 2.43
	12.9	2 17.4	− 2.40	− 2.40
	13.9	2 19.3	− 1.90	− 1.90
	14.9	2 21.95	− 2.65	− 2.65
	20.9	2 36.85	− 2.47	− 2.47
	21.9	2 39.00	− 2.15	
	24.9	2 44.35	− 2.14	
	25.9	2 48.7	− 2.90	− 2.37
	29.9	2 56.5	− 1.95	
	31.4	3 00.35	− 2.57	+ 21.
Sept.	1.9	−3 03.90	− 2.40	
	2.9	3 0'		
	3.9	3 08.90	− 2.50	
	4.9	3 11.5	− 2.60	
	5.9	3 14.15	− 2.65	
	6.9	3 16.40	− 2.25	
	8.9	3 20.50	− 2.05	
	9.9	3 22.80	− 2.30	
	11.9	3 28.15	− 2.67	
	12.9	3 29.9	−	
	13.9	3 32.5	− 2.16	
	15.9	3 37.0	− 2.25	
	16.9	3 39.1	− 2.10	
	17.9	3 41.45	− 2.35	
	18.9	3 43 30	− 1.85	
	19.9	3 46.00	− 2.70	
	20.9	3 48.10	− 2.10	
	22.9	3 55.15	− 2.35	
	24.9	3 57.50	− 2.35	
	2 29.9	4 09.8	− 2.46	
Oct.	1.9	4 14.5	− 2.35	
	6.9	4 26.4	− 2.40	
	11.9	4 38.1	− 2.34	
	14.9	4 45.5	− 2.47	
	15.8	4 48.10	− 2.60	
	16.8	4 51.50		
	18.9	4 57.50	− 2.92	
	Set back 5 minut		Set ahead 5 m.	
	21.8	0 4.1	− 3.20	
	24.8	− 12.5	− 2.80	
	29.8	19.35	− 2.30	

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1877phae.proj.1797w

1878. No. 1327. 3451. Constants Howard 191 A.W.

August.	Error.	Rate.	Error.	Rate.	Meridian Circle	Aug.	Error.	Rate.	Rate
3.3	+ 40.14					29	− 1 54.1		
3.4	+ 48.92	+2.17				5.9	2 00.5	− 2.15	
8.3	+ 51.12	+ 2.20				7.9	2 05.3	− 2.40	− 2.25
11.3	+ 58.28	+ 2.38	+ 2 10.50			8.9	2 07.7	− 2.40	− 2.40
12.3	+ 60.60	+ 2.32	+ 2 11.82	+ 1.32		11.9	2 15.0	− 2.48	− 2.43
13.4	+ 63.41	+ 2.60	+ 2 13.20	+ 1.35		12.9	2 17.4	− 2.40	− 2.40
14.4	+ 65.98	+ 2.47	+ 2 14.65	+ 1.45		13.9	2 19.3	− 1.90	− 1.90
17.4	+ 73.43	+ 2.48	+ − 20.50			14.9	2 21.95	− 2.65	− 2.65
18.4	+ 76.02	+ 2.59				20.9	2 36.85	− 2.47	− 2.47
20.4	+ 81.19	+ 2.58				21.9	2 39.00	− 2.15	
22.4	+ 86.25	+ 2.53	− 12.65	+ 1.57		24.9	2 44.35	− 2.14	
25.35	+ 93.25	+ 2.32	− 11.20			25.9	2 48.7	− 2.90	− 2.37
26.4	+ 95.94	+ 2.65	− 7.90	+ 1.25		29.9	2 56.5	− 1.95	−
27.4	+ 98.64	+ 2.70	− 5.90	+ 2.00		31.4	5 00.35	− 2.57	+ 21.
29.4	+ 104.01	+ 2.68							
31.4	+ 148.03	+ 2.01	0.00	+ 1.48					
September.									
1.4	+ 150.32	+ 2.35	1.8 + 1.9	+ 1.35		Sept. 1.9	− 3 03.90	− 2.40	
2.4	+ 152.87	+ 2.55	2.4 + 2.30	+ 1.15		2.9	3 0		
6.3	+ 2 3.37	+ 2.62	6.4 + 8.00	+ 1.47		3.9	3 08.90	− 2.50	
7.3	2 6.21	+ 2.84	7.4 + 9.88	+ 1.88		4.9	3 11.5	− 2.60	
8.3	2 8.78	+ 2.57	8.4 11.03	+ 1.15		5.9	3 14.15	− 2.65	
9.4	2 11.64	+ 2.63	9.4 12.32	+ 1.27		6.9	3 16.40	− 2.25	
10.3	2 13.67	+ 2.30	10.3 13.40	+ 1.18		8.9	3 20.50	− 2.05	
12.3	2 18.64	+ 2.46	12.5 15.96	+ 1.23		9.9	3 22.80	− 2.30	
13.3	2 21.25	+ 2.60	13.4 17.47	+ 1.60		11.9	3 28.15	− 2.67	
14.3	2 24.07	+ 2.82	14.4 19.07	+ 1.50		12.9	3 29.9	−	
15.3	2 26.76	+ 2.70	15.4 20.40	+ 1.39		13.9	3 32.5	− 2.16	
16.3	+ 2 29.34	+ 2.58	16.3 21.54	+ 1.20		15.9	3 37.0	− 2.25	
17.3	2 31.90	+ 2.44	17.4 22.90	+ 1.29		16.9	3 39.1	− 2.10	
18.3	2 34.30	+ 2.45	18.3 24.00	+ 1.10		17.9	3 41.45	− 2.35	
19.3	2 36.71	+ 2.45	19.3 25.44	+ 1.40		18.9	3 43.30	− 1.85	
22.3	2 44.04	+ 2.43	22.3 29.75	+ 1.44		19.9	3 46.00	− 2.70	
23.3	2 46.31	+ 2.27	23.3 30.45	+ 0.70		20.9	3 48.10	− 2.10	
25.4	2 50.13	+ 1.90	25.4 33.35	+ 1.20		23.9	3 55.15	− 2.35	
27.3	2 54.44	+ 2.30	27.4 35.77	+ 1.26		24.9	3 57.50	− 2.35	
28.3	2 56.83	+ 2.24	28.3 36.67	+ .90		2 29.9	4 09.8	− 2.46	
30.3	3 01.12	+ 2.30	30.3 38.80	+ 1.08					
October.									
1.3	3 2.97	+ 1.90	1.3 40.2	+ 1.40		Oct. 1.9	4 14.5	− 2.35	
2.3	3 4.33	+ 1.36	2.3 41.58	+ 1.38					
3.3		+ 2.20	3.3 43.19	+ 1.63		6.9	4 26.4	− 2.40	
4.8	3 9.98	+ 2.25	47.15	+ 1.20					
6.8	3 14.12	+ 2.07	47.15	+ 1.20		11.9	4 38.1	− 2.34	
8.3	3 16.98	+ 2.11	49.15	+ 1.33					
10.3	3 21.26	+ 2.12	52.66	+ 1.75		14.9	4 45.5	− 2.47	
13.3	3 28.12	+ 2.27	55.75	+ 1.03		15.8	4 48.10	− 2.60	
14.3	3 30.4	+ 2.24	57.21	+ 1.46		16.8	4 51.50		
16.3	3 34.6	+ 2.12	59.92	+ 1.36		18.9	4 57.50	− 2.92	
						Left Castle 5 minutes		Left ahead 5 m.	
20.3	3 43.66	+ 2.25	26.4 65.00	+ 1.27		21.8	0 4.1	− 3.20	
22.3	3 48.04					24.8	− 12.5	− 2.80	
			26.3 72.94	+ 1.32	F.W. obs.	29.8	19.35	− 2.30	
26.3	+ 3 56.95	+ 2 23.	26. 26.3						
28.4	+ 3 1.62	+ 2.21			F.W. obs.				
29.3	4 3.02				m.aR. obs.				

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1877phae.proj.1797w

Pr. 1

1878

Apr

29.4 = 27.2
19.3 = 15.6
10 11.6

1.16

61.16
56.70
3) 4.46
1.45
33.4

10.79 = 15.04
7.95 10.4
2.84 5.0
0.57

3.2

3 3.4 = 61.16
19.3 = 44.76
14.1 17.40

5) 4.27
0.86

5) 1.73
0.35

3.1) 2.04 (.66
186
180

14.1) 1,74.1 (1.2
141
280
282
-2

16.3
11.8
3.1) 4.5 (1.4
3.1
140

10) 11.7
1.17
58.45

5) 1.31
.26

3) 1.77
1.59
1.18

5) 13.8
0.8

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1977plate.proj.1797w

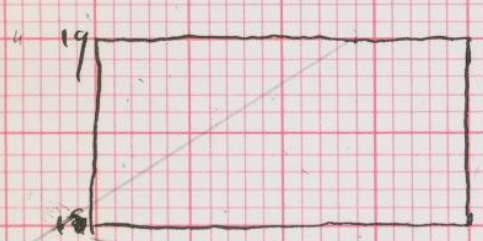
327 Fr. 3451 Russian Transit Howard 191

		Error	Rate	Error	Rate	a	b	c		Error	Rate
		°	s	s	s	s	s	s		s	s
	3.4	+21.20	+0.51	+27.97	+1.21	−1.51	+0.30	+0.321 (E)			
	7.9	+23.5	+0.57	+35.11	+1.78		+0.26				
	8.4	+25.77	+2.27 (?)	+37.01	+1.26	−1.23	+0.36	+0.32			
	12.9	+28.00	+0.50	+45.48	+1.88						
	16.4	+30.60	+0.74	+52.10	+1.89	−2.74	−0.19	+....			
	17.4			+53.4	+1.3	+2.78					
	19.4	+32.50	+0.63	+55.27	+0.95	+					
	21.4	+34.26	+0.62	+58.76							
May	1.4	+36.78	+0.25	+65.57	+0.78						
	3.4	+37.01	+0.15	+67.83	+0.90						
	4.3	+37.35	+0.19								
	5.4	+38.08	+0.53								
	6.4	+38.83	+0.61								
	8.4	+40.73	+0.90								
	10.4	+42.18	+0.73	+14.68	+0.	−0.58	−0.02	?+0.74 (E)			
	13.4	+45.62	+0.98			0.00	−0.32	+0.40			
	16.4	+47.70	+0.8	+21.70			+0.03				
	17.4	+48.65	+0.95	+22.83			−0.20				
	19.4	+50.60	+0.98	+25.30			−0.29				
	24.0	+55.07		+28.67		by ⊙					
	26.4	+58.42	+1.67	+32.12		−0.29	−0.29	+0.556 (E)			
	28.4	+61.58	+1.58	+34.78	+1.33		−0.23				
June	1.4	+67.04	+1.12	+39.64	+1.42	+0.425	−0.09	+0.62 (E)		+16.00	
	3.4	+69.47	+1.22	+42.57						+15.61	−0.20 ?
	5.4	+71.13	+1.40	+44.34						+13.54	−1.03
	6.4	+72.53	+1.41								
	7.4	+73.94	+1.60								
	9.4	+77.14	+1.61	+48.31	+1.00						
	11.4	+80.52		+50.7	+1.2						
	13.4	+84.03	+1.75	+53.55	+1.4					+5.72	−0.98
	15.4			+56.20	+1.4					+2.67	−1.52
	16.4	87.18	+1.05	+57.19	+1.0						
	19.4	+92.28	+1.37	+61.78	+1.42	+1.08	+0.06	+0.53 (E)			
	20.0									−4.80	−1.50
	20.4	+93.83	+1.55	+62.93	1.15						
	23.4			+67.52	+1.56					−10.80	−1.80
	24.4			+67.75	+0.23					−13.70	
	25.4					+0.20	−0.14	+0.50			
	26.4			70.93	+1.89					−16.76	
	28.4	−36.4		72.89	+0.98					−20.62	−1.93
	30.4	−31.78	+2.31	75.72	+1.42					−24.9	−2.2
July	1.4	−31.1	.68	76.08	+.36				July 5.9	−35.7	
	2.4	−30.76									
	3.4	−26.86							8.9	−42.0	−2.1
									9.9	−44.0	−2.0
	6.4	−21.06	+1.90	80.44	+.87				10.9	−45.5	−1.5
	8.4	16.54		82.9	+1.23				11.9	−47.8	−2.3
	9.4	−14.23	+2.31						17.9	−77.2	−3.2 2.
		~~−0.344~~							19.9	−81.83	−2.32
									21.9	−86.5	−2.82
	10.4	−12.15	+2.08						24.9	−92.3	−1.93
	13.4	−5.84	+2.10						26.9	−97.9	−2.80
	15.4	−1.23	+2.30	91.77	+1.12				28.9	102.6	−2.25
	16.4	+0.52	+1.77	93.25	+1.48				29?-31.4	104.5	−2.10
	17.4	+2.86	+2.34						31.9	107.3	−1.40
	19.5	+7.14	+2.14								
	20.3	+9.05	+1.91	140.80	+1.45						
	22.4	+14.04	+2.50								
	23.3	+16.43	+2.39								
	24.4	+18.59	+2.16								
	25.4	+20.45	+1.86	145.31	+1.13						
	27.4	+24.63	+2.18								
	28.4	+27.01	+2.38	149.47	+1.39						
	31.4	+33.44	+2.14								

Russian Transit sent out to Cincinnati.
Mer. Circle observations used for time.
E Transit used as for times in Uhmer of Prof. Rogers.

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1977phae.proj.1707W



6

5

4

19

18

17

68

69

70

50 40 30 20 10 50 40 30 20

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1877phae.proj.1797w

× Sunday. –

August. 1878.

	Greatest Error.	10 A.M. Signals.
1.	+.13	0.0
2.	+.12	0.0
3.	−.37	—
4.	−.60	−0.5
5.	−.70	0.0
6.	+.36	+0.1
7.	−.35	0.0
8.	+.58	0.0
9.	+.38	0.0
10.	−.18	—
11.	+.18	0.0
12.	−.24	0.0
13.	+.70	0.0
14.	−.31	0.0
15.	+.07	0.0
16.	+.20	0.0
17.	−.12	—
18.	−.83	0.0
19.	−.07	0.0
20.	+.34	0.0
21.	+.10	0.0
22.	−.18	0.0
23.	−.10	0.0
24	+.12	—
25	−.96	0.0
26	+.15	0.0
27	+.15	0.0
28	+.20	0.0
29	+.29	0.0
30	+.34	0.0
31	−1.35	—

Signal sent only when the error is less than .1.

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1877phae.proj.17070

July. 1878. August. 1878. September. 1878.

Greatest errors of Mean Time Clock "Bond 394."

1 6 11 16 21 26 31 5 10 15 20 25 30 4 9 14 19 24 29

0

10 A.M. Signals.

1 6 11 16 21 26 31 5 10 15 20 25 30

0.

Frank Waldo.

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1877phae.proj.1797w

1327 | 3451 | Russian Transit

		Error	Rate	Error	Rate	a	b	c	
1877	d								
Dec	11.4	− 6.70		+61.39	+0.42	+0.91	−0.03	+0.39(E)	
	12.4	− 7.80	−0.65	+61.69	+0.35				
	12.9			+ 1.9	−1m				
	13.4	− 8.33	−0.60	+ 2.67		+ 0.54	−0.06	+0.40(E)	
	15.3	− 9.79	−0.61	+ 3.44	+.41				
	16.3	−10.89	−1.07	+ 3.86	+.40	+0.58		+0.34(E)	
	17.2	−11.46	−.83	+ 4.81	+.68	+ 0.90		+0.41(E)	W.M. Obs.
	18.3	−12.70	−1.24	+ 5.24	+.43	+ 0.65		+0.45(E)	
	23.3	−17.47	−0.7						
	23.9	−17.71		+ 9.2	+.7				
	24.3	−18.13	−0.77			m	b	n	Time determined from
	25.3	−19.02	−0.82						
	26.3	−20.07	−1.12						
	27.3	−20.84	−0.77	Chron. allowed					Meridian Circle Obs.
	28.4	−21.53	−0.66	to run down.					
	29.4	−22.65	−1.00						
	31.3	−24.00	−0.70	+2.14					
1878. Jan	1.3	−24.86	−0.92						
	5.3	−28.67	−0.95						
	6.3	−30.49	−1.12	[+4.83		Jan.6.9]			
	7.3	−31.20	−1.38	[+5.4		7.9]			
	9.3	−34.26	−1.56	[+7.09		10.9]			
	11.8	−37.18	−1.12	[8.40		11.9]			
	12.8	−37.53							
	13.3	−38.65	−1.12	9.7					
	14.3	−39.81	−1.02						
	16.3	−40.73	−.80	+ 13.75					
	17.3	−42.02	−1.12	+ 14.13	+.38?				
	19.3	−44.76	−1.34	+ 15.64	+.62				
	22.4	−47.50	−1.11			+0.97	+0.30	−0.60	
	23.4	−48.57		+ 20.85	+1.27	+0.47?		+0.03?	
	24.4	−50.14	−1.39	23.0	+2.1?	+ 1.08		−0.75	
	24.4	−51.14		Owing to error in reading Chron. sheets.					
	28.4	−53.78	−1.05			+ 1.17		−0.86	
	29.4	−55.03		+27.2	+1s.16	+ 1.14		−0.82	
	29.9	−56.78	−1.3	x		+ 1.26	+ 0.35	−0.85	
				+ 28.5	1.3				
	30.4	− 56.70				+1.25		−0.94	
Feb	2.4	− 60.47	1.3	+ 30.5		+ 1.07		−0.66	
	3.4	− 61.92				+ 1.08	[+0.35]	− 0.95	
	4.4	− 63.16	−1s.3	+ 31.44		+ 1.19	[+0.35]	− 0.81	
	5.4	− 64.41							Added 3 grammes to 1327 and +1m
	6.4	− 4.37	+ 0.04						
	7.4	− 4.21	+ 0.10						
	7.9				+1s.17		+0.32		
	11.4	− 1.54	+ 0.67			+ 0.98		− 0.63	
	13.4	− 0.76	+ 0.57			+ 1.12		− 0.77	
	14.0	− 0.37				+ 1.25	+ 0.29	− 0.95	
	14.4	− 0.37	+ 0.39	+ 43. 13					
	16.4	+ 0.04							
	18.4	+ 0.80	+ 0.38		+ 0.86				
	19.4	+ 0.94	+ 0.26	+ 47. 40					
	24.4	+ 2.67	+ 0.35	[+44.7]	after Salem trip 82 miles + 3 days.			Beginning 22.9	
	26.0			[44.7]	" " " " " "				
	26.4	+ 2.90		+ 44.72					
	28.4	+ 4.76	+ 0.50	+ 47.75	+ 1s.5				
Mch	3.8	+ 5.7	+ 0.3	+ 50.4	+ 0.9				
	4.4	+ 6.0		+ 51.4					
	5.4	+ 6.50	+ 0.4	+ 52.61	+ 1.2	ε +0s.05 w +3s.32	+0s.26	+0s.304e	
	7.8	+ 7.3		+ 55.90					
	9.4					w +5s.11	+0.21	+ 0.372e	
	10.4	+ 7.95	+0.24	+ 58.45	+0s.97		+0.15		
	11.9				Sat 3451, Back 60s.				
	15.4	+ 10.79	+0.57	+ 3.77	w +0s.8 −0.30	w +0.30	+0.04	+ 0.261e	
	19.4	+ 13.44	+ 0.53	+ 8.03	+ 0.85		+0.09		
	20.4	+ 14.08	+ 0.64	+ 9.58	+1.55	−0.59	−0.10		
	21.9			+11.35	+1.18				
	23.4	+ 15.10	+ 0.34	+11.75					
	26.4	+ 17.14	+ 0.66	+ 16.30	+1.4	− 1.11w	+0.27	+ 0.21(E)	
	30.4			+ 22.42	−	− 0.84w	+0.30	+ 0.30(E)	
	31.4			+ 24.35					
April	3.4	+ 21.20	+0.51	+ 27.97	+1.71				

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