1853phae.proj..28

KG
11365
238

L.1

Reduction A
of
Zone Observations
1853.

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

KG-11365.238

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Probable Error of k
depending on the Pr. Er of Condit. Equations

Let η be the probable error of a Condition at Equation d & that of k at the middle of the Zone

To find η Substitute the least square values of x & x' & find $c - o = e$ the apparent error of each equation - From an investigation of which I have kept a copy on a sheet on file - we have

$$\eta = 0.674 \sqrt{\frac{\Sigma . we^2}{n-2}}$$

n being the number of Equations supposed large & w the weight

At the middle of the Zone k must be nearly equal to $x + x'$ & its probable error will be that of $x + x'$ if derived from all the equations Now the equations with the notation of p 6 give the final Least Square Equations as $q = wz$

$$\Sigma . wm = \Sigma . w . x + \Sigma . wz . x'$$

$$\Sigma . wzm = \Sigma . wz . x + \Sigma\, wz^2 . x'$$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

TG 11365.238

which may be put in the form

$$\Sigma wm = \Sigma . w(x+x') + \Sigma . w(z-1)x'$$

$$\Sigma wzm = \Sigma wz(x+x') + \Sigma w(z-1)z\,x'$$

HARVARD UNIVERSITY LIBRARY MAY 3 1956

Now the actual error of $(x+x')$ from e will be

$$\delta(x+x') = \frac{1}{\left(\Sigma w - \frac{(\Sigma w(z-1))^2}{\Sigma w(z-1)z}\right)}\left[\Sigma . e\sqrt{w} - \frac{\Sigma w(z-1)}{\Sigma w(z-1)z}\Sigma . e\sqrt{w}z^2\right]$$

now for the whole zone of two hours there will be on the average as many positive as negative values of $w(z-1)$ w being always positive & $(z-1)$ negative for the first half & positive for the last half of each zone so we have

$$\Sigma . w(z-1) = 0$$

$$\delta(x+x') = \frac{1}{\Sigma w}[\Sigma . e\sqrt{w}] \qquad \Sigma . e\sqrt{w} = \sqrt{e_1^2 w_1 + e_2^2 w_2 \ldots} = e\sqrt{\Sigma w}$$

$$= \frac{e\sqrt{\Sigma w}}{\Sigma w} = \frac{e}{\sqrt{\Sigma w}}$$

& the probable value of e is $\eta = 0.674\sqrt{\frac{\Sigma . we^2}{n-2}}$

so that $$\varepsilon = 0.674\sqrt{\frac{\Sigma . we^2}{(n-2)\Sigma w.}}$$

which will be the probable error of k

e being the diff. between k computed from all the obs & deduced from one catalogue &c.

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zones in the order of R.

δ + 0° to 10°	δ + 10° to 20°
22 & 23 from 23h 00m to 0h 43m	24 & 25 from 23h 24m to 1h 08m
26. 27 " 0h 40m to 2h 27m	28. 29 " 1h 04m " 2h 49m
30. 32 " 2h 21m " 4h 08m	34. 35 " 2h 42m " 4h 40m
31. 33 " 4h 08m " 6h 12m	36. 37 " 4h 29m " 6h 19m
38. 39 " 5h 58m " 7h 47m	40. 41 " 6h 17m " 8h 17m
42. 43 " 7h 47m " 8h 13m	46, 47 & 48 " 8h 08m " 10h 20m
44. 45 " 8h 15m " 10h 18m	4. 5 " 10h 17m " 12h 00m
1, 2 & 3 " 10h 14m " 11h 53m	6. 7 " 11h 00m " 13h 04m
49. 50 " 11h 52m " 13h 52m	53. 54 " 12h 59m " 15h 03m
51. 52 " 13h 47m " 15h 55m	55. 56 " 15h 01m " 16h 58m
59. 60 " 15h 57m " 18h 14m	57. 58 " 16h 53m " 18h 25m
8. 9 " 18h 06m " 19h 55m	10, 11 & 12 " 18h 01m " 19h 45m
13, 14 & 16 " 19h 48m " 21h 39m	15. 17 " 19h 39m " 21h 25m
18. 19 " 21h 33m " 23h 07m	20. 21 " 21h 39m " 23h 31m

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Standard Star Catalogues prepared by S. D. Runkle.

The Elements of Reduction have been — those of the Catalogues employed — For the new reduction of Bessels Zones the elements of precession given in the B.A.C were employed

N.B. The "annual variation" comprises the proper motion — where that is known for those stars to which an asterisk is affixed —

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

$\alpha - t_1 - k_1' = M_1$ $\qquad \delta - s_1 - d_1' = N_1$ $\qquad w$ = weight

$\alpha - t_2 - k_2' = M_2$ $\qquad \delta - s_2 - d_2' = N_2$ $\qquad \tau$ = time in hours from t_0

$k_1 = x_1 + \tau x_1' \qquad d_1 = y_1 + \tau y_1'$

$k_2 = x_2 + \tau x_2' \qquad d_2 = y_2 + \tau y_2'$

$\Delta x_1 = x_2 - x_1 \qquad \Delta y_1 = y_2 - y_1 \qquad \Delta t_1 = t_1 - t_2$

$\alpha - t_1 - k_1' = x_1 + x_1' \tau \qquad \delta - s_1 - d_1' = y_1 + y_1' \tau$

$(t_1 - t_2) + (k_1' - k_2') = (x_2 - x_1) + (x_2' - x_1')\tau'$

$(s_1 - s_2) + (d_1' - d_2') = (y_2 - y_1) + (y_2' - y_1')\tau'$

Equations of condition

w, eq, $\qquad M_1 = x_1 + x_1'\tau \qquad M_2 = x_2 + x_2'\tau$

$N_1 = y_1 + y_1'\tau \qquad N_2 = y_2 + y_2'\tau$

For Solution (approximate by least squares)

Let $q = w\tau$ to nearest unit. Then form the columns as follows

t	τ	w	q	M_1	N_1	M_2	N_2	$w\tau$	$q\tau$
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	—	—	.	.	.	.	—	—
		$\Sigma w = \cdots$	$\Sigma q = \cdots$					$\Sigma \cdots$	$\cdots$

Final Eq. for x_1, $\quad \Sigma w M_1 = \Sigma w \cdot x_1 + \Sigma w\tau \cdot x_1'$ $\qquad$ Eq for y_1, $\quad \Sigma w N_1 = \Sigma w y_1 + \Sigma w\tau y_1'$

" x_1', $\quad \Sigma q M_1 = \Sigma q \cdot x_1 + \Sigma q\tau x_1'$ $\qquad$ " y_1', $\quad \Sigma q N_1 = \Sigma q y_1 + \Sigma q\tau y_1'$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

The weights to be assigned to each value of m or n are thus found. The probable error corresponding to the unit of weight of a Catalogue Star is in $\mathcal{R}$ $\pm 0^s.10$ in D_δ $\pm 1''.4$

For a single Zone observation over two wires in $\mathcal{R}$ & one in D_δ the probable errors are assumed to be

in $\mathcal{R}$ $\pm 0^s.05$ corresponding weight = 4

in D_δ $\pm 0''.7$ = 4

If w_1 = wt of Catalogue place w_2 that of the observation then the weight of m & n will be

$$w = \frac{w_1 w_2}{w_1 + w_2} = \frac{4 w_1}{4 + w_1}$$

As used

Table of values of w for different values of w_1

Catalogue wt = w_1	w
1	1
2	2
3	2
4	3
10	3
20	3
30	4

For the equations derived directly from the differences of two zones — we have the weight of a difference by a single star $\left(\frac{0^s.10}{0^s.05\sqrt{2}}\right)^2$.

$= 2$

And for n stars $w = 2n$

For comparisons of adjacent Zones. we shall assume the $\mathcal{R}$ & D_δ of a star from a reduced zone (i.e. the Zero of Zone) to be of the unit of weight.

The wt of n observed differences of adjacent Zones is $= 2n$

Assuming then all the $\mathcal{R}$'s & D_δ's of the reduced zone to be equally in error & of the same sign & assuming that the wt of zero = 3

then — by n comparisons of adjacent Zones

$$w = \frac{2n w_1}{w_1 + 2n} = \frac{6n}{3 + 2n}$$

See next page

$w M_1$ $w N_1$ $w M_2$ $w N_2$ $q M_1$ $q N_1$ $q M_2$ $q N_2$

Eq for x_2 $\Sigma w M_2 =$ y_2 $\Sigma w N_2 =$

x_2' $\Sigma q M_2 =$ y_2' $\Sigma q N_2 =$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Table of
Values of weights to be given to an
Equation derived from the comparison
of two adjacent Zones – when
the number of stars common to
both = n $w = \frac{6n}{3+2n}$

n	W	W	W used
1	0.7	1.2	1
2	0.8	1.7	2
3	0.9	2.0	2
4	1.0	2.2	2
5	1.0	2.3	2
6	1.0	2.4	2
7		2.5	3

Instead of combining all the equations individually by Least Squares it is more convenient to form 3 normal values of equal weight or nearly so for the beginning – middle & end of each Zone. These three equations may then be solved by Least Squares.

To do this two conditions only are to be fulfilled. The sums of the squares of the error is to be a minimum & the values of k must vary uniformly.

This may be done as follows

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

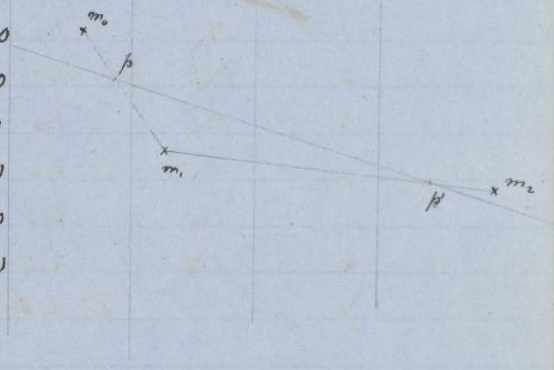
1853phae.proj.: 23

If the 3 normal values are projected graphically with m & τ as ordinates & abscissas at the points m_0, m_1 & m_2 & if the points p & p' are taken on the lines $m_0 m_1$ and $m_1 m_2$ so that $\frac{m_0 p}{m_1 p} = \frac{\tau_2 - \tau_1}{\tau_2 - \tau_0}$, and $\frac{m_2 p'}{m_1 p'} = \frac{\tau_1 - \tau_0}{\tau_2 - \tau_0}$ & the straight line pp' be drawn through the points pp' This line will represent the locus of the equation

$$m = \alpha + \tau \alpha'$$

which results from the solution of the three normal equations by least Squares

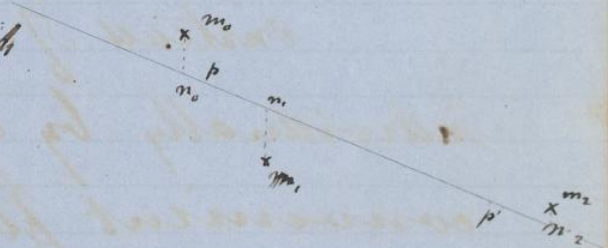
τ	m
0.00	−0.30
0.50	−0.20
1.00	−0.10
1.50	0.00
	+0.10
	+0.20
	+0.30



Demonstration

We are to prove that the line pp' passes the points m_0 m_1 & m_2 at such a distances that

$$m_0 n_0^2 + m_1 n_1^2 + m_2 n_2^2 \text{ is a minimum}$$



calling $m_0 n_0 = e_0$ $m_1 n_1 = e_1$ and $m_2 n_2 = e_2$ we have

$$e_0 = m_0 + \frac{a - \tau_0}{b}, \quad e_1 = m_1 + \frac{a - \tau_1}{b}, \quad e_2 = m_2 + \frac{a - \tau_2}{b}$$

where a & b determine the position of the line pp'

$e_0^2 + e_1^2 + e_2^2$ is to be a minimum relatively to a & b

$$e_0 de_0 + e_1 de_1 + e_2 de_2 = 0$$

When a varies

$$\frac{de_0}{da} = \frac{1}{b}, \quad \frac{de_1}{da} = \frac{1}{b}, \quad \frac{de_2}{da} = \frac{1}{b}$$

$$e_0 + e_1 + e_2 = 0 \qquad (1)$$

When b varies

$$\frac{de_0}{db} = \frac{\tau_0 - a}{b^2}, \quad \frac{de_1}{db} = \frac{\tau_1 - a}{b^2}, \quad \frac{de_2}{db} = \frac{\tau_2 - a}{b^2}$$

$$e_0(\tau_0 - a) + e_1(\tau_1 - a) + e_2(\tau_2 - a) = 0 \qquad (2)$$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

(1) & (2) give $c_0\tau_0 + c_1\tau_1 + c_2\tau_2 = 0$

or

$$c_0(\tau_0 - \tau_2) + c_1(\tau_1 - \tau_2) = 0$$

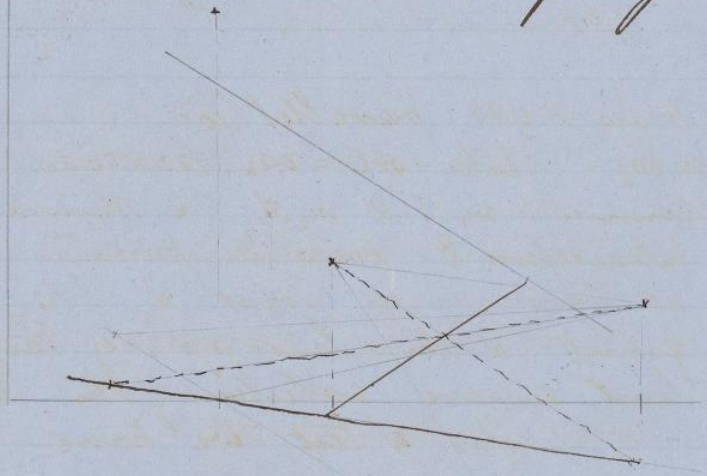
$$c_0(\tau_0 - \tau_1) + c_2(\tau_2 - \tau_1) = 0$$

$$c_1(\tau_1 - \tau_0) + c_2(\tau_2 - \tau_0) = 0$$

Since $m_0 p : p m_1 = c_0 : c_1$ $\qquad p' m_2 : p' m_1 = c_2 : c_1$

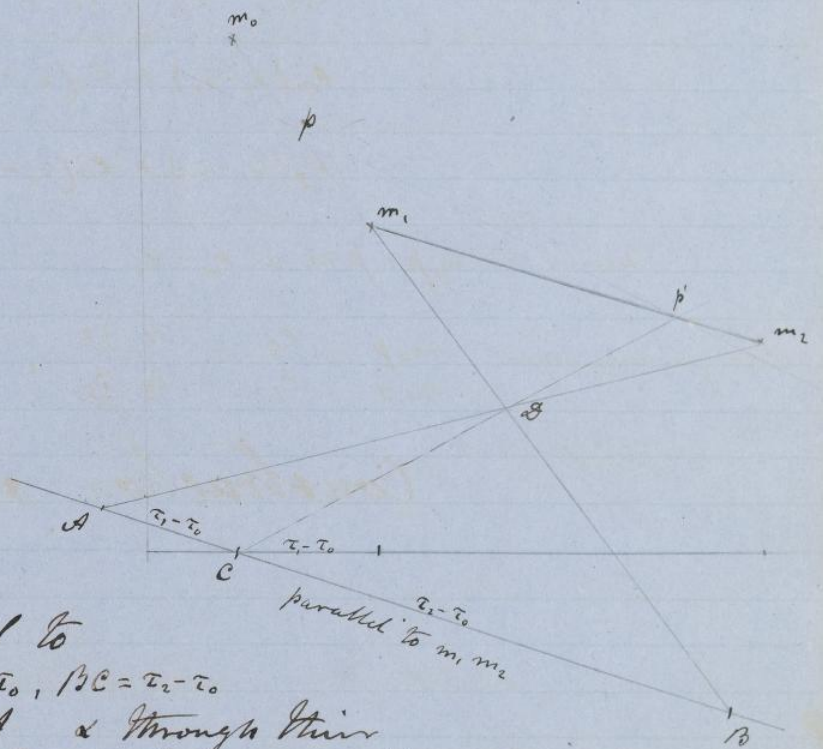
disregarding signs $\dfrac{m_0 p}{m_1 p} = \dfrac{c_0}{c_1} = \dfrac{\tau_2 - \tau_1}{\tau_2 - \tau_0}$, $\dfrac{m_2 p'}{m_1 p'} = \dfrac{c_2}{c_1} = \dfrac{\tau_1 - \tau_0}{\tau_2 - \tau_0}$.

Construction on next page.



John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23



Draw A C B parallel to
$m_1 m_2$ - Take $AC = \tau_1 - \tau_0$, $BC = \tau_2 - \tau_0$
Connect $m_1 B$ & $m_2 A$ & through their
intersection D draw DC prolonged & it will cut $m_1 m_2$
at the required point p' in the same way p is
found & the line pp' is the required locus of the
least square solution of the three equations.
For a test we have $c_0 + c_1 + c_2 = 0$

After the interpolating line has been drawn — The reading off of the values K & d for each 10^m of t is best done from the following scale of decimal parts corresponding to $t = 0^h.00^m$, $0^h.10^m$, $0^h.20^m$ &c.

h
0.00
0.17
0.33
0.50
0.67
0.83
1.00
&c

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

At B For Zones 34 & 35 the equation for the difference $x_{34} - x_{35}$ has been used & in Zones 53 & 54 one for $z_{53} - z_{54}$ has been used Both being derived from a comparison of a large number of stars in each Zone with each other

In Zones 34 & 35 a slight relative change of Zero perhaps took place of 1" in Dec.

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

In the reductions of the zones we have not taken account of second differences of k and d – we now will examine the probable amount of the neglected terms –

	for $t=0$	$t=1$	$t=2$
we	k_0	k_1	k_2
	d_0	d_1	d_2

(1) $$k = k_0 + \frac{dk_0}{dt}t + \frac{dd\,k_0}{dt^2}\frac{t^2}{1.2} \qquad d = d_0 + \frac{d.d_0}{dt}t + \frac{dd.d_0}{dt^2}\frac{t^2}{1.2}$$

If the Clock rate is uniform & the place of the instrument does not alter – or, if it changes its rate of change is uniform Then the coefficients of t^2 depend on the second differences of the correction of the apparent place of a star to its mean place & we are to ascertain how nearly the effect of second differences can be included in a terms of the form

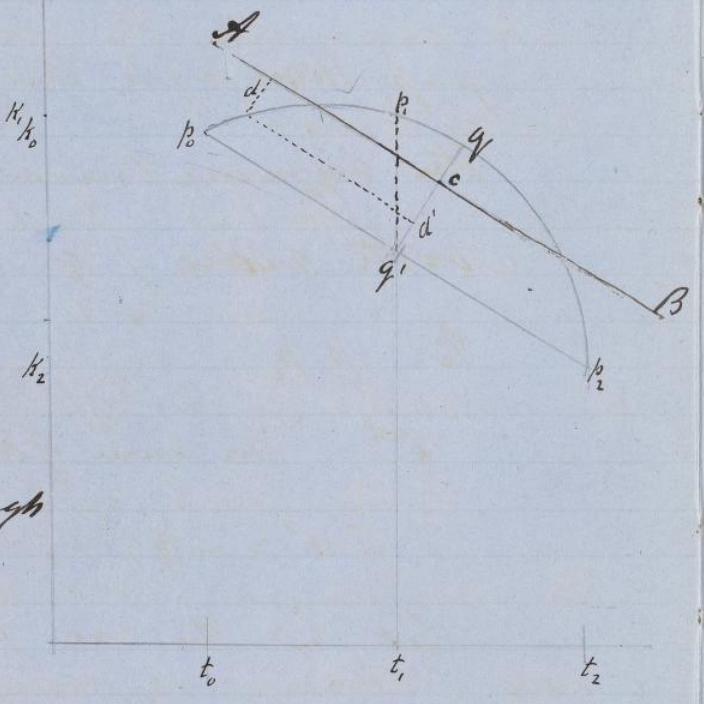
$$a + bt.$$

In the figure on the next page p_0 p_1 & p_2 represents ~~the projection of~~ three points ~~corresponding to the values of~~ t_0 t_1 & t_2 in the graphical representation

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

If (1) For three equidistant values of t & the corresponding values of k or d we will suppose $p_0\ p_1$ & p_2 to be the arc of a circle passing through three points & nearly coinciding with the actual curve of the equation



If we draw a line through a point c taken on the line qq' which bisects the arc $p_0\ p_1\ p_2$ at a distance $cq = \frac{1}{3}\ qq'$ drawing the line ab parallel to the chord $p_0\ p_2$ Then the sum of the squares of the distances of the line ab from the $\cancel{\text{three}}$ are $p_0\ p_1\ p_2$ is a minimum & the probable distance of a point on the $\cancel{\text{three}}$ line from the arc is $\frac{0.674 \times 2.99'}{\sqrt{45}}$ C is a constant but not = 0.674 because the errors are not distributed accidentally By projection C = 0.99 measuring the distance in a direction perpendicular to AB. & the maximum distance is $\frac{2}{3}\ qq'$

The constant C is required in place of 0.674 in order to find the number of errors greater & smaller than the probable error. For demonstration, see sheet on file.

$\varepsilon = \pm 0.2602 \frac{\sqrt{p_0 p_1 p_2}}{qq'}$ when $t_1 = 1$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

To prove this we have 1st that c is the centre of gravity of the arc $p_0 p_1 p_2$ when the arc is small The least square line must pass through this line - & on account of the symmetrical character of the arc on both sides of q'. AB must also be parallel to $p_0 p_2$

2nd The sum of the squares of d^2 are

$$\Sigma d^2 = \Sigma\left(qq' - cq - q'd'\right)^2 = \Sigma\left(qd' - \tfrac{1}{3} qq'\right)^2$$

Let l_n = the arc $p_0 q$ l the arc dq

$$qd' = 2\sin^2 \tfrac{1}{2} l = \tfrac{1}{2} l^2 \qquad qq' = \tfrac{1}{2} l_n^2$$

$$\Sigma d^2 = \Sigma\left(\left(\tfrac{1}{2} l\right)^2 - \left(\tfrac{1}{6} l_n^2\right)\right)^2 = \Sigma\left[\frac{l^4}{4} - \frac{1}{6} l^2 l_n^2 + \frac{1}{36} l_n^4\right]$$

By integration we have for the average value of $d^2 = \frac{\Sigma d^2}{n}$

$$\Sigma \tfrac{1}{2} l^2 = \frac{l_n^3}{3} \qquad \Sigma \frac{1}{4} l^4 = \frac{1}{4} \frac{l_n^4}{5}$$

$$\frac{\Sigma d^2}{n} = \left[\frac{1}{20} - \frac{1}{18} + \frac{1}{36}\right] l_n^4 = \frac{1}{45} l_n^4 \quad , \quad \sqrt{\frac{\Sigma d^2}{n}} = \frac{l_n^2}{\sqrt{45}} = \frac{2qq'}{\sqrt{45}}$$

probable value of $d = 0.674 \sqrt{\frac{\Sigma d^2}{n}} = \frac{2qq'}{\sqrt{45}} \times 0.674$ (0.89)

$\frac{2}{3} qq' = cq'$ is evidently the maximum value of d.

If instead of counting d parallel to qq' we take it in the direction $q'p_1$ making

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

an angle t with the latter we must use in the place of gg' $\quad gg' \sin t$

probb value of $d = 0.\overset{0.89}{6}\overset{89}{7}4 \sqrt{\frac{\Sigma d^2}{n}} = \frac{2gg'}{\sqrt{45}} \times 0.\overset{89}{6}\overset{89}{7}4 \sin t$

now we have very nearly

$$\frac{t_1^2}{1.2}\frac{dd k}{dt^2} = \tfrac{1}{2}(k_0 + k_2) - k_1 = gg' \sin t$$

If then we neglect the term depending on t^2 & make k & d to satisfy by least squares the equations

$$k = k_0 + \frac{dk_0}{dt} t$$

$$d = d_0 + \frac{d.d_0}{dt} t$$

The maximum error we shall commit will be, when $\frac{dd k}{dt^2}$ & $\frac{dd d_0}{dt^2}$ are max.

$$\text{Probable error of } k = \pm 0.674 \frac{k_0 - 2k_1 + k_2}{\sqrt{45}} = \pm \frac{0.\overset{89}{6}\overset{89}{7}4}{\sqrt{45}} \cdot \frac{dd k}{dt^2}$$

$$\text{Maximum error of } k = \frac{k_0 - 2k_1 + k_2}{3} = \frac{1}{3}\frac{dd k}{dt^2}$$

The maximum values of $\frac{dd k}{dt^2}$ and $\frac{dd d}{dt^2}$ are thus obtained - They depend near the equator on the two terms of the formula of reduction from the mean to the apparent Equinox

$$\frac{dd k}{dt^2} = \frac{dd k}{da^2} = \frac{dd.}{da^2}\left(h \sin(H+a) \sec d\right), \qquad \frac{dd.d}{dt^2} = \frac{dd.d}{da^2} = \frac{dd.}{da^2}\left(g \cos(G+a)\right)$$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Then give.

$$u'' = \frac{d\,dk}{dt^2} = +h \sin(H+\alpha) \qquad v'' = \frac{d\,d\delta}{dt^2} = +g \cos(G+\alpha)$$

u'' a maximum when $u'' = \pm h$

v'' " " $v'' = \pm g$

The greatest values of h & g are

$h = 20''.4$ $\qquad$ $g = 29''.3$

When we adopt for the unit of time 1 hour of right ascension

Max value of $\frac{d\,dk}{dt^2} = 0^s.091 = 20''.4 \times \frac{\sin^2 15^\circ}{15}$

" $\frac{d\,d\delta}{dt^2} = 1''.94 = 29''.3 \times \sin^2 15^\circ$

For the years 1852 & 53 the maximum values of g & h are

$g = 14''.2$ $\qquad$ $h = 20.4$

$\frac{d\,dk}{dt^2} < 0.091$ $\qquad$ $\frac{d\,d\delta}{dt^2} < 0''.95$

For the maximum error of $k = \frac{0^s.091}{3} = 0^s.030$, prob Er $= \pm 0^s.012$

" $\delta = \frac{1''.94}{3} = 0''.65$ " $= \pm 0''.25$

In 1852-53 " $k = \frac{0.091}{3} = 0.030$ " $= \pm 0^s.012$

" " " $\delta = \frac{0.95}{3} = 0''.32$ " $= \pm 0''.12$

For the mode of finding the probable error of k depending on the probable error of the conditional Equations See Page 1 of this Book

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zones 1 2 2 d 3

		Wt		Wt
1852.0 α	10h 14m 29.58	δ − 0° 00′ 26.″2	5	11h 28m 33.50	0° 07′ 42.″1	1
t_1	27.50	δ_1 + 35.0		31.75	8 12.0	
t_2	29.60	δ_2 − 29.0		33.70	7.. 43.0	
t_3	29.60	δ_3 − 28.0		33.75	7.. 40.0	
$\alpha - t_1$	+ 2.08	$\delta - \delta_1$ − 31.2		+1.75	− 29.9	
$\alpha - t_2$	− 0.02	$\delta - \delta_2$ + 2.8		− .20	− 0.9	
$\alpha - t_3$	− 0.02	$\delta - \delta_3$ + 1.8		− .25	+ 2.1	
K_1'	0.00	d_1' 0.0			− 1.0	
K_2'	00	d_2' 0.0			− 1.4	
K_3'	00	d_3' 0.0			− 1.5	
					−	

10.. 22.. 43.50	+ 0.. 07.. 13.2	11
41.70	7.. 44.0	
43.65	7.. 15.0	
43.70	7.. 14.0	
+1.80	− 30.8	
− .15	− 1.8	
− .20	− 0.8	
	d' = − 0.8	
	− 1.2	
	− 1.2	

11.. 29.. 22.28	− 0.. 00.. 25.″9	15
20.80	+ 5.0	
22.65	− 25.0	
22.80	− 27.0	
+ 1.48	− 30.9	
− 0.37	− 0.9	
− 0.52	− 1.1	
	− 0.1	
	− 0.1	
	− 0.1	

10.. 55.. 40.37	0.. 02.. 54.0	6
38.70	3.. 23.0	
40.60	2.. 54.0	
40.65	2.. 50.0	
+1.67	− 29.0	
− .23	0.0	
− .28	+ 4.0	
	− 0.4	
	− 0.6	
	− 0.6	

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zones 1 & 2 & 3

a	11h 33m 20.96	δ 0° 08' 44".3 — 1	11h 52m 49.86	0° 07' 51".1 — 1
	19.60	9" 19.0		
	21.55	8 48 0	50.30	7 56.0
	21.65	8. 49.0	50.40	7. 56.0
	+1.34	- 34.7	----	----
	+ .65	- 3.7	- 0.44	- 4.9
	- .71	- 4.7	- 0.54	- 4.9
		- 1.1	---	- ~~1.3~~
		- 1.6		- 1.3
		- 1.5		- 1.4

$t_1 - t_2$	$\delta_1 - \delta_2$	$t_1 - t_2$	$s_1 - s_2$
- 1.90	+ 30".0	- 2.10	+ 29
2.00	30	1.90	29
2.20	31	2.00	28
2.00	31	2.10	31
2.15	30	1.95	29
1.95	30	1.95	29
2.00	29	1.90	30
2.00	31	1.95	30
1.95	30	2.10	31
2.00	30	2.05	29
Mean 2.000	30".2	11h 29m - 1.97	+ 29".5

10h 22m

2.00	29
2 00	29
2.00	29
2.10	30
2.15	30
2 05	30
2.10	30
2.05	30
1.95	29
2 00	31
11h.00m - 2.040	+ 29".7

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zones 1-2 α 3

From Zones 49 α 50 (Catalogue reduction)

α_{49}	11h 52m 52.60	53m 23.80	54m 00.45	54m 17.40
K	+.48	+.46	+.45	+.45
	52m 53.06	24.26	00.90	54m 17m 85
	11h 52m 52.20	23.50	00.15	16.95
	+.83	+.83	+.82	+.82
	11h 52m 53.03	24.33	00.97	17 77
Mean 1853.0 α	11h 52m 53.05	53m 24.30	54m 00.94	54m 17.81
Prec -1 year	3.07	3.07	3.07	3.07
1852.0	49.98	21.23	57.87	14.74
t_1	- - - -	- - - -	- - - -	- - - -
t_2	50.30	21.75		
t_3	50.40	21.85	58.40	15.15
	- - -		~~-.53~~	~~-.41~~
	-.32	-.52		
	-.42	-.62	-.53	-.41

From Zones 49 α 50 $\alpha - t_2 = -0^s.42$ by (4 obs using $z_2 - z_3 = -0^s.08$)
& z_{49} $\alpha - t_3 = -0.50$ "

at $t = 11^h\,54^m$

$$-0^s.42 = x_2 + 1.90\,x_2' + 3.61\,x_2''$$
$$-0.50 = x_3 + 1.90\,x_3' + 3.61\,x_3''$$

z_{49}	z_{50}	d_{49}	d_{50}	Prec			Mean δ 1852.0
7.31	7.29	+2.4	+4.4	+20".0 =	0° 07' 53".4	53".4 =	0° 07' 53".4
5.07	5.05	2.6	+4.6		5 29.6	29.6	5 29.6
8.17	8.14	2.8	+4.3		8 38.3	38.3	8 38.8
5.52	5.50	2.5	+4.6		6 14.5	14.6	6 14.5

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zones 2 & 3 with 49 & 50

	$\delta = 0^h 07^m 53^s.4$	$5^m 29^s.6$	$8^m 38^s.8$	$6^m 14^s.5$
s_1	———	———	———	———
s_2	$7^m 56^s.0$	$5^m 34^s.0$	~~$8^m 41^s.0$~~	
s_3	$7^m 56^s.0$	$32^s.0$	$8^m 41^s.0$	$6^m 18^s.0$
$\delta - s_1$	———	———		
$\delta - s_2$	-2.6	-4.4		
$\delta - s_3$	-2.6	-2.4	-2.2	-3.5

$\delta - s_2 = -3''.8$ by obs & dif $s_2 - s_3$ for $\delta = 7'$ $\quad d' = -1''.3$

$\delta - s_3 = -2.7$ 4 obs. $\quad = -1.4$

$$\delta - s_2 - d_2' = -2''.5 = z_2 + 1.90 z_2' + 3.61 z_2''$$

$$\delta - s_3 - d_3' = -1.3 = z_3 + 1.90 z_3' + 3.61 z_3''$$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 1

For d' Bar +1.01 2^h dr_3 + 0".30

γ_m +.11 for h 0.00

$d\delta_1 = 0''.00$ .12 ds 1.50

0".06 $ds - dr$ +1.20

$-(ds-dr)$ −1.20

$-\frac{ds-dr}{10} = -0''.12 = corr.^{d}\ s$

Zone 2

$K' = 0''.00$ $d' = -0''.16\ s - 0''.08\ t$

Zone 3

$K' = 0''.00$ $d' = -0''.175 - 0''.06\ t$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Reduction of Zones 1 and 2

Zone 1

April 7th 1852. Sid. time $19^h\ 12^m$ Bar. 29.in930 Att. Thr 63° Ext. Thr 36.°0
$12^h\ 12^m$ 29.933 62 35.0

Zone 2

April 16th 1852 Sid. time $9^h\ 25^m$ Bar 29.in748 Att. Thr 64° Ext Thr 39.°5
$12^h\ 35^m$ 29.800 62 38.5

~~In the reduction of these Zones 1, 49 and 50 have been combined with them.~~

$t_0 = 10^h\ 00^m$

Equations of Condition for Zone 1

$k' = 0^s.00$ $\quad d' = -0''.123 - 0.06t$

α			omit			Wt
$10^h\ 14^m$	$+2^s.08 =$	$x_1 + 0.23\,x_1' + 0.05\,x_1''$		$-31''.2 =$	$y_1 + 0.23\,y_1' + 0.05\,y_1''$	5
10.. 23	$+1.80 =$	0.37	0.12	$-30.0 =$	0.37	12	11
10.. 56	$+1.67 =$	0.93	0.86	$-28.6 =$	0.93	0.86	6
11.. 29	$+1.75 =$	1.48	2.19	$-28.9 =$	1.48	2.19	1
11.. 29	$+1.48 =$	1.49	2.22	$-30.8 =$	1.49	2.22	15
11.. 33	$+1.34 =$	1.55	2.40	$-33.6 =$	1.55	2.40	1

Zone 2

$k' = 0.00$ $\quad d' = -0''.16\,s - 0.08\,t$

$10^h\ 14^m$	$-0^s.02 =$	$x_2 + 0.23\,x_2' + 0.05\,x_2''$		$+2''.8 =$	$y_2 + 0.23\,y_2' + 0.05\,y_2''$	5	1
10.. 23	$-.25 =$	.37	0.12	$+0.6 =$	.37	.12	11	4
10.. 56	$-.23 =$	.93	0.86	$+0.6 =$	.93	.86	6	6
11.. 29	$-.20 =$	1.48	2.19	$+0.5 =$	1.48	2.19	1	1
11.. 29	$-.37 =$	1.49	2.22	$-0.8 =$	1.49	2.22	15	20
11.. 33	$-.65 =$	1.55	2.40	$-2.1 =$	1.55	2.40	1	2
11.. 53	$-.44 =$	1.89	3.57	$-3.6 =$	1.89	3.57	1	2
11.. 54	$-.42 =$	1.90	3.61	$-2.5 =$	1.90	3.61	25	50
~~$10^h\ 22^m$~~	$-2.01 =$	~~$+0.37\,(x_2 - x_1)$~~	$+0.37\,(x_2' - x_1') + 0.12\,(x_2'' - x_1'')$				
~~11.. 00~~	$-2.04 =$	~~$+1.00\,(x_2 - x_1$~~	1.00	1.00			
~~11.. 28~~	$-1.97 =$	$+ \quad (x_2 - x_1)$	1.47	2.16			
10.. 22	$+30''.2 =$	~~$+0.37\,(y_2 - y_1)$~~	$+0.07\,(y_2' - y_1') + 0.12\,(y_2'' - y_1'')$				
11.. 00	$+29.7 =$	~~$+1.00$~~	$y_2 - y_1$	1.00	1.00		
11.. 28	$+29.5 =$	~~$+1.47$~~	$y_2 - y_1$	1.47	2.16		

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics - Provided by the NASA Astrophysics Data System

1853phae.proj..23

Put $x_2'' - x_1'' = 0$ &c

.028

$-0.^{s}03 = 0.63\,(x_2' - x_1') + 0.58\,(x_2'' - x_1'')$

$+0.07 = 1.10\,(\quad) + 2.04\,(\quad)$

5.86
20
5.680

~~$x_2'' - x_1'' = +0.^{s}140$~~

197
98
295

$+0.01 = 1.73\,(x_2' - x_1')$

1.47
74
221

$x_2' - x_1' = +0.^{s}006$ &c

$x_2 - x_1 = -2.046$

2.01		
0.670	= 0.33	+ 0.12
2.010	= 1.00	1.00
2.955	= 1.50	2.21
5.665	2.83	3.33

64/20(3,
192
80

$-6.02 = 3\,(x_2 - x_1) + 2 = 3.00\,(x_2 - x_1) + 2.84\,(x_2' - x_1')$

$-5.66 = \quad = 2.83 \qquad + 3.33$

$-2.007 = 1.00\,(x_2 - x_1) + 0.95$

$-5.680 = 2.83 \qquad 2.69$

$+.020 = \qquad 0.64$

$x_2' - x_1' = +0.^{s}031 \pm 0.^{s}028 = \frac{\varepsilon}{\sqrt{0.64}} = \frac{0.022}{0.80} = \pm 0.^{s}028$

$x_2 - x_1 = -2.036 \pm 0.029$

Weight of a ε for a single diff of zones $(t_2 - t_1)$ is $\pm 0.048\sqrt{2}$

mean of ten

$\varepsilon = \pm 0.^{s}048\,\frac{\sqrt{2}}{\sqrt{10}} = \sqrt{\frac{1}{5}}\ 0.046$

$= 0.^{s}048 \times 0.45$

$\varepsilon = \pm 0.^{s}022$

2.84
31
284
852
8804

$y'_2 - y'_1 = -0.''8 \pm 0.''2$

$y_2 - y_1 = +30.''7 \pm 0.''2$

3 | 0.108
2.036

Final Eq.

$65.51 = 39\,x_1 + 36.18\,x_1'$

$53.41 = 34 \quad + 42.22$

$+1.640 = x_1 + 0.93\,x_1'$

$57.72 = 34 \quad + 31.62$

$-3.71 = \quad 10.60$

$x_1' = -0.^{s}350 \pm 0.^{s}07 = \frac{0.^{s}20}{\sqrt{10.60}} = \pm 0.^{s}07$

$x_1 = +2.005 \pm 0.08$

$-68.7 = 65\,y_2 + 85.57\,y_2'$

$-148.3 = 86 \quad + 140.45\,y_2'$

$-1.05 = y_2 + 1.32\,y_2'$

$-90.3 = 86 \quad + 113.52$

$-58.0 = \quad 26.93\,y_2'$

$y_2' = -2.''1 \pm 0.''64$

$y_2 = +1.7 \pm 6.7$

$-183.7 = 63\,y_1 - 57\,y_2$

$+154.6 = -57\,y_1 + 85\,y_2$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

$y_1 = -30'' + \delta y_1$

$-12''.1 = 39\,\delta y_1 + 36.18\, y_1'$
$-11.6 = 34 + 42.22$

$-0.31 = \delta y_1 + 0.93\, y_1'$
$-10.5 = 34 + 31.62$

$-1.1 = 10.60\, y_1'$

$y_1' = -0''.1 \pm 0''.7$

$y_1 = -30''.2 \pm 0''.7$

$-20^s.47 = 65 x_2 + 85.57\, x_2'$
$-32.75 = 86 + 141.00$

$-0.315 = x_2 + 1.316\, x_2'$
$-27.09 = 86 + 113.18$

$-5.66 = 27.82\, x_2'$

$x_2' = -0^s.204 \pm 0^s.038$

$x_2 = -0.038 \pm 0.05$

~~Max values~~ ± 0.08 $+2.005 = x_1 + 0.00\, x_1' + 0.00\, x_2 + 0.00\, x_2'$

x_1				wt
x	$\pm 0^s.08$	$+2.005 = x_1$	$+ 0\, x_2$	1
~~$x_1 = +2.005$~~	± 0.05	$-0.038 = 0 x_1$	$+ x_2$	4
	± 0.03	$+2.036 = x_1$	$- x_2$	7

$+2.005$
$-.088$
$+14.252$
$16.257 = 8 x_1 - 7 x_2$
$-14.404 = -7 x_1 + 11 x_2$

$-.152$
-14.252
-14.404
$22)04\,[36$
$\frac{66}{140}$

$+4$
$+7$
$x_2 = -0.$

$2.032 = x_1 - \frac{7}{8} x^2$
$14.224 = 7 x_1 - \frac{44}{8} x^2$

$-0.180 = \frac{39}{8} x_2$

$x_2 = -0^s.037 \pm 0^s.036$

$x_1 = +2.000 \pm 0.04$

$y_2 = +1''.4$

$y_1 = -29.4$

			wt
.07	$-0.350 = x_1'$		1
.04	$-0.204 =$	x_2'	3
± 07	$-0.031 = x_1'$	$- x_2'$	4

$-0.474 = 5 x_1' - 4 x_2'$
$-0.488 = -4 x_1' + 7 x_2'$

$x_2' = -0^s.228$

$x_1' = -0.277$

$y_2' = -1''.8$

$y_1' = -0.9$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 1

α	k		d s = 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
			−29.″4	−29.″5	−29.″6	−29.″8	−29.″9	−30.″0	−30.″1	−30.″2	−30.″4	−30.″5	−30.″6
			29.5	29.6	29.7	29.9	30.0	30.1	30.2	30.3	30.5	30.6	30.7
			29.7	29.8	29.9	30.1	30.2	30.3	30.4	30.5	30.7	30.8	30.9
			29.8	29.9	30.0	30.2	30.3	30.4	30.5	30.6	30.8	30.9	31.0
			30.0	30.1	30.2	30.4	30.5	30.6	30.7	30.8	31.0	31.1	31.2
			30.1	30.2	30.3	30.5	30.6	30.7	30.8	30.9	31.1	31.2	31.3
			30.3	30.4	30.5	30.7	30.8	30.9	31.0	31.1	31.3	31.4	31.5
			30.4	30.5	30.6	30.8	30.9	31.0	31.1	31.2	31.4	31.5	31.6
			30.6	30.7	30.8	31.0	31.1	31.2	31.3	31.4	31.6	31.7	31.8
			30.7	30.8	30.9	31.1	31.2	31.3	31.4	31.5	31.7	31.8	31.9
			30.9	31.0	31.1	31.3	31.4	31.5	31.6	31.7	31.9	32.0	32.1
			31.0	31.1	31.2	31.4	31.5	31.6	31.7	31.8	32.0	32.1	32.2
			− 31.2	−31.3	−31.4	−31.6	−31.7	−31.8	−31.9	−32.0	−32.2	−32.3	−32.4

α	k	
10h.00m	+ 2.s00	−.05
10	1.95	4
20	1.91	5
30	1.86	4
40	1.82	5
50	1.77	5
11.00	1.72	4
10	1.68	5
20	1.63	5
30	1.58	4
40	1.54	5
50	1.49	−04
12.00	+ 1.45	

$k' = 0.^{s}0008$

$d' = -0.''12\,s$

Zone 2

s = 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
+1.″4	+1.″2	+1.″1	+0.″9	+0.″8	+0.″6	+0.″4	+0.″3	+0.″1	+0.0	−0.″2
1.1	0.9	0.8	0.6	0.5	0.3	+0.1	+0.0	−0.2	−0.3	0.5
0.8	0.6	0.5	0.3	+0.2	+0.0	−0.2	−0.3	0.5	0.6	0.8
0.5	0.3	+0.2	+0.0	−0.1	−0.3	0.5	0.6	0.8	0.9	1.1
+0.2	+0.0	−0.1	−0.3	0.4	0.6	0.8	0.9	1.1	1.2	1.4
−0.1	−0.3	0.4	0.6	0.7	0.9	1.1	1.2	1.4	1.5	1.7
0.4	0.6	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.8	2.0
0.7	0.9	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.1	2.3
1.0	1.2	1.3	1.5	1.6	1.8	2.0	2.1	2.3	2.4	2.6
1.3	1.5	1.6	1.8	1.9	2.1	2.3	2.4	2.6	2.7	2.9
1.6	1.8	1.9	2.1	2.2	2.4	2.6	2.7	2.9	3.0	3.2
1.9	2.1	2.2	2.4	2.5	2.7	2.9	3.0	3.2	3.3	3.5
−2.2	−2.4	−2.5	−2.7	−2.8	−3.0	−3.2	−3.3	−3.5	−3.6	−3.8

α	k	
10h.00m	−0.s04	−0.03
10	0.07	4
20	.11	4
30	.15	4
40	.19	4
50	.23	4
11.00	.27	3
10	.30	4
20	.34	4
30	.38	4
40	.42	3
50	.45	−.04
12.00	−0.49	

$k' = 0.^{s}0008$

$d' = -0.''16\,s$

Probable error of $k \pm 0.^{s}04$ in Zones 1 & 2.
$d \pm 0.''5$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae_proj.123

Reduction of Zones 2 & 3

Zone 2

April 16d 1852 Sid. time 9h 25m Bar. 29.748 att. thr. 64 Ext thr 39.5
12 35 29.800 " 62 38.5

Zone 3

April 17d 1852 Sid. time 9h 45m Bar 30.050 att thr 67 Ext thr 39.7
12 30 30.047 64 37.6

Equations of Condition for Zone 2

$t_0 = 10^h\ 00^m$	$k' = 0^s.00$	$d' = -0''.165 - d'$ last	wt
10 17 15	$+0.32 = x_2 + 0.28\, x'_2$	$+3.2 = y_2 + 0.28\, y'_2$	2
10 17 17	$+0.22 = " + 0.23$	$+4''.0 = " + .23$	2
10 23	$-0.07 = " + 0.38$	$-1.0 = " + .38$	3
10 56	$-0.15 = " + 0.93$	$-3.3 = " + 0.93$	2
11 29	$-0.23 = " + 1.48$	$+0.3 = + 1.48$	1
11 29	$-0.34 = " + 1.48$	$-1.1 = + 1.48$	4
11 33	$-0.64 = " + 1.55$	$-2.7 = + 1.55$	1
11 53	$-0.47 = " + 1.88$	$-3.6 = + 1.88$	1
11 54	$-0.42 = x_2 + 1.90\, x'_2$	$-2.5 = y_2 + 1.90\, y'_2$	2

Zone 3

$t_0 = 10^h\ 00^m$	$k' = 0^s.00$	$d' = -0''.17$ s	
10 17	$+0.35 = x_3 + 0.28\, x'_3$	$+6.3 = y_3 + 0.28\, y'_3$	2
10 17	$+0.22 = " + 0.23$	$+3.0 = " + 0.23$	2
10 23	$-0.11 = " + 0.38$	$+0.2 = " + 0.38$	3
10 56	$-0.20 = " + 0.93$	$+0.7 = " + 0.93$	2
11 29	$-0.28 = " + 1.48$	$+0.8 = " + 1.48$	1
11 29	$-0.49 = " + 1.48$	$+0.9 = " + 1.48$	4
11 33	$-0.74 = " + 1.55$	$-3.2 = " + 1.55$	1
11 53	$-0.57 = " + 1.88$	$-3.5 = " + 1.88$	1
11 54	$-0.50 = x_3 + 1.90\, x'_3$	$-1.3 = y_3 + 1.90\, y'_3$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 2.

$-0''.16$

h m	k	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
10 00	+0.23	+2.2	+2.0	+1.9	+1.7	+1.6	+1.4	+1.2	+1.1	+0.8	+0.7	+0.5
10	+.17 −.06	+1.8	+1.6	+1.4	+1.2	+1.0	+0.9	+0.7	+0.6	+0.4	+0.3	+0.1
20	+.11 −.06	+1.3	+1.1	+1.0	+0.8	+0.7	+0.5	+0.3	+0.2	+0.0	−0.1	−0.3
30	+.04 −.07	+0.7	+0.5	+0.4	+0.2	+0.1	−0.1	−0.3	−0.4	−0.6	−0.7	−0.9
40	−.02 −.04	+0.3	+0.1	±0.0	−0.2	−0.3	−0.5	−0.7	−0.8	−1.0	−1.2	−1.3
50	−.08 −.06	−0.3	−0.5	−0.6	−0.8	−0.9	−1.1	−1.3	−1.4	−1.6	−1.7	−1.9
11 00	−.15 −.07	−0.7	−0.9	−1.0	−1.2	−1.3	−1.5	−1.7	−1.8	−2.0	−2.1	−2.3
10	−.22 −.07	−1.3	−1.5	−1.6	−1.8	−1.9	−2.1	−2.3	−2.4	−2.6	−2.7	−2.9
20	−.28 −.06	−1.7	−1.9	−2.0	−2.2	−2.3	−2.5	−2.7	−2.8	−3.0	−3.1	−3.3
30	−.35 −.07	−2.3	−2.5	−2.6	−2.8	−2.9	−3.1	−3.3	−3.4	−3.6	−3.7	−3.9
40	−.42 −.07	−2.7	−2.9	−3.0	−3.2	−3.3	−3.5	−3.7	−3.8	−4.0	−4.1	−4.3
50	−.47 −.05	−3.2	−3.4	−3.5	−3.7	−3.8	−4.0	−4.2	−4.3	−4.5	−4.6	−4.8
12 00	−.53 −.06	−3.8	−4.0	−4.1	−4.3	−4.4	−4.6	4.8	−4.9	−5.1	−5.2	−5.4

By Least Squares

$\alpha = +0^s.24 \pm 0^s.046$

$\alpha' = -0.38 \pm 0.043$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 3.

h m	k		
10,,00	+	0,28	
.10	+	.20	.08
.20	+	.12	.08
.30	+	.04	.08
.40	−	.04	.08
.50	−	.12	.08
11,,00	−	.20	.08
.10	−	.27	.07
.20	−	.36	.09
.30	−	.44	.08
.40	−	.52	.08
.50	−	.59	.07
12,00	−	.67	.08

$\alpha' = -0''.17$

	0′	1′	2′	3′	4′	α	5′	6′	7′	8′	9′	10′
	+ 3″.7	+3.5	+3.4	+3.2	+3.0		+2.8	+2.7	+2.5	+2.3	+2.2	+2.0
	+ 3.2	+3.0	+2.8	+2.7	+2.5		+2.3	+2.2	+2.0	+1.8	+1.7	+1.5
	+ 2.7	+2.5	+2.4	+2.2	+2.0		+1.8	+1.7	+1.5	+1.3	+1.2	+1.00
	+ 2.3	+2.1	+2.0	+1.8	+1.6		+1.4	+1.3	+1.1	+0.9	+0.8	+0.6
	+ 1.8	+1.6	+1.5	+1.3	+1.1		+0.9	+0.8	+0.6	+0.4	+0.3	+0.1
	+ 1.4	+1.2	+1.0	+0.9	+0.7		+0.5	+0.4	+0.2	+0.0	−0.1	−0.3
	+ 1.0	+0.8	+0.7	+0.5	+0.3		+0.1	−0.0	−0.2	−0.4	−0.5	−0.7
	+ 0.4	+0.3	+0.2	−0.0	+0.3		−0.4	−0.6	−0.8	−1.0	−1.1	−1.3
	0.0	−0.2	−0.3	−0.5	−0.7		−0.8	−1.0	−1.2	−1.4	−1.5	−1.7
	− 0.4	−0.6	−0.7	−0.9	−1.1		−1.2	−1.4	−1.6	−1.8	−1.9	−2.1
	− 0.9	−1.1	−1.2	−1.4	−1.6		−1.7	−1.9	−2.1	−2.3	−2.4	−2.6
	− 1.4	−1.6	−1.7	−1.9	−2.1		−2.2	−2.4	−2.6	−2.8	−2.9	−3.1
	− 1.9	−2.1	−2.2	−2.4	−2.6		−2.7	−2.9	−3.1	−3.3	−3.4	−3.6

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

15
16
36 .8

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 4 & 5

Zone 4

April 27, 1852 Sid. time 11h.30m Bar. 29.732in Att. Ther. 69.0° Ext. Therm. 42.0°
" " 13.27 " 29.750 " " 70.0 " " 40.5

Zone 5

April 28, 1852 Sid. time 11.30 Bar. 29.830 Att. Therm. 66° Ext. Therm. 40.0
" " 14.30 " 29.844 " " 65 " " 39.2

Zone 4

$t_o = 10^h.00^m$ $k' = 0^s.000\,s$ $d' = -0''.16\,s$

10.19	$+0.73 = x_4 + 0.32\,x'_4$	$0.0 = y_4 + 0.32\,y'_4$	2
10.39	$+0.39 = " + 0.65 "$	$-1.2 = " + 0.65 "$	1
11.14	$+0.16 = " + 1.23 "$	$-4.1 = " + 1.23 "$	1
~~11.22~~	~~+.12 = + 1.36~~	~~-4.5 = + 1.36~~	2
11.47	$-0.16 = " + 1.78 "$	$-7.1 = " + 1.78 "$	1
12.00	$-0.05 = x_4 + 2.00\,x'_4$	$-4.9 = y_4 + 2.00\,y'_4$	3
~~H.22~~			

Zone 5

$t_o = 10^h.00^m$ $k' = 0^s.000\,s$ $d' = -0''.17\,s$

10.19	$+0.41 = x_5 + 0.32\,x'_5$	$-1.8 = y_5 + 0.32\,y'_5$	2
10.39	$-0.06 = " + 0.65 "$	$-3.2 = " + 0.65 "$	1
11.14	$-0.24 = " + 1.23 "$	$-7.1 = " + 1.23 "$	1
~~11.22~~	$+1.36$	$+1.36$	
~~H.47~~	$-0.22 \quad x_5 + 1.37\,x'_5$	$-6.3 \quad y_5 + 1.37\,y'_5$	2
~~12.00~~			
~~H.22~~			

* NB Zone 6 reductions have $t_o = 10^h.10^m$

11.22 AM

1853phae.proj..23

Zone 4.

$\alpha' = -0''.16$

H m	k	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
10 00 +	0.82	+0″.7	+0.5	+0.4	+0.2	+0.1	±0.0	−0.2	−0.4	−0.6	−0.7	−0.9
.10 +	.73	+0.2	0.0	−0.1	−0.3	−0.4	−0.6	−0.8	−0.9	−1.1	−1.2	−1.4
.20 +	.65	−0.3	−0.5	−0.6	−0.8	−0.9	−1.1	−1.3	−1.4	−1.6	−1.7	−1.9
.30 +	.56	−0.9	−1.1	−1.2	−1.4	−1.5	−1.7	−1.9	−2.0	−2.2	−2.3	−2.5
.40 +	.48	−1.5	−1.7	−1.8	−2.0	−2.1	−2.3	−2.5	−2.6	−2.8	−2.9	−3.1
.50 +	.40	−2.1	−2.3	−2.4	−2.6	−2.7	−2.9	−3.1	−3.2	−3.4	−3.5	−3.7
11 00 +	.32	−2.7	−2.9	−3.0	−3.2	−3.3	−3.6	−3.7	−3.8	−4.0	−4.1	−4.3
.10 +	.24	−3.3	−3.5	−3.6	−3.8	−3.9	−4.1	−4.3	−4.4	−4.6	−4.7	−4.9
.20 +	.16	−3.9	−4.1	−4.2	−4.4	−4.5	−4.7	−4.9	−5.0	−5.2	−5.3	−5.5
.30 +	.08	−4.4	−4.6	−4.7	−4.9	−5.0	−5.2	−5.4	−5.5	−5.7	−5.8	−6.00
.40:	.00	−4.9	−5.1	−5.2	−5.4	−5.5	−5.7	−5.9	−6.0	−6.2	−6.3	−6.50
57 −	.07	−5.5	−5.7	−5.8	−6.0	−6.1	−6.3	−6.5	−6.6	−6.8	−6.9	−7.10
12.00 −	.15	−6.0	−6.2	−6.3	−6.5	−6.6	−6.8	−7.0	−7.1	−7.3	−7.5	−7.6

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 5.

$d' = -0''.17$

h m	k		0′	1′	2′	3′	4′	d 5′	6′	7′	8′	9′	10′
10 00 +	0.57		−0.6	−0.8	−0.9	−1.1	−1.3	−1.4	−1.6	−1.8	−2.0	−2.1	−2.3
.10	.46	.11	−1.4	−1.6	−1.7	−1.9	−2.1	−2.2	−2.4	−2.6	−2.8	−2.9	−3.1
.20	.35	.11	−2.2	−2.4	−2.5	−2.7	−2.9	−3.0	−3.2	−3.4	−3.6	−3.7	−3.9
.30	.24	.11	−2.9	−3.1	−3.2	−3.4	−3.6	−3.7	−3.9	−4.1	−4.3	−4.4	−4.6
.40	.13	.11	−3.6	−3.8	−3.9	−4.1	−4.3	−4.4	−4.6	−4.8	−5.0	−5.1	−5.3
.50 +	.03	.10	−4.3	−4.5	−4.6	−4.8	−5.0	−5.1	−5.3	−5.5	−5.7	−5.8	−6.0
11 00 −	.07	.10	−5.0	−5.2	−5.3	−5.5	−5.7	−5.8	−6.0	−6.2	−6.4	−6.5	−6.70
.10 −	.17	.10	−5.7	−5.9	−6.1	−6.2	−6.4	−6.5	−6.7	−6.9	−7.1	−7.2	−7.4
.20 −	.27	.10	−6.4	−6.6	−6.8	−6.9	−7.1	−7.2	−7.4	−7.6	−7.8	−7.9	−8.1
.30 −	.37	.10	−7.1	−7.3	−7.5	−7.6	−7.8	−7.9	−8.1	−8.3	−8.5	−8.6	−8.8
.40 −	.47	.10	−7.8	−8.00	−8.2	−8.3	−8.5	−8.6	−8.8	−9.0	−9.2	−9.3	−9.5
.50 −	.57	.10	−8.5	−8.7	−8.9	−9.0	−9.2	−9.3	−9.5	−9.7	−9.9	−10.0	−10.20
12 00 −	.67	.10	−9.2	−9.4	−9.6	−9.7	−9.9	−10.0	−10.2	−10.4	−10.6	−10.7	−10.90

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 6 & 7

Zone 6

April 29, 1852 Sid. time 11h 05m Bar. 29.830 in Att. therm. 65° Ext. therm. 49.6°
" " 14h 00m " 29.860 " " " 63 " " 42.8

Zone 7

May 4th, 1852 Sid. time 11h 50m Bar. 30.346 in Att. therm. 65° Ext. therm 45.0°
" " 13h 35m " 30.316 " " " 64 " " 44.8

Zone 6

$t_0 = 11^h 10^m$	$k'_4 = 0^s.000$	$d'_4 = -0''.16$	
11h 14m	$-0.27 = x_6 + 0.07\, x'_6$	$-6.6 = y_6 + 0.07\, y'_6$	2
11h 14m	$-0.19 = " + 0.07\, "$	$-7.1 = " + 0.07\, "$	1
11h 47m	$-0.46 = " + 0.61\, "$	$-10.1 = " + 0.61\, "$	1
12h 00m	$-0.50 = " + 0.83\, "$	$-7.9 = " + 0.83\, "$	3
12h 11m	$-0.38 = " + 1.01\, "$	$-7.4 = " + 1.01\, "$	1
12h 32m	$-0.74 = " + 1.36\, "$	$-10.5 = " + 1.36\, "$	1
12h 34m	$-0.66 = " + 1.40\, "$	$-7.0 = " + 1.40\, "$	1
13h 02m	$-0.80 = x_6 + 1.86\, x'_6$	$-12.6 = y_6 + 1.86\, y'_6$	2

Zone 7

$t_0 = 11^h 10^m$	$k'_4 = 0.000$	$d'_4 = -0''.16$	
11h 14m	$+0.09 = x_7 + 0.07\, x'_7$	$-5.8 = y_7 + 0.07\, y'_7$	2
11h 14m	$+0.21 = " + 0.07\, "$	$-6.1 = " + 0.07\, "$	1
11h 47m	$-0.16 = " + 0.61\, "$	$-9.1 = " + 0.61\, "$	1
12h 00m	$-0.15 = " + 0.83\, "$	$-6.9 = " + 0.83\, "$	3
12h 11m	$-0.13 = " + 1.01\, "$	$-6.4 = " + 1.01\, "$	1
12h 32m	$-0.34 = " + 1.36\, "$	$-10.5 = " + 1.36\, "$	1
12h 34m	$-0.36 = x_7 + 1.38\, x'_7$	$-4.9 = y_7 + 1.38\, y'_7$	1
13h 02m	$-0.52 = x_7 + 1.86\, x'_7$	$-12.6 = y_7 + 1.86\, y'_7$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 6.

$\alpha' = -''.16$

Eq

h m	k		0′	1′	2′	3′	4′α	5′	6′	7′	8′	9′	10′
11 10	27	.05	−6.4	−6.6	−6.7	−6.9	−7.0	−7.2	−7.4	−7.5	−7.7	−7.8	−8.0
.20	32	.05	−6.9	−7.1	7.2	7.4	7.5	7.7	−7.9	8.0	8.2	8.3	−8.5
.30	37	.05	−7.3	7.5	7.6	−7.8	7.9	8.1	8.3	8.4	8.6	8.7	−8.9
.40	41	.04	−7.8	8.0	8.1	8.3	8.5	8.6	8.8	8.9	9.1	9.2	−9.4
.50	46	.05	−8.2	8.4	8.5	8.7	8.9	9.0	9.2	9.3	9.5	9.6	9.8
12 00	51	.05	−8.6	8.8	8.9	9.1	9.2	9.4′	9.6	9.7	9.9	10.0	10.2
.10	55	.04	−9.0	9.2	9.3	9.5	9.6	9.8	10.0	10.1	10.3	10.4	10.6
.20	60	.05	−9.4	9.6	9.7	9.9	10.0	10.2	10.4	10.5	10.7	10.8	11.0
.30	65	.05	−9.8	10.0	10.1	10.3	10.4	10.6	10.8	10.9	11.1	11.2	11.4
.40	70	.05	−10.3	10.5	10.6	10.8	10.9	11.1	11.3	11.4	11.6	11.7	11.9
.50	75	.05	−10.7	10.9	11.0	11.2	11.3	11.5	11.7	11.8	12.0	12.1	12.3
13 00	79	.04	−11.2	11.4	11.5	11.7	11.8	12.0	12.2	12.3	12.5	12.6	12.8
.10	84	.05	−11.6	11.8	11.9	12.1	−12.2	12.4	12.6	12.7	12.9	13.0	13.2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 7.

$\alpha' = -0''.16$

	k		0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
h m			″	″	″	″	″	″	″	″	″	″	″
11.10 +	0.15		-5.5	-5.9	5.8	-6.0	-6.1	-6.3	-6.5	-6.6	-6.8	-6.9	-7.1
.20 +	.09	.06	-5.9	6.1	6.2	6.4	6.5	6.7	6.9	7.0	7.2	7.3	-7.5
.30 +	.03	.06	-6.3	6.5	6.6	6.8	6.9	7.1	7.3	7.4	7.6	7.7	-7.9
.40 −	.02	.05	-6.8	7.0	7.1	7.3	7.4	7.6	7.8	7.9	8.1	8.2	-8.4
.50 −	.08	.06	-7.3	7.5	7.6	7.8	7.9	8.1	8.3	8.4	8.6	8.7	-8.9
12.00 −	.14	.06	-7.7	7.9	8.0	8.2	8.3	-8.5	8.7	8.8	9.0	9.1	-9.3
.10 −	.20	.06	-8.1	8.3	8.4	8.6	8.7	8.9	9.1	9.2	9.4	9.5	-9.7
.20 −	.27	.07	-8.6	8.8	8.9	9.1	9.2	9.4	9.6	9.7	9.9	10.0	-10.2
.30 −	.33	.06	-9.0	9.2	9.3	9.5	9.6	9.8	10.0	10.1	10.3	10.4	-10.6
.40 −	.39	.06	-9.5	9.7	9.8	10.0	10.1	10.3	10.5	10.6	10.8	10.9	-11.1
.50 −	.45	.06	-9.9	10.1	10.2	10.4	10.5	10.7	10.9	11.0	11.2	11.3	-11.5
13.00 −	.51	.06	-10.4	10.6	10.7	10.9	11.0	11.2	11.4	11.5	11.7	11.8	-12.0
.10 −	.56	.05	-10.8	10.0	11.1	11.3	11.4	11.6	11.8	11.9	12.1	12.2	-12.4

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Wones 8 & 9

Wone 8

August 9, 1852 — Sid. Time 17h 55m — Bar. 30.000 in — Att. Therm 70° — Ext. Therm. 67.8°
" " 21.15 " 30.010 " " 70 " " 65.0

Wone 9

August 11, 1852 — Sid. time 17h 35m — Bar. 30.076 — Att. Therm. 68 — Ext. Therm. 60.0°
" " 20.15 " 30.110 " " 67 " " 56.1

Wone 8

$t_0 = 18^h\,00^m$ $\quad k'_8 = 0^s.000$ $\quad d'_8 = -0''.16$

18.06	+0.25 =	$x_8 + 0.10\,x'_8$	+0".3 = $y_8 + 0.10\,y'_8$	2
18.06	+0.22 =	$x_8 + 0.10\,x'_8$	+2.8 = $y_8 + 0.10\,y'_8$	1
18.07	+0.40 =	" + 0.11 "	+0.8 = " + 0.11 "	3
18.08	0.00 =	" + 0.13 "	+0.9 = " + 0.13 "	2
		" + ~~0.17~~ "	" + ~~0.17~~ "	
18.14	-0.13 =	" + 0.23 "	+1.3 = " + 0.23 "	2
~~18.19~~	----	" + ~~0.28~~ "	---- " + ~~1.01~~ "	~~7~~
18.20	+0.34 =	" + 0.33 "	-0.7 = " + 0.33 "	3
18.20	+0.36 =	" + 0.33 "	+1.1 = " + 0.33 "	3
18.31	+0.70 =	" + 0.52 "	+2.6 = " + 0.52 "	1
18.32	-0.14 =	" + 0.53 "	+1.3 = " + 0.53 "	2
18.34	+0.09 =	" + 0.57 "	-4.1 = " + 0.57 "	1
18.35	+0.33 =	" + 0.58 "	+0.5 = " + 0.58 "	1
18.41	+0.30 =	" + 0.68 "	-7.4 = " + 0.68 "	1
18.43	+0.40 =	" + 0.72 "	-0.8 = " + 0.72 "	1
18.57	+0.07 =	" + 0.95 "	-4.5 = " + 0.95 "	1
~~19.07~~	----	" + ~~1.12~~ "	---- " + ~~1.12~~ "	~~+~~
19.11	+0.19 =	" + 1.18 "	-5.0 = " + 1.18 "	2
19.11	-0.06 =	" + 1.18 "	+1.0 = " + 1.18 "	3
19.15	+0.13 =	" + 1.25 "	-2.0 = " + 1.25 "	3
19.19	-0.62 =	" + 1.32 "	-5.9 = " + 1.32 "	1
19.19	+0.07 =	" + 1.32 "	-2.7 = " + 1.32 "	3
19.31	-0.08 =	$x_8 + 1.52\,x'_8$	-4.7 = $y_8 + 1.52\,y'_8$	1
~~19.49~~ 19.40	-0.30 =	$x_8 + 1.67\,x'_8$	-6.0 = $y_8 + 1.67\,y'_8$	2
~~19.50~~	----		----	
~~19.57~~ 19.57	----		----	

Obsr.

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Rhone 9

h m				
t_0 = 18.00		k'_9 = 0.000	d'_9 = −0.03	
18.06	−0.15 =	x_9 + 0.10 x'_9	−2.5 = y_9 + 0.10 y'_9	2
18.06	−0.13 =	x_9 + 0.10 x'_9	−2.5 = y_9 + 0.10 y'_9	1
18.07	−0.15 =	" + 0.12 "	−2.3 = " + 0.12 "	3
18.08	−0.40 =	" + 0.13 "	−3.4 = " + 0.13 "	2
		~~" + 0.17 "~~	~~" + 0.17 "~~	
18.15	−0.48 =	" + 0.25 "	−2.5 = " + 0.25 "	2
18.19	−0.30 =	" + 0.32 "	−6.6 = " + 0.32 "	2
18.20	−0.16 =	" + 0.33 "	−3.6 = " + 0.33 "	3
18.20	−0.09 =	" + 0.33 "	−1.8 = " + 0.33 "	3
18.31	+0.15 =	" + 0.52 "	+2.7 = " + 0.52 "	1
18.32	−0.69 =	" + 0.53 "	+01 = " + 0.53 "	2
18.33	−0.46 =	" + 0.55 "	−7.0 = " + 0.55 "	1
18.35	−0.17 =	" + 0.58 "	−1.7 = " + 0.58 "	1
18.41	−0.20 =	" + 0.68 "	−10.4 = " + 0.68 "	1
18.43	0.00 =	" + 0.72 "	−3.7 = " + 0.72 "	1
18.57	−0.33 =	" + 0.95 "	−6.7 = " + 0.95 "	1
19.07	−0.31 =	" + 1.12 "	+1.8 = " + 1.12 "	1
19.11	−0.06 =	" + 1.18 "	−7.3 = " + 1.18 "	2
19.11	−0.46 =	" + 1.18 "	−0.4 = " + 1.18 "	3
19.15	−0.17 =	" + 1.25 "	−5.7 = " + 1.25 "	3
19.19	−0.97 =	" + 1.32 "	−8.4 = " + 1.32 "	1
19.19	−0.29 =	" + 1.32 "	−5.1 = " + 1.32 "	3
19.31	−0.48 =	" + 1.52 "	−6.9 = " + 1.52 "	1
19.49	−0.58 =	" + 1.62 "	−8.2 = " + 1.62 "	2
19.50	−0.61 =	" + 1.63 "	−6.5 = " + 1.63 "	2
19.57	−0.49 =	x_9 + 1.85 x'_9	−7.7 = y_9 + 1.85 y'_9	2
19.57	−0.66 =	x_9 + 1.85 x'_9	−6.6 = y_9 + 1.85 y'_9	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 8.

$d'_8 = -0.16$

h m		k		0	1′	2′	3′	4	5	6	7	8	9	10
18h.00	+	0s.36	.06	+0s.9	+0.74	+0.58	+0.42	+0.26	+0.10	−0.06	−0.32	−0.38	−0.54	−0.70
.10	+	.30	.06	+.4	+0.24	+0.08	−0.08	−0.24	−0.40	−0.56	−0.72	−0.88	−1.04	−1.20
.20	+	.25	.05	−.1	−0.26	−0.42	−0.58	−0.74	−0.90	−1.06	−1.22	−1.38	−1.54	−1.70
.30	+	.20	.05	−.6	−0.76	−0.92	−1.08	−1.24	−1.40	−1.56	−1.72	−1.88	−2.04	−2.20
.40	+	.15	.05	−1.1	−1.26	−1.42	−1.58	−1.74	−1.90	−2.06	−2.22	−2.38	−2.54	−2.70
.50	+	.10	.05	−1.6	−1.76	−1.92	−2.08	−2.24	−2.40	−2.56	−2.72	−2.88	−3.04	−3.20
19.00	+	.05	.05	−2.0	−2.16	−2.32	−2.48	−2.64	−2.80	−2.96	−3.12	−3.28	−3.44	−3.60
.10		.00	.05	−2.4	−2.56	−2.72	−2.88	−3.04	−3.20	−3.36	−3.52	−3.68	−3.84	−4.00
.20	−	.05	.05	−2.9	−3.06	−3.22	−3.38	−3.54	−3.70	−3.86	−4.02	−4.18	−4.34	−4.50
.30	−	.10	.05	−3.4	−3.56	−3.72	−3.88	−4.04	−4.20	−4.36	−4.52	−4.68	−4.84	−5.00
.40	−	.16	.06	−3.9	−4.06	−4.22	−4.38	−4.54	−4.70	−4.86	−5.02	−5.18	−5.34	−5.50
.50	−	.21	.05	−4.3	−4.46	−4.62	−4.78	−4.94	−5.10	−5.26	−5.42	−5.58	−5.74	−5.90
20.00	−	.26	.05	−4.8	−4.96	−5.12	−5.28	−5.44	−5.60	−5.76	−5.92	−6.08	−6.24	−6.40

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 9.

h m	K		α	0′	1′	2′	3′	4′	α	5′	6′	7′	8′	9′	10′
				α′ = −″0.03											
18 „00	−″0.16	3		−2.3	−2.33	−2.36	−2.39	−2.42		−2.45	−2.48	−2.51	−2.54	−2.57	−2.60
.10	.19	.03		−2.7	−2.73	−2.76	−2.79	−2.82		−2.85	−2.88	−2.91	−2.94	−2.97	−3.00
.20	.22	.03		−3.1	−3.13	−3.16	−3.19	−3.22		−3.25	−3.28	−3.31	−3.34	−3.37	−3.40
.30	.24	.02		−3.4	−3.43	−3.46	−3.49	−3.52		−3.55	−3.58	−3.61	−3.64	−3.67	−3.70
.40	.26	.02		−3.7	−3.73	−3.76	−3.79	−3.82		−3.85	−3.88	−3.91	−3.94	−3.97	−4.00
.50	.29	.03		−4.0	−4.03	−4.06	−4.09	−4.12		−4.15	−4.18	−4.21	−4.24	−4.27	−4.30
19 .00	.31	.02		−4.3	−4.33	−4.36	−4.39	−4.42		−4.45	−4.48	−4.51	−4.54	−4.57	−4.60
.10	.33	.02		−4.7	−4.73	−4.76	−4.79	−4.82		−4.85	−4.88	−4.91	−4.94	−4.97	−5.00
.20	.36	.03		−5.0	−5.03	−5.06	−5.09	−5.12		−5.15	−5.18	−5.21	−5.24	−5.27	−5.30
.30	.39	.03		−5.3	−5.33	−5.36	−5.39	−5.42		−5.45	−5.48	−5.51	−5.54	−5.57	−5.60
.40	.42	.03		−5.6	−5.63	−5.66	−5.69	−5.72		−5.75	−5.78	−5.81	−5.84	−5.87	−5.90
.50	.45	.03		−5.9	−5.93	−5.96	−5.99	−6.02		−6.05	−6.08	−6.11	−6.14	−6.17	−6.20
20 .00	.48	.03		−6.3	−6.33	−6.36	−6.39	−6.42		−6.45	−6.48	−6.51	−6.54	−6.57	−6.60

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

Reduction of Wones 10 & 11

Wone 10

August 12, 1852 Sid. time 18h 05m Bar. 30.164 Att. Therm. 68 Ext. Therm. 67.2
" " 20.35 " 30.154 " " 68 " " 61.7

Wone 11

August 13, 1852 Sid. time 18h 32m Bar. 30.136 Att. Therm. 72.0 Ext. Therm. 70.0
" " 20.32 " 30.130 " " 70.0 " " 66.1

Wone 10

$t_0 = 18^h 00^m$ $k'_4 = 0^s.0005$ $d'_4 = +0^s.02$

18h 08m	$0.00 = x_{10} + 0.13\, x'_{10}$	$-1.1 = y_{10} + 0.13\, y'_{10}$	2
18h 06m	$+0.12 =$ ~~x_{10}~~ $+ 0.10\, x'_{10}$	$+0.2 = y_{10} + 0.10\, y'_{10}$	1
18h 08m	$-0.25 =$ " $+ 0.13$ "	$-0.7 =$ " $+ 0.13$ "	1
18h 16m	$-0.09 =$ " $+ 0.26$ "	$-3.3 =$ " $+ 0.26$ "	1
18h 22m	$-0.30 =$ " $+ 0.36$ "	$-3.2 =$ " $+ 0.36$ "	3
18h 22m	$-0.41 =$ " $+ 0.36$ "	$-3.7 =$ " $+ 0.36$ "	2
18h 23m	$-0.06 =$ " $+ 0.38$ "	$-3.1 =$ " $+ 0.38$ "	3
18h 23m	$+0.15 =$ " $+ 0.38$ "	$-4.9 =$ " $+ 0.38$ "	2
18h 55m	$+0.38 =$ " $+ 0.92$ "	$-9.0 =$ " $+ 0.92$ "	1
18h 58m	$+0.33 =$ " $+ 0.92$ "	$-7.1 =$ " $+ 0.92$ "	1
19h 05m	$+0.54 =$ " $+ 1.08$ "	$-4.3 =$ " $+ 1.08$ "	1
19h 10m	$-0.01 =$ " $+ 1.18$ "	$-6.1 =$ " $+ 1.18$ "	2
19h 11m	$-0.01 =$ " $+ 1.18$ "	$-7.6 =$ " $+ 1.18$ "	2
19h 14m	$-0.14 =$ " $+ 1.23$ "	$-7.0 =$ " $+ 1.23$ "	1
19h 31m	$-0.11 =$ ~~x_{10}~~ $+ 1.52\, x'_{10}$	$-5.6 = y_{10} + 1.52\, y'_{10}$	2
19h 41m	$+0.20 = x_{10} + 1.68\, x'_{10}$	$-6.0 = y_{10} + 1.68\, y'_{10}$	2

Wone 11

$t = 18^h 00^m$ $k'_4 = 0^s.0005$ $d'_4 = +0^s.04$

18h 08m	$+0.73 = x_{11} + 0.13\, x'_{11}$	$+1.2 = y_{11} + 0.13\, y'_{11}$	2
18h 06m	$+0.77 = x_{11} + 0.10\, x'_{11}$	$+2.2 = y_{11} + 0.10\, y'_{11}$	1
18h 08m	$+0.60 =$ " $+ 0.13$ "	$+2.3 =$ " $+ 0.13$ "	1
18h 16m	$+0.71 =$ " $+ 0.26$ "	$-3.5 =$ " $+ 0.26$ "	1
18h 22m	$+0.80 =$ " $+ 0.36$ "	$-1.3 =$ " $+ 0.36$ "	3
18h 22m	$+0.41 = x_{11} + 0.36\, x'_{11}$	$-1.7 = y_{11} + 0.36\, y'_{11}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Jones 1021

18„23	$+0,79 = x_{\prime\prime} + 0.38\, x'_{\prime\prime}$	$-4.3 = y_{\prime\prime} + 0.38\, y'_{\prime\prime}$	3
18„23	$+0.90 =$ „ $+ 0.38$ „	$-5.1 =$ „ $+ 0.38$ „	2
18„53	$+1.03 =$ „ $+ 0.92$ „	$-6.1 =$ „ $+ 0.92$ „	1
18„55	$+1.08 =$ „ $+ 0.92$ „	$-7.3 =$ „ $+ 0.92$ „	1
19„06	$+1.44 =$ „ $+ 1.10$ „	$-3.4 =$ „ $+ 1.10$ „	1
19„10	$+0.74 =$ „ $+ 1.17$ „	$-4.2 =$ „ $+ 1.17$ „	2
19„11	$+0.74 =$ „ $+ 1.18$ „	$-5.6 =$ „ $+ 1.18$ „	2
19„14	$+0.56 =$ „ $+ 1.23$ „	$-4.0 =$ „ $+ 1.23$ „	1
19„31	$+0.79 = x_{\prime\prime} + 1.52\, x'_{\prime\prime}$	$-4.7 = y_{\prime\prime} + 1.52\, y'_{\prime\prime}$	2
1941	$+0.67 = x_{\prime\prime} + 1.68\, x'_{\prime\prime}$	$-5.2 = y_{\prime\prime} + 1.68\, y'_{\prime\prime}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 10.

	Ex h m	K s		−0".02 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
t_0	18 00 −	0.09		− 1.8	1.82	1.84	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00
	10 −	.07	.02	− 2.4	2.42	2.44	2.46	2.48	2.50	2.52	2.54	2.56	2.58	2.60
	20 −	.06	.01	− 3.0	3.02	3.04	3.06	3.08	3.10	3.12	3.14	3.16	3.18	3.20
	30 −	.04	.02	− 3.6	3.62	3.64	3.66	3.68	3.70	3.72	3.74	3.76	3.78	3.80
	40 −	.03	.01	− 4.2	4.22	4.24	4.26	4.28	4.30	4.32	4.34	4.36	4.38	4.40
	50 −	.02	.01	− 4.8	4.82	4.84	4.86	4.88	4.90	4.92	4.94	4.96	4.98	5.00
	19 00 −	.01	.01	− 5.4	5.42	5.44	5.46	5.48	5.50	5.52	5.54	5.56	5.58	5.60
	10 +	.01	.02	− 5.9	5.92	5.94	5.96	5.98	6.00	6.02	6.04	6.06	6.08	6.10
	20 +	.02	.01	− 6.5	6.52	6.54	6.56	6.58	6.60	6.62	6.64	6.66	6.68	6.70
	30 +	.03	.01	− 7.1	7.12	7.14	7.16	7.18	7.20	7.22	7.24	7.26	7.28	7.30
	40 +	.05	.02	− 7.7	7.72	7.74	7.76	7.78	7.80	7.82	7.84	7.86	7.88	7.90
	50 +	.06	.01	− 8.4	8.42	8.44	8.46	8.48	8.50	8.50	8.52	8.54	8.56	8.60
	20 00 +	.08	.02	− 9.0	9.02	9.04	9.06	9.08	9.10	9.12	9.14	9.16	9.18	9.20

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 11.

h m	K		d	d' = +0".04									
			0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
18 00 +	0".81		-0".5	-0.56	-0.42	-0.4	-0.3	-0.3	-0.36	-0.2	-0.2	-0.1	-0.10
10 +	.80	.01	-1.1	-1.16	-1.02	-1.0	-0.9	-0.9	-0.96	-0.82	-0.8	-0.74	-0.7
20 +	.79	.01	-1.7	-1.76	-1.62	-1.6	-1.5	-1.5	-1.56	-1.4	-1.4	-1.3	-1.30
30 +	.79	.00	-2.3	-2.36	-2.22	-2.18	-2.14	-2.10	-2.06	-2.02	-1.98	-1.94	-1.90
40 +	.78	.01	-2.9	-2.86	-2.82	-2.78	-2.74	-2.70	-2.66	-2.62	-2.58	-2.54	-2.50
50 +	.77	.01	-3.5	-3.46	-3.42	-3.38	-3.34	-3.30	-3.26	-3.22	-3.18	-3.14	-3.10
19 00 +	.76	.01	-4.1	-4.06	-4.02	-3.98	-3.94	-3.90	-3.86	-3.82	-3.78	-3.74	-3.70
10 +	.76	.00	-4.7	-4.66	-4.62	-4.58	-4.54	-4.50	-4.46	-4.42	-4.38	-4.34	-4.30
20 +	.75	.01	-5.3	-5.26	-5.22	-5.18	-5.14	-5.10	-5.06	-5.02	-4.98	-4.94	-4.90
30 +	.74	.01	-5.8	-5.76	-5.72	-5.68	-5.64	-5.60	-5.56	-5.52	-5.48	-5.44	-5.40
40 +	.73	.01	-6.4	-6.36	-6.32	-6.28	-6.24	-6.20	-6.16	-6.12	-6.08	-6.04	-6.00
50 +	.72	.01	-7.0	-6.96	-6.92	-6.88	-6.84	-6.80	-6.76	-6.72	-6.68	-6.64	-6.60
20 00 +	.72	.00	-7.5	-7.46	-7.42	-7.38	-7.34	-7.30	-7.26	-7.22	-7.18	-7.14	-7.10

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj:23

Reduction of Zones 13 & 14

Zone 13

Nov. 3d 1852 Sid. time 22h 20m Bar. 29.906 Att. therm. 68° Ext. therm. 49.0
" " 0 50 " 29.940 " " 66 " " 45.6

Zone 14

Nov. 4, 1852 Sid. time 21 07 Bar. 30.048 Att. therm. 66 Ext. therm. 43.0
" " 23 08 " 30.036 " " 64 " " 40.6

Zone 13

$t = 19^h\,40^m$	$k'_4 = +0^s.002$	$d'_4 = -0''.09$	
19 49	$-0.47 = x_{13} + 0.15\,x'_{13}$	$-5''.8 = y_{13} + 0.15\,y'_{13}$	2
19 49 75	$-0.43 =$ ~~x_{13}~~ $+ 0.15\,x'_{13}$	$-7.9 = y_{13} + 0.15\,y'_{13}$	2
19 50	$-0.57 =$ " $+ 0.17$ "	$-4.1 =$ " .17	2
19 51	$-0.29 =$ " $+ 0.18$ "	$-5.2 =$ " 18	2
19 58	$-0.30 =$ " $+ 0.30$ "	$-5.5 =$ " 30	2
20 09	$-0.53 =$ " $+ 0.48$ "	$-1.8 =$ " 48	1
20 11	$-0.69 =$ " $+ 0.52$ "	$-6.3 =$ " 52	2
20 16	$-0.10 =$ " $+ 0.60$ "	$-3.8 =$ " 60	1
20 58	$+0.01 =$ " $+ 1.30$ "	$-5.8 =$ " 1.30	2
20 58	$-0.23 =$ " $+ 1.30$ "	$-0.3 =$ " 1.30	2
21 04	$-0.74 =$ " $+ 1.40$ "	$-2.2 =$ " 1.40	1
21 13	$-0.35 =$ " $+ 1.55$ "	$-4.3 =$ " 1.55	3 2
21 16	$+0.05 =$ ~~x_{13}~~ $+ 1.60$	$-3.5 =$ " 1.60	1
~~21 39~~ 21 35	$-0.52 = 4 + 2.00$	$-6.7 =$ " 2.00	3
~~21 35~~ 21 35	$-0.71 = x_{13} + 1.92\,x'_{13}$	$-5.9 = y_{13} + 1.92\,y'_{13}$	2

Zone 14

$t = 19^h\,40^m$	$k'_4 = +0^s.001$	$d'_4 = -0''.15$	
19 49	$+0.05 = x_{14} + 0.15\,x'_{14}$	$-10.6 = y_{14} + 0.15\,y'_{14}$	2
19 49	$+0.02 = x_{14} + 0.15\,x'_{14}$	$-10.5 = y_{14} + 0.15\,y'_{14}$	2
19 50	$-0.01 =$ " $+ 0.17$ "	$-11.7 =$ " $+ 0.17$ "	2
19 51	$+0.01 =$ " $+ 0.18$ "	$-9.7 =$ " $+ 0.18$ "	2
19 58	$+0.20 =$ " $+ 0.30$ "	$-10.4 =$ " $+ 0.30$ "	2
20 09	$-0.23 =$ " $+ 0.48$ "	$-4.7 =$ " $+ 0.48$ "	1
20 11	$-0.14 =$ " $+ 0.52$ "	$-9.8 =$ " $+ 0.52$ "	2
20 16	$+0.20 = x_{14} + 0.60\,x'_{14}$	$-8.7 = y_{14} + 0.60\,y'_{14}$	1

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zones 1344.

20ᵐ 58ˢ	+ 0.26 =	$x_{14} + 1.30\, x'_{14}$	− 10.3 =	$y_{14} + 1.30\, y'_{14}$	2
20ᵐ 58ˢ	+ 0.12 =	" + 1.30 "	− 4.1 =	" + 1.30 "	2
21ᵐ 4ˢ	− 0.59 =	" + 1.40 "	− 7.9 =	" + 1.40 "	1
21ᵐ 13ˢ	− 0.20 =	" + 1.55 "	− 14.2 =	" + 1.55 "	3
21ᵐ 16ˢ	− 0.05 =	" + 1.60 "	− 8.5 =	" + 1.60 "	1
21ᵐ 39ˢ	− 0.37 =	$x_{14} + 1.65\, x'_{14}$	− 12.7 =	$y_{14} + 1.65\, y'_{14}$	3
21ᵐ 35ˢ	− 0.57 =	$x_{14} + 1.92\, x'_{14}$	− 12.3 =	$y_{14} + 1.92\, y'_{14}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.1.23

Zone 13.

$-0''.09$

h	m	k	s		0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
19	40	−	0.35		− 5.3	− 5.39	− 5.48	− 5.57	− 5.66	− 5.75	− 5.84	− 5.93	− 6.02	− 6.11	− 6.20
	50	−	.36	01	− 5.2	− 5.29	− 5.38	− 5.47	− 5.56	− 5.65	− 5.74	− 5.83	− 5.92	− 6.01	− 6.10
20	00	−	.37	01	− 5.1	− 5.19	− 5.28	− 5.37	− 5.46	− 5.55	− 5.64	− 5.73	− 5.82	− 5.91	− 6.00
	10	−	.38	01	− 5.1	− 5.19	− 5.28	− 5.37	− 5.46	− 5.55	− 5.64	− 5.73	− 5.82	− 5.91	− 6.00
	20	−	.39	01	− 5.0	− 5.09	− 5.18	− 5.27	− 5.36	− 5.45	− 5.54	− 5.63	− 5.72	− 5.81	− 5.90
	30	−	.39	00	− 5.0	− 5.09	− 5.18	− 5.27	− 5.36	− 5.45	− 5.54	− 5.63	− 5.72	− 5.81	− 5.90
	40	−	.40	01	− 4.9	− 4.99	− 5.08	− 5.17	− 5.26	− 5.35	− 5.44	− 5.53	− 5.62	− 5.71	− 5.80
	50	−	.41	01	− 4.9	− 4.99	− 5.08	− 5.17	− 5.26	− 5.35	− 5.44	− 5.53	− 5.62	− 5.71	− 5.80
21	00	−	.42	01	− 4.8	− 4.89	− 4.98	− 5.07	− 5.16	− 5.25	− 5.34	− 5.43	− 5.52	− 5.61	− 5.70
	10	−	.43	01	− 4.7	− 4.79	− 4.88	− 4.97	− 5.06	− 5.15	− 5.24	− 5.33	− 5.42	− 5.51	− 5.60
	20	−	.44	01	− 4.7	− 4.79	− 4.88	− 4.97	− 5.06	− 5.15	− 5.24	− 5.33	− 5.42	− 5.51	− 5.60
	30	−	.44	00	− 4.7	− 4.79	− 4.88	− 4.97	− 5.06	− 5.15	− 5.24	− 5.33	− 5.42	− 5.51	− 5.60
	40	−	.45	01	− 4.6	− 4.69	− 4.78	− 4.87	− 4.96	− 5.05	− 5.14	− 5.23	− 5.32	− 5.41	− 5.50

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 14.

	h m	K		0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
6_0	19h40m +	0.15		−9.6	−9.75	−9.90	−10.05	−10.20	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10
	50 +	.10	05	−9.7	−9.85	−10.00	−10.15	−10.30	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20
	20h00m +	.06	04	−9.7	−9.85	−10.00	−10.15	−10.30	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20
	10 +	.02	04	−9.8	−9.95	−10.10	−10.25	−10.40	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30
	20 −	.02	04	−9.9	−10.05	−10.20	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40
	30 −	.06	04	−9.9	−10.05	−10.20	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40
	40 −	.10	04	−10.0	−10.15	−10.30	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20	−11.35	−11.50
	50 −	.14	04	−10.1	−10.25	−10.40	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30	−11.45	−11.60
	21h00m −	.18	04	−10.2	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40	−11.55	−11.70
	10 −	.22	04	−10.2	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40	−11.55	−11.70
	20 −	.26	04	−10.3	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20	−11.35	−11.50	−11.65	−11.80
	30 −	.30	04	−10.4	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30	−11.45	−11.60	−11.75	−11.90
	40 −	.34	04	−10.4	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30	−11.45	−11.60	−11.75	−11.90

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 14 & 16

Zone 14

Nov. 4, 1852 Sid. time 21h 07m Bar. 30.048 in Att. therm. 66° Ext. therm. 43.0°
" " 23h 08m " 30.036 " " 64 " " 40.6

Zone 16

Nov 24, 1852 Sid. time 22h 05m Bar. 30.000 Att. therm. 58° Ext. therm. 24.8°
" " 24h 04m Bar. 30.030 " " 62 " " 24.0

Zone 14

$t_0 = 19^h 40^m$ $k'_4 = +0.001s$ $d'_4 = -0.15s$

19h 49m	$+0.05 = x_{14} + 0.15\, x'_{14}$	$-10.''6 = y_{14} + 0.15\, y'_{14}$	2
19h 49m	$+0.02 = x_{14} + 0.15\, x'_{14}$	$-10.5 = y_{14} + 0.15\, y'_{14}$	2
19h 50m	$-0.01 = $ " $+ 0.18$ "	$-11.7 = $ " $+ 0.18$ "	2
19h 57m	$+0.07 = $ " $+ 0.18$ "	$-9.7 = $ " $+ 0.18$ "	2
19h 58m	$+0.20 = $ " $+ 0.30$ "	$-10.4 = $ " $+ 0.30$ "	2
20h 10m	$-0.23 = $ " $+ 0.50$ "	$-4.7 = $ " $+ 0.50$ "	1
20h 11m	$-0.14 = $ " $+ 0.52$ "	$-9.8 = $ " $+ 0.52$ "	2
20h 16m	$+0.20 = $ " $+ 0.60$ "	$-8.7 = $ " $+ 0.60$ "	1
20h 58m	$+0.26 = $ " $+ 1.30$ "	$-10.3 = $ " $+ 1.30$ "	2
20h 58m	$+0.12 = $ " $+ 1.30$ "	$-4.0 = $ " $+ 1.30$ "	2
21h 04m	$-0.59 = $ " $+ 1.40$ "	$-7.9 = $ " $+ 1.40$ "	1
21h 13m	$-0.20 = $ " $+ 1.55$ "	$-10.2 = $ " $+ 1.55$ "	3
21h 17m	$-0.05 = $ " $+ 1.62$ "	$-8.6 = $ " $+ 1.62$ "	1
21h 39m	$-0.37 = x_m + 1.98\, x'_{14}$	$-12.7 = y_m + 1.98\, y'_{14}$	3
21h 35m	$-0.57 = x_{14} + 1.922\, x'_{14}$	$-12.3 = y_{14} + 1.922\, y'_{14}$	2

Zone 16

$t_0 = 19^h 40^m$ $k = +0^s.002s$ $d'_4 = -0''.27s$

19h 44m	$-0^s.35 = x_{16} + 0.15\, x'_{15}$	$-3.''0 = y_{16} + 0.15\, y'_{16}$	2
19h 49m	~~~~~~~	$-1.8 = y_{16} + 0.15\, y'_{16}$	2
19h 50m	~~~~	$+0.2 = $ " $+ 0.17$ "	2
19h 57m	~~~~	$-0.7 = $ " $+ 0.18$ "	2
19h 58m	~~~~	$-2.2 = $ " $+ 0.30$ "	2
20h 09m	$-0^s.53 = x_{16} + 0.48\, x'_{16}$	$+1.5 = $ " $+ 0.48$ "	1
20h 11m	$-0.64 = $ " $+ 0.52$ "	$-1.9 = $ " $+ 0.51$ "	2
20h 16m	$-0.30 = x_{16} + 0.60\, x'_{16}$	$-1.4 = y_{16} + 0.60\, y'_{16}$	1

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 16

20h 58	−0.09 = x16 + 0.30 x'16	+1.7 = y16 + 1.30 y'16	2
20.58	−0.28 = " + 1.30 "	+4.5 = " + 1.30 "	2
21h 04	−1.04 = " + 1.40 "	+1.6 = " + 1.20 "	1
21h 13	−0.60 = " + 1.55 "	−1.2 = " + 1.55 "	3
21h 17	−0.35 = " + 1.62 "	−0.8 = " + 1.62 "	1
21h 39	−0.77 = x16 + 1.98 x'16	−2.5 = y16 + 1.98 y'16	3
21h 35	−0.81 = x16 + 1.92 x'16	−3.5 = y16 + 1.92 y'16	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 14.

	Et	k	α	d' = −6".15									
			0"	1'	2'	3'	4'	5'd	6'	7'	8'	9'	10'
t_0	19h40	+ 0.13	−9".3	−9.45	−9.60	−9.75	−9.90	−10.05	−10.20	−10.35	−10.50	−10.65	−10".80
	.50	+ .10	−9.5	−9.65	−9.80	−9.95	−10.10	−10.25	−10.40	−10.55	−10.70	−10.85	−11.00
	20h00	+ .06	−9.6	−9.75	−9.90	−10.05	−10.20	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10
	h10	+ .02	−9.7	−9.85	−10.00	−10.15	−10.30	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20
	h20	− .03	−9.7	−9.85	−10.00	−10.15	−10.30	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20
	h30	− .07	−9.8	−9.95	−10.10	−10.25	−10.40	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30
	h40	− .11	−9.9	−10.05	−10.20	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40
	h50	− .16	−10.0	−10.15	−10.30	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20	−11.35	−11.50
	21h00	− .20	−10.1	−10.25	−10.40	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30	−11.45	−11.60
	h10	− .24	−10.2	−10.35	−10.50	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40	−11.55	−11.70
	h20	− .28	−10.3	−10.45	−10.60	−10.75	−10.90	−11.05	−11.20	−11.35	−11.50	−11.65	−11.80
	h30	− .32	−10.4	−10.55	−10.70	−10.85	−11.00	−11.15	−11.30	−11.45	−11.60	−11.75	−11.90
	h40	− .34	−10.5	−10.65	−10.80	−10.95	−11.10	−11.25	−11.40	−11.55	−11.70	−11.85	−12.00

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 16.

α	k	δ	$d' = -0''.27$									
		0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
h m	s	″										
19.40	0.39	−0.2	−0.47	−0.74	−1.01	−1.28	−1.55	−1.82	−2.09	−2.36	−2.63	−2.90
.50	.41	−.2	−0.47	−0.74	−1.01	−1.28	−1.55	−1.82	−2.09	−2.36	−2.63	−2.90
20.00	.43	−.3	−0.57	−0.84	−1.11	−1.38	−1.65	−1.92	−2.19	−2.46	−2.73	−3.00
.10	.44	−.3	−0.57	−0.84	−1.11	−1.38	−1.65	−1.92	−2.19	−2.46	−2.73	−3.00
.20	.46	−.4	−0.67	−0.94	−1.21	−1.48	−1.75	−2.02	−2.29	−2.56	−2.83	−3.10
.30	.47	−.4	−0.67	−0.94	−1.21	−1.48	−1.75	−2.02	−2.29	−2.56	−2.83	−3.10
.40	.49	−.5	−0.77	−1.04	−1.31	−1.58	−1.85	−2.12	−2.39	−2.66	−2.93	−3.20
.50	.51	−.5	−0.77	−1.04	−1.31	−1.58	−1.85	−2.12	−2.39	−2.66	−2.03	−3.20
21.00	.53	−.6	−0.87	−1.14	−1.41	−1.68	−1.95	−2.22	−2.49	−2.76	−3.03	−3.30
.10	.55	−.6	−0.87	−1.14	−1.41	−1.68	−1.95	−2.22	−2.49	−2.76	−3.03	−3.30
.20	.57	−.6	−0.87	−1.14	−1.41	−1.68	−1.95	−2.22	−2.49	−2.76	−3.03	−3.30
.30	.59	−.7	−0.97	−1.24	−1.51	−1.78	−2.05	−2.32	−2.59	−2.86	−3.13	−3.40
.40	.61	−.7	−0.97	−1.24	−1.51	−1.78	−2.05	−2.32	−2.59	−2.86	−3.13	−3.40

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 15 & 17

Zone 15

Nov 11, 1852	Sid. time	21h 36m	Bar. 30.248	Att. therm.	64°	Ext. therm.	39.0
" "	"	23h 30m	30.236	"	65	"	35.0

Zone 17

Nov. 30. 1852	Sid. time	22h 17m	Bar. 30.348	Att. therm	62°	Ext. therm	33.8
" "	"	00h 09m	" 30.340	"	63	"	32.9

Zone 15

$t_0 = 19^h 40^m$ $\quad k'_4 = +0^s.0025$ $\quad d'_4 = -0''.185$

19h 40m	$-0.24 =$	$x_{15} + 0.00\, x'_{15}$	$-6.2 = y_{15} + 0.00\, y'_{15}$ 2
19h 45m	$-0.03 =$	$x_{15} + 0.08\, x'_{15}$	$-6.0 =$ " $+ 0.08$ " 3
19h 52m	$+0.10 =$	" $+ 0.12$ "	$-5.3 =$ " $+ 0.12$ " 1
19h 52m	$-0.11 =$	" $+ 0.12$ "	$-5.1 =$ " $+ 0.12$ " 1
20h 06m	$-0.70 =$	" $+ 0.43$ "	$-6.4 =$ " $+ 0.43$ " 1
20h 11m	$-0.76 =$	" $+ 0.52$ "	$-8.6 =$ " $+ 0.52$ " 2
20h 11m	$-0.66 =$	" $+ 0.52$ "	$-6.1 =$ " $+ 0.52$ " 2
20h 12m	$-0.55 =$	" $+ 0.53$ "	$-5.3 =$ " $+ 0.53$ " 2
20h 52m	$-0.48 =$	" $+ 1.20$ "	$-4.9 =$ " $+ 1.20$ " 1
21h 13m	$-0.74 =$	$x_{15} + 1.55\, x'_{15}$	$-3.8 = y_{15} + 1.55\, y'_{15}$ 1
21h 24m	$-0.82 =$	$x_{15} + 1.73\, x'_{15}$	$-10.4 = y_{15} + 1.73\, y'_{15}$ 2

Zone 17

$t_0 = 19^h 40^m$ $\quad k'_4 = +0^s.002$ $\quad d'_4 = -0''.20$

19h 40m	$+0.21 =$	$x_{17} + 0.00\, x'_{17}$	$-6.7 = y_{17} + 0.00\, y'_{17}$ 2
19h 45m	$+0.52 =$	$x_{17} + 0.08\, x'_{17}$	$-6.9 = y_{17} + 0.08\, y'_{17}$ 3
19h 52m	$+0.50 =$	" $+ 0.12$ "	$-5.2 =$ " $+ 0.12$ " 1
19h 52m	$-0.05 =$	" $+ 0.12$ "	$-6.0 =$ " $+ 0.12$ " 1
20h 06m	$-0.10 =$	" $+ 0.43$ "	$-5.3 =$ " $+ 0.43$ " 1
20h 11m	$-0.11 =$	" $+ 0.52$ "	$-6.6 =$ " $+ 0.52$ " 2
~~20h 11m~~	~~= = = =~~	" ~~+ 0.52~~ "	~~= = = =~~ " ~~+ 0.52~~ " ~~2~~
20h 12m	$+0.05 =$	" $+ 0.53$ "	$-5.2 =$ " $+ 0.53$ " 2
20h 52m	$+0.17 =$	" $+ 1.20$ "	$-6.8 =$ " $+ 1.20$ " 1
21h 12m	$-0.24 =$	$x_{17} + 1.52\, x'_{17}$	$-4.7 = y_{17} + 1.53\, y'_{17}$ 1
21h 24m	$-0.22 =$	$x_{17} + 1.73\, x'_{17}$	$-10.4 = y_{17} + 1.73\, y'_{17}$ 2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 15.

k		d										d' = 0".181
h m	k s	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10
19 „40	0.19	-6.1	-6.28	-6.46	-6.64	-6.82	-7.06	-7.18	-7.36	-7.54	-7.72	-7.90
.50	.27	-6.2	-6.38	-6.56	-6.74	-6.92	-7.10	-7.28	-7.46	-7.64	-7.82	-8.00
20.00	.34	-6.3	-6.48	-6.66	-6.84	-7.02	-7.20	-7.38	-7.56	-7.74	-7.92	-8.10
.10	.41	-6.4	-6.58	-6.76	-6.94	-7.12	-7.30	-7.48	-7.66	-7.84	-8.02	-8.20
.20	.48	-6.6	-6.78	-6.96	-7.14	-7.32	-7.50	-7.68	-7.86	-8.04	-8.22	-8.40
.30	.55	-6.7	-6.88	-7.06	-7.24	-7.42	-7.60	-7.78	-7.96	-8.14	-8.32	-8.50
.40	.63	-6.8	-6.98	-7.16	-7.34	-7.52	-7.70	-7.88	-8.06	-8.24	-8.42	-8.60
.50	.70	-6.9	-7.08	-7.26	-7.44	-7.62	-7.80	-7.98	-8.16	-8.34	-8.52	-8.70
21 „00	.77	-6.9	-7.08	-7.26	-7.44	-7.62	-7.80	-7.98	-8.16	-8.34	-8.52	-8.70
„10	.83	-7.0	-7.18	-7.36	-7.54	-7.72	-7.90	-8.08	-8.26	-8.44	-8.62	-8.80
„20	.90	-7.1	-7.28	-7.46	-7.64	-7.82	-8.00	-8.18	-8.36	-8.54	-8.72	-8.90
„30	.97	-7.2	-7.38	-7.56	-7.74	-7.92	-8.10	-8.28	-8.46	-8.64	-8.82	-9.00
„40	1.05	-7.3	-7.48	-7.66	-7.84	-8.02	-8.20	-8.38	-8.56	-8.74	-8.92	-9.10

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 17.

	k	d											dd = 0.20s
h	m	s		0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
				0″										
19	40	+	0.27	−6.2	−6.40	−6.60	−6.80	−7.00	−7.20	−7.40	−7.60	−7.80	−8.00	−8.20
	50	+	.21	−6.3	−6.50	−6.70	−6.90	−7.10	−7.30	−7.50	−7.70	−7.90	−8.10	−8.30
20	00	+	.15	−6.4	−6.60	−6.80	−7.00	−7.20	−7.40	−7.60	−7.80	−8.00	−8.20	−8.40
	10	+	.10	−6.5	−6.70	−6.90	−7.10	−7.30	−7.50	−7.70	−7.90	−8.10	−8.30	−8.50
	20	+	.04	−6.6	−6.80	−7.00	−7.20	−7.40	−7.60	−7.80	−8.00	−8.20	−8.40	−8.60
	30	−	.02	−6.7	−6.90	−7.10	−7.30	−7.50	−7.70	−7.90	−8.10	−8.30	−8.50	−8.70
	40	−	.08	−6.9	−7.10	−7.30	−7.50	−7.70	−7.90	−8.10	−8.30	−8.50	−8.70	−8.90
	50	−	.13	−7.0	−7.20	−7.40	−7.60	−7.80	−8.00	−8.20	−8.40	−8.60	−8.80	−9.00
21	00	−	.18	−7.1	−7.30	−7.50	−7.70	−7.90	−8.10	−8.30	−8.50	−8.70	−8.90	−9.10
	10	−	.24	−7.2	−7.40	−7.60	−7.80	−8.00	−8.20	−8.40	−8.60	−8.80	−9.00	−9.20
	20	−	.31	−7.3	−7.50	−7.70	−7.90	−8.10	−8.30	−8.50	−8.70	−8.90	−9.10	−9.30
	30	−	.38	−7.4	−7.60	−7.80	−8.00	−8.20	−8.40	−8.60	−8.80	−9.00	−9.20	−9.40
	40	−	.44	−7.5	−7.70	−7.90	−8.10	−8.30	−8.50	−8.70	−8.90	−9.10	−9.30	−9.50

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 18 & 19

Zone 18

Dec. 6, 1852 Sid. Time 23h 25m Bar. 30.000 Att. Therm. 65° Ext. Therm. 44.0
" " 1h 19 " 30.000 " " 68 " " 41.3

Zone 19

Dec. 14, 1852 Sid. Time 23h 36 Bar. 30.480 Att. Therm 63 Ext. Therm 20.2
" " 1h 20 " 30.520 " " 63 " " 18.2

Zone 18

$t_0 = 21^h\,30^m$ $k'_4 = 0^s.0005$ $d'_4 = -0''.12$

21h 35	$+0^s.10 =$	$x_{18} + 0.09\,x'_{18}$	$-4.2 =$	$y_{18} + 0.09\,y'_{18}$ 2
21h 39	----		$-4.5 =$	$y_{18} + 0.15\,y'_{18}$ 3
21h 43	$-0.31 =$	" $+ 0.22$ "	$-7.0 =$	" $+ 0.22$ " 3
22h 06	$-0.66 =$	" $+ 0.60$ "	$-7.1 =$	" $+ 0.60$ " 2
22h 11	$-0.34 =$	" $+ 0.68$ "	$-9.1 =$	" $+ 0.68$ " 1
22h 14	$-0.07 =$	" $+ 0.73$ "	$-6.3 =$	" $+ 0.73$ " 1
22h 18	$-0.21 =$	" $+ 0.73$ "	$-8.1 =$	" $+ 0.73$ " 1
22h 15	$-0.48 =$	" $+ 0.75$ "	$-4.3 =$	" $+ 0.75$ " 1
22h 49	$-0.10 =$	" $+ 1.32$ "	$-8.0 =$	" $+ 1.32$ " 1
22h 52	$-0.53 =$	" $+ 1.37$ "	$-9.5 =$	" $+ 1.37$ " 3
23.06	$-0.22 =$	$x_{18} + 1.60\,x'_{18}$	$-7.9 =$	$y_{18} + 1.60\,y'_{18}$ 3
23.06	$\mathbf{-0.46} =$	$\mathbf{x_{18} + 1.60\,x'_{18}}$	$\mathbf{-7.5} =$	$\mathbf{y_{18} + 1.60\,y'_{18}}$ 2

Zone 19

$t_0 = 21^h\,30^m$ $k'_4 = 0^s.0005$ $d'_4 = -0''.26$

21h 35	$-0.24 =$	$x_{19} + 0.09\,x'_{19}$	$-3.8 =$	$y_{19} + 0.09\,y'_{19}$ 2
21h 39	$-0.34 =$	" $+ 0.15$ "	$-1.1 =$	" $+ 0.15$ " 3
21h 43	$-0.56 =$	" $+ 0.22$ "	$-6.5 =$	" $+ 0.22$ " 3
22h 06	$-0.96 =$	" $+ 0.60$ "	$-4.9 =$	" $+ 0.60$ " 2
22h 11	$-0.59 =$	" $+ 0.68$ "	$-8.4 =$	" $+ 0.68$ " 1
22h 14	$-0.42 =$	" $+ 0.73$ "	$-7.0 =$	" $+ 0.73$ " 1
22h 14	$-0.57 =$	" $+ 0.73$ "	$-8.0 =$	" $+ 0.73$ " 1
22h 15	$-0.88 =$	" $+ 0.75$ "	$-1.6 =$	" $+ 0.75$ " 1
22h 49	$-0.45 =$	" $+ 1.32$ "	$-6.1 =$	" $+ 1.32$ " 1
22h 52	$-0.63 =$	" $+ 1.37$ "	$-5.0 =$	" $+ 1.37$ " 3
23h 06	$-0.57 =$	$x_{19} + 1.60\,x'_{19}$	$-4.6 =$	$y_{19} + 1.60\,y'_{19}$ 3
23.06	$\mathbf{-0.68} =$	$\mathbf{x_{19} + 1.60\,x'_{19}}$	$\mathbf{-7.2} =$	$\mathbf{y_{19} + 1.60\,y'_{19}}$ 2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 18.

h Eqm.	k s
21 „30	0.16
„40	.19
„50	.22
22 .00	.24
.10	.27
.20	.30
.30	.33
.40	.36
.50	.39
23 „00	.42
„10	.45
„20	.47
„30	.50

d d' = 0".12

d	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
- 5.1	5.10	5.22	5.34	5.46	5.58	5.70	5.82	5.94	6.06	6.18	6.30
- 5.6	5.60	5.72	5.84	5.96	6.08	6.20	6.32	6.44	6.56	6.68	6.80
- 6.0	6.00	6.12	6.24	6.36	6.48	6.60	6.72	6.84	6.96	7.08	7.20
- 6.3	6.30	6.42	6.54	6.66	6.78	6.90	7.02	7.14	7.26	7.38	7.50
- 6.7	6.70	6.82	6.94	7.06	7.18	7.30	7.42	7.54	7.66	7.78	7.90
- 7.0	7.00	7.12	7.24	7.36	7.48	7.60	7.72	7.84	7.96	8.08	8.20
- 7.4	7.40	7.52	7.64	7.76	7.88	8.00	8.12	8.24	8.36	8.48	8.60
- 7.8	7.80	7.92	8.04	8.16	8.28	8.40	8.52	8.64	8.76	8.88	9.00
- 8.1	8.10	8.22	8.34	8.46	8.58	8.70	8.82	8.94	9.06	9.18	9.30
- 8.5	8.50	8.62	8.74	8.86	8.98	9.10	9.22	9.34	9.46	9.58	9.70
- 8.9	8.90	9.02	9.14	9.26	9.38	9.50	9.62	9.74	9.86	9.98	10.10
- 9.2	9.20	9.32	9.44	9.56	9.68	9.80	9.92	10.04	10.16	10.28	10.40
- 9.5	9.50	9.62	9.74	9.86	9.98	10.10	10.22	10.34	10.46	10.58	10.70

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.: 23

Zone 19.

	k	d	d′ = −0.26									
h m	k	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
21 30	0.44	−4.0	−4.26	−4.52	−4.78	−5.04	−5.30	−5.56	−5.82	−6.08	−6.34	−6.60
40	.47	−4.2	−4.46	−4.72	−4.98	−5.24	−5.50	−5.76	−6.02	−6.28	−6.54	−6.80
50	.50	−4.4	−4.66	−4.92	−5.18	−5.44	−5.70	−5.96	−6.22	−6.48	−6.74	−7.00
22 00	.52	−4.7	−4.96	−5.22	−5.48	−5.74	−6.00	−6.26	−6.52	−6.78	−7.04	−7.30
10	.54	−4.9	−5.16	−5.42	−5.68	−5.94	−6.20	−6.46	−6.72	−6.98	−7.24	−7.50
20	.57	−5.1	−5.36	−5.62	−5.88	−6.14	−6.40	−6.66	−6.92	−7.18	−7.44	−7.70
30	.60	−5.3	−5.56	−5.82	−6.08	−6.34	−6.60	−6.86	−7.12	−7.38	−7.64	−7.90
40	.62	−5.5	−5.76	−6.02	−6.28	−6.54	−6.80	−7.06	−7.32	−7.58	−7.84	−8.10
50	.65	−5.7	−5.96	−6.22	−6.48	−6.74	−7.00	−7.26	−7.52	−7.78	−8.04	−8.30
23 00	.67	−5.9	−6.16	−6.42	−6.68	−6.94	−7.20	−7.46	−7.72	−7.98	−8.24	−8.50
10	.70	−6.1	−6.36	−6.62	−6.88	−7.14	−7.40	−7.66	−7.92	−8.18	−8.44	−8.70
20	.72	−6.3	−6.56	−6.82	−7.08	−7.34	−7.60	−7.86	−8.12	−8.38	−8.64	−8.90
30	.75	−6.5	−6.76	−7.02	−7.28	−7.54	−7.80	−8.06	−8.32	−8.58	−8.84	−9.10

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.: 23

Reduction of Zones 20 & 21

Zone 20

Dec. 15, 1852	Sid. time	23h 34m	Bar.	30.580 in	Att. Therm	62°	Ext. Therm	19.2°
" "	"	1h 30m	"	30.610 "	" "	63	" "	16.6°

Zone 21

Dec. 22, 1852	Sid. time	23h 58m	Bar.	30.666	Att. Therm	58	Ext. Therm.	13.1
" "	"	1h 58m	"	30.740	" "	62	" "	12.8

Zone 20

$t_0 = 21^h 40^m$ $\quad k'_4 = +0.0015$ $\quad d'_4 = -0''.269$

21h 41m	$-0.37 = x_{20} + 0.02\, x'_{20}$	$-3.6 = z_{20} + 0.023'_{20}$	2
21h 46m	$-0.32 =$ ~~x_{20}~~ $+ 0.00$ ~~x'_{20}~~	$-3.6 =$ ~~y_{20}~~ $+ 0.00$ ~~y'_{20}~~	3
21h 52m	$-0.58 =$ " $+ 0.20$ "	$-9.5 =$ " $+ 0.20$ "	3
22h 08m	$-0.89 =$ " $+ 0.47$ "	$-10.7 =$ " $+ 0.47$ "	2
22h 32m	$-0.82 =$ " $+ 0.87$ "	$-10.4 =$ " $+ 0.87$ "	1
22h 47m	$-0.86 =$ " $+ 1.12$ "	$-8.8 =$ " $+ 1.12$ "	3
22h 52m	$-0.63 =$ " $+ 1.20$ "	$-9.6 =$ " $+ 1.20$ "	3
23h 20m	$-1.15 =$ " $+ 1.67$ "	$-8.0 =$ " $+ 1.67$ "	3
23h 22m	$-1.04 =$ ~~x_{20}~~ $+ 1.70$ ~~x'_{20}~~	$-11.2 =$ ~~y_{20}~~ $+ 1.70$ ~~y'_{20}~~	1
23h 26m	$-0.90 = x_2 + 1.77\, x'_{20}$	$-9.4 = z_{20} + 1.77\, z'_{20}$	2

Zone 21

$t_0 = 21^h 40^m$ $\quad k'_4 = +0.0015$ $\quad d'_4 = -0''.285$

21h 41m	$+0.38 = x_{21} + 0.02\, x'_{21}$	$-4.6 = z_{21} + 0.023'_{21}$	2
21h 46m	$-0.18 =$ ~~x_{21}~~ $+ 0.00$ ~~x'_{21}~~	$-5.6 =$ ~~y_{21}~~ $+ 0.00$ ~~y'_{21}~~	3
21h 52m	$+0.12 =$ " $+ 0.20$ "	$-9.5 =$ " $+ 0.20$ "	3
22h 08m	$-0.29 =$ " $+ 0.47$ "	$-9.5 =$ " $+ 0.47$ "	2
22h 32m	$-0.22 =$ " $+ 0.87$ "	$-10.2 =$ " $+ 0.87$ "	1
22h 47m	$-0.36 =$ " $+ 1.12$ "	$-8.7 =$ " $+ 1.12$ "	3
22h 52m	$-0.18 =$ " $+ 1.20$ "	$-10.6 =$ " $+ 1.20$ "	3
23h 20m	$-0.65 =$ " $+ 1.67$ "	$-7.9 =$ " $+ 1.67$ "	3
23h 22m	$-0.54 =$ ~~x_{21}~~ $+ 1.70$ ~~x'_{21}~~	$-10.2 =$ ~~y_{21}~~ $+ 1.70$ ~~y'_{21}~~	1
23h 26m	$-0.38 = x_{21} + 1.77\, x'_{21}$	$-7.5 = z_{21} + 1.77\, z'_{21}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Tome 20.

Et t_0	k
21h40m	0.46
,50	,52
22h00	,57
,10	,62
,20	,68
,30	,74
,40	,80
,50	,85
23h00	,90
,10	,96
,20	1,02
,30	1,08
,40	1,13

d' = 0".26

d	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
0"	-6.3	6.56	6.82	7.08	7.34	7.60	7.86	8.12	8.38	8.64	8.90
1"	-6.7	6.96	7.22	7.48	7.74	8.00	8.26	8.52	8.78	9.04	9.30
2"	-7.1	7.36	7.62	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70
3"	-7.4	7.66	7.92	8.18	8.44	8.70	8.96	9.22	9.48	9.74	10.00
4"	-7.8	8.06	8.32	8.58	8.84	9.10	9.36	9.62	9.88	10.14	10.40
5"	-8.2	8.46	8.72	8.98	9.24	9.50	9.76	10.02	10.28	10.54	10.80
6"	-8.6	8.86	9.12	9.38	9.64	9.90	10.16	10.42	10.68	10.94	11.20
7"	-9.0	9.26	9.52	9.78	10.04	10.30	10.56	10.82	11.08	11.34	11.60
8"	-9.4	9.66	9.92	10.18	10.44	10.70	10.96	11.22	11.48	11.74	12.00
9"	-9.8	10.06	10.32	10.58	10.84	11.10	11.36	11.62	11.88	12.14	12.40
10"	-10.2	10.46	10.72	10.98	11.24	11.50	11.76	12.02	12.28	12.54	12.80
11"	-10.6	10.86	11.12	11.38	11.64	11.90	12.16	12.42	12.68	12.94	13.20
12"	-11.0	11.26	11.52	11.78	12.04	12.30	12.56	12.82	13.08	13.34	13.60

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.: 23

Zone 21.

	h m	k s	a 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
													d′ = −6″.28
t_0	21 h 40 m	+ 0.06	−7″.1	−7.38	−7.66	−7.94	−8.22	−8.50	−8.78	−9.06	−9.34	−9.62	−9.90
	.50	.00	−7.3	−7.58	−7.86	−8.14	−8.42	−8.70	−8.98	−9.26	−9.54	−9.82	−10.10
	22 h 00 m	− .06	−7.6	−7.88	−8.16	−8.44	−8.72	−9.00	−9.28	−9.56	−9.84	−10.12	−10.40
	.10	− .12	−7.9	−8.18	−8.46	−8.74	−9.02	−9.30	−9.58	−9.86	−10.14	−10.42	−10.70
	.20	− .18	−8.1	−8.38	−8.66	−8.94	−9.22	−9.50	−9.78	−10.06	−10.34	−10.62	−10.90
	.30	− .24	−8.3	−8.58	−8.86	−9.14	−9.42	−9.70	−9.98	−10.26	−10.54	−10.82	−11.10
	.40	− .29	−8.6	−8.88	−9.16	−9.44	−9.72	−10.00	−10.28	−10.56	−10.84	−11.12	−11.40
	.50	− .34	−8.9	−9.18	−9.46	−9.74	−10.02	−10.30	−10.58	−10.86	−11.14	−11.42	−11.70
	23 h 00 m	− .39	−9.1	−9.38	−9.66	−9.94	−10.22	−10.50	−10.78	−11.06	−11.34	−11.62	−11.90
	.10	− .45	−9.3	−9.58	−9.86	−10.14	−10.42	−10.70	−10.98	−11.26	−11.54	−11.82	−12.10
	.20	− .50	−9.6	−9.88	−10.16	−10.44	−10.72	−11.00	−11.28	−11.56	−11.84	−12.12	−12.40
	.30	− .56	−9.8	−10.08	−10.36	−10.64	−10.92	−11.20	−11.48	−11.76	−12.04	−12.32	−12.60
	.40	− .62	−10.1	−10.38	−10.66	−10.94	−11.22	−11.50	−11.78	−12.06	−12.34	−12.62	−12.90

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 22 & 23

Zone 22

Dec. 29, 1852	Sid. time	00h 46m	Bar.	30.118	Att. therm	62°	Ext. therm.	34.5°
" "	"	2h 21	"	30.160	"	61	"	33.6

Zone 23

Jan. 5, 1853	Sid. time	1h 23	Bar.	30.140	Att. therm	60°	Ext. therm.	21.5°
" "	"	3h 18	"	30.160	"	63	"	18.7

Zone 22

$t_0 = 23^h 00^m$	k'_4 0.000s	$d'_4 = -0.17s$	
23h 01	$-0.07 = x_{22} + 0.02\, x'_{22}$	$-2.9 = z_{22} + 0.02\, z'_{22}$	2
23h 06	$-0.02 = $ ~~x_{22}~~ $+ 0.10$ ~~x'_{22}~~	$-3.6 = $ ~~z_{22}~~ $+ 0.10$ ~~z'_{22}~~	3
23h 23	$-0.35 = $ " $+ 0.38$ "	$-1.9 = $ " $+ 0.38$ "	1
23h 32	$-0.53 = $ ~~x_{22}~~ $+ 0.53$ ~~x'_{22}~~	$-7.3 = $ ~~z_{22}~~ $+ 0.53\, z'_{22}$	1
~~0h 48~~			
0h 00	$-0.80 = x_{22} + 1.00\, x'_{22}$	$-22 = z_{22} + 1.00\, z'_{22}$	2

Zone 23

$t_0 = 23^h 00^m$	$k'_4 = 0.000s$	$d'_4 = -0.25s$	
23h 01	$-0.30 = x_{23} + 0.02\, x'_{23}$	$-3.7 = z_{23} + 0.02\, z'_{23}$	2
23h 06	$-0.42 = $ ~~x_{23}~~ $+ 0.10$ ~~x'_{23}~~	$-3.0 = $ ~~z_{23}~~ $+ 0.10$ ~~z'_{23}~~	3
23h 23	$-0.75 = $ " $+ 0.38$ "	$-1.6 = $ " $+ 0.38$ "	1
23h 32	$-1.03 = $ " $+ 0.53$ "	$-5.5 = $ " $+ 0.53$ "	1
0h 14	$-1.58 = $ " $+ 1.23$ "	$-3.7 = $ " $+ 1.23$ "	1
0h 31	$-1.73 = $ ~~x_{23}~~ $+ 1.52$ ~~x'_{23}~~	$-3.7 = $ ~~z_{23}~~ $+ 1.52$ ~~z'_{23}~~	3
0h 42	$-1.46 = x_{23} + 1.70\, x'_{23}$	$-2.6 = z_{23} + 1.70\, z'_{23}$	2

Equations thus far have been copied & compared for Y.H.S.

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zones 22.

h m	k s
23 00	0.16
10	.27
20	.38
30	.50
40	.61
50	.72
24 00	.83
10	.94
20	1.05
30	1.16
40	1.27
50	1.38
1 00	1.49

α $\quad \alpha' = +0''.17$

	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
	−4.0	−4.17	−4.34	−4.51	−4.68	−4.85	−5.02	−5.19	−5.36	−5.53	−5.70
	−3.8	−3.97	−4.14	−4.31	−4.48	−4.65	−4.82	−4.99	−5.16	−5.33	−5.50
	−3.6	−3.77	−3.94	−4.11	−4.28	−4.45	−4.62	−4.79	−4.96	−5.13	−5.30
	−3.4	−3.57	−3.74	−3.91	−4.08	−4.25	−4.42	−4.59	−4.76	−4.93	−5.10
	−3.2	−3.37	−3.54	−3.71	−3.88	−4.05	−4.22	−4.39	−4.56	−4.73	−4.90
	−3.0	−3.17	−3.34	−3.51	−3.68	−3.85	−4.02	−4.19	−4.36	−4.53	−4.70
	−2.7	−2.87	−3.04	−3.21	−3.38	−3.55	−3.72	−3.89	−4.06	−4.23	−4.40
	−2.5	−2.67	−2.84	−3.01	−3.28	−3.45	−3.62	−3.79	−4.96	−5.13	−5.30
	−2.3	−2.47	−2.64	−2.81	−2.98	−3.15	−3.32	−3.49	−3.66	−3.83	−4.00
	−2.1	−2.27	−2.44	−2.61	−2.78	−2.95	−3.12	−3.29	−3.46	−3.63	−3.80
	−1.9	−2.07	−2.24	−2.41	−2.58	−2.75	−2.92	−3.09	3.26	−3.43	−3.60
	−1.7	−1.87	−2.04	−2.21	−2.38	−2.55	−2.72	−2.89	−3.06	−3.23	−3.40
	−1.5	−1.67	−1.84	−2.01	−2.18	−2.35	−2.52	−2.69	−2.86	3.03	3.20

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 23.

	h m	k s	d 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
			d′ = −0″.25										
t_0	23 00	− 0.40	− 3″.4	− 3.65	− 3.90	− 4.15	− 4.40	− 4.65	− 4.90	− 5.15	− 5.40	− 5.65	− 5.90
	.10	− .54	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.20	− .67	− 3,3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.30	− .80	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.40	− .94	− 3,3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.50	− 1.07	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	24 00	− 1.20	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.10	− 1.34	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.20	− 1.47	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.30	− 1.61	− 3.3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.40	− 1.75	− 3,3	− 3.55	− 3.80	− 4.05	− 4.30	− 4.55	− 4.80	− 5.05	− 5.30	− 5.55	− 5.80
	.50	− 1.88	− 3.2	− 3.45	− 3.70	− 3.95	− 4.20	− 4.45	− 4.70	− 4.95	− 5.20	− 5.45	− 5.70
	1 00	− 2.01	− 3.2	− 3.45	− 3.70	− 3.95	− 4.20	− 4.45	− 4.70	− 4.95	− 5.20	− 5.45	− 5.70

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1850phae.proj.23

Reduction of Zones 24 & 25

Zone 24

Jan. 6, 1853	Sid. time	h m 1.. 14	Bar.	30.000	Att. therm	59°	Ext. therm.	27.8
" "	"	3.. 08	"	29.994	"	52	"	27.0

Zone 25

Jan 7, 1853	Sid. time	1.. 51	Bar.	29.964	Att. therm.	62	Ext. therm	36.8
" "	"	3.. 53	"	30.000	"	52	"	35.8

Zone 24

h m t_0 23.. 20	$k'_4 = 0^s.000\,s$	$d'_4 = -0''.21\,s$	
23.. 26	$-0.51 = x_{24} + 0.10\,x'_{24}$	$-7.5 = z_{24} + 0.10\,z'_{24}$	2
23.. 36	$-0.35 = $ " $+ 0.27$ "	$-5.2 = $ " $+ 0.27$ "	1
23.. 41	$-0.57 = $ " $+ 0.35$ "	$-7.7 = $ " $+ 0.35$ "	1
23.. 42	$-0.55 = $ " $+ 0.37$ "	$-9.5 = $ " $+ 0.37$ "	3
23.. 53	$-0.58 = $ " $+ 0.55$ "	$-9.3 = $ " $+ 0.55$ "	1
23.. 53	$-0.52 = $ " $+ 0.55$ "	$-7.9 = $ " $+ 0.55$ "	1
00.. 00	$-0.68 = $ " $+ 0.67$ "	$-8.7 = $ " $+ 0.67$ "	1
00.. 27	$-0.89 = $ " $+ 1.12$ "	$-8.3 = $ " $+ 1.12$ "	1
00.. 32	$-1.05 = $ " $+ 1.20$ "	$-5.9 = $ " $+ 1.20$ "	1
00.. 33	$-1.29 = $ " $+ 1.22$ "	$-8.0 = $ " $+ 1.22$ "	1
00.. 34	$-1.00 = $ " $+ 1.23$ "	$-3.8 = $ " $+ 1.23$ "	1
00.. 35	$-0.78 = $ " $+ 1.25$ "	$-2.7 = $ " $+ 1.25$ "	1
1.. 05	$-1.62 = x_{24} + 1.75\,x'_{24}$	$-4.5 = z_{24} + 1.75\,z'_{24}$	1
1.. 06	$-1.26 = x_{24} + 1.77\,x'_{24}$	$-4.1 = z_{24} + 1.77\,z'_{24}$	2

Zone 25

h m t_0 23.. 20	$k'_4 = 0^s.000\,s$	$d'_4 = -0''.16\,s$	
23.. 26	$-0.35 = x_{25} + 0.10\,x'_{25}$	$-7.2 = z_{25} + 0.10\,z'_{25}$	2
23.. 36	$-0.15 = $ " $+ 0.27$ "	$-8.6 = $ " $+ 0.27$ "	1
23.. 41	$-0.26 = $ " $+ 0.35$ "	$-8.7 = $ " $+ 0.35$ "	1
23.. 42	$-0.68 = $ " $+ 0.37$ "	$-10.7 = $ " $+ 0.37$ "	3
23.. 52	$-0.53 = $ " $+ 0.53$ "	$-9.6 = $ " $+ 0.53$ "	1
23.. 53	$-0.17 = $ " $+ 0.55$ "	$-7.1 = $ " $+ 0.55$ "	1
0.. 00	$-0.58 = $ " $+ 0.67$ "	$-10.0 = $ " $+ 0.67$ "	1
00.. 27	$-0.74 = x_{25} + 1.12\,x'_{25}$	$-8.3 = z_{25} + 1.12\,z'_{25}$	1

over

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 25

0h 32	$-0.93 = r$	$x_{25} + 1.20\, x'_{25}$	$-5.0 = r$	$y_{25} + 1.20\, y'_{25}$	1
0h 33	$-1.09 = r$	" $+ 1.22$ "	$-11.5 = r$	" $+ 1.22$ "	1
0h 34	$-0.90 = r$	" $+ 1.23$ "	$-2.9 = r$	" $+ 1.23$ "	1
0h 35	$-0.68 = r$	" $+ 1.25$ "	$-1.9 = r$	" $+ 1.25$ "	1
1h 05	$-1.22 = r$	$x_{25} + 1.75\, x'_{25}$	$-5.9 = r$	$y_{25} + 1.75\, y'_{25}$	1
1h 06	$-1.24 =$	$x_{25} + 1.77\, x'_{25}$	$-4.1 =$	$y_{25} + 1.77\, y'_{25}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1953phae.proj..23

Zone 24

h m	k (s)		d 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
													d′ = −0.21
23 20	0.49		−9.5	−9.71	−9.92	−10.13	−10.34	−10.55	−10.76	−10.97	−11.18	−11.39	−11.60
30	.57	.08	−9.0	−9.21	−9.42	−9.63	−9.84	−10.05	−10.26	−10.47	−10.68	−10.89	−11.10
40	.65	.08	−8.5	−8.71	−8.92	−9.13	−9.34	−9.55	−9.76	−9.97	−10.18	−10.39	−11.60
50	.72	.07	−8.0	−8.21	−8.42	−8.63	−8.84	−9.05	−9.26	−9.47	−9.68	−9.89	−12.10
0 00	.80	.08	−7.5	−7.71	−7.92	−8.13	−8.34	−8.55	−8.76	−8.97	−9.18	−9.39	−9.60
10	.88	.08	−7.0	−7.21	−7.42	−7.63	−7.84	−8.05	−8.26	−8.47	−8.68	−8.89	−9.10
20	.95	.07	−6.5	−6.71	−6.92	−7.13	−7.34	−7.55	−7.76	−7.97	−8.18	−8.39	−8.60
30	1.03	.08	−6.0	−6.21	−6.42	−6.63	−6.84	−7.05	−7.26	−7.47	−7.68	−7.89	−8.10
40	1.10	.07	−5.5	−5.71	−5.92	−6.13	−6.34	−6.55	−6.76	−6.97	−7.18	−7.39	−7.60
50	1.18	.08	−5.0	−5.21	−5.42	−5.63	−5.84	−6.05	−6.26	−6.47	−6.68	−6.89	−7.10
1 00	1.26	.08	−4.5	−4.71	−4.92	−5.13	−5.34	−5.55	−5.76	−5.97	−6.18	−6.39	−6.60
10	1.34	.08	−4.1	−4.31	−4.52	−4.73	−4.94	−5.15	−5.36	−5.57	−5.78	−5.99	−6.20
20	1.42	.08	−3.6	−3.81	−4.02	−4.23	−4.44	−4.65	−4.86	−5.07	−5.28	−5.49	−5.70

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

0,,32 -0,93 = -5:0 =

Zone 25.

K		d										
h m	ks	d' = -0".16s										
		o"	1'	2'	3'	4'	d 5'	6'	7'	8'	9'	10
23,,20	- 0.20	-10".3	-10.46	-10.62	-10.78	-10.94	-11.10	-11.26	-11.42	-11.58	-11.74	-11.90
,30	- ,30	-9.7	-9.86	-10.02	-10.18	-10.34	-10.50	-10.66	-10.82	-10.98	-11.14	-11.30
,40	- ,41	-9.2	-9.38	-9.52	-9.68	-9.84	-10.00	-10.16	-10.32	-10.48	-10.64	-10.80
,50	- ,51	-8.7	-8.86	-9.02	-9.18	-9.34	-9.50	-9.66	-9.82	-9.98	-10.14	-10.30
0,,00	- ,62	-8.2	-8.36	-8.52	-8.68	-8.84	-9.00	-9.16	-9.32	-9.48	-9.64	-9.80
,10	- ,72	-7.6	-7.76	-7.92	-8.08	-8.24	-8.40	-8.56	-8.72	-8.88	-9.04	-9.20
,20	- ,83	-7.0	-7.16	-7.32	-7.48	-7.64	-7.80	-7.96	-8.12	-8.28	-8.44	-8.60
,30	- ,93	-6.4	-6.56	-6.72	-6.88	-7.04	-7.20	-7.36	-7.52	-7.68	-7.84	-8.00
,40	- 1.03	-5.8	-5.96	-6.12	-6.28	-6.44	-6.60	-6.76	-6.92	-7.08	-7.24	-7.40
,50	- 1.14	-5.3	-5.46	-5.62	-5.78	-5.94	-6.10	-6.26	-6.42	-6.58	-6.74	-6.90
1,,00	- 1.24	-4.7	-4.86	-5.02	-5.18	-5.34	-5.50	-5.66	-5.82	-5.98	-6.14	-6.30
,10	- 1.35	-4.2	-4.36	-4.52	-4.68	-4.84	-5.00	-5.16	-5.32	-5.48	-5.64	-5.80
,20	- 1.46	-3.6	-3.76	-3.92	-4.08	-4.24	-4.40	-4.56	-4.72	-4.88	-5.04	-5.20

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 26 & 27

Zone 26

Jan. 8, 1853 Sid. Time 1h 47m Bar. 30.238 in Att. Therm 63 Ext. Therm. 37.°4
" " 3h 43m " 30.250 " " 62 " " 33.2

Zone 27

Jan. 11, 1853 Sid. time 2h 48 Bar. 29.860 Att. therm. 69 Ext. therm 29.°4
" " 4h 40 " 29.840 " " 69 " " 27.3

Zone 26

t_0 0h 0m 40s	$k_4' = 0.000s$	$d_4' = -0.''17s$	
0h 42m	$-0.59 = x_{26} + 0.03\, x'_{26}$	$+16.0 = y_{26} + 0.03\, y'_{26}$	2
0h 47m	$-0.44 = r$ " $+ 0.12$ "	$+21.3 = r$ " $+ 0.12$ "	1
1h 08m	$-0.33 = r$ " $+ 0.47$ "	$+14.6 = r$ " $+ 0.47$ "	3
1h 08m	$-0.32 = r$ " $+ 0.47$ "	$+14.2 = r$ " $+ 0.47$ "	1
1h 34m	$-0.38 = r$ " $+ 0.90$ "	$+19.6 = r$ " $+ 0.90$ "	1
1h 36m	$-0.57 = r$ " $+ 0.93$ "	$+15.2 = r$ " $+ 0.93$ "	1
1h 58m	$-0.75 = r$ " $+ 1.30$ "	$+9.5 = r$ " $+ 1.30$ "	1
2h 02m	$-0.41 = r$ " $+ 1.37$ "	$+12.3 = r$ " $+ 1.37$ "	1
2h 07m	$-0.67 = r$ " $+ 1.45$ "	$+15.3 = r$ " $+ 1.45$ "	1
2h 22m	$-0.84 = r$ " $+ 1.70$ x'_{26}	$+11.9 = r$ " $+ 1.70$ y'_{26}	1
2h 22m	$-1.02 = x_{26} + 1.70\, x'_{26}$	$+13.7 = y_{26} + 1.70\, y'_{26}$	2

Zone 27

t_0 0h 0m 40s	$k_4' = 0.000s$	$d_4' = -0.''21s$	
0h 42m	$-0.75 = x_{27} + 0.03\, x'_{27}$	$+14.8 = y_{27} + 0.03\, y'_{27}$	2
0h 47m	$-0.59 = r$ " $+ 0.12$ "	$+18.1 = r$ " $+ 0.12$ "	1
1h 08m	---- " $+ 0.47$ "	$+15.4 = r$ " $+ 0.47$ "	3
1h 08m	---- " $+ 0.47$ "	$+17.8 = r$ " $+ 0.47$ "	1
1h 34m	$-0.63 = r$ " $+ 0.90$ "	$+16.4 = r$ " $+ 0.90$ "	1
1h 36m	$-0.71 = r$ " $+ 0.93$ "	$+17.8 = r$ " $+ 0.93$ "	1
1h 58m	$-0.95 = r$ " $+ 1.30$ "	$+10.2 = r$ " $+ 1.30$ "	1
2h 02m	$-0.86 = r$ " $+ 1.37$ "	$+13.5 = r$ " $+ 1.37$ "	1
2h 07m	$-0.97 = r$ " $+ 1.45$ "	$+15.0 = r$ " $+ 1.45$ "	1
2h 22m	$-1.49 = r$ " $+ 1.70$ x'_{27}	$+13.6 = r$ " $+ 1.70$ y'_{27}	1
2h 22m	$-1.56 = x_{27} + 1.70\, x'_{27}$	$+13.8 = y_{27} + 1.70\, y'_{27}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 26.

h m	k s	d 0′	1′	2′	3′	4′ d	5′	6′	7′	8′	9′	10′
						$d' = -0''.17^s$						
0 m 40	0.34	+ 16″.5	16.33	16.16	15.99	15.82	15.65	15.48	15.31	15.14	14.97	14.80
.50	.38	+ 16.2	16.03	15.86	15.69	15.52	15.35	15.18	15.01	14.84	14.67	14.50
1 m 00	.42	+ 15.9	15.73	15.56	15.39	15.22	15.05	14.88	14.71	14.54	14.37	14.20
.10	.47	+ 15.6	15.43	15.26	15.09	14.92	14.75	14.58	14.41	14.24	14.07	13.90
.20	.51	+ 15.2	15.03	14.86	14.69	14.52	14.35	14.18	14.01	13.84	13.67	13.50
.30	.55	+ 14.9	14.73	14.56	14.39	14.22	14.05	13.88	13.71	13.54	13.37	13.20
.40	.60	+ 14.5	14.33	14.16	13.99	13.82	13.65	13.48	13.31	13.14	12.97	12.80
.50	.64	+ 14.2	14.03	13.86	13.69	13.52	13.35	13.18	13.01	12.84	12.67	12.50
2 m 00	.68	+ 13.9	13.73	13.56	13.39	13.22	13.05	12.88	12.71	12.54	12.37	12.20
.10	.73	+ 13.5	13.33	13.16	12.99	12.82	12.65	12.48	12.31	12.14	11.97	11.80
.20	.77	+ 13.2	13.03	12.86	12.69	12.52	12.35	12.18	12.01	11.84	11.67	11.50
.30	.82	+ 12.8	12.63	12.46	12.29	12.12	11.95	11.78	11.61	11.44	11.27	11.10
.40	.87	+ 12.4	12.23	12.06	11.89	11.72	11.55	11.38	11.21	11.04	10.87	10.70

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 27.

	k	k	d	d′ = − 0.21 s									
	h m	s	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
t_0	0 h 40 m	− 0.46	+ 16.2	15.99	15.78	15.57	15.36	15.15	14.94	14.73	14.52	14.31	14.10
	.50	− .56	+ 15.9	15.69	15.48	15.27	15.06	14.85	14.64	14.43	14.22	14.01	13.80
	1 h .00	− .64	+ 15.7	15.49	15.28	15.07	14.86	14.65	14.44	14.23	14.02	13.81	13.60
	.10	− .72	+ 15.4	15.19	14.98	14.77	14.56	14.35	14.14	13.93	13.72	13.51	13.30
	.20	− .80	+ 15.2	14.99	14.78	14.57	14.36	14.15	13.94	13.73	13.52	13.31	13.10
	.30	− .87	+ 15.0	14.79	14.58	14.37	14.16	13.95	13.74	13.53	13.32	13.11	12.90
	.40	− .96	+ 14.8	14.59	14.38	14.17	13.96	13.75	13.54	13.33	13.12	12.91	12.70
	.50	− 1.06	+ 14.6	14.39	14.18	13.97	13.76	13.55	13.34	13.13	12.92	12.71	12.50
	2 h .00	− 1.13	+ 14.3	14.09	13.88	13.67	13.46	13.25	13.04	12.83	12.62	12.41	12.20
	.10	− 1.21	+ 14.1	13.89	13.68	13.47	13.26	13.05	12.84	12.63	12.42	12.21	12.00
	.20	− 1.29	+ 13.8	13.59	13.38	13.17	12.96	12.75	12.54	12.33	12.12	11.91	11.70
	.30	− 1.38	+ 13.6	13.39	13.18	12.97	12.76	12.55	12.34	12.13	11.92	11.71	11.50
	.40	− 1.46	+ 13.3	13.09	12.88	12.67	12.46	12.25	12.04	11.83	11.62	11.41	11.20

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 28 & 29

Zone 28

Jan. 21, 1853	Sid. time	h m 2 55	Bar. 29.968	Att. therm	62	Ext. therm	27.9
" "	"	4 60	" 30.020	"	62	"	25.2

Zone 29

Jan. 29, 1853	Sid time	3 18	Bar. 30.126	Att. therm	61	Ext. therm	25.8
" "	"	5 08	30.050	"	58	"	26.3

Zone 28

t_0 h m 1 00	$k'_q = 0.000s$	$d'_q = -0.22s$	wt
1 06	$-0.12 = x_{28} + 0.10\, x'_{28}$	$-3.0 = z_{28} + 0.10\, z'_{28}$	2
1 11	$-0.30 = $ " $+ 0.18$ "	$-6.4 = $ " $+ 0.18$ "	1
1 32	$-0.37 = $ " $+ 0.53$ "	$+0.3 = $ " $+ 0.53$ "	1
1 42	$-0.75 = $ " $+ 0.70$ "	$-5.7 = $ " $+ 0.70$ "	1
2 01	$-0.79 = $ " $+ 1.02$ "	$-7.2 = $ " $+ 1.02$ "	1
2 14	$- - - = $ " $+$ XXX "	$- - - = $ " $+$ XXX "	X
2 42	$-1.37 = $ " $+ 1.70\, x'_{28}$	$-11.8 = $ " $+ 1.70\, z'_{28}$	3
2 47	$-1.44 = x_{28} + 1.78\, x'_{28}$	$-10.7 = z_{28} + 1.78\, z'_{28}$	2

Zone 29

t_0 h m 1 00	$k'_q = 0.000s$	$d'_q = -0.23s$	wt
1 06	$-0.22 = x_{29} + 0.10\, x'_{29}$	$-2.1 = z_{29} + 0.10\, z'_{29}$	2
1 11	$-0.30 = $ " $+ 0.18$ "	$-5.3 = $ " $+ 0.18$ "	1
1 32	$-0.37 = $ " $+ 0.53$ "	$-0.6 = $ " $+ 0.53$ "	1
1 42	$-0.65 = $ " $+ 0.70$ "	$-4.7 = $ " $+ 0.70$ "	1
2 01	$-0.64 = $ " $+ 1.02$ "	$-6.2 = $ " $+ 1.02$ "	1
2 14	$-0.91 = $ " $+ 1.23$ "	$-6.4 = $ " $+ 1.23$ "	1
2 42	$-1.37 = $ " $+ 1.70\, x'_{29}$	$-12.7 = $ " $+ 1.70\, z'_{29}$	3
2 47	$-1.38 = x_{29} + 1.78\, x_{28}$	$-11.2 = z_{29} + 1.78\, z'_{29}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 28

a	k
1h 00m	−0s.13
10	.28
20	.38
30	
40	
50	
2h 00	
10	
20	
30	
40	
50	
3h 00	

Zone 28.

	k	d	d′ = −0″.22 s									
h m	s	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
1h 00m	0s.14	−2″.4	−2.62	−2.84	−3.06	−3.28	−3.50	−3.72	−3.94	−4.16	−4.38	−4.60
.10	.27	−3.2	−3.42	−3.64	−3.86	−4.08	−4.30	−4.52	−4.74	−4.96	−5.18	−5.40
.20	.38	−4.0	−4.22	−4.44	−4.66	−4.88	−5.10	−5.32	−5.54	−5.76	−5.98	−6.20
.30	.50	−4.8	−5.02	−5.24	−5.46	−5.68	−5.90	−6.12	−6.34	−6.56	−6.78	−7.00
.40	.62	−5.6	−5.82	−6.04	−6.26	−6.48	−6.70	−6.92	−7.14	−7.36	−7.58	−7.80
.50	.74	−6.3	−6.52	−6.74	−6.96	−7.18	−7.40	−7.62	−7.84	−8.06	−8.28	−8.50
2h 00m	.86	−7.1	−7.32	−7.54	−7.76	−7.98	−8.20	−8.42	−8.64	−8.86	−9.08	−9.30
.10	.98	−7.9	−8.12	−8.34	−8.56	−8.78	−9.00	−9.22	−9.44	−9.66	−9.88	−10.10
.20	1.10	−8.7	−8.92	−9.14	−9.36	−9.58	−9.80	−10.02	−10.24	−10.46	−10.68	−10.90
.30	1.21	−9.6	−9.82	−10.04	−10.26	−10.48	−10.70	−10.92	−11.14	−11.36	−11.58	−11.80
.40	1.33	−10.4	−10.62	−10.84	−11.06	−11.28	−11.50	−11.72	−11.94	−12.16	−12.38	−12.60
.50	1.45	−11.2	−11.42	−11.64	−11.86	−12.08	−12.30	−12.52	−12.74	−12.96	−13.18	−13.40
3h 00m	1.57	−12.0	−12.22	−12.44	−12.66	−12.88	−13.10	−13.32	−13.54	−13.76	−13.98	−14.20

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 29.

h m	k s	d 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
						d′ = −0″.235						
t₀ 1 00	− 0.05	−1.4	−1.63	−1.86	−2.09	−2.32	−2.55	−2.78	−3.01	−3.24	−3.47	−3.70
.10	− .20	−2.3	−2.53	−2.76	−2.99	−3.22	−3.45	−3.68	−3.91	−4.14	−4.37	−4.60
.20	− .34	−3.2	−3.43	−3.66	−3.89	−4.12	−4.35	−4.58	−4.81	−5.04	−5.27	−5.50
.30	− .48	−4.2	−4.43	−4.66	−4.89	−5.12	−5.35	−5.58	−5.81	−6.04	−6.27	−6.50
.40	− .62	−5.2	−5.43	−5.66	−5.89	−6.12	−6.35	−6.58	−6.81	−7.04	−7.27	−7.50
.50	− .76	−6.2	−6.43	−6.66	−6.89	−7.12	−7.35	−7.58	−7.81	−8.04	−8.27	−8.50
2 00	− .90	−7.1	−7.33	−7.56	−7.79	−8.02	−8.25	−8.48	−8.71	−8.94	−9.17	−9.40
.10	− 1.04	−8.0	−8.23	−8.46	−8.69	−8.92	−9.15	−9.38	−9.61	−9.84	−10.07	−10.30
.20	− 1.18	−8.9	−9.13	−9.36	−9.59	−9.82	−10.05	−10.28	−10.51	−10.74	−10.97	−11.20
.30	− 1.31	−9.9	−10.13	−10.36	−10.59	−10.82	−11.05	−11.28	−11.51	−11.74	−11.97	−12.20
.40	− 1.46	−10.8	−11.03	−11.26	−11.49	−11.72	−11.95	−12.18	−12.41	−12.64	−12.87	−13.10
.50	− 1.60	−11.7	−11.93	−12.16	−12.39	−12.62	−12.85	−13.08	−13.31	−13.54	−13.77	−14.00
3 00	− 1.74	−12.7	−12.93	−13.16	−13.39	−13.62	−13.85	−14.08	−14.31	−14.54	−14.77	−15.00

d Zone 28 N° 2

k s	d ″
− 0,06	−2.3
− .19	−3.3
− .31	−4.2
− .43	−4.9
− .56	−5.7
− .68	−6.4
− .80	−7.2
− .92	−8.0
− 1.04	−8.8
− 1.17	−9.6
− 1.29	−10.4
− 1.41	−11.2
− 1.53	−12.1

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Feb. 1st 1853 E.C. 3.27.00 Bar. 30.548 Ext. Th. +25.0

7.27.00 " 30.534 " +20.2

4h = 14 4.8

2 = .007 2.4

$\delta_r = -0.01$

$\gamma_r = +0.25$

dr' +0.24

$dr_0 = +0.30$

d_4r +0.01

$dr = +0.31$

ds +2.61

$ds - dr$ +2.30

$d\delta$ +12.89

$d\delta'$ +12.95

$d\delta - d\delta'$ −0.06

$-2.36 = (d\delta - d\delta') - (ds - dr) = d$ for Zone 30

Zone 32

$dr_0 = +0.30$

$d_4r = +0.04$

dr +0.34

ds +2.34

$(ds - dr) = +2.00$

$d\delta$ −8.44

$d\delta'$ −8.38

$(d\delta - d\delta') = -0.06$

$(d\delta - d\delta') - (ds - dr) = -2.06$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.: 23

Reduction of Zones 30 & 32

Zone 30

Feb. 1st, 1853	Sid. time	3.27	Bar. 30.548	Att. therm	60°	Ext. therm.	25.0°
" "	"	7.27	" 30.534	"	58	"	20.2

Zone 32

Feb. 8, 1853	Sid. time	4.20	Bar. 30.120	Att. therm	60	Ext. therm.	30.0
" "	"	6.19	30.100	"	61	"	28.5

Zone 30

$k'_4 = 0.0005$ $\quad d'_4 = -0''.24$

h m			
t. 2.20			
2.22	$+0.68 = x_{30} + 0.33\, x'_{30}$ ×	$-1''.2 = y_{30} + 0.33\, y'_{30}$	2
2.22	$+0.46 = $ ~~$x_{30} + 0.33\, x'_{30}$~~ ×	$+0.9 = $ ~~$x_{30} + 0.33\, x'_{30}$~~	1
3.14	$+0.27 = $ " $+ 0.90$ "	$-3.4 = $ " $+ 0.90$ "	1
3.29	$+0.52 = $ " $+ 1.15$ "	$-3.9 = $ " $+ 1.15$ "	3
3.38	$+0.13 = $ ~~$x_{30} + 1.30\, x'_{30}$~~	$-5.6 = $ ~~$x_{30} + 1.30\, x'_{30}$~~	1
4.08	$+0.14 = x_{30} + 1.77\, x'_{30}$	$-3.0 = y_{30} + 1.77\, y'_{30}$	2

Zone 32

$k'_4 = 0.0005$ $\quad d'_4 = -0''.21$

h m			
t. 2.20			
2.22	$+0.28 = x_{32} + 0.33\, x'_{32}$ ×	$-1.2 = y_{32} + 0.33\, y'_{32}$	2
2.22	$-0.01 = $ ~~$x_{32} + 0.33\, x'_{32}$~~ ×	$+1.6 = $ ~~$y_{32} + 0.33\, y'_{32}$~~	1
3.14	$-0.73 = $ " $+ 0.90\, x'_{32}$	$-2.4 = $ " $+ 0.90$ "	1
3.29	$-0.98 = $ " $+ 1.15$ "	$-4.1 = $ " $+ 1.15$ "	3
3.38	$-1.02 = $ ~~$x_{32} + 1.30\, x'_{32}$~~	$-4.8 = $ ~~$y_{32} + 1.30\, y'_{32}$~~	1
3.52	$-1.08 = x_{32} + 1.53\, x'_{32}$	$-3.0 = y_{32} + 1.53\, y'_{32}$	2

× The two first in each Zone multiplied by .30/1.00

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 30

	k	α	α′ = − 0″.24									
h m	s	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
2 h 20 m	+ 0.62	− 0.7	− 0.94	− 1.18	− 1.42	− 1.66	− 1.90	− 2.14	− 2.38	− 2.62	− 2.86	− 3.10
.30	+ .58	− 1.0	− 1.24	− 1.48	− 1.72	− 1.96	− 2.20	− 2.44	− 2.68	− 2.92	− 3.16	− 3.40
.40	+ .54	− 1.4	− 1.64	− 1.88	− 2.12	− 2.36	− 2.60	− 2.84	− 3.08	− 3.32	− 3.56	− 3.80
.50	+ .50	− 1.8	− 2.04	− 2.28	− 2.52	− 2.76	− 3.00	− 3.24	− 3.48	− 3.72	− 3.96	− 4.20
3 .00	+ .46	− 2.2	− 2.44	− 2.68	− 2.92	− 3.16	− 3.40	− 3.64	− 3.88	− 4.12	− 4.36	− 4.60
.10	+ .42	− 2.6	− 2.84	− 3.08	− 3.32	− 3.56	− 3.80	− 4.04	− 4.28	− 4.52	− 4.76	− 5.00
.20	+ .38	− 2.9	− 3.14	− 3.38	− 3.62	− 3.86	− 4.10	− 4.34	− 4.58	− 4.82	− 5.06	− 5.30
.30	+ .33	− 3.3	− 3.54	− 3.78	− 4.02	− 4.26	− 4.50	− 4.74	− 4.98	− 5.22	− 5.46	− 5.70
.40	+ .29	− 3.7	− 3.94	− 4.18	− 4.42	− 4.66	− 4.90	− 5.14	− 5.38	− 5.62	− 5.86	− 6.10
.50	+ .25	− 4.0	− 4.24	− 4.48	− 4.72	− 4.96	− 5.20	− 5.44	− 5.68	− 5.92	− 6.16	− 6.40
4 .00	+ .21	− 4.4	− 4.64	− 4.88	− 5.12	− 5.36	− 5.60	− 5.84	− 6.08	− 6.32	− 6.56	− 6.80
.10	+ .17	− 4.7	− 4.94	− 5.18	− 5.42	− 5.66	− 5.90	− 6.14	− 6.38	− 6.62	− 6.86	− 7.10
.20	+ .12	− 5.1	− 5.34	− 5.58	− 5.82	− 6.06	− 6.30	− 6.54	− 6.78	− 7.02	− 7.26	− 7.50

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1953phae.pr031.0023

Zone 32.

	k	d	d″ = −0″.215									
h m	k	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
2 h 20	+ 0.19	− 0″.3	−0.51	−0.72	−0.93	−1.14	−1.35	−1.56	−1.77	−1.98	−2.19	−2.40
.30	+ .03	− 0.7	−0.91	−1.12	−1.33	−1.54	−1.75	−1.96	−2.17	−2.38	−2.59	−2.80
.40	− .13	− 1.0	−1.21	−1.42	−1.63	−1.84	−2.05	−2.26	−2.47	−2.68	−2.89	−3.11
.50	− .28	− 1.4	−1.61	−1.82	−2.03	−2.24	−2.45	−2.66	−2.87	−3.08	−3.29	−3.50
3 h 00	− .43	− 1.8	−2.01	−2.22	−2.43	−2.64	−2.85	−3.06	−3.27	−3.48	−3.69	−3.90
.10	− .58	− 2.1	−2.31	−2.52	−2.73	−2.94	−3.15	−3.36	−3.57	−3.78	−3.99	−4.20
.20	− .73	− 2.4	−2.61	−2.82	−3.03	−3.24	−3.45	−3.66	−3.87	−4.08	−4.29	−4.50
.30	− .87	− 2.8	−3.01	−3.22	−3.43	−3.64	−3.85	−4.06	−4.27	−4.48	−4.69	−4.90
.40	− 1.03	− 3.1	−3.31	−3.52	−3.73	−3.94	−4.15	−4.36	−4.57	−4.78	−4.99	−5.20
.50	− 1.18	− 3.5	−3.71	−3.92	−4.13	−4.34	−4.55	−4.76	−4.97	−5.18	−5.39	−5.60
4 h 00	− 1.33	− 3.8	−4.01	−4.22	−4.43	−4.64	−4.85	−5.06	−5.27	−5.48	−5.69	−5.90
.10	− 1.48	− 4.2	−4.41	−4.62	−4.83	−5.04	−5.25	−5.46	−5.67	−5.88	−6.09	−6.30
.20	− 1.63	− 4.5	−4.71	−4.92	−5.13	−5.34	−5.55	−5.76	−5.97	−6.18	−6.39	−6.60

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 31		Zone 33	
$d\gamma_0$ +0.30	$d\delta$ −5.85	$d\gamma_0$ +0.30	$d\delta$ −6.59
$d_2\gamma$ +0.01	$d\delta'$ −5.80	$d_2\gamma$ +0.05	$d\delta'$ −6.54
$d\gamma$ +0.31	$d\delta - d\delta'$ −0.05	$d\gamma$ +0.35	$d\delta - d\delta'$ −0.05
ds +2.75	$ds - d\gamma$ +2.44	ds +2.08	$ds - d\gamma$ +1.73
$ds - d\gamma$ +2.44	$d\zeta$ −2.49	$ds - d\gamma$ +1.73	$d\zeta$ −1.78

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 31 & 33

Zone 31

Feb. 1st, 1853 Sid. time 3h 27m Bar. 30.548 Att. therm. 60° Ext. therm 25.0
" " 7h 27m " 30.534 " " 58 " " 20.2

Zone 33

Feb. 11, 1853 Sid. time 6h 32m Bar. 29.750 Att. therm. 67° Ext. therm. 35.3
" " 8h 30m 29.760 " " 60 " " 32.5

Zone 31

t_0 4h 00m $k'_4 = 0.000s$ $d'_4 = -0''.25s$

4h 08m	$+0.14 = x_{31} + 0.13\, x'_{31}$	$-2.7 = y_{31} + 0.13\, y'_{31}$	3
4h 26m	$+0.17 = $ " $+ 0.43$ "	$-3.5 = $ " $+ 0.43$ "	1
4h 27m	$+0.34 = $ " $+ 0.45$ "	$-3.0 = $ " $+ 0.45$ "	1
4h 28m	$+0.52 = $ " $+ 0.47$ "	$-4.2 = $ " $+ 0.47$ "	1
4h 32m	$+0.12 = $ " $+ 0.53$ "	$-1.9 = $ " $+ 0.53$ "	1
4h 49m	$+0.34 = $ " $+ 0.82$ "	$-4.0 = $ " $+ 0.82$ "	1
4h 58m	$+0.51 = $ " $+ 0.97$ "	$-4.1 = $ " $+ 0.97$ "	1
5h 00m	$+0.07 = $ " $+ 1.00$ "	$-3.5 = $ " $+ 1.00$ "	1
~~5h 0x~~	~~- - - = " + 1.NN "~~	~~- - - = " + NN.~~	x
5h 36m	$-0.39 = $ " $+ 1.60$ "	$-4.5 = $ " $+ 1.60$ "	1
5h 42m	$-0.23 = $ " $+ 1.70$ "	~~NN NN~~	1
5h 50m	$-0.24 = $ " $+ 1.83$ "	$-1.2 = $ " $+ 1.83$ "	1
5h 59m	$-0.74 = $ " $+ 1.98$ "	$+2.7 = $ " $+ 1.98$ "	1
5h 59m	$-0.56 = $ " $+ 1.98$ "	$-6.5 = $ " $+ 1.98$ "	3
6h 09m	$-0.38 = x_{31} + 2.15\, x'_{31}$	$-8.1 = $ " $+ 2.15\, y'_{31}$	1
5h 59m	$-0.29 = x_{31} + 1.98\, x'_{31}$	$-5.2 = y_{31} + 1.98\, y'_{31}$	2

Zone 33

$t_0 = 4h\ 00m$ k'_4 $d'_4 = -0''.18$

4h 08m	$-0.10 = x_{33} + 0.13\, x'_{33}$	$-3.0 = y_{33} + 0.13\, y'_{33}$	3
4h 26m	$-0.03 = $ ~~x_{33}~~ $+ 0.43$ ~~x'_{33}~~	$-3.5 = $ " $+ 0.43$ "	1
4h 27m	$+0.09 = $ " $+ 0.45$ "	$-4.4 = $ " $+ 0.45$ "	1
4h 28m	$-0.01 = $ " $+ 0.47$ "	$-3.5 = $ " $+ 0.47$ "	1
4h 32m	$+0.02 = $ ~~x_{33}~~ $+ 0.53$ ~~x'_{33}~~	$-2.0 = y_{33} + 0.53\, y'_{33}$	1

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 33.

4h 49	+0.09 = r	x_{33} + 0.82 x'_{33}	−2.2 = r	y_{33} + 0.82 y'_{33}	1
4 58	+0.16 = r	" + 0.97 "	−4.7 = r	" + 0.97 "	1
5.00	−0.13 = r	" + 1.00 "	−3.7 = r	" + 1.00 "	1
5 08	−0.81 = r	" + 1.13 "	−0.1 = r	" + 1.13 "	1
5 36	−0.69 = r	" + 1.60 "	−6.8 = r	" + 1.60 "	1
~~5 42~~		" + ~~1.70~~ "		" + ~~1.70~~ "	~~1~~
5 50	−0.34 = r	" + 1.83 "	−1.2 = r	" + 1.83 "	1
5 59	−0.74 = r	" + 1.98 "	+2.6 = r	" + 1.98 "	1
5 59	−0.81 r	~~x~~ + 1.98 x'_{33}	−6.9 = r	~~y~~ + 1.98 y'_{33}	3
~~6 09~~	= = =		= = =		
5 59	−0.36 =	x_{33} + 1.98 x'_{33}	−5.2 =	y_{33} + 1.98 y'_{33}	2

Zone 31.

k $\quad$ d $\quad$ $d' = -0.''25$

h m	k	d = 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
4 00	+ 0.37	−2.6	−2.85	−3.10	−3.35	−3.60	−3.85	−4.10	−4.35	−4.60	−4.85	−5.10
.10	+ .30	−2.8	−3.05	−3.30	−3.55	−3.80	−4.05	−4.30	−4.55	−4.80	−5.05	−5.30
.20	+ .24	−3.0	−3.25	−3.50	−3.75	−4.00	−4.25	−4.50	−4.75	−5.00	−5.25	−5.50
.30	+ .17	−3.1	−3.35	−3.60	−3.85	−4.10	−4.35	−4.60	−4.85	−5.10	−5.35	−5.60
.40	+ .10	−3.3	−3.55	−3.80	−4.05	−4.30	−4.55	−4.80	−5.05	−5.30	−5.55	−5.80
.50	+ .03	−3.4	−3.65	−3.90	−4.15	−4.40	−4.65	−4.90	−5.15	−5.40	−5.65	−5.90
5 00	− .04	−3.6	−3.85	−4.10	−4.35	−4.60	−4.85	−5.10	−5.35	−5.60	−5.85	−6.10
.10	− .11	−3.8	−4.05	−4.30	−4.55	−4.80	−5.05	−5.30	−5.55	−5.80	−6.05	−6.30
.20	− .18	−3.9	−4.15	−4.40	−4.65	−4.90	−5.15	−5.40	−5.65	−5.90	−6.15	−6.40
.30	− .25	−4.0	−4.25	−4.50	−4.75	−5.00	−5.25	−5.50	−5.75	−6.00	−6.25	−6.50
.40	− .32	−4.2	−4.45	−4.70	−4.95	−5.20	−5.45	−5.70	−5.95	−6.20	−6.45	−6.70
.50	− .39	−4.4	−4.65	−4.90	−5.15	−5.40	−5.65	−5.90	−6.15	−6.40	−6.65	−6.90
6 00	− .46	−4.6	−4.85	−5.10	−5.35	−5.60	−5.85	−6.10	−6.35	−6.60	−6.85	−7.10
10	− .53		−4.8	−5.05	−5.30	−5.55	−5.80	−6.10	−6.30	−6.55	−6.80	−7.10 −7.30
20	− 0.60		−5.0	−5.25	−5.50	−5.75	−6.0	−6.25	−6.50			

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Tome 33.

	K		α										
	h m	s		0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′
				″										
t_0	4 h 00	+ 0.10		− 3.0	− 3.18	− 3.36	− 3.54	− 3.72	− 3.90	− 4.08	− 4.26	− 4.44	− 4.62	− 4.80
	.10	+ .03		− 3.1	− 3.28	− 3.46	− 3.64	− 3.82	− 4.00	− 4.18	− 4.36	− 4.54	− 4.72	− 4.90
	.20	− .02		− 3.2	− 3.38	− 3.56	− 3.74	− 3.92	− 4.10	− 4.28	− 4.46	− 4.64	− 4.82	− 5.00
	.30	− .08		− 3.3	− 3.48	− 3.66	− 3.84	− 4.02	− 4.20	− 4.38	− 4.56	− 4.74	− 4.92	− 5.10
	.40	− .14		− 3.4	− 3.58	− 3.76	− 3.94	− 4.12	− 4.30	− 4.48	− 4.66	− 4.84	− 5.02	− 5.20
	.50	− .19		− 3.5	− 3.68	− 3.86	− 4.04	− 4.22	− 4.40	− 4.58	− 4.76	− 4.94	− 5.12	− 5.30
	5 h 00	− .24		− 3.6	− 3.78	− 3.96	− 4.14	− 4.32	− 4.50	− 4.68	− 4.86	− 5.04	− 5.22	− 5.40
	.10	− .30		− 3.7	− 3.88	− 4.06	− 4.24	− 4.42	− 4.60	− 4.78	− 4.96	− 5.14	− 5.32	− 5.50
	.20	− .36		− 3.8	− 3.98	− 4.16	− 4.34	− 4.52	− 4.70	− 4.88	− 5.06	− 5.24	− 5.42	− 5.60
	.30	− .42		− 3.8	− 3.98	− 4.16	− 4.34	− 4.52	− 4.70	− 4.88	− 5.06	− 5.24	− 5.42	− 5.60
	.40	− .47		− 3.9	− 4.08	− 4.26	− 4.44	− 4.62	− 4.80	− 4.98	− 5.16	− 5.34	− 5.52	− 5.70
	.50	− .53		− 4.0	− 4.18	− 4.36	− 4.54	− 4.72	− 4.90	− 5.08	− 5.26	− 5.44	− 5.62	− 5.80
	6 h 00	− .60		− 4.0	− 4.18	− 4.36	− 4.54	− 4.72	− 4.90	− 5.08	− 5.26	− 5.44	− 5.62	− 5.80
	10	− .66		− 4.1	− 4.28	− 4.46	− 4.64	− 4.82	− 5.00	− 5.18	− 5.36	− 5.54	− 5.72	− 5.90

$d' = -0''.18$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 34

$d\gamma_0 + 0.30 \quad d\delta - 8.09$

$d_4\gamma + 0.05 \quad d\delta' - 8.04$

$d\gamma + 0.35 \quad d\delta - d\delta' - 0.05$

$ds + 2.80 \quad ds - d\gamma + 2.45$

$ds - d\gamma + 2.45 \quad d = -2.50$

Zone 35

$d\gamma_0 + 0.30 \quad d\delta -$

$d_4\gamma + 0.04 \quad d\delta'$

$d\gamma + 0.34 \quad d\delta - d\delta' = -0.06$

$ds + 3.01 \quad ds - d\gamma + 2.67$

$ds - d\gamma + 2.67 \quad d = -2.73$

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae_proj1.23

Reduction of Zones 34 & 35

Zone 34

Feb. 12, 1853 Sid. time 4h 59m Bar. 30.220 Att. therm. 60 Ext. therm. 22.0°
" " 7h 2 " 30.232 " " 59 " " 19.3

Zone 35

Feb. 14, 1853 Sid. time 4h 41 Bar. 30.038 Att. therm. 54 Ext. therm 16.7°
" " 6h 52 " 30.160 " " 55 " " 15.6

Zone 34

k'_4 0.000s $\quad d'_4 = -0.25s$

h m				
t₀ 2h 40m				
2h 44m	−0.09 =	$x_{34} + 0.07\, x'_{34}$	−11.8	$y_{34} + 0.07\, y'_{34}$ 2
2h 42m	−0.02 =	$x_{34} + 0.03\, x'_{34}$	−11.5 =	$y_{34} + 0.03\, y'_{34}$ 3
2h 58m	−0.25 =	" + 0.30 "	−9.4 =	" + 0.30 " 1
3h 00m	−0.69 =	" + 0.33 "	−9.3 =	" + 0.33 " 1
3h 06m	−0.31 =	" + 0.43 "	−7.8 =	" + 0.43 " 3
3h 08m	−0.59 =	" + 0.47 "	−9.3 =	" + 0.47 " 1
3h 27m	−0.65 =	" + 0.78 "	−13.8 =	" + 0.78 " 1
3h 31m	−0.44 =	" + 0.85 "	−11.0 =	" + 0.85 " 1
3h 51m	−0.91 =	" + 0.85 "	−14.0 =	" + 0.85 " 1
4h 29m	−0.71 =	" + 1.82 "	−14.2 =	" + 1.82 " 1
4h 30m	−0.75 =	" + 1.83 "	---- =	" + 1.83 " 1
4h 30m	−0.92 =	" + 1.83 "	−11.6 =	" + 1.83 " 1
4h 33m	−0.85 =	" + 1.88 "	−14.2 =	" + 1.88 " 1
4h 34m	−0.79 =	" + 1.90 "	−14.6 =	" + 1.90 " 1
4h 37m	−0.59 =	" + 1.95 "	−11.8 =	" + 1.95 " 3
4h 40m	−0.75 =	x_{34} + 2.00 x'_{34}	−14.0 =	" + 2.00 " 1
4h 39m	−0.72 =	x_{34} 1.98 x'_{34}	−15.0 =	$y_{34} + 1.98\, y'_{34}$ 2
	−0.19 =	$x_{34} - x_{35}$		

Zone 35

$k'_4 = 0.000s$ $\quad d'_4 = -0.27s$

h m				
t₀ 2h 40m				
2h 44m	−0.05 =	$x_{35} + 0.07\, x'_{35}$	−11.7 =	$y_{35} + 0.07\, y'_{35}$ 2
2h 42m	−0.02 =	$x_{35} + 0.03\, x'_{35}$	−11.4 =	$y_{35} + 0.03\, y'_{35}$ 3
2h 58m	−0.15 =	" + 0.30 "	−8.2 =	" + 0.30 " 1
3h 00m	−0.44 =	" + 0.33 "	−8.1 =	" + 0.33 " 1
3h 06m	−0.26 =	$x_{35} + 0.43\, x'_{35}$	−6.8 =	$y_{35} + 0.43\, y'_{35}$ 3

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 35

3.. 08	$-0.39 = r\ x_{35} + 0.47\ x'_{35}$	$-9.3 = r\ y_{35} + 0.47\ y'_{35}$	1
3.. 27	$-0.65 = r$ " 0.78 "	$-10.7 = r$ " $+ 0.78$ "	1
3.. 31	$-0.44 = r$ " 0.85 "	$-9.8 = r$ " $+ 0.85$ "	1
3.. 57	$-0.86 = r$ " 1.18 "	$-10.8 = r$ " $+ 1.18$ "	1
4.. 29	$-0.56 = r$ " 1.82 "	$-13.0 = r$ " $+ 1.82$ "	1
4.. 30	$-0.55 = r$ " 1.83 "	$= r$ " $+ 1.83$ "	1
4.. 30	$-0.82 = r$ " 1.83 "	$-11.5 = r$ " $+ 1.83$ "	1
4.. 33	$-0.60 = r$ " 1.88 "	$-12.1 = r$ " $+ 1.88$ "	1
4.. 34	$-0.74 = r$ " 1.90 "	$-14.5 = r$ " $+ 1.90$ "	1
4.. 36	$-0.55 = x_{35} + 1.95$ "	$-10.0 =$ " $+ 1.95$ "	2
~~4.. 40~~	$= r$ " ~~2.00~~ "	$= r$ " $+$ ~~2.00~~ "	~~1~~
~~4.. 29~~	~~x_{35} 1.96~~ x'_{35}	~~y_{35}~~ + ~~1.96~~ y'_{35}	

$-0.19 = x_{34} - x_{35}$

Zone 34.

$d'' = -0''.25$

	k		d									
h m	ks		0'	1'	2'	3'	4' cf. 5'	6'	7'	8'	9'	10'
2.40	0.27		10.3	10.55	10.80	11.05	11.30	11.55	11.80	12.05	12.30	12.55	12.80
.50	31	04	10.6	10.85	11.10	11.35	11.60	11.85	12.10	12.35	12.60	12.85	13.10
3.00	36	05	10.8	11.05	11.30	11.55	11.80	12.05	12.30	12.55	12.80	13.05	13.30
.10	40	04	11.0	11.25	11.50	11.75	12.00	12.25	12.50	12.75	13.00	13.25	13.50
.20	45	05	11.2	11.45	11.70	11.95	12.20	12.45	12.70	12.95	13.20	13.45	13.70
.30	50	05	11.4	11.65	11.90	12.15	12.40	12.65	12.90	13.15	13.40	13.65	13.90
.40	55	05	11.7	11.95	12.20	12.45	12.70	12.95	13.20	13.45	13.70	13.95	14.20
.50	60	05	11.9	12.15	12.40	12.65	12.90	13.15	13.40	13.65	13.90	14.15	14.40
4.00	65	05	12.1	12.35	12.60	12.85	13.10	13.35	13.60	13.85	14.10	14.35	14.60
.10	70	05	12.3	12.55	12.80	13.05	13.30	13.55	13.80	14.05	14.30	14.55	14.80
.20	75	05	12.5	12.75	13.00	13.25	13.50	13.75	14.00	14.25	14.50	14.75	15.00
.30	80	05	12.7	12.95	13.20	13.45	13.70	13.95	14.20	14.45	14.70	14.95	15.20
.40	85	05	12.9	13.15	13.40	13.65	13.90	14.15	14.40	14.65	14.90	15.15	15.35

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

Zone 35.

	k		d										d' = −0".27 s
	h m	s		0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'
				0"										
t_0	2 40	− 0.08		−9.4	−9.67	−9.94	−10.21	−10.48	−10.75	−11.02	−11.29	−11.56	11.83	−12.10
	.50	− .12	04	−9.6	−9.87	−10.14	−10.41	−10.68	−10.95	−11.22	−11.49	−11.76	12.03	−12.30
	3 00	− .17	05	−9.7	−9.97	−10.24	−10.51	−10.78	−11.05	−11.32	−11.59	−11.86	−12.13	−12.40
	.10	− .21	04	−9.9	−10.17	−10.44	−10.71	−10.98	−11.25	−11.52	−11.79	−12.06	−12.33	−12.60
	.20	− .26	05	−10.0	−10.27	−10.54	−10.81	−11.08	−11.35	−11.62	−11.89	−12.16	−12.43	−12.70
	.30	− .30	04	−10.2	−10.47	−10.74	−11.01	−11.28	−11.55	−11.82	−12.09	−12.36	−12.63	−12.90
	.40	− .34	04	−10.3	−10.57	−10.84	−11.11	−11.38	−11.65	−11.92	−12.19	−12.46	−12.73	−13.00
	.50	− .39	05	−10.5	−10.77	−11.04	−11.31	−11.58	−11.85	−12.12	−12.39	−12.66	−12.93	−13.20
	4 00	− .43	04	−10.7	−10.97	−11.24	−11.51	−11.78	−12.05	−12.32	−12.59	−12.86	−13.13	−13.40
	.10	− .48	05	−10.9	−11.17	−11.44	−11.71	−11.98	−12.25	−12.52	−12.79	−13.06	−13.33	−13.60
	.20	− .52	04	−11.1	−11.37	−11.64	−11.91	−12.18	−12.45	−12.72	−12.99	−13.26	−13.53	−13.80
	.30	− .56	04	−11.3	−11.57	−11.84	−12.11	−12.38	−12.65	−12.92	−13.19	−13.46	−13.73	−14.00
	.40	− .61	05	−11.5	−11.77	−12.04	−12.31	−12.58	−12.85	−13.12	−13.39	−13.76	−14.03	−14.30

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 36

H 302°.53

α	82 30	sin δ	7.46373
H+α	25.23	cos(H+α)	9.95591
h +19".18		h	1.28285
			8.70249

dδ-dδ' = +0.050

dγ₀	+0.30
dμ r	+0.03
dγ	+0.33
dδ	+2.64
dδ-dγ	+2.31
dδ-dδ'	−0.05
d =	+2.36

Zone 37

H 298°.42

α	82.30	sin δ	7.46373
H+α	21.12	cos H+α	9.96957
h +19".08		h	1.28058
			8.71388

dδ-dδ' −0.05

dγ₀	=+0.30
dμ r	+0.02
dγ	+0.32
dδ	+2.78
dδ-dγ	+2.46
dδ-dδ'	−0.05
	−2.51

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

Reduction of Zones 36 & 37

Zone 36

Feb. 17, 1853 Sid. time 6h 04m Bar. 30.000 Att. therm. 58 Exet. therm. 24.4
" " 8.06 " 30.036 " " 60 " " 23.2

Zone 37

Feb. 21, 1853 Sid time 5h 55m Bar. 30.008 Att. therm 64 Exet. therm 22.0
" " 6.47 " 30.027 " " 66 " " 20.2

Zone 36

t	$k_4 = 0.0005$	$d'_4 = -0.24s$	
4h 30			
4.30	+0.13 = x_{36} + 0.00 x'_{36}	+3.5 = y_{36} + 0.00 y'_{36}	2
4 30	+0.15 = " + 0.00 "	[illegible]	(1)
4 30	−0.07 = " + 0.00 "	+3.3 = " + 0.00 "	1
4 32	+0.05 = " + 0.03 "	+4.7 = " + 0.03 "	1
4 34	−0.09 = " + 0.07 "	+3.3 = " + 0.07 "	1
4 37	−0.14 = " + 0.12 "	+3.8 = " + 0.12 "	3
4 40	−0.10 = " + 0.17 "	+2.1 = " + 0.17 "	1
4 40	−0.35 = " + 0.17 "	+4.1 = " + 0.17 "	1
4 47	+0.51 = " + 0.28 "	+7.6 = " + 0.28 "	1
4 48	+0.49 = " + 0.30 "	+4.1 = " + 0.30 "	1
4 51	+0.31 = " + 0.35 "	+8.5 = " + 0.35 "	2
5 04	−0.34 = " + 0.57 "	+5.2 = " + 0.57 "	1
[illegible]	[illegible]	[illegible]	+
5 06	−0.48 = " + 0.60 "	+2.2 = " + 0.60 "	1
5 29	−0.88 = " + 0.98 "	+6.1 = " + 0.98 "	1
5 34	−0.78 = " + 1.07 "	+3.7 = " + 1.07 "	3
5 43	−1.13 = " + 1.22 "	+7.1 = " + 1.22 "	1
6 00	−0.89 = " + 1.50 "	+1.6 = " + 1.50 "	3
6 10	−1.02 = " + 1.67 "	+4.1 = " + 1.67 "	3
6 20	−1.09 = " + 1.83 "	+5.2 = " + 1.83 "	1
6 17	−1.24 = x_{36} + 1.78 x'_{36}	+1.5 = y_{36} + 1.78 y'_{36}	2

Zone 37

t	$k_4 = 0.000$	$d'_4 = -0.25s$	
4h 30			
4.30	+0.67 = x_{37} + 0.00 x'_{37}	+4.0 = y_{37} + 0.00 y'_{37}	2
4 39	+0.75 = " + 0.00 "	[illegible]	(1)
4 34	+0.48 = x_{37} + 0.00 x'_{37}	+4.3 = y_{37} + 0.00 y'_{37}	1

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 37.

4h 33	+0.70 = r	x_{37} + 0.05 x'_{37}	+4.7 = r	y_{37} + 0.05 y'_{37}	1
4.34	+0.36 = r	" + 0.07 "	+0.3 = r	" + 0.07 "	1
4h 37	+0.41 = r	" + 0.12 "	+3.9 = r	" + 0.12 "	3
4h 40	+0.35 = r	" + 0.17 "	+0.1 = r	" + 0.17 "	1
4h 40	+0.15 = r	" + 0.17 "	+3.1 = r	" + 0.17 "	1
4.47	+1.01 = r	" + 0.28 "	+7.7 = r	" + 0.28 "	1
4h 48	+1.04 = r	" + 0.30 "	+5.1 = r	" + 0.30 "	1
4h 51	+0.81 = r	" + 0.35 "	+7.6 = r	" + 0.35 "	2
5h 04	+0.36 = r	" + 0.57 "	+4.3 = r	" + 0.57 "	1
5h 06	+0.17 = r	" + 0.60 "	+2.3 = r	" + 0.60 "	1
5h 29	−0.25 = r	" + 0.98 "	+5.1 = r	" + 0.98 "	1
5h 34	−0.23 = r	" + 1.07 "	+2.7 = r	" + 1.07 "	3
5h 43	−0.68 = r	" + 1.22 "	+7.2 = r	" + 1.22 "	1
~~6h 00~~		" + ~~1.50~~		" + ~~1.60~~	~~3~~
6h 10	−0.77 = r	" + 1.67 "	+2.3 = r	" + 1.67 "	3
6h 20	−0.79 = r	" + 1.83 "	+6.2 = r	" + 1.83 "	1
6h 17	−1.12 =	x_{37} + 1.78 x'_{37}	+1.0 =	y_{37} + 1.78 y'_{37}	2

Zone 36.

	k		α	α′ = −0″.24									
h m	k		0′	1′	2′	3′	4′	α 5′	6′	7′	8′	9′	10′
4h 30	+0.08		+4.4	+4.16	3.92	3.68	3.44	3.20	2.96	2.72	2.48	2.24	+2.00
.40	−.04	02	+4.3	+4.06	3.82	3.58	3.34	3.10	2.86	2.62	2.38	2.14	1.90
.50	−.15	11	+4.2	3.96	3.72	3.48	3.24	3.00	2.76	2.52	2.28	2.04	1.80
5h 00	−.27	12	+4.1	3.86	3.62	3.38	3.14	2.90	2.66	2.42	2.18	1.94	1.70
.10	−.38	11	+4.0	3.76	3.52	3.28	3.04	2.80	2.56	2.32	2.08	1.84	1.60
.20	−.49	11	+4.0	3.76	3.52	3.28	3.04	2.80	2.56	2.32	2.08	1.84	1.60
.30	−.60	11	+3.9	3.66	3.42	3.18	2.94	2.70	2.46	2.22	1.98	1.74	1.50
.40	−.71	11	+3.8	3.56	3.32	3.08	2.84	2.60	2.36	2.12	1.88	1.64	1.40
.50	−.82	11	+3.7	3.46	3.22	2.98	2.74	2.50	2.26	2.02	1.78	1.54	1.30
6h 00	−.93	11	+3.7	3.46	3.22	2.98	2.74	2.50	2.26	2.02	1.78	1.54	1.30
.10	−1.04	11	+3.6	3.36	3.12	2.88	2.64	2.40	2.16	1.92	1.68	1.44	1.20
.20	−1.14	10	+3.5	3.26	3.02	2.78	2.54	2.30	2.06	1.82	1.58	1.34	1.10
.30	−1.26	12	+3.4	3.16	2.92	2.68	2.44	2.20	−1.96	1.72	1.48	1.24	1.00

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

Zone 37.

	k			d											d' = −0.″25 s
	h m	s		0′	1′	2′	3′	4′	4.5′	6′	7′	8′	9′	10′
t_0	4 h 30	+ 0.74		+ 4.3	4.05	3.80	3.55	3.30	3.05	2.80	2.55	2.30	+ 2.05	+ 1.80
	.40	+ .60	14	+ 4.3	4.05	3.80	3.55	3.30	3.05	2.80	2.55	2.30	2.05	1.80
	.50	+ .45	15	+ 4.2	3.95	3.70	3.45	3.20	2.95	2.70	2.45	2.20	1.95	1.70
	5 h 00	+ .29	16	+ 4.1	3.85	3.60	3.35	3.10	2.85	2.60	2.35	2.10	1.85	1.60
	.10	+ .12	17	+ 4.0	3.75	3.50	3.25	3.00	2.75	2.50	2.25	2.00	1.75	1.50
	.20	− .04	16	+ 3.9	3.65	3.40	3.15	2.90	2.65	2.40	2.15	1.90	1.65	1.40
	.30	− .20	16	+ 3.8	3.55	3.30	3.05	2.80	2.55	2.30	2.05	1.80	1.55	1.30
	.40	− .35	15	+ 3.7	3.45	3.20	2.95	2.70	2.45	2.20	1.95	1.70	1.45	1.20
	.50	− .50	15	+ 3.6	3.35	3.10	2.85	2.60	2.35	2.10	1.85	1.60	1.35	1.10
	6 h 00	− .65	15	+ 3.5	3.25	3.00	2.75	2.50	2.25	2.00	1.75	1.50	1.25	1.00
	.10	− .80	15	+ 3.4	3.15	2.90	2.65	2.40	2.15	1.90	1.65	1.40	1.15	0.90
	.20	− .96	16	+ 3.3	3.05	2.80	2.55	2.30	2.05	1.80	1.55	1.30	1.05	0.80
	.30	− 1.12	16	+ 3.2	2.95	2.70	2.45	2.20	1.95	1.70	1.45	1.20	0.95	0.70

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

Zone 38

H 293°.22

α	106.00	sin δ 7.46373
H+α =	38.22	cos(H+α) 9.98342
h	+18.97	h 1.27807
		8.72522

dr_0 +0.30 $d\delta - d\delta'$ −0.05

d_4r +0.01

dr +0.31

ds +2.72

$ds - dr$ +2.41

$d\delta - d\delta'$ −0.05

d −2.46

Zone 39

H 270°.44

α	106.00	sin δ 7.46373
H+α	16.44	cos. H+α 9.98342
h	+18.74	h 1.27393
		8.72108

dr_0 +0.30 $d\delta - d\delta'$ −0.05

d_4r +0.02

dr +0.32

ds +3.03

$ds - dr$ +2.71

$d\delta - d\delta'$ −0.05

d −2.76

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Reduction of Zones 38 & 39

Zone 38

Feb. 26, 1853 Sid. Time 6h 48m Bar. 30.060 Att. therm 60° Ext. therm 22°.5
" " 8h 43m " 30.080 " " 63 " " 22.0

Zone 39

March 16, 1853 Sid. Time 7h 25m Bar. 30.030 Att. therm. 58 Ext. therm 16.9
" " 9h 27m " 30.092 " " 65 " " 14.6

Zone 38

t_0 = 5h 50m k'_4 = 0.000s d'_4 = −0.25s

5h 59m	+0.22s =	x_{38} + 0.15 x'_{38}	−64.0 =	y_{38} + 0.15 y'_{38} 2
5h 59m	+0.11 =	" + 0.15 "	−56.1 =	" + 0.15 " 1
5h 59m	+0.29 =	" + 0.15 "	−64.3 =	" + 0.15 " 3
6h 09m	+0.22 =	" + 0.32 "	−64.8 =	" + 0.32 " 1
6h 16m	— — — =	" ~~+ 0.43~~ "	−67.7 =	" + 0.43 " 2
6h 16m	— — =	" ~~+ 0.43~~ "	−62.8 =	" + 0.43 " 1
6h 22m	— — =	" ~~+ 0.53~~ "	−57.5 =	" + 0.53 " 1
6h 23m	— — =	" ~~+ 0.55~~ "	−62.4 =	" + 0.55 " 1
6h 26m		" ~~+ 0.60~~ "	−56.5 =	" + 0.60 " 1
~~6h 33m~~		~~+ 0.72~~ "		~~+ 0.74~~ "
~~6h 34m~~		~~+ 0.73~~ "		~~+ 0.73~~ "
6h 36m	−0.31 =	" + 0.77 "	−66.8 =	" + 0.77 " 1
6h 38m	+0.12 =	" + 0.80 "	−65.9 =	" + 0.80 " 1
6h 38m	−0.59 =	" + 0.80 "	−66.1 =	" + 0.80 " 1
6h 57m	−0.47 =	" + 1.02 "	−64.7 =	" + 1.02 " 1
~~6h 57m~~		~~+ 1.03~~ "		~~+ 1.03~~ "
6h 58m	−0.58 =	" + 1.07 "	−66.2 =	" + 1.07 " 1
6h 58m	−0.35 =	" + 1.10 "	−66.4 =	" + 1.10 " 1
6h 59m	+0.79 =	" + 1.15 "	−68.4 =	" + 1.15 " 1
7h 00m	−0.30 =	" + 1.17 "	−67.8 =	" + 1.17 " 1
~~7h 01m~~		~~+ 1.18~~ "		~~+ 1.18~~ "
7h 03m	−0.08 =	" + 1.22 "	−67.0 =	" + 1.22 " 1
7h 06m	+0.13 =	" + 1.27 "	−68.2 =	" + 1.27 " 2
7h 06m	−0.14 =	" + 1.27 "	−66.1 =	" + 1.27 " 1
7h 08m	+0.26 =	x_{38} + 1.30 x'_{38}	−68.2 =	y_{38} + 1.30 3

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1953phae.proj..23

Zone 38

7h 11	−0.17 = r	x_{38} + 1.35 x'_{38}	−67.8 = r	y_{38} + 1.35 y'_{38}	1
7 16	−0.04 = r	" + 1.43 "	−66.9 = r	" + 1.43 "	1
7 17	−0.19 = r	" + 1.45 "	−66.9 = r	" + 1.45 "	1
7 20	−0.23 = r	" + 1.50 "	−68.3 = r	" + 1.50 "	1
7 24	−0.01 = r	" + 1.57 "	−66.8 = r	" + 1.57 "	1
7 31	−0.19 = r	" + 1.68 "	−68.5 = r	" + 1.68 "	3
7 41	−0.35 = r	" + 1.85 "	−66.5 = r	" + 1.85 "	1
~~7 48~~	~~− − − =~~	~~" + 1.97~~	~~− − − − =~~	~~" + 1.97~~	~~+~~
~~7 49~~	~~− − − =~~	~~" + 1.98~~	~~− − − =~~	~~" + 1.98~~	~~+~~
7 48	**−0.36 =**	x_{38} + 1.97 x'_{38}	**−67.5 =**	y_{38} + 1.97 y'_{38}	2

Zone 39

t_0 5h 50m k_x 0.000s d'_x −0.28s

5h 59	**+0.18s =**	x_{39} + 0.15 x'_{39}	**−62.0" =**	y_{39} + 0.15 y'_{39}	2
5 59	+0.21 = r	" + 0.15 "	−54.0 = r	" + 0.15 "	1
5 59	+0.24 = r	" + 0.15 "	−63.1 = r	" + 0.15 "	3
6 09	+0.07 = r	" + 0.32 "	−61.7 = r	" + 0.32 "	1
~~6 16~~	~~−0.97 =~~	~~" + 0.43 "~~	−65.6 = r	" + 0.43 "	2
6 16	−0.17 = r	" + 0.43 "	−60.7 = r	" + 0.43 "	1
6 22	−0.06 = r	" + 0.53 "	−55.4 = r	" + 0.53 "	1
6 23	+0.15 = r	" + 0.55 "	−58.2 = r	" + 0.55 "	1
6 26	+0.18 = r	" + 0.60 "	−54.3 = r	" + 0.60 "	1
~~6 33~~		~~" + 0.72 "~~		~~" + 0.72 "~~	~~+~~
~~6 34~~		~~" + 0.73 "~~		~~" + 0.73 "~~	~~+~~
6 36	−0.81 = r	" + 0.77 "	−63.6 = r	" + 0.77 "	1
6 38	−0.28 = r	" + 0.80 "	−63.7 = r	" + 0.80 "	1
6 38	−0.81 = r	" + 0.80 "	−61.9 = r	" + 0.80 "	1
6 51	−0.67 = r	" + 1.02 "	−61.5 = r	" + 1.02 "	1
~~6 52~~		~~" + 1.03 "~~		~~" + 1.03 "~~	~~+~~
6 54	−0.90 = r	" + 1.07 "	−66.0 = r	" + 1.07 "	1
6 56	−0.82 = r	" + 1.10 "	−65.3 = r	" + 1.10 "	1
6 59	+0.64 = r	" + 1.15 "	−66.3 = r	" + 1.15 "	1
7 00	−0.65 = r	" + 1.17 "	−63.6 = r	" + 1.17 "	1
~~7 01~~		~~" + 1.18 "~~		~~" + 1.18 "~~	~~+~~
7 03	−0.38 = r	" + 1.22 "	−65.8 = r	" + 1.22 "	1
7 06	−0.27 = r	" + 1.27 "	−62.1 = r	" + 1.27 "	2
7 06	−0.44 = r	" + 1.27 "	−64.8 = r	" + 1.27 "	1
7 08	−0.04 = r	" + 1.30 "	−65.1 = r	" + 1.30 "	3
7 16	−0.67 = r	x_{39} + 1.35 x'_{39}	−64.7 = r	y_{39} + 1.35 y'_{39}	1

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.23

Zone 39

7" 16	$-0.24 = x_{39} + 1.43\, x'_{39}$	$-64.7 = y_{39} + 1.43\, y'_{39}$	1
7" 17	$-0.69 =$ " $+ 1.45$ "	$-66.7 =$ " $+ 1.45$ "	1
7" 20	$-0.63 =$ " $+ 1.50$ "	$-64.0 =$ " $+ 1.50$ "	1
7" 24	$-0.41 =$ " $+ 1.57$ "	$-64.4 =$ " $+ 1.57$ "	1
7" 31	$-0.59 =$ " $+ 1.68$ "	$-63.3 =$ " $+ 1.68$ "	3
7" 41	$-0.70 =$ " $+ 1.85$ "	$-65.3 =$ " $+ 1.85$ "	1
7" 48	$-0.66 =$ " $+ 1.97$ "	$-65.8 =$ " $+ 1.97$ "	1
7" 49	$-0.65 =$ " $+ 1.98$ "	$-63.2 =$ " $+ 1.98$ "	1
7" 48	$-0.59 = x_{39} + 1.97\, x'_{39}$	$-62.0 = y_{39} + 1.97\, y'_{39}$	2

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj...23

Zone 38.

$d' = -0,25$

h m	K	d 0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10
t_0 5 50	+ 0.18	−62.1	62.35	2.60	2.85	3.10	3.35	3.60	3.85	4.10	4.35	4.60
6 00	+ 0.14	−62.7	2.95	3.20	3.45	3.70	3.95	4.20	4.45	4.70	4.95	5.20
.10	+ .10	−63.2	3.45	3.70	3.95	4.20	4.45	4.70	4.95	5.20	5.45	5.70
.20	+ .07	−63.8	4.05	4.30	4.55	4.80	5.05	5.30	5.55	5.80	6.05	6.30
.30	+ .04	−64.4	4.65	4.90	5.15	5.40	5.65	5.90	6.15	6.40	6.65	6.90
.40	± .00	−64.9	5.15	5.40	5.65	5.90	6.15	6.40	6.65	6.90	7.15	7.40
.50	− .03	−65.5	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00
7 00	− .07	−66.0	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50
.10	− .10	−66.6	6.85	7.10	7.35	7.60	7.85	8.10	8.35	8.60	8.85	9.10
.20	− .13	−67.2	7.45	7.70	7.95	8.20	8.45	8.70	8.95	9.20	9.45	9.70
.30	− .17	−67.8	8.05	8.30	8.55	8.80	9.05	9.30	9.55	9.80	10.05	10.30
.40	− .20	−68.4	8.65	8.90	9.15	9.40	9.65	9.90	10.15	10.40	10.65	10.90
.50	− .23	−69.0	9.25	9.50	9.75	10.00	10.25	10.50	10.75	11.00	11.25	11.50

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj.:23

Zone 39.

$d' = -0''.28$

	h m		K s
t_0	5 11.50	+	0.16
	6 11.00	+	.10
	.10	+	.03
	.20	−	.04
	.30	−	.11
	.40	−	.17
	.50	−	.24
	7 11.00	−	.31
	.10	−	.37
	.20	−	.44
	.30	−	.51
	.40	−	.58
	.50	−	.64

d	0′	1′	2′	3′	4′	0.5′	6′	7′	8′	9′	10′
−60.6	0.88	1.16	1.44	1.72	2.00	2.28	2.56	2.84	3.12	63.40	
−60.9	1.18	1.46	1.74	2.02	2.30	2.58	2.86	3.14	3.42	3.70	
−61.3	1.58	1.86	2.14	2.42	2.70	2.98	3.26	3.54	3.82	4.10	
−61.7	1.98	2.26	2.54	2.82	3.10	3.38	3.66	3.94	4.22	4.50	
−62.1	2.38	2.66	2.94	3.22	3.50	3.78	4.06	4.34	4.62	4.90	
−62.4	2.68	2.96	3.24	3.52	3.80	4.08	4.36	4.64	4.92	5.20	
−62.8	3.08	3.36	3.64	3.92	4.20	4.48	4.76	5.04	5.32	5.50	
−63.2	3.48	3.76	4.04	4.32	4.60	4.88	5.16	5.44	5.72	6.00	
−63.6	3.88	4.16	4.44	4.72	5.00	5.28	5.56	5.84	6.12	6.40	
−64.0	4.28	4.56	4.84	5.12	5.40	5.68	5.96	6.24	6.52	6.80	
−64.4	4.68	4.96	5.24	5.52	5.80	6.08	6.36	6.64	6.92	7.20	
−64.8	5.08	5.36	5.64	5.92	6.20	6.48	6.76	7.04	7.32	7.60	
−65.2	5.48	5.76	6.04	6.32	6.60	6.88	7.16	7.44	7.72	68.00	

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

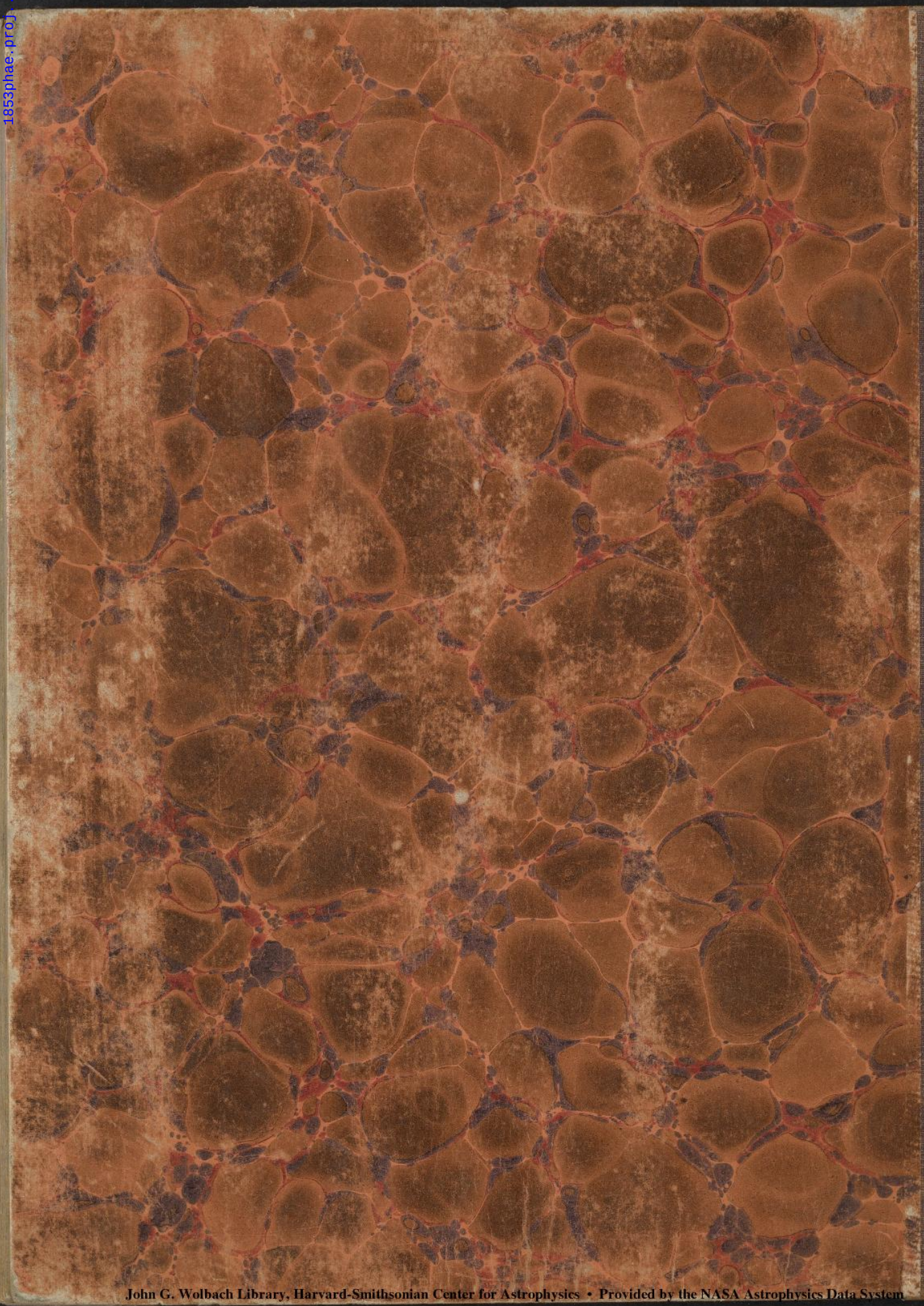
1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae.proj..23

John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System

1853phae..proj..23



John G. Wolbach Library, Harvard-Smithsonian Center for Astrophysics • Provided by the NASA Astrophysics Data System