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KG
11366
153

No. 44

PREPARATIONS FOR OBSERVING TOTAL ECLIPSE.

Aug. 29, 1886.

W. H. P.

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V. KG11366.153

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Preparations for Observing Total Eclipse of the Sun, visible at Grenada Aug. 29, 1886.

W. H. Pickering.

Wed. Apr. 14. Obtained appropriation of $500. for the expedition from the Rumford Committee.

Im eacing photographed gibbous moon at Institute. Employed Seed 21. Pyro 3½ min.

No	Lens	Focus	Aper	Exp.	Lens Aper					Exp
P1	Spectacle	125 cm	5 cm	2 sec	.05	6	13	25	50	Hemispherical
P2	Voigt-port.	20.	3.5	4 min						No square. Shield
P3	" "	"	"	5 "	.05	3	6	13	25	"
P4	" "	"	"	30 sec	"	(13	25	50	100)(12)	No shield
P5	Spectacle	125	15	2. "	.20	3	6	13	25	"
P6	Voigt-port.	20	3.5	30 sec	.05	3	6	13	25	Shield
P7	" "	"	"	30+15						No square "

Sat. Apr. 17.

Took photos of Pole. Seed 21 as before.

No	Lens	Focus	Aper	Exp.	
P8	Voigt-port.	14.	2.	3-3-5 min	Hard diff foc.
P9	" "	20	3.5	"	"
P10	Dear. "	35	4	"	"
P11	Darlot "	35	4	"	"
P12+13	" "	"	"	3+5	" Exposed together
P14+15	Dear. "	"	"	"	" " " (Glass side out)

Photos of Moon. (Full Apr 18 at 9 am.)

No	Lens	Focus	Aper	Exp.	Lens Aper					Exp
P16	Voigt-port.	20	3.5	30	.05	3	6	13	25	Shield
P17	" "	"	"	"	"					No shield
P18	Spectacle	125	15	2						Spoiled.
P19	Darlot port	35	4	3 min						Sky blackened

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Sunday. Apr. 18, '86.

Took photos of full moon.

No	Lens	Focus	Aper	Exp.	Lens	Aper	Exp.				
P 20	Spectacle	12.5	.5	2 sec	.20	3	6	13	25		
P 21	Voigt-port	20	3.5	30	.05	25	50	.20	6	13	Shield
P 22	"	"	"	"	"	.20	3	6	13	25	No Shield
P 23	Dallot	"	35	4	10						Bad focus.

Dates various

P 24	Dallot	"	"	"	33.5	diff. focus
P 25 26 27	rejected lenses.					
P 28	Photobelia	1200	10.	4 sec	Focus 38 ft 10 in	Through red glass
P 29	"	"	"	1	"	"

May 7.

~~P~~ photobelia measured from center lens to [illegible] back of camera.

P 30	photobelia	39 ft 4 in	10 cm	dep. shutter	Seed 21	No bromide.	
P 31	"	"	2	"	"	Carbo B	40 drops bromide about
P 32	"	"	0	"	"	"	"
P 33	"	~~38~~ "	~~10~~	"	"	"	"
P 34	"	38	10	"	"	"	"
P 35	"	38	8	"	"	"	Good background ~~probably loss~~
P 36	"	"	6	"	"	"	"
P 37	"	"	8	"	"	"	"

The focus is probably about 38 ft 8.5 in.

The thickness of the indistinct edge is about $\frac{1}{10}$ th of an inch.

Number 34 the best.

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May. 9, '86.

No	~~Lens~~ Photo	Focus	Aper	Exp	Plate	Lge	Subject
P 38	Photo Clio	38 ft	8.5"	4.5"	2 sec	Seed 21	6½ x 8½	Crescent Moon
P 39	"		6.5	"	"	"	"	"
P 40	"		5.5	"	5	"	"	"
P 41	"		2.5	"	"	"	"	"
P 42	"		4.5	"	10	"	"	"
P 43	"		0.5	"	"	"	"	"

Best focus 38 ft 4.5 inches. Visible focus 10 to 11 inches further out.

Definition with 10 secs exp quite equal to best 1 sec exposure

Number 42 the best.

May 10, '86.

No	Lens	Focus	Aper	Exp	Plate	Lge	Subject
P 44	Photo-Clio	38	8.5	4.5	1/100 sec	Carb B	4x5	Sun spot
P 45	"	"	1.	"	"	"	"
P 46	"	"	4.5	"	"	"	"
P 47	"	"	4.5 + 2.	"	"	"	"

The focus was 11 inches shorter than the visual but seemed unsatisfactory for P 44 to P 45. The 2 in. disk gave ~~better~~ greater distinctness than the full aperture but apparently the camera or mirror moved during the exposure giving a double image. Changed the focus for P 46 & P 47 as the camera had blown down.

May 12, '86.

Wrote to M. A. Seed requesting terms of dry plate.

1½ day 20 x 24 1 day 6½ x 8½

2 day 8 x 10 ½ day 4 x 5

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May 14/21 '86.

No	Lens	Focus	Aper	Exp	Plate	Liga	Subject
P 48 a	Photo-hel.	38 8½	2	1/100	Cram 8	4×5	Sun's limb
b	"	"	4½	"	"	"	"
P 49 a	"	10½	2	"	"	"	"
b		"	4	"			
c		6½	2	"			
P J-0 a	"	"	"	"	"	"	"
b		8½	"	"			
P J-1 a	"	4½	"	"	"	"	"
b		6½	1	1/100			

P J-0 b is best focus of P J-0 a next, then P J-1 a.
Why plate P 48 & P 49 were indistinct is not clear unless the focus was different from what I supposed, which is I think improbable. Perhaps air currents on roof were more marked.

May 17. '86.

No	Lens	Focus	Aper	Exp	Clock	Plate	Liga	Subject
P J-2	Photo-hel.	38 4½	2	2	on	Seed 21	6½×8½	Full Moon
P J-3	"	"	4½	"	"	"	"	"
P J-4	"	"	2	10	"	"	"	"
P J-5	"	"	4½	1/4(?)	off	"	"	"
P J-6	"	"	"	3	on	"	"	"
P J-7	"	"	"	"	off	"	"	"
P J-8	"	"	"	2	on	"	"	"
P J-9	"	"	2	10	"	"	"	"

Nos. P J-2 P J-3 P J-4 & P J-5 were taken when Moon was quite hazy. Nos. P J-6 & P J-7 Moon was nearly clear. Nos P J-8 & P J-9 Moon was perfectly clear.
P J-8 is the best, and as good or better than the crescent.

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Nos P J-2 P J-4 & J-5 were ~~clear~~ negative, but not strong enough. Nos J-7 & P J-9 were perhaps a trifle more distinct, but the motion was too marked.

May 19 '86.

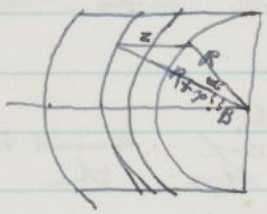
	Smithsonian Institute Sun	Moon	Harvard Observatory Sun	Moon	Sun	Nebraska Corona
Atmospheric motion	✓		✓		✓	
Adjustment mirror		✓				
" lens	✓	✓				
Escapement of clock		✓		✓		✓
Jar of apparatus						
Aberration lens chem.		✓		✓		✓
" " after.		✓		✓		✓
Current bet. lens + plate.	✓	✓				

All of the above defects may tend to injure the image as indicated.

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May 20, '86.



p = thickness atmos. y = per cent light absorbed at middle of disc, which is taken as unit thickness.
I = total light at surface
I_1 = " " transmitted at center of disc i = light transmitted at any portion of disc.

$$R\sin\alpha = (R+p)\sin\beta \qquad z = (R+p)\cos\beta - R\cos\alpha$$

$$\left(\frac{R\sin\alpha}{R+p}\right)^2 = \sin^2\beta \qquad \left(\frac{z+R\cos\alpha}{R+p}\right)^2 = \cos^2\beta$$

$$R^2\sin^2\alpha + z^2 + 2zR\cos\alpha + R^2\cos^2\alpha = (R+p)^2$$

$$R+p = \sqrt{R^2+z^2+2zR\cos\alpha}$$

$I(1-y)$ = amt trans. by thickness p
$I(1-y)^2$ = " " " " $2p$
$I(1-y)^3$ = " " " " $3p$ etc

$$i = I(1-y)^{\frac{z}{p}} \qquad i_1 = I(1-y) \qquad I = \frac{i_1}{1-y}$$

$$i = i_1(1-y)^{\frac{z}{p}-1} = I_1(1-y)^{\frac{z}{z+a}}$$

$R = 400\,000$ approx

α	$\sin\alpha$	$\cos\alpha$	Chem. intens.
0.0°	.00	1.0000	1.00
30.0°	.50	.8660	.90
48.6	.75	.6613	.66
71.8	.95	.3123	.25
78.5	.98	.1994	.18
90.0°	1.00	.0000	.13

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$\sqrt{z^2 + 2zR\cos\alpha + R^2} - R = \rho$ $\quad \cos\alpha = 1$

$\sqrt{z^2 + 2z \times 400000 + 400000^2} - 400000 = z = \rho$

$l = l_1(1-y)^\circ \quad l = l_1$

$\cos\alpha = 0.\ \sqrt{z^2 + R^2} - R = \rho$ #

$l = .13 = 1\left(1-y\right)^{\frac{z}{\sqrt{z^2+R^2}-R}} - 1 = \left(1-y\right)\frac{z+R-\sqrt{z^2+R^2}}{\sqrt{z^2+R^2}-R}$ $\quad \cos\alpha = 0$

$1-y = .13\,\frac{\sqrt{z^2+R^2}-R}{z+R-\sqrt{z^2+R^2}} \qquad y = 1 - .13\,\frac{\sqrt{z^2+R^2}-R}{z+R-\sqrt{z^2+R^2}}$

$\sqrt{z^2 + 2z \times 346400 + 160000\,000000} - 400000 = \rho$

$\sqrt{z^2 + 2zR\cos 30^\circ + R^2} - R = \rho$ $\quad \cos\alpha = .866^0$

$l = .90 = (1-y)^{\frac{z}{\sqrt{z^2+2zR\cos 30^\circ + R^2} - R}} - 1$

$1-y = .90\,\frac{\sqrt{z^2+2zR\cos 30^\circ + R^2} - R}{z+R-\sqrt{z^2+2zR\cos 30^\circ + R^2}} \qquad y = 1 - .90\,\frac{\sqrt{z^2+2zR\cos 30^\circ + R^2} - R}{z+R-\sqrt{z^2+2zR\cos 30^\circ + R^2}}$

$\sqrt{z^2 + 2z \times 346400 + 346400^2 + 40284\,000000} = \begin{cases} 160000\,000000 \\ 119716\,000000 \\ 40284\,000000 \end{cases}$

$\sqrt{(z + 346400)^2 + 40284\,000000}$

$y = 1 - .90^u = 1 - .40^v \quad$ then $.90^u = .40^v$

$.90\,\frac{\sqrt{z^2+2zR\cos 30^\circ + R^2} - R}{z+R-\sqrt{z^2+2zR\cos 30^\circ + R^2}} = .13\,\frac{\sqrt{z^2+2zR\cos 90^\circ + R^2} - R}{z+R-\sqrt{z^2+2zR\cos 90^\circ + R^2}}$

$.90\,\frac{a-R}{z+R-a} = .13\,\frac{b-R}{z+R-b}$

$.90(qz + aR - ab - Rz - R^2 + Rb) = .13(bz + bR - ab - Rz - R^2 + aR)$

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$$R + y = \sqrt{R^2 + z^2 + 2Rz\cos\alpha}$$

$$R^2 + 2Rx + x^2 = R^2 + z^2 + 2Rz\cos\alpha$$

$$z^2 + 2Rz\cos\alpha + R^2\cos^2\alpha = x^2 + 2Rx + R^2\cos^2\alpha$$

$$z + R\cos\alpha = \sqrt{x^2 + 2Rx + R^2\cos^2\alpha}$$

$$z = \sqrt{x^2 + 2Rx + R^2\cos^2\alpha} - R\cos\alpha \qquad l = l_1(1-y)^{\frac{z}{x}-1}$$

$$\frac{l}{l_1} = (1-y)^{\frac{z-x}{x}} \qquad 1-y = \left(\frac{l}{l_1}\right)^{\frac{x}{z-x}}$$ let $l_2 + z_2$ be other values of $l+z$

$$\text{Then } 1-y = \left(\frac{l_2}{l_1}\right)^{\frac{x}{z_2-x}} \quad \therefore \left(\frac{l}{l_1}\right)^{\frac{x}{z-x}} = \left(\frac{l_2}{l_1}\right)^{\frac{x}{z_2-x}}$$

Since $l_1 = 1$ we have $l^{\frac{x}{z-x}} = l_2^{\frac{x}{z_2-x}}$ or substituting

$$\cdot 90^{\frac{x}{\sqrt{x^2+2Rx+R^2\cos^2 30^\circ} - R\cos 30^\circ - x}} = .13^{\frac{x}{\sqrt{x^2+2Rx+R^2\cos^2 90^\circ} - R\cos 90^\circ - x}}$$

$$\log .90\left(\frac{x}{\sqrt{x^2+2Rx+R^2\cos^2 30^\circ} - R\cos 30^\circ - x}\right) = \log .13\left(\frac{x}{\sqrt{x^2+2Rx+R^2\cos^2 90^\circ} - R\cos 90^\circ - x}\right)$$

$$(\log .90)\, x\left(\sqrt{x^2+2Rx+R^2\cos^2 90^\circ} - R\cos 90^\circ - x\right) = (\log .13)\, x\left(\sqrt{x^2+2Rx+R^2\cos^2 30^\circ} - R\cos 30^\circ - x\right)$$

Call last radical sign $c + 2d$ &

$$a(\log .90)\, x - R\cos 90^\circ \log .90 - x\log .90 = b\log .13 - R\cos 30^\circ \log .13 - x\log .13$$

$$a\log .90 - b\log .13 = x(\log .90 - \log .13) + R(\cos 90^\circ \log .90 - \cos 30^\circ \log .13)$$

$$\log .90\sqrt{(x+R)^2} - \log .13\sqrt{(x+R)^2 - C} = dx + e$$

$$\frac{x\log .90 + R\log .90 - xd - e}{\log .13} = \sqrt{(x+R)^2 - C}$$

$$\frac{\left[x^2(\log .90 - d) + R\log .90 - e\right]^2}{\log^2 .13} = (x+R)^2 - C\log^2 .13$$

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$x^2 (\sin 90 - d)^2 + 2x(\sin 90 - d)(R \sin 90 - e) + (R \sin 90 - e)^2 =$

$\sin^2 13\, x^2 + 2 \sin^2 13\, x R + \sin^2 13\, R^2 - c \sin^2 13$

$((\sin 90 - d)^2 - \sin^2 13)\, x^2 + 2[(\sin 90 - d)(R \sin 90 - e) - \sin^2 13\, R]\, x =$

$\sin^2 13\, R^2 - c \sin^2 13 - (R \sin 90 - e)^2$

$[x(\sin 90 - d) + R \sin 90 - e]^2 - [x + R]^2 \sin^2 13 = -c \sin^2 13$

$x(\sin 90 - \sin 90 + \sin 13) + R(\sin 90 - \cos 90$

Value of "a" $R = 430$ Value of "b"

$a = \sqrt{x^2 + 2Rx + R^2 \cos^2 90^\circ} = \sqrt{x^2 + 860x}$ $\quad b = \sqrt{x^2 + 2Rx + R^2 \cos^2 30^\circ} =$

$\sqrt{x^2 + 860x + 139876}$

$x^2 + 860x \;\big|\; x + 430 - \frac{92450}{x} = "a"$
$x^2 \qquad\qquad + \frac{39732000}{x^2}$

$860x \;\big|\; 2x + 430$
$860x + 430^2$

-430^2
$-184900 \;\big|\; 2x + 860 - \frac{92450}{x}$
$-184900 - \frac{92450 \times 860}{x} + \frac{92450^2}{x^2}$

$+\frac{92450 \times 860}{x} - \frac{92450^2}{x^3} \;\big|\; 2x + 860 - \frac{2 \times 92450}{x}$

$\cos 30^\circ = .866 = .87$

$R = 430.$
2610
348
$R \cos 30^\circ = 374.10$
$374.$
1496
2618
1122
$139876.$

430
430
12900
172
184900

$x^2 + 860x + 139876. \;\big|\; x + 430 - \frac{22512}{x}$
$+\frac{9675000}{x^2}$

x^2

$860x + 139876 \;\big|\; 2x + 430$
$860x + 184900$

$-45024 \;\big|\; 2x + 860 - \frac{22512}{x}$
$45024 - \frac{22512 \times 860}{x} +$

$+\frac{22512 \times 860}{x} \;\big|\; 2x + 430$

$92400.$
$430.$
2772
3696
39732000
$x^2 = 361800$
1000

225000
430
6750
9000
9675000 $= 300$
36180

$a = x + 430 - \frac{92450}{x}$ $\qquad b = x + 430 - \frac{22512}{x}$

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$+1000(\log .90)$

$(\log .90)x + (\log .90)430 = (\log .90)\frac{92450}{x} - (\log .13)x - (\log .13)430 +$

$-300(\log .13)$

$(\log .13)\frac{2250-12}{x} - (\log .90)x + (\log .13)x = -430(.87)\log .13$

$(\log .13)\frac{2250-12}{x} - (\log .90)\frac{92450}{x} = (\log .13 - \log .90 - .87\log .13)430 -$

$1000(\log .90) + 300(\log .13)$

$\frac{2250-12\log .13 - 92450\log .90}{x} = 430(\log .13 - \log .90 - .87\log .13)$

$-1000(\log .90) + 300(\log .13)$

$x = \frac{2250-12\log .13 - 92450\log .90}{430(\log .13 - \log .90 - .87\log .13) - 7220}$ The unit is 1000 miles.

$\log .13 = 9.1139$

$\log .90 = 9.9542$

$9.114 \times 2250 = 20506.5$

$9.954 \times 9240 = 91974960$

$9.114 \times .87 = 7.9291 8$

$9.954 - 17.883$

$+9.114$

8.769

$43.$

377.067

$377)31479(19$

377

3377

$x = \frac{20506. - 91974.96}{-43. \times 8.769 - 7220} = \frac{71469.}{377.} = 190$

$x = 190000$ miles.

2d Approx

$-1000\log .90 = -954.2$

$300\log .13 = -33.8$

$-7220.$

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July 23. Had a Photoheliograph tube constructed at Observatory & took several photos of the sun with it & learned to manage the mirror. Also experimented on other cameras testing their faci etc. Obtained large packing case & packed all apparatus with excelsior. Dimensions of case approximately 4½ x 4¼ x 1½. All these things were done but not recorded prior to this date.

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Journal of the Eclipse.

July 24, 1886. Left sail for Grenada from New York in s.s. Barraconta.

Tues July 17, Sighted Grenada & daylight called on Mr. Wright

Landed about 10 a.m. & secured rooms.

Called on Prof. Lockyer & the Governor.

Wed. July 18. Called on Dr. Schuster. Visited Fort St. George in afternoon & decided on it as an observing station.

Visited Barraconta & learned that she will probably reach New York about Sept. 3d & leave the 10th. If she then takes shorter route will reach Grenada by Sept 25th.

Set my chronometer & that of Capt. Evans at about 4.30 p.m. local time.

Correct time	8h 38m 45.5s	
Chronometer	8 32 12.	
Difference	6m 33.5s	to be added to my time.

Time of Totality.

69	31	61	45
60	22	60	22
9	13	1	23
60			

5.5 : 83 = 5m 0.[5/7 × 60] sec.

300/7 = 45 sec.

Latitude & Longitude of Flagstaff on Fort St. George.

Lat. 12° 3' 2"

Long. 61° 44' 5.5"

According to latitude belonging to Mr. Wright, Inspector of Police at Grenada.

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$23^h\ 20^m\ 0^s$

45^s

$23^h\ 19^m\ 15^s$ G.M. Time of Totality at Fort St. George.

12^h { 6 33.5

$11^h\ 13^m\ 41.5^s$ Chronometer time of Totality

1 53.

$11^h\ 11^m\ 48.5^s$ } Commencement of

The Rate of the chronometer is I believe 3 secs. per day but I cannot find the figures. This would produce error of 3 secs. fast or slow.

Duration of Totality — $3^m\ 46^s = 226^s$

Thurs. Aug. 19. Visited Mr. Wright & obtained authority to use the Fort from the Governm. Got my case of instruments through custom house & up to the Fort.

Fri. Aug. 20. Decided on location of observing station in the Fort. Obtained a room for storage & photographic purposes & moved things in. Laid out assumed meridian & a sun dial & in the evening obtained series of settings on Polaris. Found vertical cross wire was broken but got on very well without it.

Polaris	8.15	206	07	26	09
	8.20 x	206	07	26	05
Assumed meridian	x	211	41	31	40
		211	41	31	42
	8.30	206	06	26	07
	8.35 x	206	08	26	09

x The horizontal clamp screw under eye-piece.

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Compared watch & chronometer

Watch $4^h\ 37^m\ 35^s$ Reduce to correct watch

Chron $8\ 37\ 25^s$ to chronometer add 4^h & subtract 10^s.

Sat. Aug. 21. Determined position of True Meridian & laid it out with pegs & also notches in the rocks.

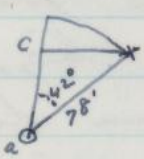
Mean angle on Notch $211°\ 41'$

" " " Polaris $206\ 07$ Watch time 8.25

$5°\ 34'$

Watch	Chron.	G.M.T.	
$8^h\ 25^m$	$12^h\ 25^m$	$12^h\ 32^m$	
		$2\ 3$	Time of Sidereal noon
		$1^h\ 31^m$	Time previous to Sid. noon.
		$1\ 18$	Polaris culminates.
	Observed Polaris	$2^h\ 49^m$	before culmination.

$1^h = 15°$ $2^h\ 49^m = 42°$



Declination Polaris $1°\ 18' = 78'$

$bc = 78 \sin 42°$

M

$\sin 45° = .7071$

$\sin 40° = .6428$ $\therefore \sin 42° = .67$ about.

$78 \times .67 = 52' = bc.$

Correction for Polaris $52'$.

Notch to Polaris $5°\ 34'$

Polaris to Pole $52'$

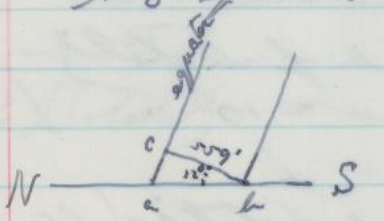
Notch to Pole $6°\ 26'$

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Position of Photoheliograph.

N & of Sun Aug 29 at 11.15 G.M.T. 9°19' = 559'



$ab \cos 12° = 559'$

$ab = \frac{559'}{\cos 12°} = 585' = 9° 45'$

$\sin 10° = .174$

$\sin 20° = .34 \quad \therefore \sin 12° = .209$

$$\begin{array}{r} 174 \\ 35 \\ \hline 209 \\ 209 \\ \hline 1881 \\ 418 \\ \hline .04368 \end{array}$$

$1 - .04368 = .9563 = \cos 12°$

$$\begin{array}{r|l} 9756 & 55990 \;(\; 5 \cdot 8 \; - \\ & 4780 \\ \hline & 8100 \\ & 7654 \\ \hline & 4560 \end{array}$$

Photoheliograph should point $\equiv 9°45' S$

Sun is Mon Aug 23 $2° = 4$ days to north of this.

Took series angles on assumed meridian.

×	327	39	147	36
×	327	37	147	33
	327	36	147	36
	327	37	147	37

Mean values 327 37 + 147 36

$$\begin{array}{r} 327° \quad 37' \\ 6 \quad 26 \\ \hline 321° \quad 11' \end{array}$$ = Reading on true meridian

$$\begin{array}{r} 99 \quad 45 \\ \hline 420 \quad 56 \\ 360 \\ \hline 60° \quad 56' \end{array}$$ = Reading for Photoheliograph.

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Aug. 22. Time of Totality at Fort St. George

$23^h\ 19^m\ 15^s$ Middle of Totality (Nautical Almanac)

$1\ 53$

$23^h\ 17^m\ 22^s$ Commencement of Totality " "

$23^h\ 17^m\ 13^s$ " " " (Lockyer)

9^s

$3^m\ 46^s$ Duration of Totality (Naut. Alm.)

$3^m\ 49^s$ " " " (Lockyer)

3^m

My chronometer time is $11^h\ 11^m\ 48.5^s$ (N.A.) or $11^h\ 11^m\ 39.5^s$ (L.)

Compared Watch & Chronometer.

Watch	Chron
$2^h\ 5\text{-}3^m\ 10^s$	$6^h\ 5\text{-}1^m\ 5\text{-}2^s$

Hence to convert watch to chron. add 4^h & subtract $1^m\ 18^s$

Aug. 28 Chronometer ran down. Anne rode over to Prickly Pointe to compare with Schuster. At 11.20 compared with my watch.

Chron #3 20 44.65 - Results from sum

Watch 11 20 45 10 readings. I read

Watch fast .35 Chron. & Anne watch.

Comparison was made at 3 pm. When Anne returned watch was faster, perhaps 30 seconds.

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Chron slow 25·5 secs ∴ add 25·5 secs. for true time

Totality commenced at 23 17 22
25·5
" " " 23 16 56·5 Chron.

Aug 30th. At 11.10 compared Chron & watch as before. 5 settings gave:-

Chron	3h	9m	47.4s
Watch	11	11	00.
Watch fast		1m	12.6s

Left 6 Compared Watch + Chronometer.

Chron.	5h	0m	55·4s
Watch	1h	6	30.
Watch fast		5m	34.6s

Date	day	Watch fast
Aug 28	0	35s
29	1	
30	2	72.6s
Left 6	9	334.6

9) 334.6 (37.2
27
64.6
63
1.4

Watch gains 37s per day.
At this rate on Aug 30th Watch would be 74.3 (2.6) s fast or 1.7s ahead of what it was.
Hence Watch probably did not lose or gain much on the ride to St. George.

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Lists of Instruments & Observers.

Photoheliograph Telescope and Dagmeter	W. H. Pickering. His Honour J. W. Carrington.
2 Astronomical Cameras	Mrs. W. H. Pickering. Miss M. A. Clarke. J. C. Griffith.
Prismatic Camera	H. H. Massiah E. H. Moore
Photoheliograph and Chronometer	W. D. Glean.
Photometer	B. J. G. Munro.
Metronome	H. A. Martin.
Anemometer, Vane, and Thermometer	A. G. Wilson.
Shadow Bands — Distance (Upper)	G. A. Krogh.
Direction "	J. N. Evanson. ~~His Honor Sir David Chalmers~~
Speed "	~~Dalzell~~ A. A. Lewis
Distance (Lower)	J. A. Critchlow H. M. McDowall
Direction "	~~Evanson~~ B. Sobers.
Speed "	~~Lewis~~ P. A. Dalzell.
General Phenomena	Sir David Chalmers.

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Personal Account

Was called at 5 a.m. Reached Fort at 5:30. Other observers arrived at 6 & soon after. Got out instruments. Had a shower & a few drops from another one, so had to take in some of the instruments twice. Putting coat on Astronomical Camera to protect them broke instrument down so had to have them repaired just before totality the clock apparatus broke so it could not be used. Sun came out of cloud for first time about five minutes before totality & I set heliostat so as to center image correctly. This required perhaps two minutes. Then I went to telescope & observed approach of totality. Bare Eye field magnified about 40 diams. Bailey's beads did not come out till crescent was very minute, as indicated. bc was full line & ab & cd dotted. Should not think they would have been visible to naked eye. When I looked for Corona which must have been about or before this time, it was clearly visible and conspicuous all around the Moon. I called "Now". At commencement of totality I called "Six" &



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Mr. Martin who had been conducting since Mrs Pickering said "Turn", had accounted a few minutes when I said "Set" & then began 2, 2, 4, etc. till the end of Totality. After noting the contacts I went at once to the Photoheliograph & made ~~my~~ I think 5 exposures, & also exposed 3 plates of the Dagueter. The first Photoheliograph plate I think was accidentally exposed to the crescent for some time. It was ~~given~~ exposed to the Corona at 29 & until I think 31 but it may have been 30.

No. 2 was exposed from 44 to 48 = 4

" 3 probably not put in according to Judge Corwin

" 4 was exposed from 64 to 84 = 20

" 5 " " " 102 " 134 = 32

" 6 I failed to expose but thought I removed cap at 156.

Exposed Dagueter plates ~~two I think~~ 84 156. One of them was exposed I think between ~~102~~ and ~~134~~ & the other ~~two~~ from 2 2 11 secs. instead of 2 2 4 as intended. ~~134 to 156.~~ ~~Possibly~~ After 156 I went to telescope. Hazy clouds had already covered the Sun. The Corona was



much brighter than in 1878 & more marked in its features. The ray on the left was conspicuous & three fine protuberances were seen at the top. One was like elm trees & the other two like two thorns.

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They appeared lighter than I had expected. Later heavy clouds covered the Corona & I could not tell when totality was over. but called "Dip" at about 2.40. Went round to see how other observers had got on. On my return Sun came out and I exposed Plate holder A to partial glare after resetting heliostat with shutter at 11h 5-6m 0s

11 5-7m 0

11 5-8m 0

Clock stopped & first exposure made with Sun in middle of plate. Noticed that ~~after~~ clock was started image did not stand still as usual but in 10 secs. moved about 1/8 of an inch. as if clock were not going. Later image stopped & moved contrary direction 3/16 inch in 120 secs.

During Totality I noticed the corona not colder than before. Noticed Venus exceedingly bright, also Mercury, as according to maps. Think I noticed Regulus. Saw Orion & other stars.

Chronometer readings J. M. Glean

"Now" (Corona visible) 11 14 43¼

"Dip" (Totality) 11 14 53

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The Corona was therefore conspicuous visible through telescope 10 seconds before Totality.

Time of Totality—

Calculated (with Chronometer correction) 23 16 53.5—

Observed 23 14 53.

Totality occured therefore 2m 3.5s—

before it should if chronometer was correct, or else the time was wrongly recorded. The error was ~~widely~~ either in the record & ~~or~~ in the chronometer, value given me by Sclusters.

Aug 31 The time of Totality was observed by Martin, Alvord & Evanson, and found to be correct. Hence ~~the~~ reading should be

Observed time 23h 16m 53.5s

Error 3.5s (calculated time too late). Assuming chronometer correct.

I watched Sun through telescope for about 2 minutes ~~through~~ before Totality I should think. At the time Bailey's beads were visible the thin crescent of the Sun flickered in a manner analagous to twinkling, causing the crescent to appear to revolve in the direction indicated. ← This was the direction in which the wind blew. This may be connected with the shadow bands.

Jan. 12, '88.

Observed time 23 16 53.0

Elson correct +2.5

Corrected observed time 23 17 18.5

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Phototelescope.

"All these observations were made through clouds". I. D. Sloan.

No	Exp	From	To	
1	1	145	146	
2	2½	180	182½	
3	6	220	226	(Sun invisible) W.W.P.
4	16	230	246	(after Potatis-)

In a letter written Sept. 2d. Mr. Sloan says he thinks that during the first exposure the Sun was perfectly clear, and that in the 2d & 3d the Sun was visible through the clouds. He says his vision was so affected by the darkness that he could not see at first.

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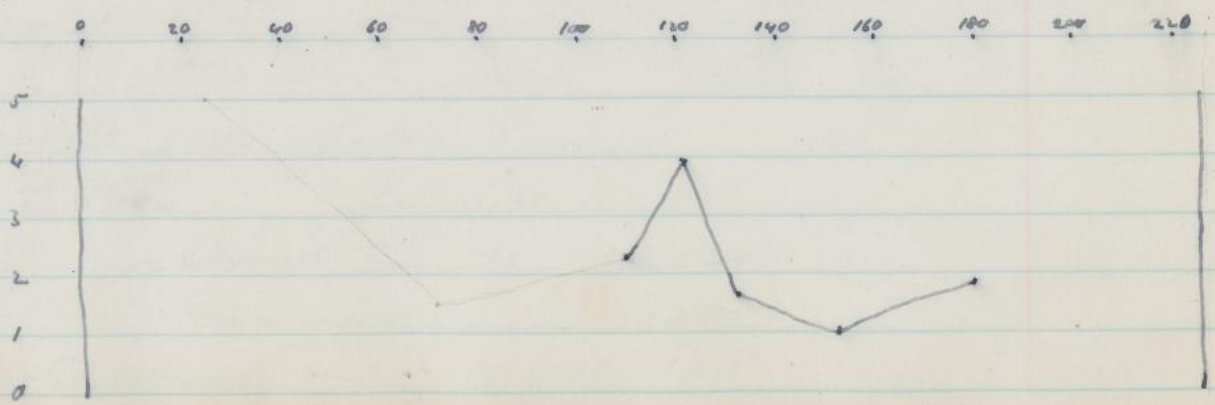
Photometer.

No	Secs	Aperture	Weather	Inches	from eyepiece. After eye.	large Aperture	Light Ratio
1	10	large	Clear	21.0	441.	441.	2:3
2	22	"	"	16.3	265.	265.	3.9
3	33	small	~~Clear~~	17.2	296. ×2=592.		1.7
4	54	"	"	22.1	485.	970.	1.0
5	80	"	"	17.0	289.	578.	1.8
		large	"	26.0	676.	676.	1.5
		"	"	13.9	193.	194.	5.0

The lamp went out once or twice before totality (perhaps on account of not winding sufficiently early), but had been burning 4 minutes when totality began. The chimney was pushed way down & the wick untrimmed projected 3/16 inch above the tube.

Sept. 10. Mr. Munro says that the above exposures should be 110, 122, 133, 154, & 180. The two other marks were made on the photometer during the first 100 seconds, when he noticed that two policemen were standing in front of his instrument, and therefore did not record them.

Assuming the smaller aperture of half the area of the larger one. Lamp placed as far back as possible.



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Prismatic Camera.

No	Secs	From	To	
1	1	3	4	
2	2½	21	23	
3	6	44	49	
4	16	66	81	
5	40a	106	145	
6	40b	170	209	yellow glass. Lens disaf. after 5 exp.

The exposures were probably pretty exact. The last was cut short of clouds.

Note Herschel & Respighi's observations. Rayet pp. 45-8.9 & 463.1 + 487.9 + 365-367

Study hydrogen spectrum at various pressures & temperatures. See Rayet pp. 362.5.

Photometer continued Apr. 6, '88,

Secs	Inches	Cm.	Cm²	Recip.	Unit light
—	13.9	35.	1220.	82.	
—	26.0	66.	4360.	23.	
10	21.0	53.	2810.	36.	
22	16.3	41.	1680.	60.	
		100.	10 000.	10.	

4/201
50

3/178
59

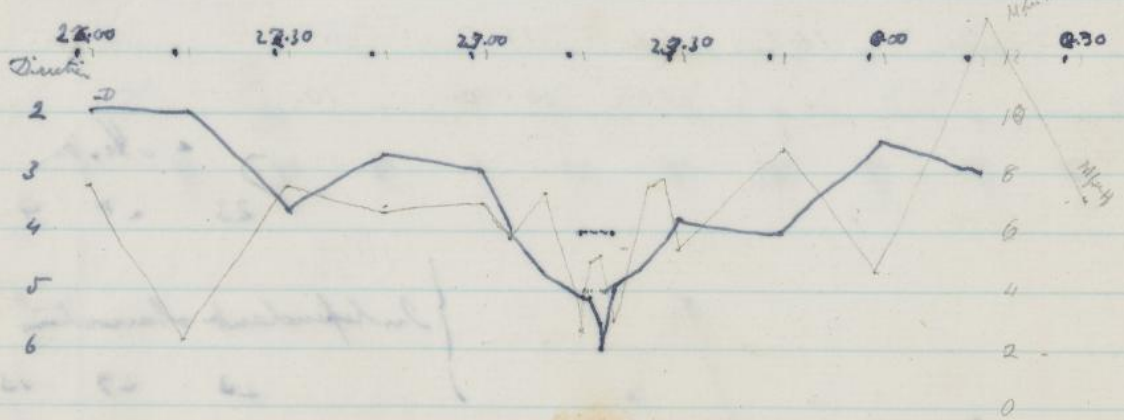
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Meteorological Instruments.

Height of Anemometer above parapet 36 ft.

Hours	Dir. Wind.	Resultg Wind.	Ft per 20 secs	Ft per sec.	Miles per hour	Temp.
6.00 a.m.	E 2.0 S *	~~0.76~~ 0.96	226.	11.3	7.7-	
6.15-	2.0	3.02	63.	3.2	2.2	26.2
.30	3.6	3.65-	225-	11.2	7.4	.6
45-	2.7	5.90	196.5-	9.8	6.6	.6
7.00	3.0	7.86 5-	211.	10.6	7.0	.8
.05-	4.0	9.97 5-	171.5-	8.6	5.8	.8
7.10	4.6	1.69	224.	11.2	7.4	.8
B	5.1	3.93	80.	4.0	2.6	.8
1m	5.1	4.73	147.	7.4	5.0	.8
3m	5.6	6.20	155-	7.8	5.2	.8
E	6.0	7.75-	89.	4.4	3.0	.8
.20	5.0	8.64	225.5-	11.3	7.7-	.8
.25-	4.6	0.89 5-	234.	11.7	7.8	.8
.30	3.8	3.23 5-	161.5-	8.2	5.4	.8
.45-	4.0	4.85-	259.	13.0	8.7	27.1
8.00	2.4	6.02 8.61	139.	7.0	4.6	.6
.15-	3.0	2.50 3.89	396.	19.8	13.2	.8
.30		4.02 7.98	214.	10.7	7.2	.8
		0.12				



* E 2 point - S 32 point - to a circumference.

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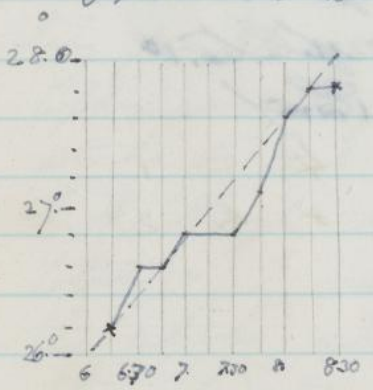
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Correction to Mr. Wilson's watch

Watch	8	52	30
Chron	12	55	13
G M T	0	55	39

Add 4h 2m 43s to Mr. Wilson's times

Thermometer Curve



××× Sun flashing through clouds at 6.55.4. Again disappearing behind clouds. Wind shifting at 5m to 7. Clearing in S E at 7.02. Still heavy in front of Sun which clears out at 7.03 with clouds to left of Sun & clear to E. Light grey clouds in S.E. just before totality - clouds creeping up but the Sun visible at totality & heavy clouds around and below, but clear above & moving from right over Sun & cover at ~~19 past~~ 7.19. Cloudy to north east of Sun & very cloudy below over hills at 7.23. W (west?) bright light & clouds moving towards Sun & must darken it. Sun under clouds at 7.26, but bright through clouds (light visible through clouds). Shining clear at 7.26.30 & surrounded by clouds. ×××

Time of Clouds according to Mr. Wilson.

23	05	43	Sun		23	28	43	Clouds but sun visible
	17	22	Totality	Independant observations				
	20	22	Clouds					
	21	08	End		23	29	13	Clear
	21	43	Clouds					
	25	43	Clear					

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Plates taken & developed immediately after the Eclipse.

Sept. 9. By mistake developed one of the Dagmeir plates. The developer was old (iron). It developed about right.

Sept. 13, At last the full moon was clear & I got two Dagmeir plates.

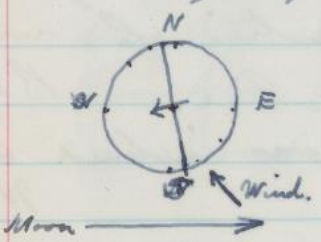
No	Exp				Exp			
	3	2	1	1	7	4	2	1
	7	4	2	2	15	8	4	2

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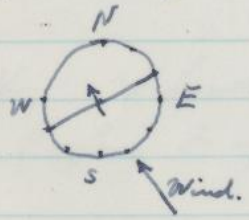
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Shadow band observations.

Sept 5, 86. Two large pieces of sail cloth were laid down, the whitest one in the yard of the fort & a darker one on the parapet near the flag pole. The observers were provided with 2 4ft. sticks at each canvas, one stick being painted at intervals of 6 inches. At the upper canvas J. N. Evanson held the two unpainted sticks & laid them down under the direction of G. A. Krogh who held the painted one. After totality I visited the spot & sighted along the sticks sketching the hills towards which they pointed. A few days later I took the bearings of the hills with the theodolite.



Before totality bands lay N 12° W + S 12° E
Travelled west.



After totality bands lay N 60° E + S 60° W
Travelled north.

Bands were 5" in. wide and 8 in. apart, & moved very rapidly perhaps 30 to 40 miles an hour, — with speed of express train. — Krogh.

Ran after them but could not keep up with them — They went much faster Wm. J. A. A. Lewis.

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Note. Moon's shadow travelled nearly due east.
Meteorological observations E 4. S = S 45° E
E 5. S = S 34° E
E 6. S = S 22° E

At 7.10 i.e. 23h 12m 43s Wind was E 4.6 S = S 39° E Vel. 7.4 miles
" Beginning 17 22 " E 5.1 S = S 33° E " 26 "
" ~~7.29~~ 22 43 " E 5.7 S = S 34° E " 7.5 "
" 7 25 43 (clear)
" 7 25 ~~43~~ 27 43 " E 4.6 S = S 39° E " 7.8 "

Clouds during eclipse were drifting over sun from south to north, probably S.E. to N.W. probably at distance 4-6.5 miles judging (since probably over high hills) & would be at heights of 1 to 1½ miles.

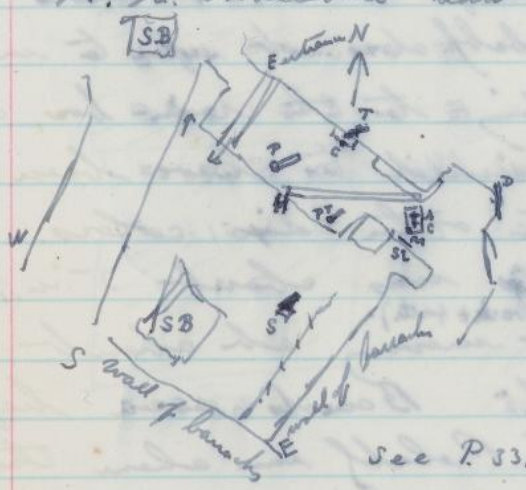
After totality - direction of motion of bands nearly coincided with direction of wind but lay slightly nearer south to north line. Before totality - direction of motion was inclined 69° to wind

W.W.P.

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K. H. Massiah saw the bands before totality on S wall of barracks. Bands were 5 or 6 inches wide + 7 in. apart. Moved 6 or 7 miles an hour at least. Bands horizontal & moved up the wall ∴ they moved towards the south-west, & not thought that moving as fast as man could run.



See P 33.

Direction S. wall. N 114° E & S 114° W

Some of bands were 6 ft long & some longer, – length unknown. They appeared spotted & sparkling.

A. A. Lewis. Bands before totality moved north ∴ after ∴ ∴ west

Breadth bands 4 to 5 in. Dist. bet. 5–6 in. Rainbow colored. Saw second set after sun came out of clouds.

Mr. Sheek at Rectory, St. Croix saw bands before & after & said they travelled west.

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J. N. Evanson. Direction of fast bands from south-east. Of second bands from south-west. (Probably does not refer to motion)

Color - Corresponding to the rain-bow, only the violet rays seemed to have been more perceptable than the other six colors.

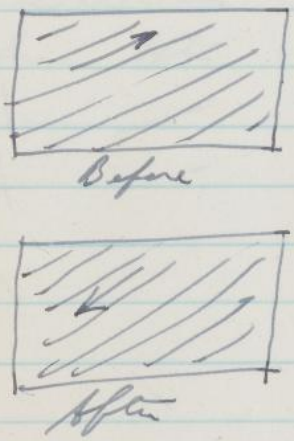
Breadth of bands was about 3" in. - their motion undulatory (i.e. back + forth). + waving ^ about the velocity of a "gale". Bands seen before sun came out. [Probably seen above through clouds].

P. A. Dalzell. Shadows was seen off the wall after totality - travelling very speedily. Direction of bands left to right (i.e. horizontal), direction of motion left to right (i.e. longitudinal). Shadows appeared to be rainbow colored. Shadows seen before sun came out of cloud. Spoke of it at the time. Did not see shadows before totality. Bands 8 in. apart + 3" in. wide. Bands compared fine lines 3/8 inch apart.

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J. A. Critchelow. Saw no bands on canvas. It was covered with triangular sparkles like black jet beads in ladies' dresses about 6 inches long. Saw bands on barrack wall. Bands came few secs. after sparkles. After totality sparkles came after bands. Sun was not hidden by clouds at the time. Bands + sparkles like rainbow. Motion of bands longitudinal as indicated. Breadth bands 6 in. Dist bet. 12 in.



Drawing would give direction bands nearly east & west, with motion before west & afterwards east. He may have confused the motion of the bands before, with the direction after totality.

Explanation of Diagram on Page 31.

S B, S B Canvas for drawing shadow bands. Near the one on the parapet is the flag-staff which was used as a station for the meteorological instruments.

S	Prismatic Camera	P.T.	Photo-telescope.
P	Photometer	A.C.	Astronomical Cameras.
T	Telescope	M	Metronome
C	Chronometer	S1	Slide for Prismatic Camera. (not used)
H	Mirror end of Photoheliograph		
D	Support for disc for Astronomical Camera.		

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Summary of Shadow band Notes.

Direction		Motion		Size		Colored bands	Observers, Etc
Before	After	Before	After	Breadth	Dist.		
|	/	←	↑	5-	8		Krogh } a
|	/	←	↑	5-		Colored	Evanson } a
		↑	←	4-5-	5-6	Colored	Lewis a
\		↙		5-6	7	(1st Spotted & sparkly)	Massiah b
		←	←				Skeek
	\		↖	5-	8	colored	Dalzell b
—	=	→	←	6	12		Critchelow b
		←	←			colored	McDowell b

Lewis was likely got the motion before & after confused, which would make observations more accordant. Should put the most confidence in the observations of Krogh & Massiah, and consider Krogh's observations substantially correct, with the addition that the bands were colored.

Note June 23, '87. The bands appeared after Totality although Sun was obscured by clouds at the last contact.

Feb. 13, '88. See "Nature" Vol 37 p. 224.

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Appendix.

Exposures I had intended to make with Photoheliographs.

No	Aper	Exp
1	.5 in	inst Before totality to obtain spec.
2	1	2
3	full (4¼)	1
4	"	4
5	"	16
6	"	40
7	"	100
8	.5	inst After totality to obtain spec.

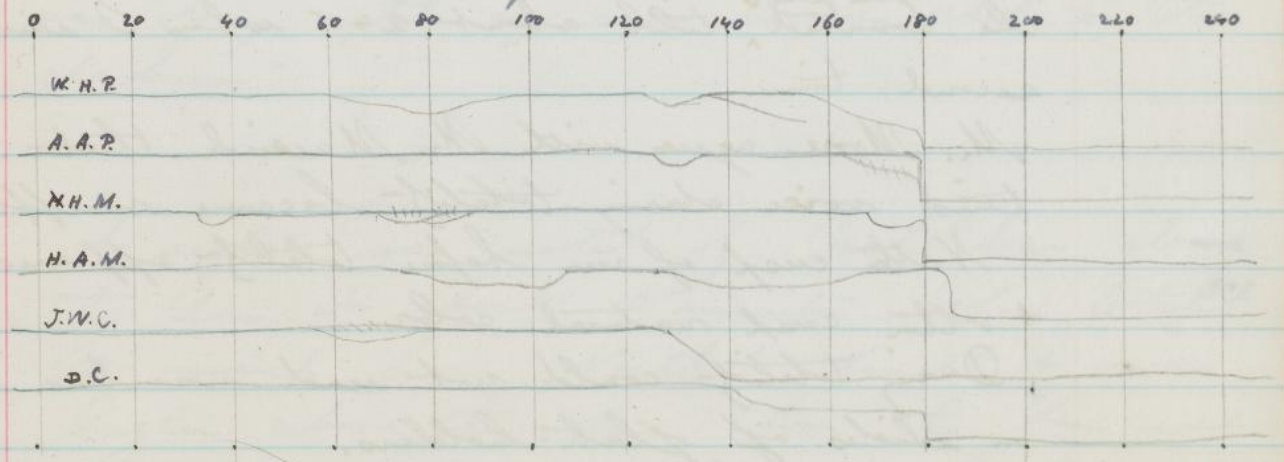
Bishop's Ring was not visible on days previous to the eclipse & so was not looked for.

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Miscellaneous Notes.

Times of Clouds



Mr. Massiah noted that just before totality the Sun was surrounded by a ring first red & then violet. This was also observed by Mrs. P.

He noted that as darkness came on the grass looked bluish. Sunlight just before totality was yellowish.

Mr. Martin, independantly noticed that the moon appeared covered with small spots, but not so markedly as it ~~appeared~~ was drawn by Mr. Massiah. Mrs. Massiah I am told noticed the same thing independantly. Also a Miss Killykelly.

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Mr. Martin began counting at the word "Two" from Mrs. P. She counted to 14 when I said "Six" + he counted again from 0 till about 245 when I said "Six" a second time.

Mr. Moore agrees with Mr. Messiah that Mr. Martins voice during totality became muffled.

North cusp of sun before totality appeared greenish + other cusp natural color.

During totality could not read numbers painted on slides of plate-holders.

Mr Gleam writes:— "at the same time the darkness became intense, and the chronometer could just barely be read."

Sir David Chalmers says:- "After the commencement of totality the Sun was clear of cloud for about 140 seconds, after which a portion of cloud passed over it, but for 40 seconds more the cloud was so light that the phenomena were still observed, after which a denser portion of cloud came over and obscured it till after the totality had terminated." x x x

"During the time of greatest obscuration I could not distinguish the place of the hands on my watch. I could see the places of the figures (which are very conspicuous ones)."

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Mr. Sloan writes:— "my vision was so affected that I could not for a little see what I was doing, until my eyes became used to the darkness."

A meteor was noted by Critchelow above the Sun at about 10 minutes before totality. It moved from North to South & was higher above the Sun than the Sun was above the horizon. It was about as bright as Mercury was during totality.

P. A. Dalgell writes:— "just before totality a star appeared in the east & it was travelling rapidly through the atmosphere to the south"

It was suggested by two persons that this was the planet Venus which the motion of the clouds would cause to appear to move in that direction. W. H. P.

Dalgell writes again:— "The star that was in the south disappeared at about 7.40" (Canopus, Sirius)? "A short time after the other" (Venus Mercury)? "disappeared also.

"When the Sun & Moon were in contact a black ring appeared to be around both."

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Mr. Massiah writes:- "Baily's beads distinctly visible immediately before totality." [Viewed with naked eye]

"The shadows of men and things seemed to get gradually thinner and more indistinct, and finally at totality disappeared."

"Voice of man counting to metronome seemed to grow dull and muffled soon after totality began, as if the surrounding atmosphere had undergone a change and become less elastic."

"The air did not grow perceptibly colder, but seemed suddenly to become humid as if from accumulated vapor."

"The darkness was very sudden, and the walls etc, became a sickly yellowish blue, and looked larger and much further away. Men's faces became suddenly jaundiced."

"Simultaneously with totality I saw innumerous shadows of a dull red, tinted with brown and grey - 7 inches wide and 6 inches apart, flowing rapidly like the ripples on the sea, from east to west over the wall of the Police Barracks. The bands were parallel and about equal in breadth, but not of the same length. They flowed rapidly enough to render counting them impossible."

"At totality the cocks crew distinctly - crickets and other insects chirped, a dog near

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by howled, and the birds in the neighboring trees began to twitter as at early morning."

"The Corona appeared at the top of the disc at least 7 seconds before totality began. Its color was pale yellow, very brilliant. The maximum length of its rays was about a diameter of the disc, the minimum one half a radius. The Corona seemed to be most brilliant and its rays longest at the left of the upper half of the disc, and seemed to grow more brilliant towards the lower segment of the disc as totality advanced, and then again to fade below and grow bright above as at first."

"A cloud passed over the disc at about 175 seconds after totality began."

"The appearance of the Moon most attracted my attention, it appeared at totality of an ashen grey, covered very thickly with dark spots, as if an irregular spatter-work pattern. The colors gradually changed to black, but the spots were still visible though not as distinctly as at first. I called the attention of some people to the fact at the time, and some have since corroborated my opinion." [No haze at the time].

"The light on the hills was of a yellowish blue and the effect was like that of moonlight in a picture, and seemed to throw objects back into the distance."

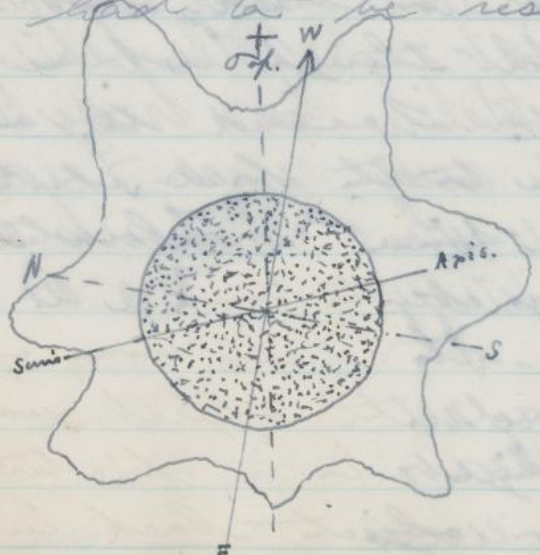
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"The sky to the west was purple, getting dark blue towards north and south, and changing into violet as it approached the Corona. I also noticed at the end of totality [in the air] a stream of light from the western horizon of a saffron color, whose boundaries seemed to contract as it approached me. Might not this be due to reflection of the returning rays by some bank of clouds to the west?

He says he saw a pink streamer before totality projecting from the lower left hand side.

W. H. S. ~~It is~~ Cabs crowded during totality. It is said that a boy at the Front had a fit, and that a dog tried to throw himself over the parapet & had to be restrained.



Sketch of Corona as drawn by Mr. Massiah just after Eclipse, showing spotted appearance of Moon. Position angles worked out by myself.

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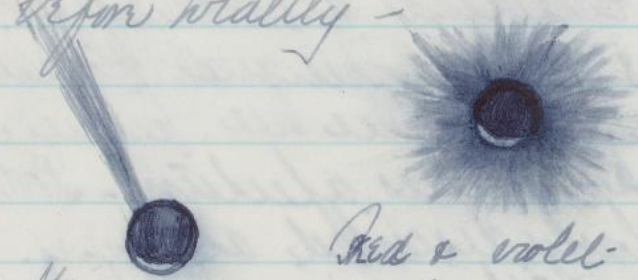
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My apparatus consisted of two Cameras. no. 1 a large one, 28 inches focus and 4½ inches aperture. no 2. a smaller one. nine inches focus and 2½ inches aperture. Both have been particularly described above.
The exposures with no. 1 were to be 2 seconds 8 seconds, 40 seconds & one second with the smallest stop. With No 2. the exposures were to be 40 and 100 seconds.
At totality ~~advanced~~ the shadows became hard and distinct as in the case of eclipses known by the electric light and the grass tips and profile appeared yellowish in color like stars with very brilliant. Venus & Mercury particularly.
A little before totality there was a break in the clouds which for my purposes had almost continuously covered the eastern sky and at this epoch left portions of the moon between 300 & 330 degrees reckoning around by the right ascension a slightly diverging radial rose colored stream was seen extending nearly three moon's diameters from the limb. A little later perhaps 15 seconds before totality there being a slight haze over the sun and moon I noticed a similar colored light which I think crossed the moon and extended about a diameter from the limb. This vanished into violet which in its turn melted into white near the limb and then the corona appeared distinctly unlike every ~~one~~ picture or like record

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before totality -



Red & violet halo

Streamers - white colored -

At tick 27 of the metronome a thin haze spread over the surface of the moon, but had passed at 174. it was then clear until tick 177; at that time a second thin haze over the outskirts of a cumulous cloud covered the disc from E to 180 degrees.

I wished to make my last exposure & waited a second or two expecting the moon to clear after the haze but by tick 180 it was covered by the cloud and we saw no more until two or three minutes after totality.

A short time before my totality I endeavored to bring the dark slide into the camera so I could have a second image from my smaller camera into place. but I was unable to see it on the ground glass against the glare of the sky. I made a number of efforts & the time should probably have exceeded when my assistant broke the string - so I was obliged to give up opening it. A white cloth placed behind the disc and before the sun would remedy the glare on the ground glass.

At the first second of totality I exposed plate #7 which belonged to the smaller

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cameras and the others according to the following list - Encapping at the word "Hour" and capping at "Lip".

Plate.	Hour.	Lip.	Exposure.	Exposed
Large Camera.				
1.	15.	17.	2 Sec.	2. Sec.
2.	52.	60.	8. "	8. "
3.	—	—	1 "	—
4.	90	130	40 Sec.	40 Sec.
Small Camera.				
7.	1.	100.	100.	100.
8	134.	174.	40	40

On plate Nine I should have obtained the image with the slot, but was prevented by the cloud as I stated above.
I heard the owls cry and the crickets chirp.

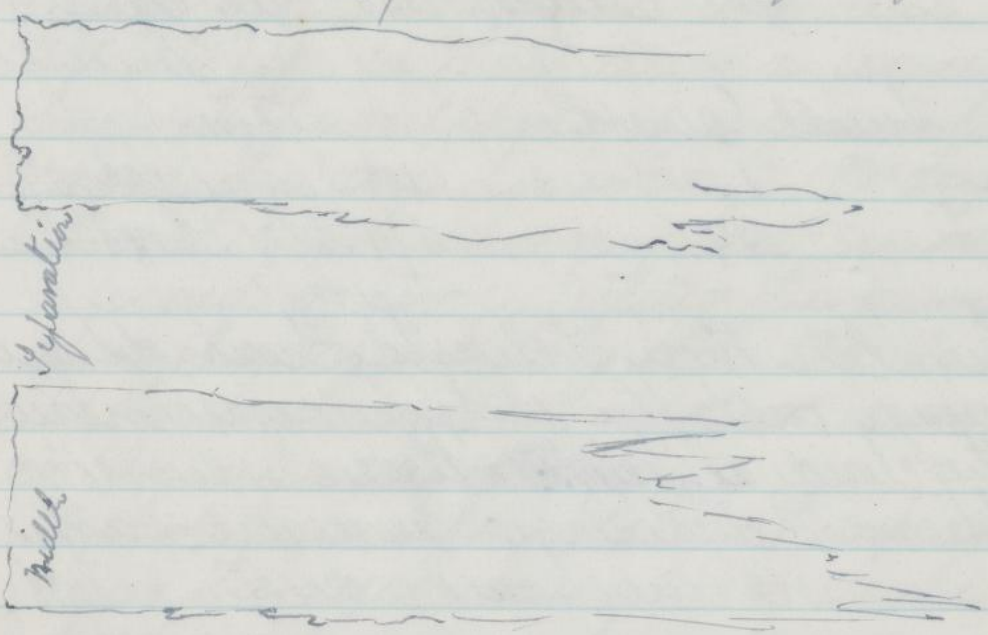
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Mr. Krug's account.

Before totality saw the evil horizon was seen a long red streamer - measuring apparently 30 feet of the parts wall. Mr. Krug was standing about feet from the wall. Totality lasted apparently 2.'40".

The shadow bands appeared like lightning. He endeavored to count them & counted four. Five but they passed so rapidly.



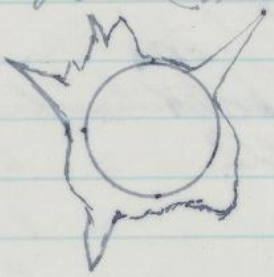
They were four to five and a half feet long and were longer than others. Before totality their direction was from and after totality from

Just before totality a long streamer was seen coming from the sun they a cliff in the clouds and a little later the streamer was no longer visible but the moon was surrounded with a red colored halo

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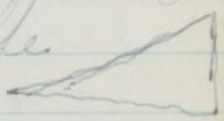
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The Corona appeared like the drawing



J. A. Catchiloo says: Saw a rose colored halo around the moon, which changed in manner. Then at the edge of the moon was an orange colored band which trembled when totality approached. The little sparkles preferred to show more of this shape.





He says he can yield upon protuberances with the naked eye.

Prof. Dowell says: That the shadow bands travelled due East and were irregular. They were much more distinct before totality than after.

Mr. J. C. Griffith noticed the color around the moon before totality and said that it changed color but owing to color blindness was unable to tell the color.

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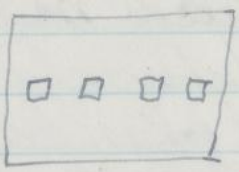
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Numbering of Photographic Plates.

Dagmeter

Holder	Plate
	P 101
	P 102
	P 103
	P 104

Exposed four central holes.



Photoheliograph

Holder	Plate
1	P 105
2	P 106
3	P 107
4	P 108

Numbered on protected side of plate



Spectroscope

Holder	Plate
1	P 109
2½	P 110
6	P 111
16	P 112
40a	P 113
40b (y. glass)	P 114

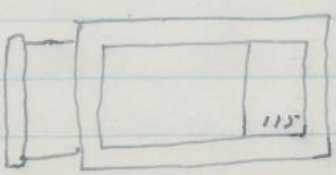


Protected at both ends.

Astronomical Cameras.

Holder	Plate
1	P 115
2	P 116
4	P 117
Smaller camera	
7	P 118
8	P 119

Seen on drawing slide



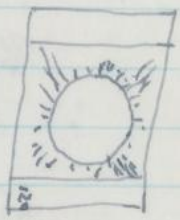
Protected at both ends.

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Photoheliographs.

Herolder	Plate	
1	P 120	
2	P 121	4
3	P 122 (probably not exposed)	
4	P 123	20
5	P 124	32
6	P 125	Top and bottom protected.
8	P 126 (After totality, without clock)	



Daymeter on Moon (Full 13d 6h 50m A.M.)

Date	Hour	No	Diff exp				Exp			
Feb. 12	11.30 p.m.	P 127	3	2	1	1	7	4	2	1
" "	"	P 128	7	4	2	2	15	8	4	2
" 14	"	P 129	4	2	1	1	8	4	2	1
" "	"	P 130	8	4	2	2	16	8	4	2

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Suggestions for Observing future Eclipses.
Sept. 8, 1886.

Do not observe beginning of Totality myself through telescope as one loses too much to make it pay, and also loses time at the start.

Let two observers working together note times, of Shadow of Moon, Shadow bands, Baileys beads, Totality, & Times of clouds & Miscellaneous features, at beginning & end of Totality.

Have pasteboards instead of paper to record on & have all the same size.

Otherwise do the same as at this eclipse.

Tell some observers to look at Corona with view of drawing it immediately after Totality.

Have two observers try & count the shadow bands that pass them in 3 secs or 5 secs if possible. Also have some one run after them as this time.

Look out for colored rays before & after Totality like that seen by Mr. Pickering.

Note how long the Corona is visible before & after Totality with telescope & without. See Ramyard 1.88.0

Use plate holders containing several plates like Sockyers.

Center image in Photoheliograph ½ hour before Totality. Just before, insert plate holder, & give 1 sec. exposure as soon as corona becomes visible. This will probably show Baileys beads

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at the cusps also. Do not use diaphragm till all the full aperture pictures are taken.

Photograph spectrum of reversing layer showing heights of lines (perhaps) by their thickness. See Rayard p. 480.9.

With Photoheliograph get direction solar motion ½ hour previous & ½ hour after Totality.

Oct 15, '86 Erect a tent or box over the mirror of the photoheliograph, the top of which can be removed, so that the mirror can be adjusted on the morning of Totality — & need not be moved later in case of showers.

Oct. 18, '86. One should measure photometrically the brightness of the corona as well as the general brightness of the corona & sky.

May 5 '87. Provide all with shade glass so that they shall not dazzle their eyes just before totality. Also caution them.

Dec. 12, '87. Take phot. short exp. at the first instant of totality & another similar just before totality is over so as to study corona at limb of sun. Also take phot just after totality to study brightness corona & of sky.

Jan. 12, '88. Make exposures in multiples of five and ten seconds, in order to simplify calculations during totality.

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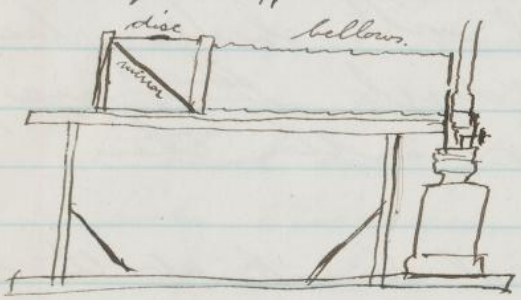
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Apr. 5, '88. Have a camera loaded with a sheet of blue paper as a Sunshine Recorder during the ~~[illegible]~~ ten minutes containing the total phase. As the Sun will be a narrow crescent it will record accurately.

Apr. 5, '88 Note angular velocity of clouds about Sun. Note direction of motion of bands & see if it is at right angles to bands themselves or if bands are parallel to limb of Sun. Observe velocity of motion of bands on surface at right angles to direction of Sun, ~~Count the bands that~~ estimate velocity of motion.

Apr. 23, '88. Look for lunar detail with telescope.

Apr 29, '88 A photometer for measuring the general brightness of the sky.



Do not at top of this page use a plate instead of blue paper with a lens & record only during totality & the second before & after giving Baileys beads at each end.

May 20, '88. Keep before eclipse to Mem. Nat. Acad. Vol 2 1884 Eclipse 1883 p. 134. Prismatic telescope.

May 21, '88 Think one of the pictures accurately by a wire attached to the plate holder.

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May 23, '88 Notice color corona. Determine proportion radiant to reflected light. See Mem. Nat. Acad. p. 115.

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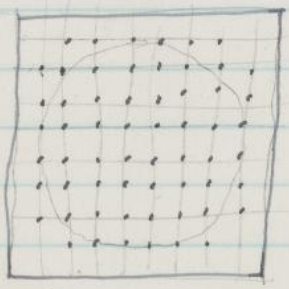
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Device for aiding in making Photometric measurements of the Sun. Sept. 9, 1886.

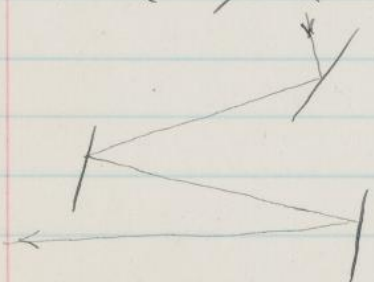


A sheet of thin brass 5 inches square pierced with 100-200 minute holes made as small as possible ($\frac{1}{200}$ in. sq), at regular distances, so as to insure equal distribution. Look at sun shine through this which is placed at 3½ ft. distance from photometer disc. Area of brass covered by sun 10 cms in diam. Diam of holes $\frac{1}{80}$ cm = $\frac{1}{200}$ total. = $\frac{1}{64\,000}$th area. Area of 100 holes : area brass = 1 : 6400. Hence light would be reduced in this proportion & Sun would equal about 10 candles at 1 meter.

To make the holes insert fine needle in small brass tube & solder it at the head leaving only $\frac{1}{32}$ inch projecting. Plug lower end with wooden wedge. This will make all holes circular & of the same size.

May 3, '88.

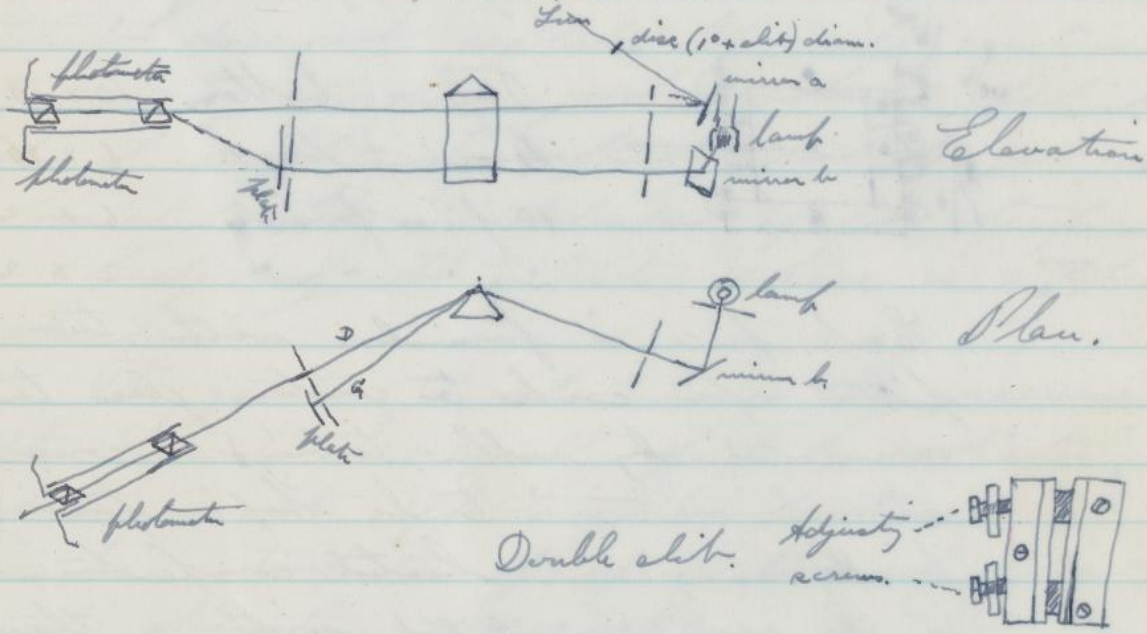
Try reducing brightness by reflecting sun from several pieces of plate glass.



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Apparatus for measuring brightness of Sky near Sun.
Sept. 8, 1886.



"Mirror a" can be turned so as to measure sky 1°, 3°, 10°, + 30° from Sun. Disc is independent. slits are 1 cm high & 2 cms apart. Arrangement might be made so that holes could be substituted for slits & prisms reversed to compare light directly. D regions, compared by photometer. (Probably wgs. through yellow glass would be too absorb). G + perhaps E compared by plate. Plate slide up & down into four positions for sky & four for lamp.

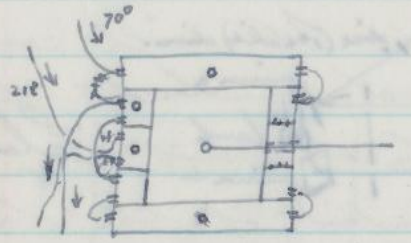
Apparatus is to be used different days throughout the year, at different hours, places & altitudes. To be used photographically also for Moon.

What is of especial interest however is to find under what conditions the light around the Sun is the minimum.

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Apparatus for studying Laws of Radiation.
Sept. 9, 1886.



Top + bottom	10 × 10	× 2
Front + back	6 × 6	× 2
10 pieces for sides	6 × 2	× 2 (one perforated)
3 " " "	2 × 2	× 2

Each piece is furnished with two apertures fitted for corks to contain glass tubes to be connected by rubber tubing & a constant current of water is to be kept passing. One front, back, and heated compartment are to be each furnished with a thermometer. All will have the inner walls blackened & the outer walls bright. The heated compartment will be surrounded with flannel & made a trifle smaller. One of the ten pieces will be perforated to permit the insertion of a blackened bulb thermometer. Total inside area 216 sq. inches. Area of inscribed sphere $= 4 \times \frac{22}{7} \times 9 = \frac{396}{7} = \frac{792}{7} = 113$ sq. in.

Example

Temp heated compartment = 80° Area = 40 sq. in.
" other " = 20° " = 113 " (again)
Areas 1 : 2.8 Diff. temp. 60°
Temp. of bulb. $= 20° + \frac{60}{2.8} = 22°$

Try removing heating compartment & let sun shine on bulb.
Try effect of layer heating compartment.
Try effect of moving bulb nearer to, & finally touching heating compartment.
Try effect of coating half of bulb with plaster of paris.

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Case of the Sun.

A good radiator or absorbant is a body that does not reflect. It will continue to act if it has a good conductor behind it of sufficient capacity not to get exhausted. It is independant of the temperature.

Judged by these tests space is a very perfect absorbant.

The question to determine is then, assuming the Sun to be an equally perfect radiator, to determine its effective temperature.

Assume temperature of space that of lowest arctic observation $-70° F = -60° C$.

$$\frac{\text{Angular area of heavens}}{\text{Angular area of Sun}} = \frac{4 \times \frac{22}{7} \times 57^2}{\frac{22}{7} \times \frac{1}{4}^2} = 4 \times 16 \times 57^2 =$$

$$208000$$

$$57 \times 57 = 3249 \qquad 285 \times 4 = 1140$$

$$3249 \times 64 = 208000$$

Moon radiates as well as it absorbs, but the center of its disc radiates only to half the sphere, or to 100 000 times the area of the Sun.

Its temperature at full moon is $70° F$ (roughly) or $140° F.$ at least above what it would be without the Sun. $\frac{140° F \times 5}{9} = \frac{700}{9} = 80° C$

Temp of Moon $= 20° C = -60° + \frac{x}{100000}$ $\quad x =$ Temp. of Sun $-$ (Temp. of Space i.e. $-60°$)

$x = (20 + 60)\,100000 = 8000000\,°C$ Temp. of Sun. (at least).

Now assume Temp. of Sun $20000°$. To determine Temp. of full moon. $y = -60° + \frac{20000}{100000} = -59.8° C$ (at most).

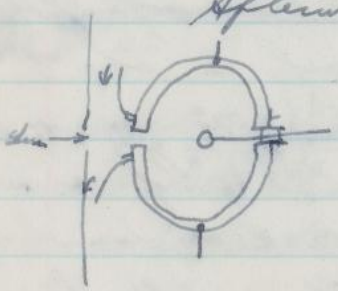
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If the Sun is not a perfect radiator its real temperature must be much higher.

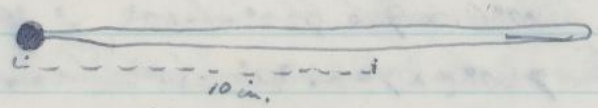
By trying the foregoing apparatus we can make a determination of the temperature of the Sun, & secondarily of the Moon, independently of Langley's.

One should try also an uncovered bulb since that does not rise as high in the Sun as a blackened one. A polished one should heat up as much, but should take longer to do it.



Afterwards one might make a large bulb-blow sphere filled with water, & let Sun shine on blackened bulb & the amount that the bulb rose above the temperature of the water would indicate the Sun's temperature. Other sources should also be tried — red hot coal, gas lime, electric, melted lead, (also Sunrise Sunset with & without ☁)

A small sphere should also be tried, and also another sized bulb.



The thermometer should be 16½ inches long. 10 inches from the bulb should be marked 15°C, & 6 inches further 40°C. The bulb should measure 3/4 inch in diam. and the stem should be very small where it joins. Mercury filled.

See Young "Sun" pp. 260.00 266.5

By substituting thermo-pile for thermometer using an area of Leslie cube as a background & repeat- results with different areas & distances when the deflection is equal to unity

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Theory of Constitution of Sun.

Sept. 7, 1886.

Lowest temp. observed by arctic explorers $-70°$ F. This cannot be colder than interplanetary space, & since it is not constant, must be warmer, owing to air & water currents from warmer regions. Temperature of surface full moon $+70°$ F (Langley). Since this rapidly cools when moon is eclipsed it must rapidly heat up and hence conduction is of comparatively small consequence as compared to radiation, for the heat can have travelled only a short distance beneath the surface, as we know it travels slowly through stone. If a minute body were traversing space at a distance of 90 000 000 miles from the Sun it would be heated up 70° F (since it would radiate in all directions) = 40° C. At 60 000000 mils a large body like Venus would be heated up 80° C × 2 = 160° + (−60° C) = 100° C = boiling water at 15 lbs pressure.

At 30 000 000	80° C × 9 = 720° + (−60° C.)	= 660° C	Mercury.
" 10 000 000	720° C × 9 = 6480° − 60° C	= 6400° C	(large body).
" "	360° C × 9 = 3240° − 60°	= 3200° C	(small body).
" 5 000 000	3200° C × 4 = 12 000° (without)	= 12 000° C	" "



If a blackened hemisphere were placed near the Sun & a nonconductor were placed behind it, the hemisphere would assume the temperature of the Sun. If instead a blackened sphere were placed near the Sun, it could radiate into outer space, & its temperature should be half

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way between that of the Sun & outer space. If the Sun had no atmosphere, such would probably be the case. If it was then brought in contact, it temperature would suddenly rise to that of the Sun. On this theory as we have seen the temperature of the Sun is about 8 000 000° C. At 5 000 000 miles from the Sun the temperature is about 12 000° C and as from there down to the reversing layer the pressure can nowhere be above 15 lbs to the inch or there about, it is evident that no matter can exist in a solid or liquid condition. See Young "Sun" p 268.0

The prominences have been seen to form and grow when completely detached from the Sun, hence it is evident that hydrogen & the calcium element (H line stuff) may exist there in either a visible or invisible condition. The boundary line between the two states is very sharp, indicating a difference of condition & not merely a difference of temperature; as if matter might exist there in a fourth state.

In the same way it seems as if the photosphere might be the visible & the reversing layer the invisible condition of the heavier metallic gases. See Young "Sun" p 275.0

On the earth the pressure of the atmosphere doubles for every descent of 3.5 miles. If the mean molecular path were 100 times

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~~300~~ 18000 ~~0~~
27000
3.5
135000
81
9450000

as low, ~~the pressure~~ owing to the absolute temperature being 100 times as great, it would be necessary to descend 350 miles (I think) - the temperature remaining constant. On this supposition on the Sun one would have to descend 100 000 miles to double the pressure. This would be diminished, as near the outer portions of the atmosphere the temperature would fall rapidly. As indicated in the figure the spectrum lines would broaden as one approached the photosphere & being considerably colder near the top of the reversing layer would reverse them easily, - the reversing portion being perhaps only a few miles thick, & for this reason would not give denser lines near the limb of the Sun.

The gases would not uniformly diffuse on the Sun as here, because if each existed on the Sun alone, it would on account of its quantity & weight only diffuse to a certain height, & each gas would act as if independant.

The general absorption at the limb is due to the coronal gases.

If beyond a certain distance the attraction between hot bodies changes to a repulsion the

[2 pages omitted]

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Experiments on Shadow bands.

Sept. 15, 1886.

Try experiment on twinkling of stars. 7th mag. stars at equator will leave trail. These are 8½ mags. fainter than Sirius or 2500 times. They move 30′ in 2 min or 1′ in 4 secs. Hence if Sirius were made to move 1000′ in 4 secs or 250′ in 1 sec or 4° per sec. it would leave a trail as bright as a 6 mag. star. With a lens of 23 inches focus 4° equals about 4 cms. ∴ any variations in light occuring as often as 100 times per sec. ought to be distinctly visible. Study the scintilation of Sirius in this way, placing the camera on a divided circle & moving it by hand. Observe if there are any periodic variations corresponding to shadow bands.

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Photographing the Moon.

Sept. 16, 1886.

Photograph the Moon with an eyepiece & the Draper telescope & thus obtain better definition.

Determination of Solar Parallax & Mercury.

Sept. 23, '86.

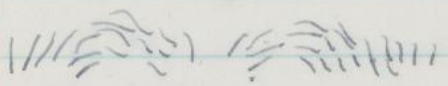
Take series of photos of transit with eyepiece similar to Janssen's sun spot pictures. His pictures show probably details of spot of at ~~least~~ most half the size that would be obtained with a photoheliograph, hence results should be obtained which would compare favorably with transit of Venus work hitherto.

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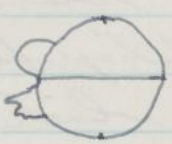
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Sun may be merely a hollow sphere, which would account for its low specific gravity.

Photosphere is cooler in the outside layers slightly, and there are therefore formed ascending and descending currents, drawing out viscous gaseous matter into filaments. When these are drawn over & descend we have sun spots.



As in the case of storms in the earth's atmosphere these currents are not continuous, but after a considerable thickness of the outer layers get colder & heavier, the state of unstable equilibrium is overbalanced & descending & ascending currents are formed which right matters, and then the comparatively quiescent state is resumed for a time. This explains the 11 year period. The faculae are due to the upruding currents.



If the spots are caused by a downrush, the upflow from the heated interior must be on the whole chiefly at the poles, and therefore the velocity in northern & southern latitudes would be less than in the middle latitudes.

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Observations on the Grenada Libry.
Oct. 5, 1886.

Sept. 30, While sailing along the coast of Grenada at about 7 p.m. noted the appearance of the Moon (New 27d 5h 6m local time). It was slightly hazy around the Moon but I could clearly distinguish the markings upon the "old moon" particularly the left hand eye of the face. I could glimpse the other eye. Noticed the same thing at the previous new moon.



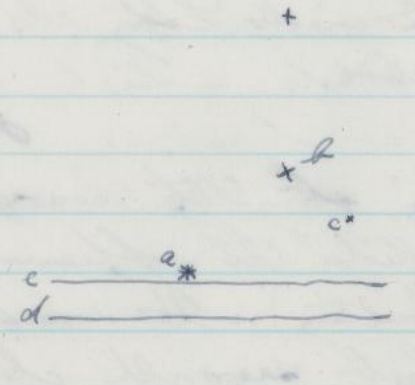
Was waked in the morning early after the Moon had set, and got up & read my watch by starlight. It was 12.40. Not more than one quarter of the sky shone on the watch but I read it with certainty. The sky at night seems blue & brighter than ours.

Oct. 1, Distinguished markings on Moon, but not as readily as yesterday, though the sky was entirely clear. Markings came out much more clearly when the crescent was hidden by a house. Field glass brought them out finely. Time 7 p.m. After Moon set read watch by starlight at 10.07.

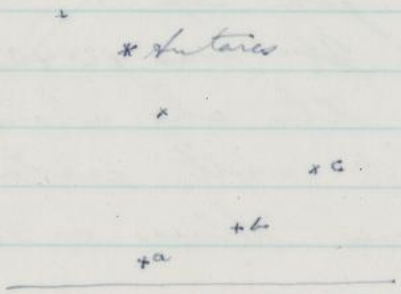
Watch the setting of Arcturus at 7.55 p.m. See Fig. on next page. Sky clear. When horizon was at d so that Arcturus was ½ dist. b.c, it was as bright as b. When its altitude was ½ b.c

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it disappeared & was then about as bright as c. It did not gradually fade away but seemed to suddenly disappear for a second & then reappear. It may have gone behind a cloud, but of this I am not certain. c was fairly bright at the time, & readily seen. bc is about 5° ∴ a disappeared when at an altitude of about 1°.



Later watched the Scorpion setting. When altitude of b was 2/3 bc, b disappeared.

Oct. 4. Near Grande Etang at altitude of 1740 ft noticed that the sky appeared a very dark blue even up to within a degree or so of the Sun, which was hidden behind a dense white cumulus cloud. When Sun came out sky was blue till one was dazzled by the sunlight. Sky was as dark, or darker, close to the Sun as it ever is at home on the clearest days at a distance from it. It seemed about as dark as it did 5 or 10 minutes before Totality on Aug 29th. When the

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It is difficult to judge of the color on account of the clouds which make it appear darker & contrast. The next day noted the sky at St. George. It was not as dark a blue, not darker than with us on a very clear day, & the sky was a yellowish grey near the Sun as with us.

In the afternoon at that altitude at 3.45 saw the Moon just on the quarter, but could not distinguish the old moon. In the evening could clearly make out the old moon without a screen & with one could see a light streak near the limb. It came out well with the glass. (First quarter Oct. 4 d. 6 h. 30 m. P.M. Local time).



Oct. 5. Could ~~glimpse~~ the "old moon" without a screen, & with one that was 40 feet off could see it readily. With glass could see the light streak. With screen at 20 ft distance the diffraction fringe was so bright & wide that it hid the "old moon".

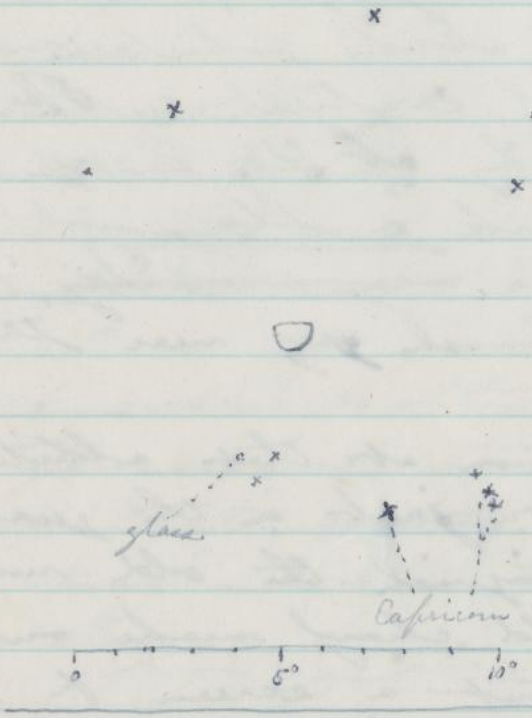


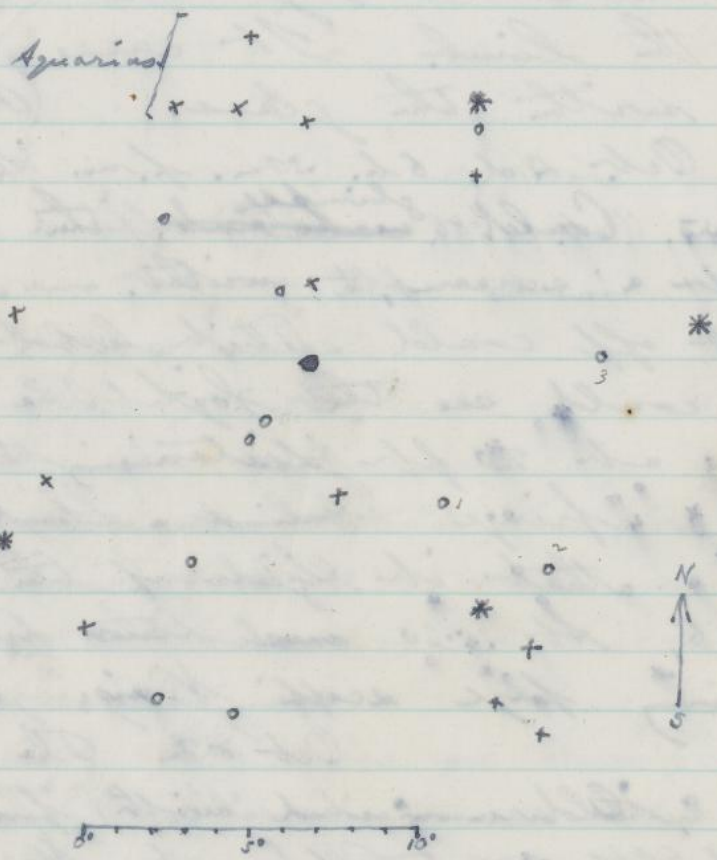
Oct. 6. At 10.30 made the map on the following page screening my eyes from the moon.

Oct. 8. "Old moon" invisible. A fair clear evening. Mapped stars near moon. Grenada. Bright stars seen without screening Moon marked X Venus " " by " " "

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		UA		
✓	1.	130	5.4	Cah
✓	2.	115	6.1	"
✓	3.	81 ~~384~~	5.0 ~~6.4~~	Aq
○	4.	132 UA	6.6	"
○	5.	128 UA	6.4	"
✓	6.	104 UA	5.7	"
○	7.	118 115	6.3 65	"
✓	8.	121	6.7	"
✓	9.	131	6.4	"
○	10.	139	5.8	"
○	11.	160	6.2	"
✓	12.	166	5.2	"
○:	13.	157	6.2	"
○	14.	138	6.2	"
✓	15.	134	5.6	"
✓	16.	129	4.3	"
○:	17.	130	6.4	"

8.20 Fri. Oct. 8, 1886 Local time.

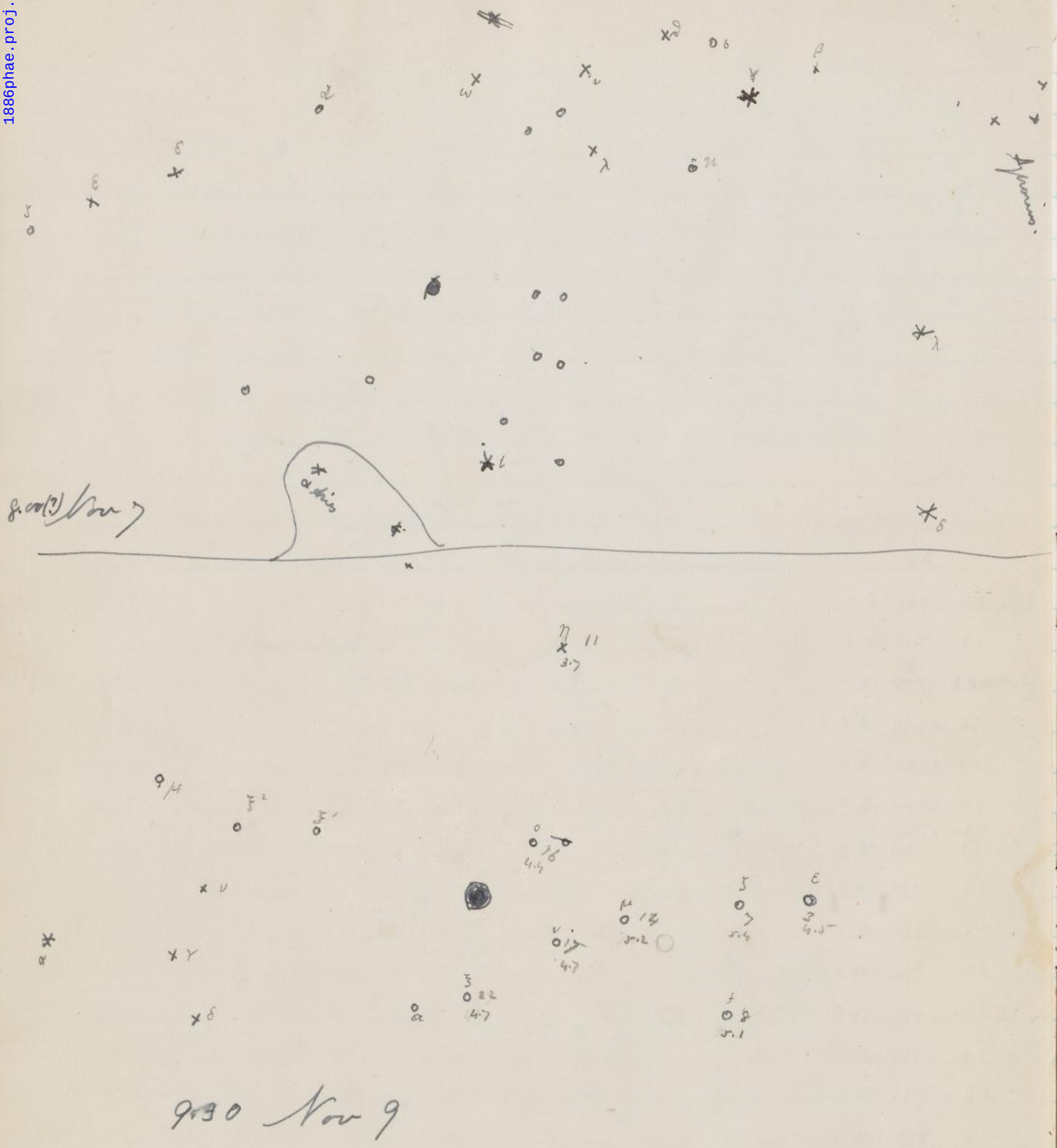
Mags seen 4.3 5.0 5.2 ~~5.4~~ 5.6 5.7 6.1 6.4 ~~6.4~~ ~~6.6~~ 6.7

Mags mean 5.8 6.2 6.2 6.2 6.3 6.4 ~~6.5~~ 6.6

'381 a variable?

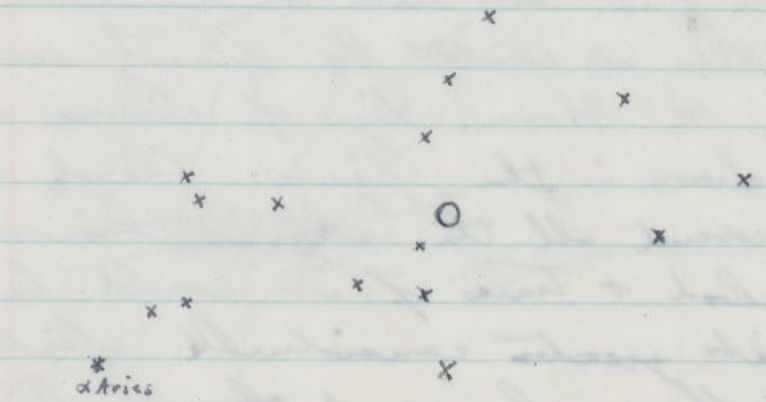
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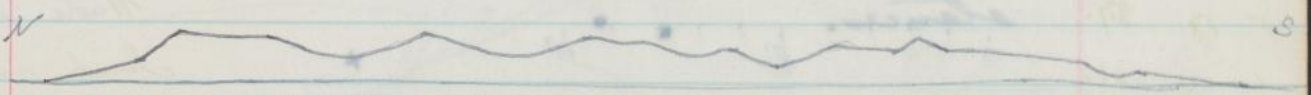


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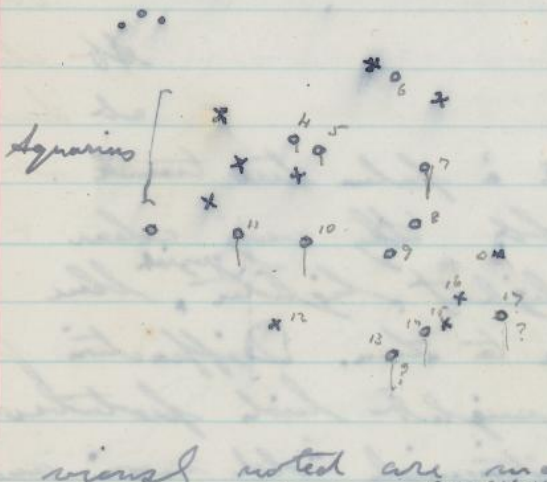


Tues. Oct 12, '86. 10.15 p.m. At sea off the north point of Dominica. Moon in a thin cloud of haze visible only when Moon was hidden behind a fully black. Moon full. abt Oct 12 at 11.24 p.m. local time. All these stars were mapped with the Moon screened.



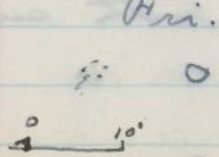
Soufrière of St. Vincent:
A profile drawn when about due west from the north end of the island. The northern peak is the Soufrière. Drawn Oct. 11.

Thurs. Oct. 14. '86. Altair affgrand in the zenith just 10 minutes after sunset.



This sketch was made abt 7.05. The Moon was just rising & was hidden behind a cloud but did not light up the sky. The sketch was drawn from the steamer off Nevis. M. Position of Moon Oct 8th. The stars not previously noted are marked with pencil.

Fri. Oct. 15, '86. When the Moon was situated in about this position with regard to Aldebaran and the Pleiades



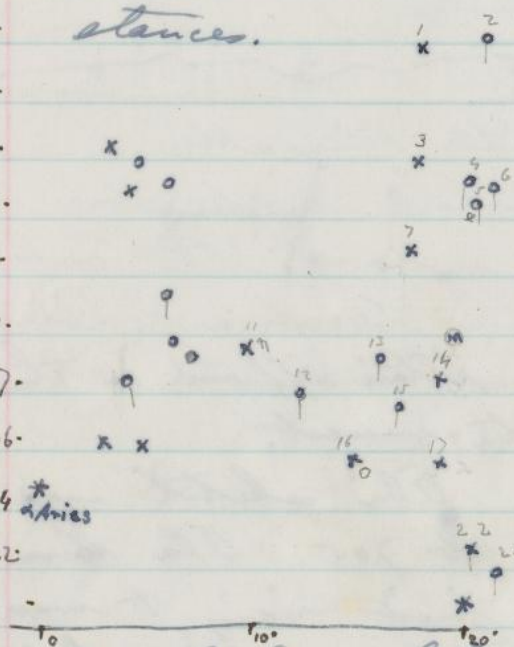
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at about 12 p.m. it had a distinct cirrous cloud around it as could be plainly seen without screening the Moon. Size of cirrus about as drawn in this figure. Cloud evidently covered all the sky in this neighborhood & traces of it could be seen at greater considerable distances from the Moon here and there. Nevertheless all eleven of the Pleiades were about as distinctly visible to me as they are at home under the most favorable circumstances.



	HP	
✓ 1	125	4.6.
○ 2	123	5.7.
✓ 3	162	4.5.
○ 4	167	6.4.
○ 5	181	5.7.
○ 6	171	6.1.
✓ 7	199	5.4.
○ 8	207	5.1.
○ 9	194	6.3.
○ 10	166	6.0.
✓ 11	239	3.7.
○ 12	25-2	5.6.
○ 13	215	7.4 * Aries
✓ 14	237	5.2.
○ 15	....	
✓ 16	272	4.4.
✓ 17	260	4.7.
○ 18	211	6.2.
○ 19	204	6.1.
○ 20	....	
○ 21	206	5.6.
○ 22	294	4.7.
○ 23	—	



Made the annexed map of the stars near Aries. Those marked with pencil were not seen before when full moon was amongst them.

Sat. Oct. 16,

At about 4 p.m. at Santa Cruz hid the Sun behind a palm tree trunk at distance 40 to 50 ft. Sky very clear & appeared a slight greyish lighter blue color close to Sun. Diffraction fringes so marked that they might hide protuberances. In evening tried to distinguish "old moon" and failed. Think might have succeeded with suitable screen.



Mags seen 3.7 4.4 4.5 4.6 4.7 5.2 5.4

Mags unseen 4.7 5.1 5.6 5.6 5.7 5.7 6.0 6.1 6.4 6.2 6.3 6.4 . . . 7.4?

See p. 140

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Studying the Corona without an Eclipse.

Sept. 21 1886.

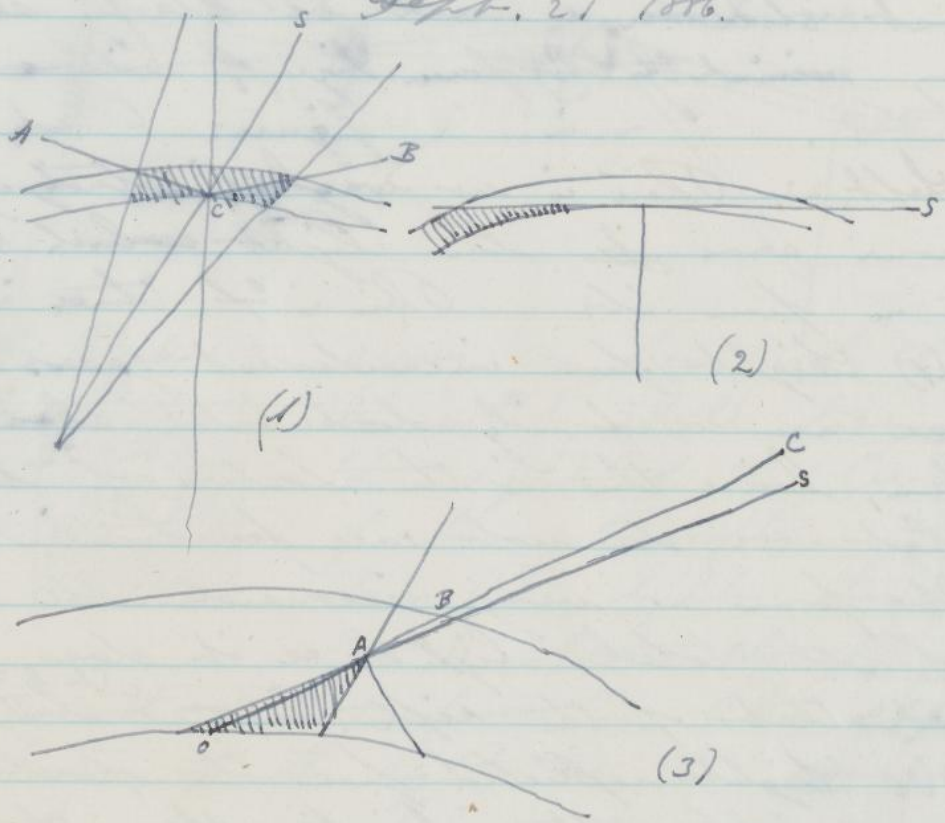


Fig. (1) represents the case of a Total Eclipse when the ~~spherical~~ solid angle A C B is in darkness

Fig. (2) represents the case of a sunset.

Fig. (3) represents the Sun going behind a high mountain. The observer at O sees the Corona through the thickness of atmosphere A B. It is therefore independent of his own elevation. He should obtain as high a mountain as possible, with as steep a slope.

If Corona is seen 1 min. before or after Totality, the light of sky is then diminished about 30 times (or 60 times on account of darkening of limbs). Sky can be darkened by mountain about 2 or 3 times, ∴ is still 20 times too bright

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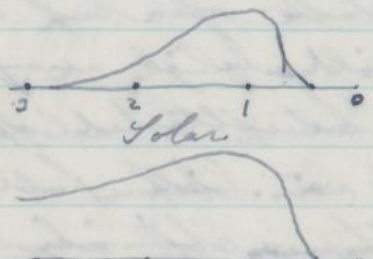
In order to observe the Corona, one must discover some method of detecting very minute differences of illumination.

Sept. 23, There is no way of studying the Corona save by the light which comes to us from it. This is of three kinds.

(1) Light from incandescent gases. These gases are uniformly distributed about the Sun, hence this is the portion of the light that we do not care particularly to study. It forms a very inconsiderable portion of the total light as it does not exceed that of the stars. The way to study it would [be by the spectroscope.]

(2) Light reflected from the particles. This is probably rather fainter than the third portion, as it is the only part that is polarized, and the corona is only slightly polarized. Perhaps some method might be discovered of studying the polarized spectra.

(3) Light radiated from the particles. This probably forms the largest portion of the light.

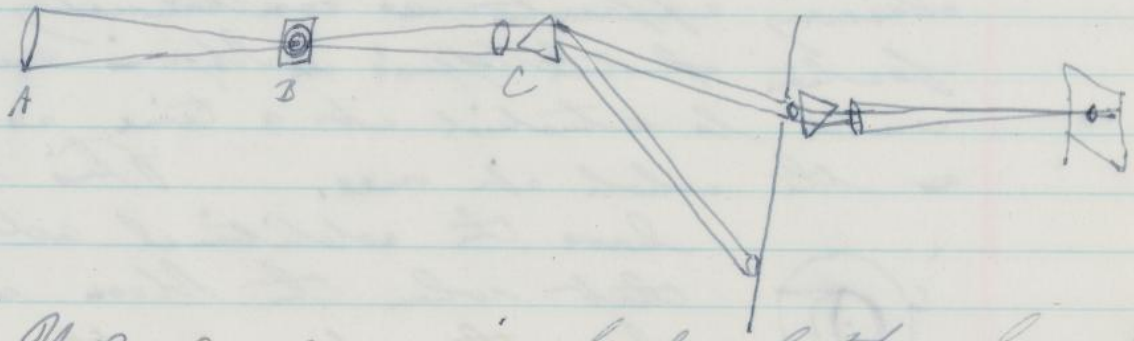


The Sun's spectrum terminates at 2.00 mic. while heated bodies have a spectrum ~~going~~ containing much longer wave-lengths. There are certain absorption bands in the solar spectrum 1.40, 1.80, etc. which may be caused by the corona. Hence use a bolometer & study

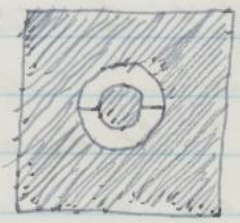
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the long wave-lengths about the Sun.



Make a screen in front of the lens like



this, which shall transmit only the light of the Corona & that of the atmosphere in front of it. The light then falls on the lens A, passes through the aperture B & the lens & prism C. This separates it. Portions of the light are then reunited by a similar prism & lens & the image cast on the plate. Or on a bolometer. There is really no need of the annular pictured screen. Simply a disc placed before the lens to cut off the Sun would be sufficient.

It would be convenient to have a tall flag-pole say 100 ft erected on the observatory grounds. This would carry a ball of 1 ft diameter which could be run up & down by halliards. It should be so arranged that a larger ball could be attached if necessary. This could also be used to hoist full Moon in order to study clearness of sky & mapping the stars. Oct. 16. It would be better to have a 1 ft ball fixed permanently at the top of a 50 ft pole & one layer in proportion as it

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would not involve moving any piece of observing apparatus so continually, & one portion of the Sun's or Moon's surroundings could be studied at a time as well as the whole at once. This would have the additional advantage that when the Moon was gibbous, the edge of the disc would be nearly parallel to the terminator of the Moon, thus rendering it more convenient to study the "old Moon". For looking for solar protuberances one would use a telescope of perhaps 2 ft focus with the aperture stopped down to 1 inch or less perhaps ½ inch.

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Law of Absorption of Media.
Oct. 1, '86.

Total light before absorption = $1 = \frac{x_0}{x_0}$.

Absorp. of 1st layer = $\frac{1}{x_0}$ Light trans. of 1 layer = $\frac{x_0-1}{x_0}$

" " 2d " $\left(\frac{x_0-1}{x_0}\right)\frac{1}{x_0} =$ " " " 2 " $\frac{x_0-1}{x_0} - \frac{x_0-1}{x_0^2} =$

$\frac{x_0-1}{x_0^2}$ $\frac{x_0^2-x_0-x_0+1}{x_0^2} = \frac{x_0^2-2x_0+1}{x_0^2}$

Absorp. of 3d layer = $\frac{x_0^2-2x_0+1}{x_0^3}$ Light trans. of 3 layers =

$\frac{x_0^2-2x_0+1}{x_0^2} - \frac{x_0^2-2x_0+1}{x_0^3} =$

$\frac{x_0^3-2x_0^2+x_0-x_0^2+2x_0-1}{x_0^3} =$

$\frac{x_0^3-3x_0^2+3x_0-1}{x_0^3}$

Absorp. of 4th layer = $\frac{x_0^3-3x_0^2+3x_0-1}{x_0^4}$ Light trans. of 4 layers =

$\frac{x_0^3-3x_0^2+3x_0-1}{x_0^3} - \frac{x_0^3-3x_0^2+3x_0-1}{x_0^4} =$

$\frac{x_0^4-3x_0^3+3x_0^2-x_0-x_0^3+3x_0^2-3x_0+1}{x_0^4} =$

$\frac{x_0^4-4x_0^3+6x_0^2-4x_0+1}{x_0^4}$

Absorption for 1st layer = $\frac{(x_0-1)^0}{x_0} = \frac{1}{x_0}$

" " 2d " = $\frac{(x_0-1)^1}{x_0^2}$

" " 3d " = $\frac{(x_0-1)^2}{x_0^3}$

" " 4th " = $\frac{(x_0-1)^3}{x_0^4}$

" " nth " = $\frac{(x_0-1)^{n-1}}{x_0^n}$

" " n layers = $\frac{(x_0-1)^0}{x_0} + \frac{(x_0-1)^1}{x_0^2} + \frac{(x_0-1)^2}{x_0^3} + \cdots \frac{(x_0-1)^{n-2}}{x_0^{n-1}} + \frac{(x_0-1)^{n-1}}{x_0^n}$

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Light transmitted $\int$ n layers =

$$1 - \left(\frac{(x-1)^0}{x} + \frac{(x-1)^1}{x^2} + \frac{(x-1)^2}{x^3} + \frac{(x-1)^3}{x^4} + \ldots \frac{(x-1)^{n-2}}{x^{n-1}} + \frac{(x-1)^{n-1}}{x^n} \right)$$

In the above formula x in the case of sheet glass would equal 10.

If we use the simpler formula on page 6 [$L(1-x)^3$ = amt trans. through 3 layers] & use x instead of y we obtain
Light trans. through n layers = $L(1-x)^n$. Here x in the case of glass = $\frac{1}{10}$.

Starting now with the formulae on p. 8.

$$z = \sqrt{x_2^2 + 2Rx + R^2\cos^2\alpha} - R\cos\alpha \quad \& \quad l^{\frac{x}{z-x}} = l_2^{\frac{x}{z_2-x}}$$

we obtain $\log l \left(\frac{x}{z-x}\right) = \log l_2 \left(\frac{x}{z_2-x}\right)$

$$\frac{\log l}{\log l_2} = \frac{\frac{x}{z_2-x}}{\frac{x}{z-x}} = \frac{x(z-x)}{(z_2-x)x} = \frac{z-x}{z_2-x}$$

Let $\alpha = 90°$ then $\cos\alpha = 0$ $\quad z = \sqrt{x^2+8x}$

$\alpha_2 = 60°$ $\quad \cos\alpha_2 = \frac{1}{2}$ $\quad z_2 = \sqrt{x^2+8x+4} - 2$

$R = 4$

$\alpha = 90°$ then $\sin\alpha = 1.00+$ $\quad l = .13$ (w.l. .408 Bony p. 247)

$\alpha_2 = 60°$ " $\quad \sin\alpha_2 = .87$ $\quad l_2 = .53$ " "

$$\frac{\log .13}{\log .53} = \frac{\sqrt{x^2+8x} - x}{\sqrt{x^2+8x+4} - x - 2} = A = \frac{9.0000}{9.7000} = .9 \text{ approx}$$

$$\sqrt{x^2+8x} - x = .9\left[\sqrt{x^2+8x+4} - x - 2\right]$$

$$\sqrt{x^2+8x} - x = .9\sqrt{x^2+8x+4} - .9x - 1.8$$

$$\sqrt{x^2+8x} - \frac{x}{10} + 1.8 = .9\sqrt{x^2+8x+4}$$

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$x^2 + 8x = $ ~~something~~

$\sqrt{u} - x = .9\sqrt{u+4} - .9x - 1.8$

$\pm\sqrt{x^2+8x+4} = \frac{\sqrt{x^2+8x}}{.9} - \frac{\left(\frac{x}{10} \mp 1.8\right)}{.9}$

$x^2 + 8x + 4 = \frac{x^2+8x}{.81} - etc$

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Intensity of Sunlight from different positions of the Disc.

Oct. 2, 1886.

Use small telescope to project image of Sun & place electric arc in front of it & study relative light.

Also study light from different portions with double image prism photometer

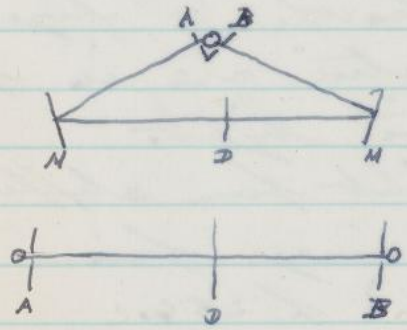
See also Berry "Sun" p 264.2

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Research on Standards of Light & various Photometric Methods.

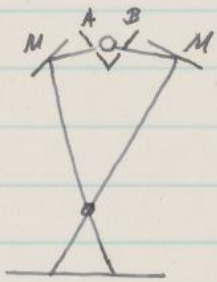
Oct. 15, '86.



Use a mirror photometer with ~~two~~ a lamp shining through two equal apertures A & B & compare a series with Bunsen disc.

Then use same apertures & disc & two separate lamps P M P equally distant P P, & A M P = A P. Try the lamps on a number of different days.

By turning the mirrors M M compare accuracy after of Rumford, & Double-wedge-prism photometer.



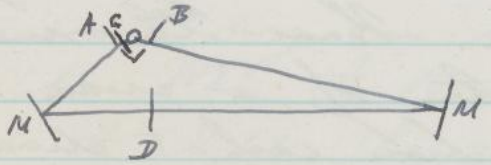
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Photometry & Photography of Colored Light.

Oct. 15, '86.

Use a mirror photometer as in the previous research but between A & the light insert a piece of light blue glass of such density as when tested by the Rumford Photometer shall ~~be of the~~ give a light of the same color as sunlight. Compare these lights by the various photometric & photographic processes & note the result. See my lectures on Photometry. Try numerous kinds of dry plates & see if they all give the same result.



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Rotation of the Solar Disc.

Oct. 15, 1886.

Take a series of 18 inch photographs of the Sun, — two a day say at 9 & 3, for a year. Have the meridian marked on them by a cross wire. Make bromides from each & draw the polar axis, & mark the pole & some parallels & meridians. Then study the motions of the faculae, granules (at least 50 000 miles from the nearest spot), and sun spots, & determine their rate of motion in different latitudes. By this means the rate of rotation near the poles can be found. See Young pp. 134.6 & 137.9 also note p. 143.0 & 132.3

At the equator on an 18 inch scale a granule would move 54 inches in 27 days apparently or 1 in. in 12 hours. By a series of photos. taken every 30 mins. a granule on the place of one could be traced for example to determine its rate of motion within 1 per cent. Perhaps they could some of them be recognized over night. This would give 36 hours. Possibly when one pole was turned towards us, granules could be shown going in opposite directions on opposite sides of the pole thus doubling the effect.

Obs. Note if spots appear at same points of disc always. Divide surface up into areas & see if zones are more spotted than others. See Young 208.6

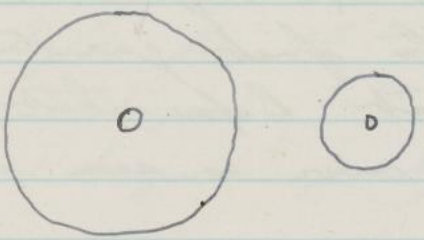
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Methods of determining Clearness of the Sky. ~~as determined by counting the Stars near full moon~~

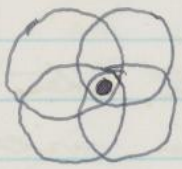
Oct. 15, 1886.

When the Moon is full, stars of perhaps the sixth mag. can be seen within 5° or 10° of it. When the Moon is on the quarter giving 1/10 the light they can be seen within say 3°. This is too small a circle to be of use, accordingly it is not worth while to observe with a phase less than this. The full moon is hardly bright enough, as with a clear sky the radius of the circle must be small. If one used a telescope which enabled one to go 3 mags fainter than the eye on a dark night it would probably furnish the same near the Moon. This would have the advantage of giving more stars, but would add considerably to the trouble & would involve a telescope & a special mounting. Should the telescope add only 1 mag. when near the Moon it would have a decided advantage over the eye. With a very clear sky it might be necessary to use the Sun at rising or setting, using an instrument to find the stars with. One would then use 1st mag stars near the meridian. It may be best to use a field glass or a telescope, with a large field ~~or a telescope~~ & revolve it around the moon thus:-



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By using these four positions we should cover a large field of perhaps 3 times the area of that of the glass, & should get enough faint stars to make it worth while. The disadvantage would be that a very distant screen of just the right size & shape would be required.

On and after the first quarter use the "old moon" as a test. Before that use the markings on the "old moon" as seen with naked eye.

When there is no Moon make photometric & photographic measures of light of sky. Make forms with luminous paint or with sheet of white paper illuminated by lamp shining through pin hole.

See also p. 61.

Various Methods.

1. Light of Sky near Lun. p. 61
2. Stars in daytime with telescope. a Polaris varying aperture.
3. Stars at sunrise & sunset with naked eye & telescope.
4. Markings on "old moon" near quarter.
5. Distinguishing "old moon" near quarter.
6. Photometry of starlight sky and moonlight sky.
7. Photography of starlight sky and moonlight sky.
8. Mapping stars near full moon.
9. Observing the Prominences through red glass when Lun is hidden by distant screen, also photographing them.
10. Observing Moon with eye & planets & stars with telescope

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when near Sun. Also markings on Moon.

11 Photographing the Moon in the daytime as it is when on the meridian as it approaches nearer + nearer to the Sun, or when it is same alt. as Sun.

12 Matching color of sky near edge of Sun with strip of paper painted various tints of blue + illuminated by a mirror reflecting direct sunlight, or use some device employing polarized light for the same purpose. Look through large end of field glass.

13 Distinguishing "old moon" when Sun is above the horizon.

14 Polarization of sky at right angles to Sun.

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Consideration of preceding Tests.

Oct. 16, '86.

Markings on the "old moon".

Markings { No screen { Eye 3b
Glass 3a
Screen { Eye 3 v
Glass 2 v

Old Moon { No screen Eye 1a
Screen Eye 1 v

Date	Test	Phase
On Oct 1	3 + 3b	
" 4	3 + 1a	Quarter.
" 5	2 + 1a	

The important tests are indicated by marks and by the numerals. & the less important ones by numerals with letters attached.

Lunar Tests.

Test	4	5	6	7	8	10	11	13
New								
Crescent								
Quarter								
Gibbous								
Full								

The above figure indicates the phases during which the different tests may be applied.

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Clothing for the Orcopis.

Oct. 15. '86.

5 Flannel shirts (white) + 1 colored flannel.

For 4 months' trip. Morning costume.

Have them made to order of wool & cotton mixed. One or two of them might be of wool & silk.

Measurement from neck to tail.

" of cut in front 14 inches.

" breadth of flap under cut 5 inches.

Gathered at neck so as to keep large enough round chest when they shrink.

Made to hang over trousers so as to hide belt. Made to button at wrist so that sleeves will roll up.

Made as large as possible so that they will look well.

4 pr white flannel trousers same material flap under fly 2½ inches wide, made very long.

3 pr very loose drawers, 6 pr thinnest socks.

4 pr low shoes + 1 pr of older ones.

Pr slippers. Dozen handkerchiefs White helmet

Two neckties Belt (white) 2 Flannel coats striped & made ~~Afternoon costume~~ flaps large around chest

Afternoon costume.

Also, - 5 thinnest undershirts 2 White duck ~~suits~~ coats buttoning up in neck with narrow stand up collar so that no linen collar need be worn. These will be worn directly over undershirts. 2 pr white duck trousers to be worn over thin drawers.

White hammock hat for steamer.

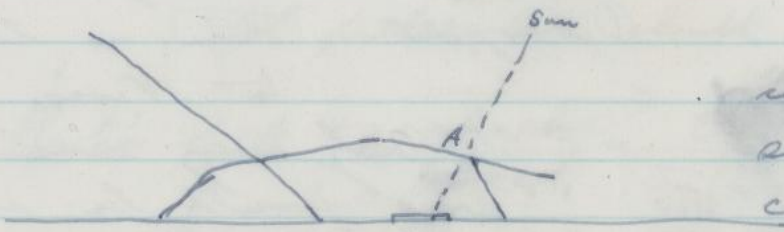
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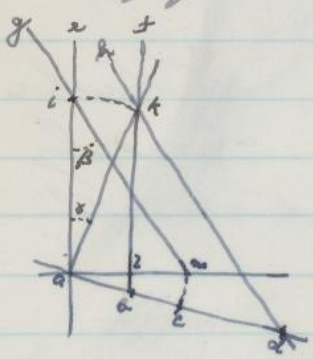
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Observations on the Rolling of the Steamship "Barracouta" Oct. 14, '86.



Steamer chair H.P.

The sunlight was allowed to shine through the cane seat of the chair at the part marked A, onto this book which was placed flat on the deck, with the top of the page towards the bows. The observation lasts one minute in each case. Height of the aperture in the cane vertically above the page.



Let i be the point casting the shadow & k be its position after moving through angle α. Let $ia = ka = R$

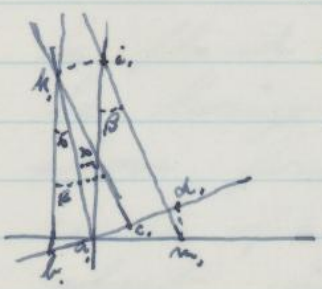
Then $al = R \sin\alpha$. $ab = ak \cos\alpha$

$$ak = \frac{al}{\cos\alpha} \quad \therefore \quad ab = \frac{R\sin\alpha}{\cos\alpha} = R\tan\alpha$$

$am = ac \quad \therefore \quad ac = R\tan\beta$

$ad = R\tan(\alpha+\beta)$ $\quad cd = ad - ac = R[\tan(\alpha+\beta) - \tan\beta]$

$$\frac{ab}{cd} = \frac{\tan\alpha}{\tan(\alpha+\beta) - \tan\beta}$$



$a_1b_1 = R\tan\gamma$ $\quad a_1d_1 = $ ~~$R\sin\beta$~~ $a_1m_1 = R\tan\beta$

~~$a_1c_1 = R\tan(\beta-\alpha)\gamma$~~ $R\tan(\beta-\gamma)$

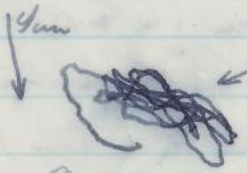
$c_1d_1 = a_1d_1 - a_1c_1 = R[\tan\beta - \tan(\beta-\gamma)]$

$$\frac{a_1b_1}{c_1d_1} = \frac{\tan\gamma}{\tan\beta - \tan(\beta-\gamma)}$$

$a_1m_1 = am \quad \therefore \quad a_1d_1 = ac$ $\quad cd + c_1d_1 = ad - ac + ac - a_1c_1 = ad - gc$

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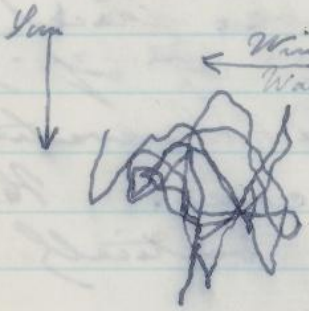


Oct. 14, 2.25 — Just after leaving Antigua about 45 min. on the way to Nevis.

Only very sensitive persons would be made seasick by this motion.



Oct. 14. 2.20
44 m.s



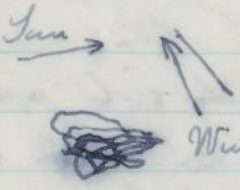
This curve indicates sufficient motion to make perhaps one lady in four sick when first exposed to it.

Oct. 14. 3.55 — At the time was less than the amount of the pitch was perhaps doubled. The roll was unaffected.



At anchor off Nevis Scarcely any motion at all.

Oct. 15, 1 p.m.



Oct. 16, 12 p.m.
South of the west end of Santa Cruz.

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$ad - a_1 c_1 = R\left[\tan(\alpha+\beta) - \tan(\beta-\gamma)\right] = cd + c_1 d_1$,

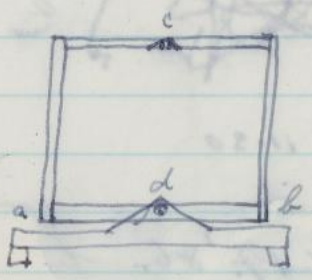
Total path actually traversed.

$ab + a_1 b_1 = R(\tan\alpha + \tan\gamma)$

Total path which should have been traversed.

Ratio of the two $\dfrac{ab+ab_1}{ad+c_1 d_1} = \dfrac{\tan\alpha + \tan\gamma}{\tan(\alpha+\beta) - \tan(\beta-\gamma)}$

Fig. 1



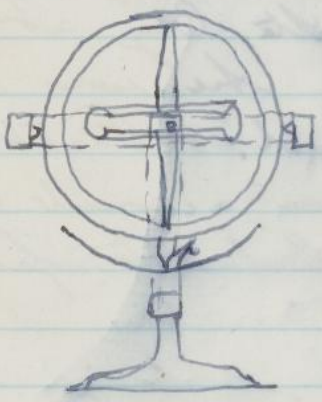
Assume that $\alpha = \gamma$

We then have

Ratio $\dfrac{ab}{cd} = \dfrac{2\tan\alpha}{\tan(\beta+\alpha) - \tan(\beta-\alpha)}$

or $cd = R\left[\tan(\beta+\alpha) - \tan(\beta-\alpha)\right]$.

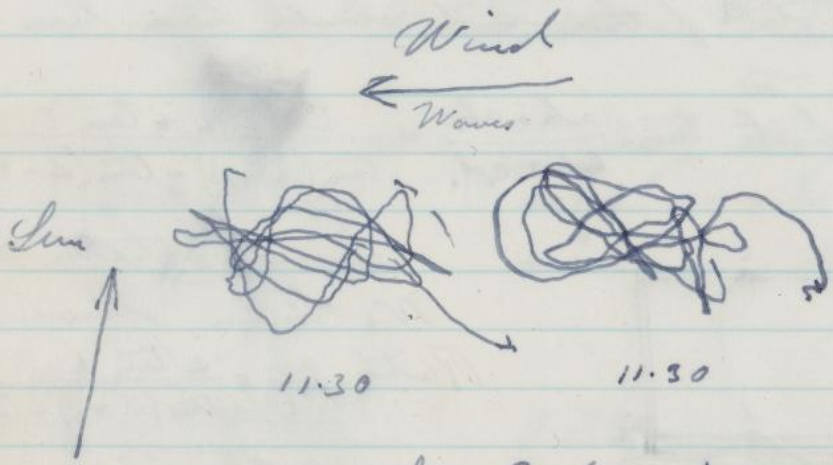
When paper is level in mean position $\alpha = \gamma$, β being known d can be found.



Apparatus for obtaining curves. A gyroscope might be used furnished with a pencil p. Or instead If a board ab Fig 1 be arranged so that it can be tilted sideways on an axle d parallel to the keel of the ship the board can be placed so that its mean position shall be horizontal. In this case $\alpha = \gamma$ and the above formulae apply. The distance of the center of the curve from the center of the sheet will show at once the angular altitude of the Sun, β, from which we obtain B.

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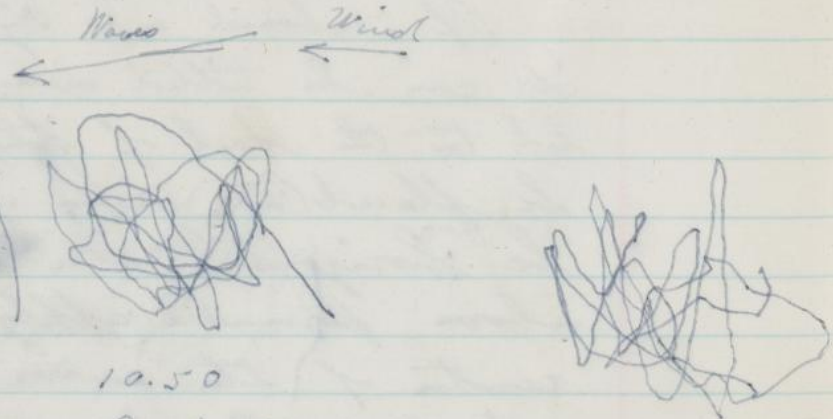
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Sun. Oct 17. '86.



Left Sta. Cruz at 11 p.m. last night. Ate now out of sight of land. First figure not quite complete on account of a heavy roll which caused a shadow to fall on the chair used. Earlier this morning I did not feel quite comfortable, although not really feeling sick. Not enough to prevent my going to breakfast or reading.

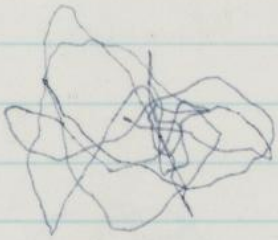


Did not feel so comfortable as yesterday though not actually sick.

M. A. C. has just Mon. Oct. 18. awakened.

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10·5-5-

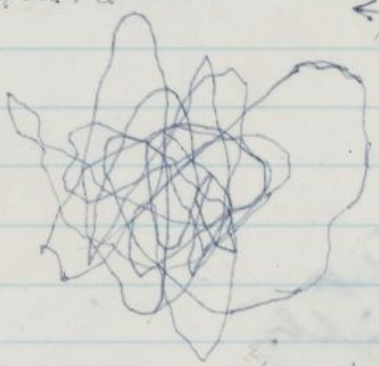
Mon. Oct. 18.

Wind →

← Waves



Strata of clouds 12·20 Oct. 18.

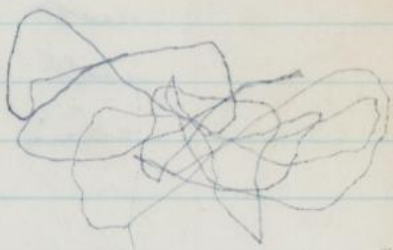


Sun

12·20 (2 min)

Mon. Oct. 18.

Today & yesterday about half the gentlemen passengers came to their meals & inquired after two of the ladies.



12·30 Mon. Oct. 18.

lat 23 °

lon 64 42.

235 miles.

Wave →

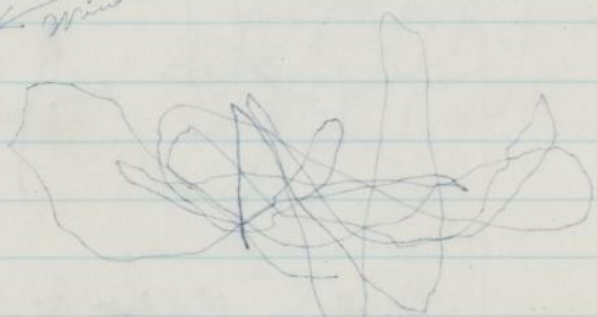
← Wind.

Sun



12.0ᵐ Oct. 19

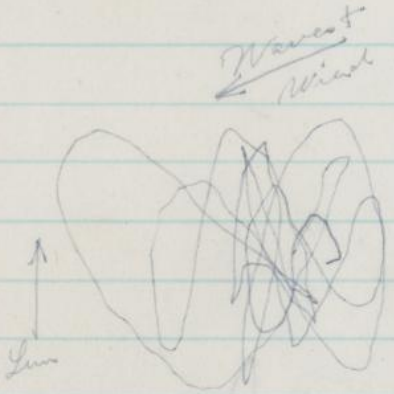
incomplete. accᵗ of clouds



11.08 Oct. 19

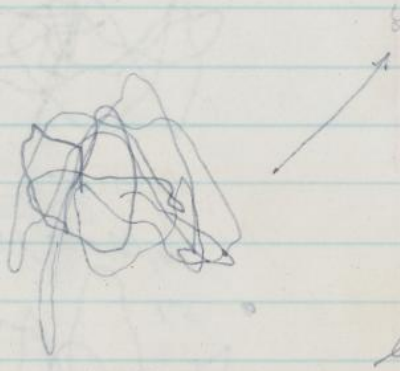
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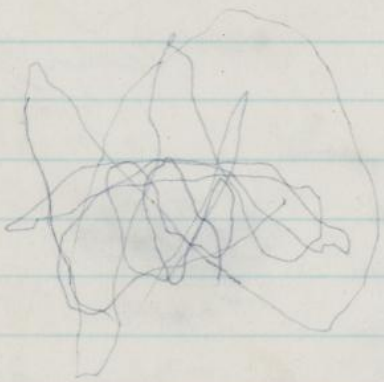
11.10 Oct. 19.

Felt almost as comfortable as on land.

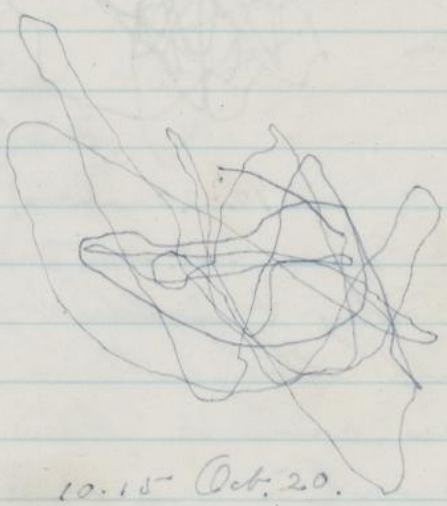


12.30 Oct. 19.

lat 26 37
long 69 36
247 miles

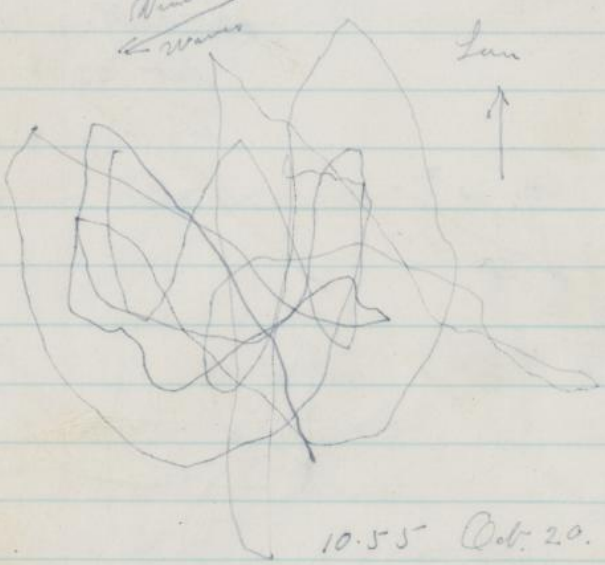


12.30 Oct. 19.

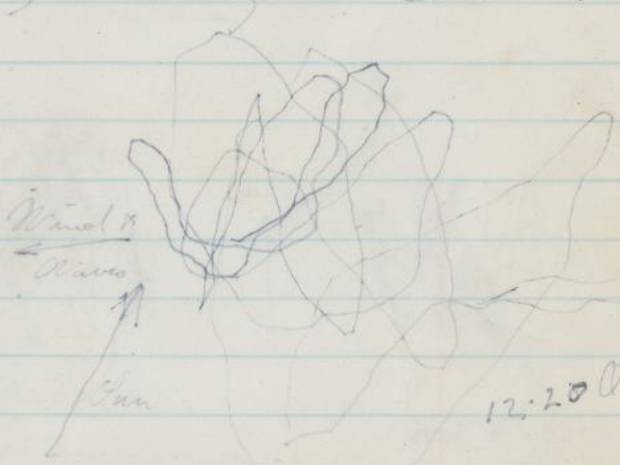


10.15 Oct. 20.

M.A.C. sick.
5 passengers at breakfast this
I felt all right.
Otherwise some stiffing morning,
only in walking about the deck.



10.55 Oct. 20.



12.20 Oct. 20

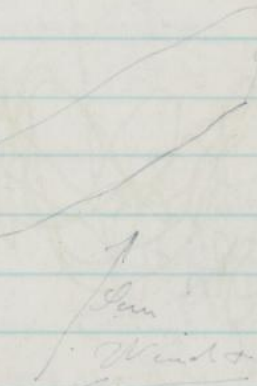
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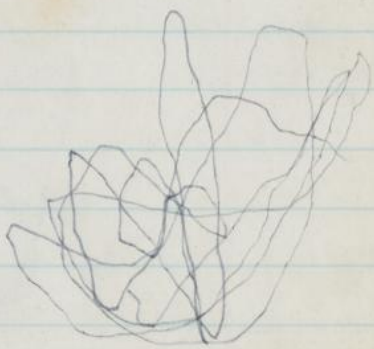
12.25 Oct. 20.

Lat 29 51
Long 71 32
225 miles

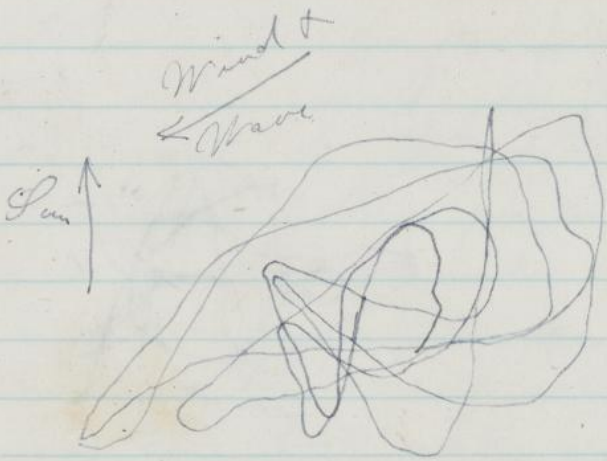


Had the Racks on at lunch today also at dinner. Did not go down to dinner but felt all right as long as I stayed on deck.

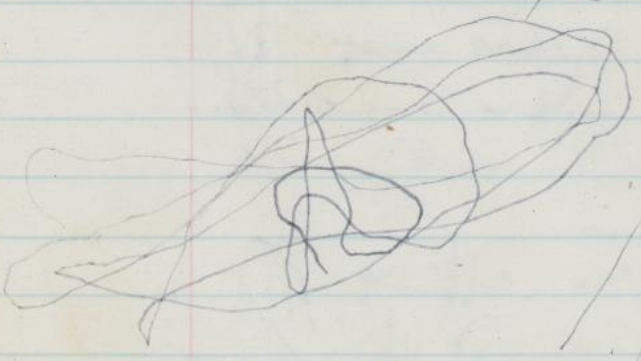
Only 5 passengers at lunch.



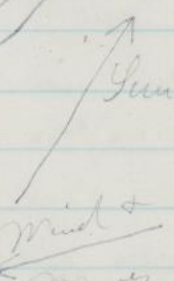
11.40 Oct. 21.

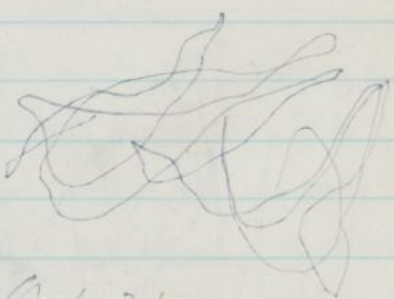


11.37 Oct. 21.



12.10 Oct. 21.



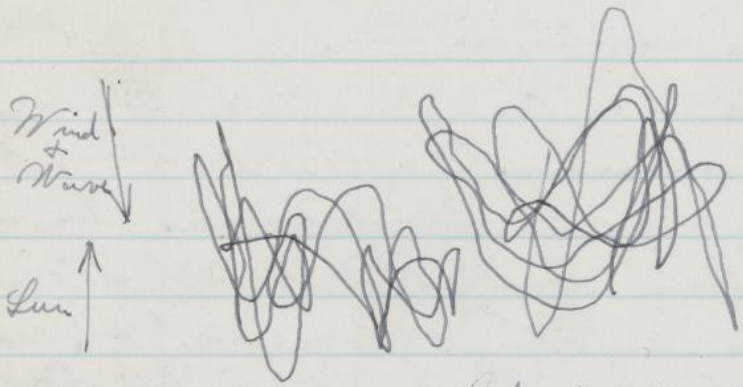


12.45 Oct. 21.

Lat 33 22
Long 73 33
Dist 235

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Oct 22 11.48

Oct 22 11.50

Cat 37.17
Leg 74.03
235

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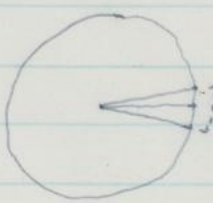
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Various Observations on Sun.

Oct. 17, '86.

Distribution of Prominences. Photograph them regularly every day around circumference. In order to eliminate error from counting polar prominences several times owing to their slower motion (see Young, Ntes. p. 200), divide observations into 14 series, each series composed of photographs taken 14 days apart, when Sun & Earth are in same relative positions in the reverse. Thus one series would be taken on alternate Sundays, the next on alternate Mondays and so on. Then any one of these series would give a fair record of the distribution of the prominences, without favoring the poles. By combining the series we should get a larger number of observations. 14 days is chosen as the mean time of a half rotation of the whole solar disc with regard to the Earth. But really any number of days would do; so long as no prominence should last so long as to be recorded twice in the same series.

Sun revolves through 13° per day apparently, hence the amount cut off from its base at beginning & end would be $16'(1-\cos 6.5°)$ suffering it to reach edge at middle of 24 hours. And one day previous it would be $16'(1-\cos 13°)$



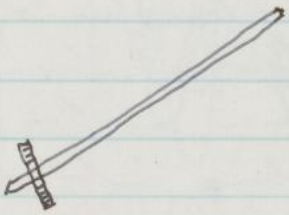
28)360(13
28
80

Other two classes of prominences should be treated separately & series of photos should be obtained illustrating growth of numerous prominences.

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Sunlight Recorder.
Oct. 31, '86.



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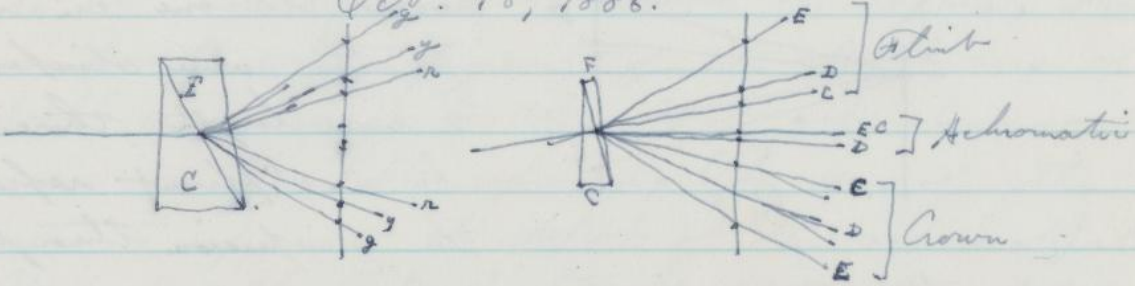
1886phae.proj.1155P

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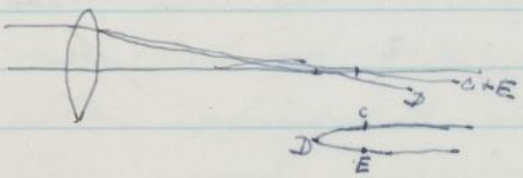
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Visual and Achromatization of Photographic Lenses.

Oct. 18, 1886.



The above is for visual lenses when all the light is between lines C + E with a max. at D.



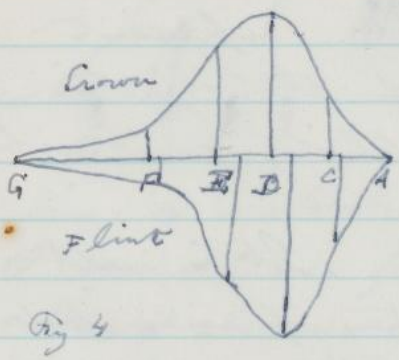


Fig 4

On the curves Fig 4 one wishes to select the two bounding wave lengths so as (a) to leave as little light as possible outside & (b) to have the ~~greatest difference of~~ refraction of ~~any intermediate~~ the intermediate rays giving the greatest difference of refraction (when the extreme coincide) as small as possible. In the above sketch (Fig 4), A+G coincide, & C+F thus comes & then E. see Fig 5.

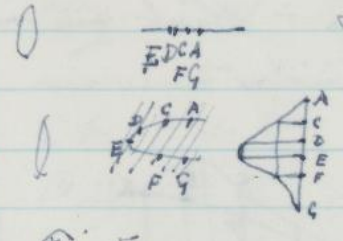


Fig 5

We can represent the objection to this (i.e. the ~~simple unpressed light~~) system by the area A E Y Z (Fig 6) which is large on account of the length of E A. E Y represents the external unpressed light. Fig 7 shows the area when C+F coincide. The area is smaller than E X is greater.

Fig 8 shows the area when D coincides with some point between E + F. Again the area is larger

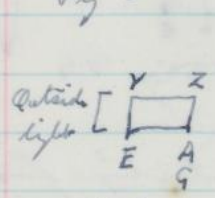


Fig 6

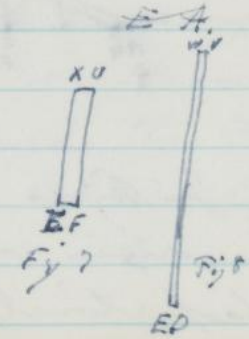


Fig 7

Fig 8

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The best combination of achromatizing media would be one in which for the same dispersion between 2 wave lengths there would be a different refraction that the dispersion throughout the spectrum would be uniform.

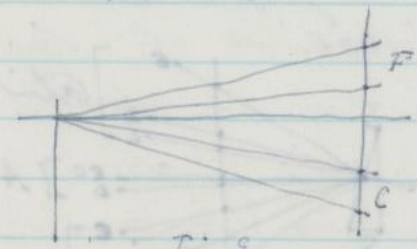


Fig 9

For a photographic lens the areas represented by Figs 6, 7, & 8 would probably be smaller than for a visual lens.

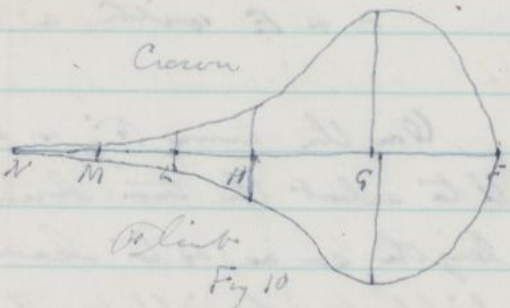


Fig 10



Fig 12.

Area F G X Y (Fig. 12) represents the area of the objective for the photographic achromatization

It is really not a question of areas but of moment. Fig 13 corresponds to Fig 4, but shows the state of things when C & F of the crown & flint are made to coincide.

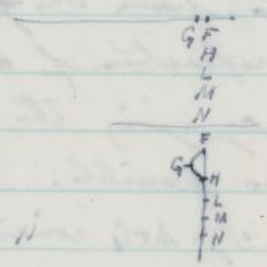


Fig 11

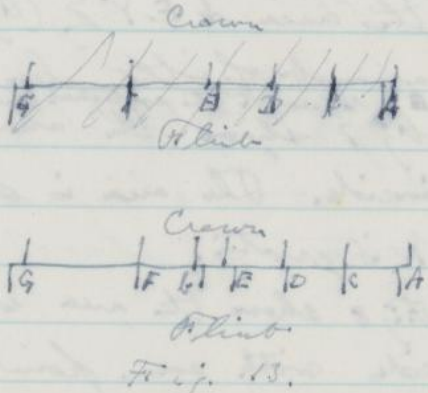


Fig. 13.

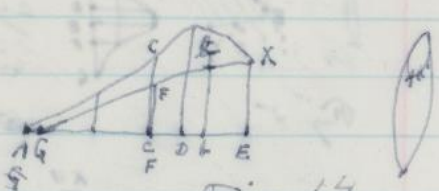


Fig. 14

In Fig 14 starting from C F as an origin we plot abscissae proportional to distances

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difference of distances measured along Fig 13. Ordinates are proportional to intensities of lights. Measuring now from the center of gravity of the ~~double~~ area of the double curve areas to the right are downward, & areas to the left upward. The sum of these moments represent the defect of the achromatization. It is possible that instead of plotting CD, CB, & CE proportional to the distances in Fig 13, they should be proportional to the squares of the distances or some other exponential quantity. The problem is to make these moments a minimum. The areas Fig 14 GEX & AEX may be studied experimentally by cutting out a piece of paper like Fig 15 & bending it back at EX.

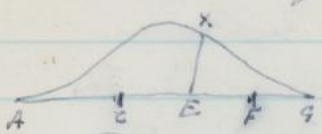


Fig 15

To determine the best coincident lines. (a) Construct Fig 13 by experiment. (b) Determine the ordinates once for all of Fig 15. (c) Determine the ~~ordinates~~ abscissae of Fig 15 making different wave lengths coincide & thus getting several different curves like Fig 15. (d) Cut them out of paper & bend them. If the best cannot be selected by inspection, they could be cut out of tin & weighed and their moments determined by experiment, cutting them again at C & F. Probably the best way to construct Fig 13 for photographic purposes is to get two prisms made of the same sample of glass, to be used for the five of such angles as to give very nearly the same dispersion, & then photograph the two spectra one above the other on the same plate.

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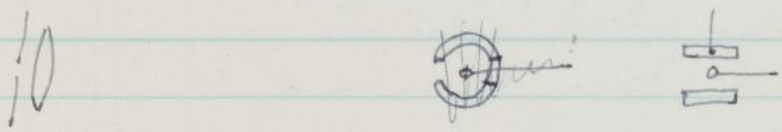
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Laws of Radiation.

Oct. 19, '86.

Sun at 10 000 000 miles has ap aperture of 45° or $\frac{\text{diam}}{\text{dist}} = \frac{8}{100}$. Get a lens 8 in aper & 100 in. focus. Stop it down so that aperture = size image Sun.



Enclose blackened bulb thermometer in a blackened hollow cylinder containing water at const. temp. & determine how much its temp. is raised as compared with one similarly placed exposed to direct sunlight. Try having water various temperatures. Try closing rear end with block of ice & with blackened box containing water various temperatures. Vary aperture in front of lens to represent Sun as seen from various planets. This would represent effect on Earth if it were moved to dist. Venus, Mercury, Mars etc.

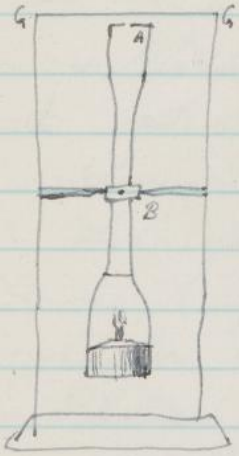
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Apparatus for recording motion of a ship at sea.
Oct. 21, '86.



A sheet of glass G G supports the paper, on which the curve is to be traced. Below it is a lamp surrounded with an iron chimney V which forms the bob to a pendulum hung on pivots at B. This carries above a screen with a small hole pierced in it at A. As the ship moves the light coming through this hole traces a curve on the paper above which can be followed by a pencil. The glass could be painted in concentric circles to indicate the extent of the motion & form a scale.

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Flying Fish

Oct. 21, '86.



Oct 17 I stood on the bow + watched them as they rose beneath me in schools or singly. They were not more than 20 to 30 ft distant + I could see them distinctly. The wings were thin fins held horizontal. When they first rose from the water + after passing through the crest of a wave they had a rapid vibration of from 1/8 to 1/4 of an inch. But after travelling a few feet the wings would be held still + they would soar. On one occasion one fish gave his wings a slower motion moving the tips through about 1 inch but after travelling a few feet it diminished + at the end of five or ten feet he soared also.

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Measurements of the Radiations of Dark Bodies at High Temperatures.

Oct. 26. 1886.

Measure the Radiant Energy, Light, & Actinism of the following bodies.

Sun (Determine also outside of air, and at Photosphere)
Arc (pos. carbon)
" (neg. carbon)
Carbon heated by oxy-hydrogen jet. (Compare with lime)
Platinum black heated by spirit lamp.

Use Carcel light through diaphragm as standard. One could use as unity the light which would radiate under standard conditions a calorie per sec per sq. cm. This light would give a unit of light & actinism. Scales could thus be constructed. By increasing the pressure possibly the heat of the arc could be increased & we could determine the pressure necessary to make it as bright as the photosphere.

By continuing our curves we could from the light & actinism determine the intrinsic ~~brilliancy of stars~~ & hence their ang. diameters and ~~distances~~ combined with their distances their size.

Probably the iron lines in the Chromosphere are the long cool ones, while the short hot ones do not appear. Iron in the Sun is not necessarily decomposed but merely changes its spectrum with the temperature, like strontium, & many other substances. Com-

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pare the arc with the Sun, the pos. car-
bon resembling the photosphere

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Continued from p. 80. Sky Observations
Oct. 31, 86.

The magnitudes of the stars observed in the tropics were found testing & comparison with the Uranometria Argentina & Harvard Photometry. In general when the Moon is 4 days past the quarter I could see stars of mag. 6.1 & ~~brighter~~, while without Moon I could see 6.5 or 6.6 N. H. Diff .4 to .5 mag.

When Moon was full could see stars of mag 5.4 to 5.5 & without Moon I could see 6.5-6 6 H. P. Diff .9 to 1.0 mag. At Moon Sky slightly hazy.

These statements include regions 10° to 12° distance from the Moon.

Nov. 1. Boston. Moon 1st quar. Date Nov. 3, at 12 noon

Seen on Moon	3a(?)	2	1a 1 Can see
Seen 5.45		3 b 3	Cannot see

3a is rather doubtful.

In Boston therefore 2 days before the quarter I cannot see as well as I could at Grenada on the quarter, but can see about as well as, at Grenada on the day following.

Nov. 2 Could see Seen test 1 + 1a.

Nov. 3 Quarter. Could see 1 + 1a

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Observations which may be made at High Altitudes to particular advantage.

Nov. 4, '86.

Those involving great contrast.

(a) Measurement of radiations from old moon.
(b) Spectroscopic (visual & photographic) observations of the Protuberances.
(c) Observations of Corona.
(d) Observations of Zodiacal Light.

Photographic Observations.

(a) Extreme ultra violet - solar ~~& stellar~~ spectrum.
(b) Spectra of faint stars.
(c) Mapping faint stars.
(d) Photographing nebulae

Those involving great steadiness of the air.

(a) Solar photographs.
(b) Lunar & planetary photographs.
(c) Photographic determinations of parallax.
(d) Double star measurements

Measurement of Solar & Lunar Radiations.

(a) Actinic.
(b) Visual.
(c) Energic.

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Tues. May 3, '87.

Began work on Eclipse picture
2 mm Aperture of Lensitometer Seed plate
Developed 5-min Pyro. Plate 135

Diff Exp	Exp	Days	lighted lamp about
8	16	16	11.20
4	8	8	
2	4	4	
2	2	2	

Moon exp longest perhaps 6 or 7 instead of 8

Plate 131 Full Moon

12.10 Exp. Exp to Moon Dec. 9, 86.

Moon Diff exp	Exp	Lens Diff. Exp	Exp	Days
~~8~~ 4	8	8	16	16
~~4~~ 2	4	4	8	8
~~2~~ 1	2	2	4	4
1	1	2	2	2

Longest moon exp. perhaps 6 or 7 instead of 8

Plate 133 Full Moon

12.17

Moon Diff exp	Exp	Lens Diff exp	Exp	Day
8	16	64	128	128
4	8	32	64	64
2	4	16	32	32
2	2	16	16	16

~~Longest~~ Moon exp. perhaps irregular.

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Tues. May 3, '87.

Plate 127 Full Moon Grenada.

1.50 offexp. Exp 6 Moon Left 13, 86.

Moon Diff exp	Exp	Lens. Diff exp	Exp	Days
3	7	32	64	64
2	4	16	32	32
1	2	8	16	16
1	1	8	8	8

Plate 128 Full Moon Grenada

7	15	64	128	128
4	8	32	64	64
2	4	16	32	32
2	2	16	16	16

Plate 117 6½ x 8½ Eclipse

Dev ~~4 min~~ with. bromide. ~~(16 8 4 2) (2)~~

Plate 116 6½ x 8½ Eclipse

Dev. 4 min. - Exposed Eclipse 8 sec

Plate 126 8 x 10 ~~Pl~~ Eclipse

Partial phase after Totality

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Wed. May 4, '87.

Lamps rens. lighted at 11.00

Plate 120 8×10 Photoheliograph Corona.

Corona Sun. on both ends.

2 or 1 sec.	Diff exp.	Exp.	Days
	16	32	32
	8	16	16
	4	8	8
	2	4	4
	2	2	2

Plates 123 124 & 121 developed – all failures

Plate 111 6¼×8½ Spectrum Corona.

Exposed at 1 Lens 63mm

Exposure Spect 6 sec

	Diff. Exp.	Exp.	Days.
	40	80	8
	20	40	4
	10	20	2
	5	10	1
	5	5	5

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Thurs. May 5, '87.

Lamp lighted at 10.42.

Plate 103 Dagmeter Eclipse

Began exposing 10.57 Lens aper. 2 mm.

Eclipse Lens	Diff exp	Exp	Days
8	126	253	253
4	63	127	127
2	32	64	64
1	32	32	32

Plate 104 Dagmeter Eclipse

Began exposing 11.31 Lens. aper. .63 mm.

Eclipse Lens	Diff exp	Exp	Days
8	80	160	16
4	40	80	8
2	20	40	4
1	20	20	2

Plate 108 Photetelescope Eclipse

Began exposing 11.51 Lens aper. .63 mm. Dev 2 min.

Dev. at 12.00.

Eclipse	Lens Exp	Days
16 sec	80	8
	40	4
	20	2
	10	1

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Obsns. May 5, '87.

Plate 107 Phototelescope Eclipses.

Expr to secs at 12.15 Lens after .63 mm

Eclipse	Expr	Days
6 sec	80 sec	8
	40	4
	20	2
	10	1

Plate 106 Extinguished lamp at 12.45 Relighted & filled at 12.52

Expr to secs 12.59 Lens after 2. mm Dev. 4 min.

Eclipse		
2½ sec	Expr	Days
	16	16
	8	8
	4	4
	2	2

Extinguished lamp at 1.45 Plate 119

Relighted lamp at 3.25 (trimmed also).

Expr to secs 1.20[?]1 Lens 2. mm Dev. 5 min.

Eclipse	Diff Expr	Days	Days
40	125	25/1	25/1
	63	125	125
	31	63	63
	16	32	32
	16	16	16

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Thurs. May 5, '87.

Plate 118 6½x8½ Eclipse.

Dev. 5 min with perhaps 40 drops bromide in 8 oz dev.

Lens open = 2. mm. Dev 5 min. Raised lamp of Lens. on boards.

Eclipse	Diaph	Exp	Days
100 sec	16	32	32
	8	16	16
	4	8	8
	2	4	4
	2	2	2

12.32

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Fri. May 6, '87

Approximate Results.

No	Size	Instrument	Observed Days: Outside of Immediate Clouds	Observed Days: Clouds ½ Past	Days reduced to Sept.: Outside of Immediate Clouds	Days reduced to Sept.: Clouds ½ Past
101	4×5	Daguerre				
102	"		Deer. in Grenada ~~16 days~~		2 days	
103	"		16 day ~~?~~		1 " (?)	
104	"		~~Deer. at Grenada~~ 8 " (?)			
105	"	Phototelescope				
106	"		8? ~~20~~ 32		3? ~~8~~ ~~16~~	
107	"		Clouds 16		Clouds 2	
108	"		Partial Clear			
109	6½×8½	Spectroscope	60	60	60	60
110	"		32	63	12	25
111	"		8 16		1.3 2.6	
112	"		126	63	8	4
113	"					
114	"		~~Log~~ 16			
115	"	Large Camera	Clouds 2 4	6 48	Clouds 1 2	3 24
116	"		Confound 111 12 24 118 24 36	63	Confound 119 2 4	8
117	"		———			
118	"	Small Camera	48	64	.5	.6
119	"		8	16 32	.2	.4 .8
120	8×10	Photoheliograph	———			
121	"		———			
122	"		+++			
123	"		——			
124	"		———			
125	"					
126	"	* Through clouds (?)	——			

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Condensed table

Reduced to Portrait lens for 1 sec.

No.	Outer sky	Inner sky	Mid Corona	Prominences	General light
102					2
103					1 [illegible]
106		27. ?=3? tab.	72. *=8? tab.		
107	Clouds 27				
115	Clear 1 2.	3.	24		
116	2.	4.	8		
118	.5	.6			
119	.2	.4	.8		
109			60	120	
110			12	30	
111		1.3		48	
112			8.	8.	
113					
114					

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Fri. May 6, '87.

Lighted lamp at 2.40 Fixed Sensitometer so as to have lamp higher than formerly.

Plate 101 4x5 - Dagmeter Eclipse

After 2 min.

Eclipse	Diff of Exp	Exp	Days
	16	32	32
	8	16	16
	4	8	8
	4	4	4

Plate 129 4x5 - Dagmeter Full Moon Grenade

	16	32	32
	8	16	16
	4	8	8
	4	4	4

Plate 130 4x5 - Dagmeter Full Moon Grenade

	16	32	32
	8	16	16
	4	8	8
	4	4	4

Above 3 plates all dev. 5 min at once in same tray.

Plate 115 - 6½ x 8½ Large Camera

Eclipse 2nd After .63 min

Diff of Exp	Exp	Days
80	160	16
40	80	8
20	40	4
10	20	2
10	10	1

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Fri. May 6, '87.

Plate 114 6½×8½ Spect. through Yellow Glass.

Eclipse	Diff of Exp	Exp	Days
	80	160	16
	40	80	8
	20	40	4
	10	20	2
	10	10	1

Aper .63 mm.

Plate 112 6½×8½ Spect.

Lens Aper 6.32 mm

Eclipse				
16 secs.	50	100%	1000	Mixed 20% rather old dev with 10oz water & added per-
	25	50%	501	haps 30 drops brom.
	12	25.7	251	Did not come out in
	7	13	126	2 min as for plate
	6	6	63	inlet rather old dev

In about 2 min. it came out. Dev. in this dev. 5 min.

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Lab. May 7, '87.

Plate 109 6½x8½ Spect.

Lens Aper. 2. mm

Corona	Diff Exp	Exp	Days
1 sec	63	126	126
	31	63	63
	16	32	32
	8	16	16
	8	8	8

Plate 110 6½x8½ Spect.

Lens Aper. 2. mm

2½ secs.	63	126	126
	31	63	63
	16	32	32
	8	16	16
	8	8	8

Probably Mon. May 9, '87.

Dev. Plate 113 Spect Corona in ordinary dev. It failed to come out well.

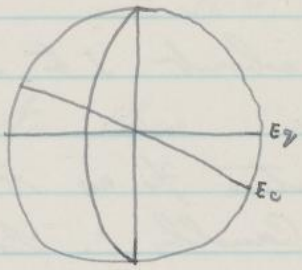
Dev Plate 105 - Photoheliograph Corona Evidently previously exposed to light.

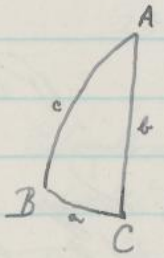
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Cuca. May 10, '87.

Inclination of Ecliptic to Equator by 29, '86.





sin c : sin b = sin C : sin B

Sun's δ = 9° 18' 16"
Inclin Eq = 23° 27' 6"

c = 90° − 9° 18' 16" = 80° 41' 44" = 80.7° } log sin c =
b = 90° = 90.0° } log sin b =
C = 90° − 23° 27' 6" = 66° 32' 54" = 66.5° } log sin C =

$$\sin B = \frac{\sin b \sin C}{\sin c}$$

log sin C = 9.9624
log sin c = 9.9943
log sin B = 9.9681
B = 68.3°

90.0°
68.3°
21.7°

Inclin Equator to Ecliptic = 21.7°

Plate 132 Full Moon

Cash B plate Exp to Moon Sept. 13, '86. see small pg note book
Moon Diff of Exp Exp Days Dew fresh dew. 5- min.

Moon	Diff of Exp	Exp	Days
8	32	64	64
4	16	32	32
2	8	16	16
1	8	8	8

Plate 134 Full Moon (same conditions)

16	63	126	126
8	31	63	63
4	16	32	32
2	16	16	16

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Tues. June 21. 87

Diam small aperture Photometer reads 3.6 mm
" large " " " " 6.3

3.6	63
36	63
216	189
108	378
1296	3969

Ratio about 1 to 3.

Large aperture 1/4 as bright as Standard Candle ∴ Small = 1/4 C.P.

13

~~17.2~~	21.0	~~16.0~~
22.1	16.3	13.9
17.0	2 | 37.3	2 | 39.9
3 | 56.3	18.6	20.0
18.8		

log 18.6 = 1.2695
log √3 = .2386
~~1.8469~~
~~7.03~~
1.5081
32.2

log 20.0 = 1.3010
log √3 = .2386
~~1.8784~~
1.5396
34.6

18.8	
18.8	
32.2	
34.6	
4 | 104.4	
26.1	

Allowing twice the weights to the comparative uniform small aperture readings we get 26.1 inches for that aperture or 5-2.2 in. for a standard candle.

Reduction of all the Readings to the distance it would be required to place a standard candle.

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log	21.0 = 1.3222	16.3 = 1.2122	26.0 = 1.4150	13.9 = 1.1430
	.2386	.2386	.2386	.2386
	1.5608	1.4508	1.6536	1.3816
	36.4	28.2	45.0	24.1

No	Secs.	Aper	Reading		Equiv. reading for smaller Aper	Equiv. reading Candle
1		6.3	26.0	45.0	45.0	
2		6.3	13.9	24.1	24.1	
3	110	6.3	21.0	36.4	36.4	
4	122	6.3	16.3	28.2	28.2	
5	133	3.6	17.2	34.4	17.2	
6	154	3.6	22.1	44.2	22.1	
7	180	3.6	17.0	34.0	17.0	
				246.3		
				35.2		

log	26.0 = 1.4150	13.9 = 1.1430	21.0 = 1.3222	16.3 = 1.2122
log V3	= .2386	.2386	.2386	.2386
	1.1764	.9044	1.0836	.9736
	15.0	8.02	12.1	9.41

No	Secs	Aper	Reading	Equiv. reading Small Aper.	Equiv. reading Candle
1		6.3 mm	26.0 in.	15.0	30.0
2		"	13.9	8.0	16.0
3	110	"	21.0	12.1	24.2
4	122	"	16.3	9.4	18.8
5	133	3.6	17.2	17.2	34.4
6	154	"	22.1	22.1	44.2
7	180	"	17.0	17.0	34.0
					7 | 201.6
					28.8 in

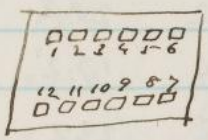
Equiv. dist of Candle 28.8 inches.

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Sah. Dec. 10, 1887.

The two following plates exposed by Mr. Serrick about Sept. 13, 87, and numbered of him 127, +6148 are renumbered in my series P 137, & P 136. Mr. Serrick says, "The exposures on the plates were 2, 4, 8, 16, 32, 63, 126, 252, 11, 22, 45 and 90 secs. in the order named, the second row of six squares being made in the opposite direction thus —"



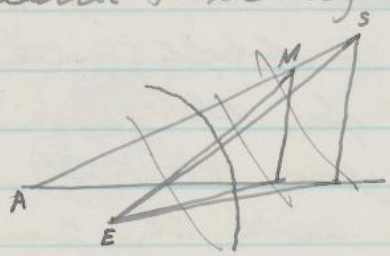
The exposures were made with the 2 mm. aperture, and plate P 137 was the plate used exclusively for the Eclipse measures.

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Oct. 8, '87.

Breadth & velocity of shadow at Grenada



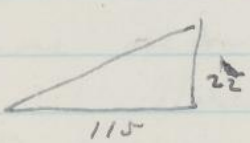
1.9h 20m

Northern limit	13°	2.8
Southern "	11	13.2
	109.6′ =	1° 49.6′
	18.2	
	127.9	

Shadow 125 miles wide

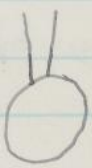
* Eclipse of Jan. 1, 1889.

Northern limit	40 30.6	121 8.7
Southern "	38 52.4	121 42.2
	1 38.2	33.5′ = 22 miles
	98.2′	
	16.4	
	114.6	



Breadth shadow about 120 miles

Major axis of ellipse of shadow about 140 miles, traversed in 120 secs.



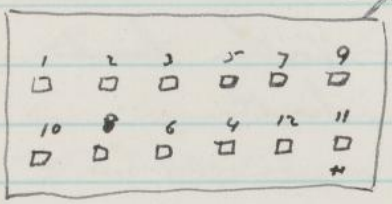
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Sept. 27, 1887.

Measurement of Eclipse Plate.

Comparison Plate 127 E.



Adopting these numbers for the squares Mr. Levick gave them the following squares with the 2 mm aperture.

1	2	3	4	5	6	7	8	9	10	11	12	Nos.
2	4	8	11	16	22	32	45	63	90	126	172	Dys.

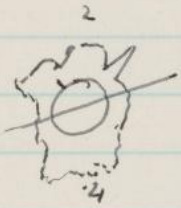
Eclipse Plate 106 (Area 4 squares on it)

Squares (106)	Squares (127)	Days (meas.)	Days (comp.) (÷ 164)
1	too faint		2
2	1.1	2.2	4
3	2.1	4.4	8
4	2.0	4.0	16

Lightest portion of Corona (1) next to limb 3.5 sq. = 19 days Darkest portion (2) + (3) 6.2 sq. = 24 days.

Nov. 7th '87.

Numbering of Coronal regions.



The actual comparison of the standard squares with the corona pictures was made as follows:- Paper masks are cut to fit over standard squares & are glued down ~~thus~~ on the glass side of plate thus:-

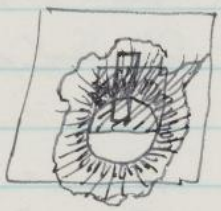


The ~~large square~~ number "3" refers to the number of the standard square. The large square is of paper, & has a long narrow slot in it, placed over the standard (shaded) square. The standard plate so prepared is compared with the

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corona plate as follows:- The middle portion of the slot becomes opaque owing to the superposition of the standard square & the corona. The lower end of the slot is obscured only by the standard square. The upper end of the slot is obscured only by the corona. A comparison is made between them, & the distance from the edge of the moon to the top of the square is noted & reduced to minutes of arc. The nearer the corona to the limb of the moon, the more accurate the comparison.



Measurements of other portions of the corona

Standard square No 6 (22 days)		Standard square No 5 (16 days)	
Region of corona 1	too faint	Region 1	1′
2	1′	2	4′
3	too faint	3	2′
4	" "	4	1.5′

Standard square No. 4 (11 days)		Standard square No. 3 (6 days)	
Region 1	2′	1	4.5′
2	5′	2	10′
3	4′	3	8.5′
4	2.5′ (cloud interferes)	4	cloud interferes

[Illegible] 5 days

Shy 2° faint trace less than sk. sq 1 & would meas ~~less than~~

All measures of the square & sky are absolute. Measures of the corona show the excess of light over the sky in front of moon.

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Nov. 4 '87.

Plate 115. Measurements made Sept. 27, '87.

Squares 115	Squares 115	Days (meas.)	Days (exp. p. 168)	Remarks
1	1.1	2.2	2	
2	1.1	2.2	4	
3	2.0	4.0	8	
4	2.7	6.3	16	
5	too faint		2	film decomposed
6	1.2	2.4	4	" "
7	1.9	3.8	8	" "
8	2.7	6.3	16	" "

Height of cloud 16° from Sun = square 1 (about) = 2 days
" " " " " = " 2 " = 4 days
Brightest portion of corona (region 1) next limit = 6.2 about 24 = 25 days
Darkest " " " " 2 3 & 4 " " 7.1 " = 33 days

Measurement of other portions of the corona.

Standard square No 6 (22 days)

Region 1	1'
2	3'
3	3'
4	4'

Standard square No 5 (16 days)

Region 1	4'
2	9'
3	6'
4	7'

Standard square No. 4 (11 days)

Region 1	8'
2	13'
3	11'
4	9'

Standard square No. 3. (8 days)

Region 1	12'
2	26'
3	23'
4	19'

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Ons. Nov. 8, '87.

Plate 116. Measurements made this date.

Height of clouds 8° from Sun = dr. sq. 2.0 = 4 days.
" " obj. 8° to 8° " " = " 2.7 = 6.5 days.
" " " 9° " " = " 1.1 = 2.2 days.

In the latter measurement the part of the plate measured is somewhat decomposed, & therefore not so much weight should be attached to the measurement.

Measurements of density of corona at limit.

Region 1 5.7 dr sq = ~~days~~ 20 days
2 5.3 18 " Confused when corona overlaps moon
3 5.3 18 " " " " " " "
4 6.5 26 "

Comparison of overlapping part above, with moon direct.
1.7 dr. sq. = 3.5 days This correction should be added to all readings in the "2" & "3" regions of the corona
Making this correction above we obtain:-

Region 1 20. days
2 21.5 "
3 21.5 "
4 26. "

Measurement of other portions of the corona

Standard square No 6 (22 days)
Region 1 too faint
2 "
3 "
4 3'

Standard square No 5 (16 days)*
Region 1 2.5
2 1
3 4
4 6.

* 3½ days must be added for region 2 & 3.

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Tues. Nov. 8, '87.

Plate 116 continued.

Standard square No 4 (11 days)*		Stand. square No 3 (8 days)*	
Region 1	4.5'	Region 1	7.5'
2	5.'	2	9.'
3	6.5'	3	6.'
4	10.'	4	15.'

Standard square No. 2 (4 days)	
Region 1	20'
2	25'
3	20'
4	27'

The comparisons in this series were made with that portion of the moon not overlapped by the corona, hence no corrections are necessary.

In measurements of the outer corona two difficulties are encountered impairing their value. (1) The parts to be compared are so remote. (2) The varying density of the corona between them gives a strong contrast effect. This latter might be remedied by covering the inner corona with a piece of paper.

*3½ days must be added for region 2 & 3.

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Ours. Nov. 8, '87.

Plate 118 Measurements made Sept. 20, '87.
Height of clouds 15° from Sun = alt. eq. 2.2 = 4.7 days
" " alt 7° " " = " 2.9 = 7.5 "

Squares (118)	Squares (127)	Days (meas)	Days (wt) (p. 165)	
3	too faint		8	
4	1.	2.	16	Evidently
5	1.8	3.7	32	this
8	too faint		8	plate
9	.9	1.8	16	was
10	1.	2.	32	restrained.

Plate 119 Measurement made Sept. 20, '87.
Height of alt 5°±20° from Sun = alt. eq. 2.5° = 5.8 days

Squares (119)	Squares (127)	Days (meas)	Days (wt) p. 164	Remarks	
1	2.9	7.5	16	Somewhat foggy	
2	3.8	10.6	32	"	"
3	5.3	18.	63	"	"
4	5.6	20.	125	"	"
5	5.9	21.5	251	"	"
6	2.8	7.1	16	Badly	"
7	2.9	7.5	32	"	"
8	3.0	8.	63	"	"
9	3.1	8.3	125	"	"
10	3.6	9.6	251	"	"

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Tues. Nov. 8, '87.

Discussion of Results.

The plates were in part decomposed so that the squares did not come out uniform. Using plates 106 & 115 which were used without restrainer, & considering only the two middle squares which seem generally to be the most regular we get the following results

Plate	Squares	Days (meas)	Days (exp)
106	2	2.2	4
"	3	4.4	8
115	2	2.2	4
	3	4.0	8
	6	2.4	4
	7	3.8	8
Mean of 1st 3d & 5th		2.3	4
Mean of 2d 4th & 6th		4.1	8
Double Addenda		4.6	8
		8.7	16

87) 160. (1.84
87
730
696
340

Sensitiveness of Standard plate (127) is 1.84 times eclipse plates, hence the number of days measured by standard plate must in each case be multiplied by 1.84 or 1 5/6

Applying the same process to 118.

Squares (118)	Days (meas)	Days (exp)
4	2.	16.
5	3.7	32.
9	1.8	16.
10	2.	32.

Mean of 4 & 9 1.9 16.
" " 5. & 10 ÷ 2 = 1.85 16.

19) 160 (8.4
152
80

Sensitiveness correction 8.4

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Tues. Nov. 9, '87

Sensitiveness correction to plate 119

Repeated measurement of square

Square (119)	Square (127)	Days (meas)	Days (exp.)	
1	3.0	8	16	Three measurements
2	4.0	11	32	compare fairly
3	5.3	18	63	with those re-
4	5.9	21	125-	corded on page
5-	5.8	20.5-	25-1	181. The sensi-
6	2.8	7	16	tiveness of the
7	2.9	7.5-	32	plate must be
8	3.0	8	63	determined by a
9	3.3	9	125-	study of the
10	4.3	12.5-	25-1	first four.

Days meas	Days exp.	Ratio	
8-	16	.50	Sensitiveness ratio = $\frac{1}{32}$ = 3.1
11	32	.34	
18	63	.29	
21	125-	.17	
		4 | 1.30	
Sum		.32	

Repetition of plate 118 (see p. 181)

Square (118)	Square (127)	Days (meas)	Days (exp.)
3	.4	1.	8
4	1.1	2.2	16
5-	1.8	3.5-	32
8	.5-	1.	8
9	.9	1.9	16
10	1.0	2.	32

Height of alcohol 20° mean 8 days. 2.0 = 4 days. Height alcohol at 5.0°

" " " 22° " both 3 & 4 " 2.2 = 4.7 " " 5.6

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Tabulated Results.

Subject	Plate	Page	Measured	Gens.	+ dev. correction	Dim correction	Abs. ratio corr.
Sky 16° dist.	115⁻	178	4 days	× 1.84 = 8 7.4	÷ 2 sec = 3.7	÷ 7140 = .000520	days
" 5°–8°	116	179	6.5 "	× 1.84 = 16 11.96	÷ 8 sec = 1.5	÷ 7140 = .000210	"
" 2° 5° & 22°	118	183	~~9.5~~ 7.5 "	× 8.4 = 89 ~~39.48~~ 63.0	÷ 100 sec = 39	÷ 23100 = .000~~17~~ 27	"
" 5° & 20°	119	181	~~11~~ 5.8 "	× 3.1 = 125 17.98	÷ 40 sec = .45	÷ 23100 = .000019	"
" 2°	106	177	.5 "	× 1.84 = 1.4 .92	÷ 2.5 sec = .37	÷ ~~1406~~ 1024 = .000361 ~~.000263~~	"
Clouds 16°	115⁻	178	2 "	× 1.84 = 3.2 3.7	÷ 2 sec = 1.85	÷ 7140 = .000260	
" 8°	116	179	4 "	× 1.84 = 8.0 7.4	÷ 8 " = .92	÷ 7140 = .000129	
" 15°	118	181	4.7	× 8.4 = 9.5 39.48	÷ 100 " = .39	÷ 23100 = .000017	

Corona (inner edge)	106	19.	× 1.84	= 34.96	÷ 2.5 sec = 13.98	÷ 1406. = .00 ~~99~~	
"	"	24.	"	= 44.16	÷ " = 17.66	" .0126	
"	115⁻	23⁻	"	= 46.00	÷ 2 sec = 23.00	÷ 7140. = .0032	
"	"	33.	"	= 60.72	" = 30.36	" .0042	
" (1)	116	20.	"	= 126. 36.80	÷ 8 sec = 4.60	" .000644	
" (2+3)	"	21.5⁻	"	= 39.56	" = 4.94	" .00069	
" (4)	"	26.	"	= 47.84	" = 5.98	" .00084	
Corona (other portion)	106	22	"	= 40.48	÷ 2.5 = 16.19	÷ ~~1406~~ 1024 = ~~.0115~~ .0159	
"	"	16	"	29.44	" = 11.78	" ~~.0084~~ .0116	
"	"	11	"	20.24	" = 8.10	" ~~.0058~~ .0079	
"	"	8	"	14.72	" = 5.89	" ~~.0042~~ .0058	
"	115⁻	22	"	40.48	÷ 2 = 20.24	÷ 7140 = .0028	
"	"	16	"	29.44	" 14.72	" .0021	
"	"	11	"	20.24	" 10.12	" .0014	
"	"	8	"	14.72	" 7.36	" .0010	
"	116	22	"	40.48	÷ 8 = 5.06	" .00070	
"	"	16	"	29.44	" 3.68	" .00052	
"	"	11	"	20.24	" 2.53	" .00035	
"	"	8	"	14.72	" 1.84	" .00026	

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Absorption correction Dew cor.

day	×1.66 =	·87 mildew		·85
"	"	·35	×2 = .70	·50
"	"	·04		·06
"	"	·03		·02
"	×1.40 =	~~·37~~ ·51		·80
60	× 1.66 =	·44		·38
29	"	·22	× 2 = .44	·24
17	"	·03		·07
9	× 1.40 =	~~13.9~~ 9.9		
6	"	~~17.6~~ 12.6		
2	× 1.66 =	~~5.4~~		
2	"	~~7.0~~		
F4	"	1.1	× 2 = 2.2	3.8
9	"	1.2	" 2.4	7.8
4	"	1.4	" 2.8	
	× 1.40 =	~~22.3~~ 22.3		22 3.
	"	~~16.2~~ 16.2		27.
	"	~~11.2~~ 11.2		18.
	"	~~8.1~~ 8.1		11.
8	× 1.66 =	~~4.7~~		47.
1	"	3.5		6.
	"	2.4		3.8
	"	1.7		2.3
70	"	1.16	× 2 = 2.32	11.6
52	"	·87	1.74	1.4
45	"	·58	1.16	.9
26	"	·44	~~·88~~	.6

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Tabulated Result Continued.

Subject	Plate	Meas.	Sens+obs. cor.	Time cor.	Aper. cor.	Obs. cor.	Result
Corona (other portion)	116	19.5 dyp	× 1.84 = 35.88 ÷ 8 = 4.48 ÷ 7140 =	.00063	× 1.66 =	1.05 mlds	
"	"	14.5 "	"	26.68	" 3.34 "	.00047 "	.79 "
"	"	11.5 "	"	21.16	" 2.64 "	.00037 "	.61 "
"	"	4.0 "	"	7.36	" .92 "	.00013 "	.21 "

The second developer correction was made to Plate 116 because it had no squares to judge by, & as the dark parts had faded more than the light, the best thing to judge by was the sky & clouds. The factor 2 brings these to the mean of the other two plates.

On obtaining lens of 3 in telescope I find its aperture is 7.8 cms and its focus 122.0, hence its Aper. per cent 3.20 and its Aper. cor. = 1024.

122) 390 (03.20
366
240
122
1180

Subject	Plate	Squares	Meas	Sens+obs. cor.	Time cor.	Aper. cor.	Obs. cor.	Result
Corona minus edge	106	(1)	5.1	16.5	× 1.84 = 30.4 ÷ 2.5 =	12.2 ÷ 1.024 =	12.0 mlds	× 1.40 = 16.8 mlds
"		(2)	6.1	23.0	"	42.3	" 16.9 "	16.6 "	23.2
"		(3)	5.8	20.5	"	37.7	" 15.1 "	14.8 "	20.7
"		(4)	5.5	18.5	"	34.0	" 13.6 "	13.3 "	18.6
"	115	(1)	6.1	23.0	"	42.3	2 = 21.2	7.140 20.7 3.0	1.66 5.0
"		(2)	7.0	32.0	"	58.9	" 29.4 "	28.7 4.1 "	6.8
"		(3)	6.3	25.0	"	46.0	" 23.0 "	22.4 3.2 "	5.3
"		(4)	7.0	32.0	"	58.9	" 29.4 "	28.7 4.1 "	6.8

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Calculation of Tabulated Results

(2) Dav. cor.

× 2 = 2·10 milds 3·

" 1·58 " 1·5

" 1·22 " 1·0

" ·42 " ·5

714.) 37.00 (.052
3570
1300

231.) 630 (.0027
462
1680

32) 110 (·344
96
140
128
120

60) 180 (.29
126
540

125) 210 (·17
125
850

4 | 1.84
46.

1.84
33
5522
5522
6072

1406.) 3700 (.000263
2812
8880
8436
4440

215
184
860
1720
215
3955-60

1406.) 11.780 (.0084
11248
5320

1.84
19.5
920
1656
184
3580

1.84
145
920
736
184
26680

1.84
115
920
184
184
21.160

5·8
174
1798

47
141
1457

84
4.7
588
336
3948

231) 39 (17
231
1590
1617

231) 450 (19
231
2190

7140.) 23.000 (.0032
21420
15800

1406.) 13.98 (.0099
1406
800

7140.) 4.6000 (.64
42840
31600
7140

7140.) 5.9800 (.00084
5120
26800

7140.) 20.240 (.0028
14280
59600

7140.) 4.4800 (.00063
42840
19600

7140.) 33400 (.0047
28560
48400

1.84
184
1104
184
2944

7140.) 1.5000 (.000021
14280
7200
7140
600

1406.) .9200 (.00065
8436
7640

7140.) .9200 (.000129
7140
20600
14280
63200

7140.) 30.360 (.42
28560
18000

1406.) 13.98 (.0099
1406
800

7140.) 4.9400 (.69
42840
6560

1406.) 16.18 (.0115
1406
2130
1406
7240

7140.) 14720 (.206
14280
44000

7140.) 26400 (.0037
21420
49800

7140.) .9200 (.00013
7140
20600

184
19
1656
184
3496

1.84
24.
736
368
4416

1406.) 34.96 (.025
2812
6840

1406.) 44.16 (.0314
4218
19800
1406
5760

1406.) 17.66 (.0125
1406
3600
2812
7880

368
368
4048

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Remeasurement of Plates

Nov. 25–'87.

for Corona north limb of Moon

Position	Plate	Stand squares	Degs
1	106	5.1	16.5
2	"	6.1	23.0
3	"	5.8	20.5
4	"	5.5	18.5
1	115	6.1	27.0
2	"	7.0	32.0
3	"	6.3	25.0
4	"	7.0	32.0

Plate 119

Measurement of squares where least fogged.

Squares 119	Squares 127	Degs (mean)	Degs (real)
1	3.3	9.	16
2	4.3	12.	32
3	5.7 (clear)	20.	63
4	6.0 (fogged)	22.	125
5	6.0 (much fogged)	22	251

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Calculation of Tabulated Results

520	263	126	115	84	58	1024	23)63(27
173	526	25	23	17	116	261	161
173	526	25	23	17	116	61440	170
866	368		161	118	81	30720	161
						1024	
						36/96	

361	159	116
140	14	14
1444	636	464
361	159	116
5054	2226	1624

$\log 165 = 1.2175$ $\log 230 = 1.3617$ $\log 205 = 1.3118$ $\log 185 = 1.2672$ $\log 210 = 1.3222$ $\log 250 = 1.3979$

$\log 1.84 = 0.2648$ 0.2648 0.2648 0.2648 0.2648 0.2648

1.4823	1.6265	1.5766	1.5320	1.7699	1.6627
30.4	42.3	37.7	34.0	58.9	46.0

714)212(.297 1428 6920 6426 494

714)294(41 2856 840

714)230(32 2142 1580

28	664	542	532	166	332
14	166	148	133	664	498
	2324	207	186	581	531

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Revised Tabulated Results.

Subject	Plate	Page	Measured Coord.	log.	Corresp. numb.	Time correct.	Aper. correct.	
Sky 16° dist	P 115	178	4 lags	.90 .83	68	÷ 2 = 34 ÷	7140 =	.00048
" 5 & 8° dist	116	179	6.5 "	1.20 1.09	12.3	8	1.5 "	.00021
" 2° dist	106	177	.5 "		.75	2.5	.30 1024	.00029
Corona cusp edge (1)	106	188	16.5 "	1.67 1.72	52.5	2.5	21.0 1024	.0205
" (2)	"	"	23.0	1.87 2.03	107.2	"	42.9 "	.042
" (3)	"	"	20.5	1.81 1.93	85.1	"	34.0 "	.033
" (4)	"	"	18.5	1.76 1.83	67.6	"	27.0 "	.026
" (1)	115	"	23.0	1.87 2.03	107.2	2.	53.6 7140	.0075
" (2)	"	"	32.0	2.08 2.41	257.0	"	1285 "	.0180
" (3)	"	"	25.0	1.91 2.12	131.8	"	65.9 "	.0092
" (4)	"	"	32.0	2.08 2.41	257.0	"	128.5 "	.0180
Corona (other portions)	106	177	22.0	1.84 1.99	97.7	2.5	39.1 1024	.0381
"	"	"	16.0	1.64 1.70	50.1	"	20.0 "	.0195
"	"	"	11.0	1.44 1.43	26.9	"	10.8 "	.0105
"	"	"	8.0	1.29 1.21	16.2	"	6.5 "	.0063
"	115	178	22.0	1.84 1.99	97.7	2	48.8 7140	.0068
"	"	"	16.0	1.64 1.70	50.1	"	25.0 "	.0035
"	"	"	11.0	1.44 1.43	26.9	"	13.4 "	.0019
"	"	"	8.0	1.29 1.21	16.2	"	8.1 "	.0011

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Abs. corrct. Millidyn

× 1.66 =	.00080	× 1000 =	.80
"	.00035	"	.35
1.40	.00041	"	.41

1.40	.0287	1000	28.7
"	.0588	"	58.8
"	.0462	"	46.2
"	.0364	"	36.4
1.66	.0125	"	12.5
"	.0300	"	30.0
"	.0154	"	15.4
"	.0300	"	30.0
1.40	.0533	"	53.3
"	.0273	"	27.3
"	.0148	"	14.8
"	.0088	"	8.8
1.66	.0114	"	11.4
"	.0059	"	5.9
"	.0031	"	3.1
"	.0019	"	1.9

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Lab. Dec. 10, 1887.

Study of Logarithmic Curve Plate III

Meas. days	Log Eclipse plate	Log Stand plate	Diff Log.	Corresp. number
3.	.73	.48	.25	1.78
9.	1.33	.95	.38	2.40
15.	1.61	1.18	.43	2.69
21.	1.82	1.32	.50	3.16
27.	1.96	1.43	.53	3.39
33.	2.10	1.52	.58	3.80

The last column gives the ratio of sensitiveness of the plates for the Measured days in the first column.

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Calculation of Tabulated Results.

714.) 3.4000 (.00048 — 2856 — 5440

714.) 15.00 (21 — 1428 — 720

1024) 4290 (.042 — 4096 — 1940

1024) 3400 (33 — 3072 — 3280

714.) 5.360 (75 — 4998 — 3620 — 3570

714.) 12.85 (.018 — 714 — 5710 — 5712

714.) 6.58 (.0092 — 6426 — 1640 — 1428

714.) 4.880 (.0068 — 4284 — 5960

714) 25.00 (35 — 2142 — 3580

714.) 13.40 (19 — 714 — 6260

714.) .810 (.0011 — 714 — 960

29 — 14 — 116 — 29 — 41 — .0205 — .02870

14 — 42 — 28 — 56

14 — 33 — 42 — 72

14 — 26 — 84 — 28

14 — 381 — 14 — 112 — 42

14 — 195 — 70 — 126 — 14

14 — 106 — 84 — 14

14 — 63 — 42 — 84

1.66) 7140.00 (4301. — 664 — 500 — 498 — 200

1.40) 1024.00 (731. — 980 — 440 — 420 — 200

43) 400 (9 3 — 387 — 130 — 9

73) 187 (2 5 6 — 146 — 410 — 365 — 450

73) 296 (405 — 292 — 400

73) 258 (35 3 — 219 — 390 — 365 — 250

73) 230 (315 — 219 — 110 — 73 — 370

43) 370 (860 — 344 — 260 — 258 — 20

43) 601 (140 — 43 — 171 — 172 — -10

43) 406 (94 — 387 — 190

~~43) 730~~ 73) 277 (38 — 219 — 580 — 584 — -40

73) 174 (24 — 146 — 280 — 292 — -120

73) 110 (15 — 73 — 370 — 365 — 50

73) 28 (10) — 73 — 500

43) 346 (805 — 344 — 200

43) 218 (5 — 215 — 50

43) 138 (3 — 129 — 90

43) 98 (23 — 86 — 120

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Lab. Dec. 10, 1887.

Revised Tabulated Results.

Subject	State	Mags	Measdgs	Coeff. by	Corresp. number	Time correct	Mechs. Aperture	obscn
Sky	16° dist	115°	178	4	.90	7.9 ÷ 2 = 4.0	÷4300 =	.93
"	5°-8° "	116	179	6.5	1.20	15.8	8	2.0	"	.46
Corona inner edge	(1)	106	188	16.5	1.67	46.8	2.5	18.7	730	25.6
"	(2)	"	"	23.0	1.87	74.1	"	29.6	"	40.6
"	(3)	"	"	20.5	1.81	64.6	"	25.8	"	35.3
"	(4)	"	"	18.5	1.76	57.5	"	23.0	"	31.5
"	(1)	115°	"	23.0	1.87	74.1	2	37.0	4300	8.6
"	(2)	"	"	32.0	2.08	120.2	"	60.1	"	14.0
"	(3)	"	"	25.0	1.91	81.3	"	40.6	"	9.4
"	(4)	"	"	32.0	2.08	120.2	"	60.1	"	14.0
Corona other portion		106	177	22.0	1.84	68.2	2.5	27.7	730	37.9
"		"	"	16.0	1.64	43.6	"	17.4	"	23.9
"		"	"	11.0	1.44	27.5	"	11.0	"	15.1
"		"	"	8.0	1.29	19.5	"	7.8	"	10.7
"		115°	178	22.0	1.84	68.2	2	34.6	4300	8.0
"		"	"	16.0	1.64	43.6	"	21.8	"	5.1
"		"	"	11.0	1.44	27.5	"	13.8	"	3.2
"		"	"	8.0	1.29	19.5	"	9.8	"	2.3

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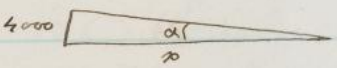
Sat. Dec. 10, 1887.

Apparent Semidiameter of the Moon

Sun's true semid. 15′ 50.8″

Moon's " " 16 42.4

" equa. hor. parallax 61 21.7



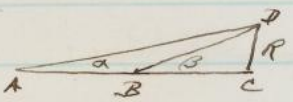
$\tan \alpha = \frac{4000}{p}$ $\therefore p = \frac{4000}{\tan 61' 22''}$

log 4000 = 3.6020600

log tan 61′ 22″ = 8.2517048

5.3503552

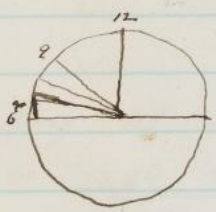
224060 miles



$\sin \alpha = \frac{R}{AC}$ $R = AC \sin \alpha$

$\sin \beta = \frac{R}{BC}$ $R = BC \sin \beta$

$\sin \beta = \frac{AC}{BC} \sin \alpha$



1 hour = 15° 1 hour 15 min = 19°

$\sin 19° = \frac{p}{4000}$ $\therefore p = 4000 \sin 19°$

log 4000 = 3.6021

log sin 19° = 9.5126

3.1147

1300 miles

224060 = AC

1300 = AB

222760 = BC

log BC 5.3478372

~~$\sin \beta = \sin \alpha \frac{AC}{BC}$~~

~~log sin α = log sin 16′ 7″~~

log sin 16′ 42.″ = 7.6864480

log 224060 = 5.3503552

a c log 222760 = 4.6521628

7.6889640

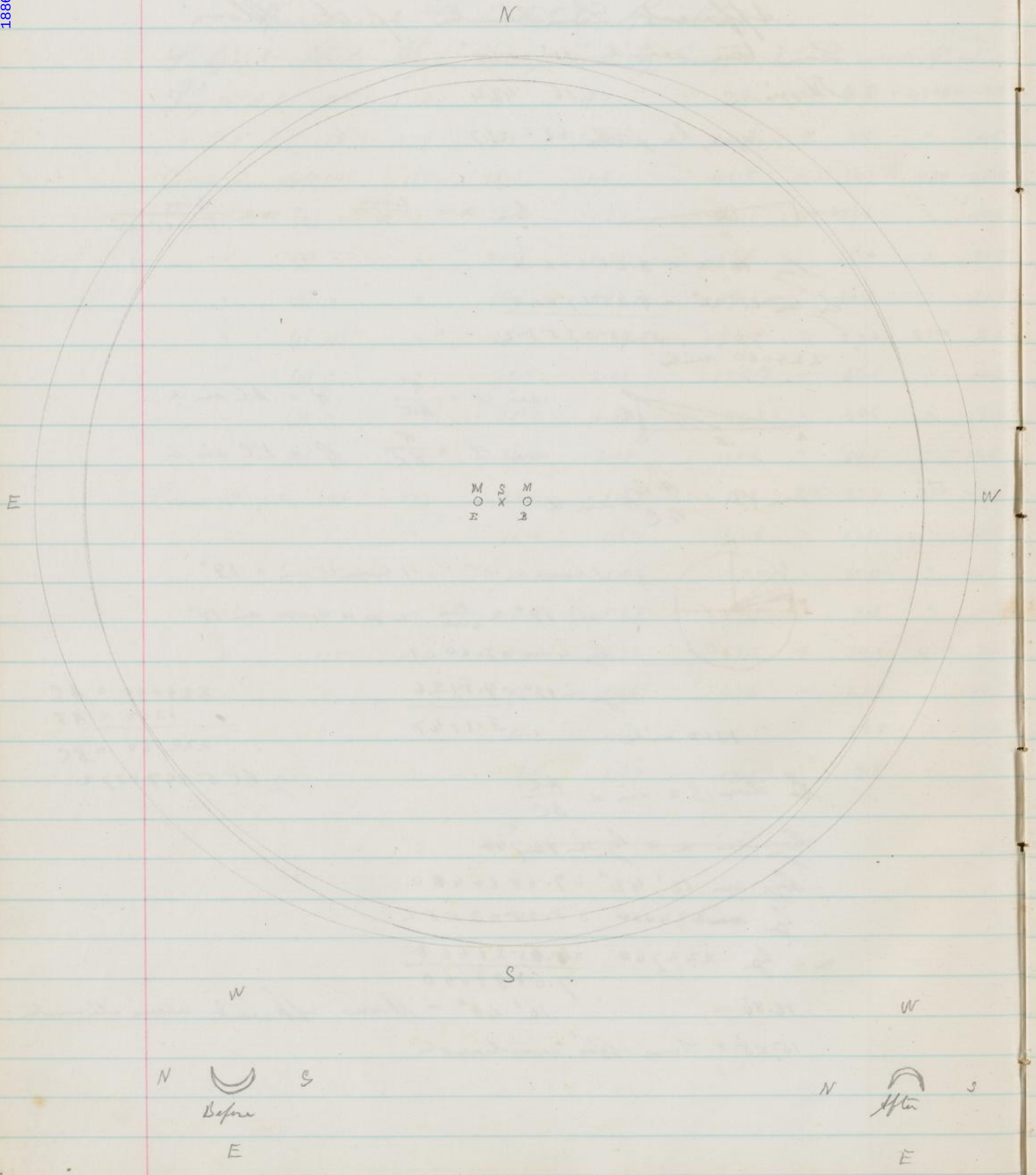
16.86′ = 16′ 48″ = Moons apparent semi diameter.

15.85′ = Suns apparent semidiameter

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1886phae.proj.1155P

Lab. Dec. 10, '87.



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At the beginning of Totality the whole of region 4 of the Corona was seen out to the edge of the sun. At the end of Totality the whole of region 2 was visible. Plate 106 therefore ends to ~~gibble~~ 2 ~~the brightest~~ its full brightness, & Plate 115 gives the full brightness to 4.

Apparent Moon 16.80'
" " Sun 15.85'
Difference .95'

Amount Moon laps over Sun at contacts } 2 / 1.90'

Position Central Line.

long 69° 35' lat 11 16
" 60 22 12 8
9° 13' 52'

long Fort 61° 45' lat 12° 3'
long central 60 22 12 8
1° 23' 5'

9 13 = 553'
1 23 = 83'

83) 553 (6.67 = 20/3 ∴ ratio = 3/20
498
550
498
57

52' × 3/20 = 156/20 = 8'

12° 8' − 8' = 12° 0' = lat. of central line where it crosses the meridian of ~~the~~ Fort St. George.

We were therefore 3' north of the central line.

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Sat. Apr. 21, '88.

3.001 1" = .00000485

206265" = radius

206.26" = rad. standard aperture.

Taking that area of the corona between 40' radius & 16' radius its average intensity is about 8. millidays.

The quantity of light in the region = $\pi(40^2 - 16^2).008$ days

The quantity in 1 day = $\left(\pi\left(\frac{206}{60}\right)^2\right)1.$

$$\frac{\pi(40^2-16^2).008}{\pi\left(\frac{206}{60}\right)^2} = \frac{60^2(40^2-16^2).008}{206^2} = \frac{3^2(1600-256).008}{10^2}$$

$$\frac{9. \times .008 \times 1350.}{100.} = .97 \text{ days}$$

Probably the total light of the corona does not exceed 3. days

1350.
.072
2700
945
97.200

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