

KG
11365
187

H.33

Equatorial
March 15 1860 to
March 29 1860

Sold by T. Groom & Co., Stationers, India Building, 62 State St., Boston.

KG-11365,187

12, 31

- 10, 44

Photography

Supplement no of April 1874 4 at 1000

Experiments

1870 - June 14

Used a thermometer bulb with polished on the
 the bulb was a by using a black ground glass
 of glass white. (The white with was laid on a surface of
 polished). Then placed a moderate lamp at a dis-
 tance of 2 feet from mirror and arranged from
 same point a lamp was obtained the relative
 quantities of light obtained by white disc and
 the same reflected from bulb. placing both end of
 glass so as to form lines of equal apparent diameter.
 then increased size of disc until the light from it
 was that from mirror on bulb. Both being at equal dis-
 tance from the lamp & eye. Having equated all by mirror
 the size of disc found it when equal. Distance = 0.40

Size of thermometer bulb surface of glass = 0.31

The diameter of illuminated surface from which mirror of the
 light was now been reflected was found to be 0.38

distance = 0.40 for distance of glass

43
15

KG 11365.187



Photometry

1860 March 14

Placed a thermometer bulb, ^{ordinarily} well polished, on a dead
 blue-black screen, & by side of it on black ground a disc
 of flake white (very white water color laid on as dense as
 possible) Then placed a "moderate lamp" at a dis-
 tance of 11 feet from screen and examined from
 same point where lamp was stationed the relative
 quantities of light returned by white disc and
 the image reflected from bulb. placing both out of
 focus so as to form discs of equal apparent diameter:
 then increased size of disc until the light from it equ-
 alled that from image on bulb. Both being at equal dis-
 tances from the lamp & eye. Having equalised ill. by increas-
 ing size of disc found it when equal. $\text{Diam} = 0.146$

Bulb of thermometer outer surface of glass .. = 0.324

The diameter of mercurial surface from which most of the
 light must have been reflected was probably 0.304
 allowing ^{0.010} 0.005 for thickness of glass.

Spent 1 or 2 days trying to exclude daylight from
dome or some part of it so as to be able to compare
Sun & Jupiter met with many discouragements

Photometry

1960 March ¹⁴/₁₅

Put on aperture of 0.022^{in} on Great Telescope
& adjusted disc of 0.044^{in} at solar focus - Same
as used for Jupiter

March ¹⁵/₁₆

Experiments initiated by stray light

Subsequently & before experiments on 17th had a
bag made of 6 thicknesses of black cambric effectually
excluding stray light. Perfectly dark after eye has
outstayed 10^m or 15^m enclosed in it.

The cover of object glass has 4 thicknesses
of stout paste board.

Venus

1860 March 15th

very bad definition

4, 45 sid. 4.

Was seen with the naked eye first
 by H P Tuttle from knowing approx.
 place at $4 \frac{3}{4}$ and then by A H. and S.C.
 Very unsatisfactory from bad definition
 Is gibbous by about $\frac{1}{4}$ $cb = \frac{1}{4} ac$

with neither

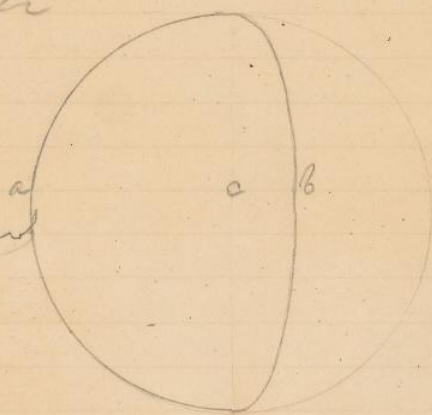
141 nor 401

could I

or even

dustiness

to bad



see any spot

any trace of

owing perhaps

vision

S.C.

Jupiter

1860 March 30^{15th}power 141
excellent definition

At 6^h 53^m (236) (clock striking in town) caught sight of a β 7^h 14^m dusky roundish spot near upper part of belt though not with α certainly α & in drawing round dark spot (shadow) of β just on edge ball thus



6.57 moment of admirable vision during which could not see satellite - the dusky spot noticed before belongs to belt - 7^h 7^m notice whitish round spot at β not noticed before 7^h 14^m noticed a faint roundish spot at γ not noticed before

7.18 is shadow perfectly circular? it seems elongated thus $\bullet$ (see egg) 7.25 spot β not visible

7^h 31 I do not think the shadow is as black as sky. I see nothing of satellite anywhere order of brightness at 7^h 31 $\times 1$ $\odot$ $\times 3$

over

Jupiter Continued

160 March ~~22~~ 15th

The vision tonight was admirable but I could not distinguish any trace of the satellite neither white nor dusky. It had entirely disappeared. As I did not know exactly when to search for it I scrutinized closely belt and zone from limb to shadow. Even in moments of best vision I could not follow any of the belts up to limbs the interval where they were invisible was about $\frac{1}{4}$ or $\frac{1}{5}$ of the mean belt.

The vision was such this evening as not to leave me the shadow of a doubt of the total extinction of the satellite. It is curious that tonight for the first time within my remembrance the upper or southern edge of principal belt a & P A A' was straight, without undulations & well defined, while the lower or northern was sagged and spotted. So near Jupiter as before.

I Satellite has always transited on dark S. belt this spring. Saw the shadow as black spot ^{on belt} with definition. When it passed the preceding limb it became dusky & was scarcely discernible. G. P. B.

Photometry

1860 March 15th

Having set the perforated disc having aperture of 0.044 in focus of eyepiece No 2 power 206 by pushing adjustable diaphragm to which the disc is attached $\frac{1}{4}$ inch outside of its sliding tube & by unscrewing the tube carrying the lenses about $\frac{1}{8}$ of an inch outside of its usual place so that the distance of flat end of eyepiece (the part of the telescope furthest from object glass) ~~was~~ distant from the face of the moveable plate carrying the eyepieces ~~was~~ ab in margin - found that ^{to bring} the solar focus to the opening of disc - the micrometer must be screwed towards the object glass until the edge of tube cuts the outer edge of the 0 mark of the "30" this

30

edge

The 30 being just concealed -

At 8^h m.s.t. to 10^h Examined Jupiter with different dark glasses with Power No 2. & the aperture of Object glass 15 in & that of focus 0.044 in solar focus well adjusted

Image easily seen with all the glasses H(1,2,3 & 4) " Seen also with ease when eye has been kept in dark room long enough with D & E both deep red glasses - certainly but not always

Photometry Jupiter

March 15 Cont. Fine clear sky - Cloudless fine & calm -
 without some difficulty with A+M Compounded of a dark
 slightly blueish-grey-white glass^A, & another^M of tint of madeira wine
 red-transmitting three times? light that the other did

The two B and C. together, each of white with a blue-
 ish grey cast. ~~was~~ admitted pretty certain glimpses especially
 when planet was highest. But latterly only strong suspic-
 ions. On the whole I think these together were just the
 limits for eye protected from all light but that of differences
 by 4 & stars - 4 at 70° alt. & sky perfectly clear.

Shall try the above glasses tomorrow, if clear, with
 the sun, using same power throughout =
 At 11^h a.m. s.t.

Next tried disappearance of image of 4 projected on
 a blue-black dead ground = All light but that of planet
 excluded from lens = Object glass ap = 16ⁱⁿ Focus ap = 0.044

Disappearance Obsd. by A.H. P.D.C. J.H.S. Standing at dis-
 tances from 4 to 8 ft from screen by two trials = 7^{ft} 6ⁱⁿ, 8^{ft} 8ⁱⁿ
 Screen from solar focus & aperture } ^{this dif. between these & March 2 is} mainly due to absence of Moon.

I held the screen at some length & fixed on
 nearly same distance within 6ⁱⁿ or 12ⁱⁿ in & pr. or ± 6ⁱⁿ

3rd Found at 11^h 15^m That at a distance of 4 or
5 ft from focus the lines of print in Herschel's outlines were
distinguishable in image-light And on close inspection
the letters of word "Astronomy" could be distinguished
individually with perfect clearness in light-circle of 1st diam
& could be made out, even when image was 1¹/₂ in diam-

G.P.B.

I Virginis (Smyth cccclv)

1860 March 15thpower 141
good vision.well made
as to
nebula

The upper line of nebula seems straight and in the direction of R towards the points a & b where it begins to curve south but this is doubtful on account of the extreme faintness of object here. I can follow it however as far as c to the left and d to the right. Immediately south of c d there seems to be a dark channel but I suspect this is ^{from} contrast, for by looking away to or to see the very faint nebulosity n n n n n it becomes exceedingly narrow and even seems to disappear entirely by moments.

The nebulosity n n n n n is extremely faint and cannot be seen by direct vision except at m m and that with great difficulty.

at x there is an object difficilime I saw it twice distinctly when least expecting it. This is a fine object for studying indirect vision

S.C.

Saturn

1860 March 15th

vision tolerable

12 P.M.

powers 141, 401 and
2004

- Ring A Am not sure of having seen pencil line either with 140 or 401. Had I never seen it before would not have suspected it.

Division of rings It is more plainly seen

(I was interrupted here by and have forgot all about this night's observation — March 17th)

Saturn

Photometry Jupiter

1860 March 16 Fine clear sky 4 Close to meridian

Adjusted clock to sid. motion very accurately - put on diaphragm on color focus = 0.046^{in} - Full aperture of object glass - tried various colored screens A. B. C. different tints

intensities of white with pale blue tint or grey-blue - E

dense bright red F Greenish yellow dense G dense blue

H Yellowish red or orange thin L Blue thin indigo

Could see Jupiter plainly with A & just discern it with entire certainty with A+H and A+L - Easily seen with ~~W. F. G.~~ W. F. G.

though they will not bear much increase of density. E is nearest

to observing planet it though still readily distinguished under it & its red tint strongly evident.

It could not be seen with B+C.

Used throughout Power 206 $7^{\text{h}} 30^{\text{m}}$ to $8^{\text{h}} 30^{\text{m}}$ Sid. time

The central part of Jupiter was placed as usual at centre of focus aperture.

Tried also aperture of 0.011^{in} - same result

Word 'ASTRONOMY' Title page of Herschel's Outlines read by light of dividers one letter at a time

Photometry Sun

Moon

March 17th NoonAperture reduced to 0.022 ^{Focus-} Diaphragm 02044

2 Power 206 adjusted just as for Jupiter - Eyes perfectly
 secured from all light - Centre of Sun in field.

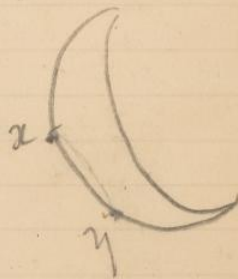
1st Stopped aperture & found ^{when pointed at Sun} absolutely no light
 visible. Then opened aperture of 0.022 & directed teles-
 cope on Sun with Clock attached - After resting eye in

dark for 10^m or 15^m tried all the combinations as on
 last night. The Sun was very nearly equal in in-
 tensity to Jupiter - but very slightly less bright for it was
 not to be discerned with A+K & 'barely' with A+L

& not at all with B+C. With the others there seemed
 also a perceptibly less intensity. The Sun was
 on the meridian but there was a very thin haze
 in the sky - though the clearest openings were taken.

The Moon this morning 1 hour after Sun-
 rise about 3 days from new moon

showed a region α to γ narrow but
 quite as bright as any part of full
 Moon as I should judge



Photometry

1860 March 17

12^h 30^m

Vide May 2

$\frac{\text{Albido Brick}}{\text{Albido paper white}} = \frac{1}{4.96}$

After Sun - obs. as on ~~pre~~ page turned on the "Triste College" building with aperture 9ⁱⁿ - found that the red-brick side of the building - fronting towards the Observatory & now about 180° in azimuth from the Sun was ^{just} visible through A+K and was not far from intensity of Jupiter with 15ⁱⁿ ap. - Sun at the time a little obscured by haze but shining full on building - The hill side of withered grass was of about same brightness. The distant forest slightly darker.

Diaphragm at solar focus 0.044 as with Jupiter & Sun

N.B. Light reflected from Earth's atmosphere is more considerable at horizon than that of surface of earth since at outline of horizon Earth looks dark on sky. L.P.B.

I conclude from foregoing experiments that a disc of 24 of about 35" diam. with aperture of 15ⁱⁿ is as bright as one of the Sun of equal diameter and aperture of 0.022. The centre of Sun being in the field -

of f' = means brightness of whole visible disc of Jupiter
 " " " " " Sun

λS = brightness center of Sun disc 35"

R_j' = " " " Jupiter " "

$\alpha \lambda S$ = light of Sun disc corrected for absorption

$\alpha R_j'$ = " " " Jupiter

Jupiter

1860 March 17th Admirable defin. 2 3 4 nearly equal
 4 3 2 1 not very much brighter
 (power 141)

Diameter of Jupiter being taken at 43''
 the upper line of belt A A' is 15'' from S
 and the lower B B' is 20'' from S
 breadth estimated

separately A A' is 5 $\frac{1}{2}$ ''
 as seen B B' through micas sec

8^h 50 (326 not corr) An independent
 measurement without illum.
 position behind micas sec gives

S	3. 14''
A A'	29
B B'	36

at 8^h 54

S	3. 16
A A'	20
B B'	25-26
N	39

in same way

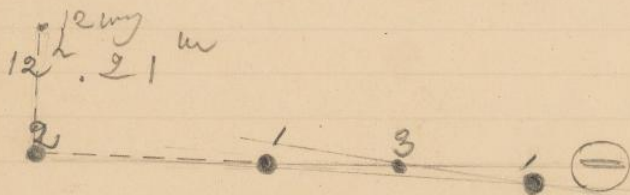
CC' - N = 1 $\frac{3}{4}$ AB The north cap can
 mostly be seen up to the preceding edge
 but cannot up to the following one

Jupiter cont.

1860 March 17th

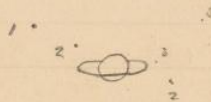
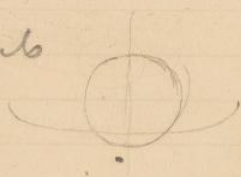
The main belt can be seen nearer to the following edge than to the preceding one

9^h 16^m 2 and 3 especially of nearly same magnitude 4 very slightly smaller than 12-73. There is a round white spot at a AB' is cut in two by a faint narrow zone requiring best definition to be made out - but spot 6 in its upper part where it encroaches on it has a faint dusky ring round it and does not communicate with it as before on the 15th at c there is a curious white spot in zone perhaps appearing white from contrast with faint clouds on either side. (For this drawing the only thing depending on accurate diameter is the length of belts outside of the lines yy', yy'. - while on the 15th it was assumed as the true diameter and the zone of belts must be stretched out in consequence)

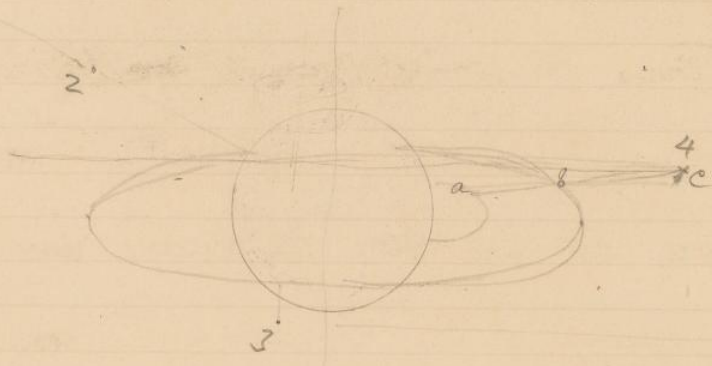
Sunday 17/18th March 1860

EC 23^h 59^m 0^s
236 23 56 36.8

Saturn

860 March 17thVery good definition
powers 141 & 401at 9^h 26 (236 not correct)At 9.40 with 401 noticed another satellite very lightly
preceding northern limb10^h 0^m

not looked for

 $ab = bc$ c is hard to see, though after once seeing it with
141 I made it out with 401.

3 is easy

Saturn continued

1860 March 17th

Out Ring A. I have not been able tonight to see the "pencil line". Though I looked attentively for it. Not quite the whole outer half of this ring is more dusky than the inner half ~~though~~ this inner half is not however as bright as outer half of ring B

Ring B. The inner half of this ring is dusky as noticed before. It seems to fade off gradually from inner ellipse without any sudden changes

Ring C. This ring appears rather darker to me than what it generally was in 1856 and 57. It seems as well as could be judged by the eye to fill nearly half of crescent, on both sides now and then I thought the preceding ~~area~~ was not quite equal to half the distance and the following one fully equal to it. But of this I am uncertain. It has no particular color to it. I noticed tonight especially

Saturn continued

1860phae.proj...187B
160 March 17

how easy it would be to make the preceding
ansa reddish and the following blueish or vice-
versa, as some observers have done by
merely putting the planet to the left or
to the right of centre ^{of field} as these bright colours
affect the inner ring long before they do
the remaining portions of the system the decep-
tion is good. There is no ~~redness~~

Ball The equatorial belt is faint and
^{and equal to $\frac{2}{3}$ or more of} narrow ^{bright zone}. The bright zone below it is about
 $\frac{1}{2}$ the width of crescents or fully equal to
dusky ring at its major axis. It fades off
towards the limbs where it is very nearly of the
same intensity as the belt above at the limbs

That is to say: the belt ~~fo~~ becomes lighter,
loses in colour, fades off towards the limbs —
the zone becomes darker ^{loses in brightness, shades off}, and where they meet
the outline of the planet they are ^{both} of the same

Saturn continued

1860 March 17

depth and color — neither a zone nor a belt —

The regions above it are uniform and show no particularity of colour — during one or two seconds, at different times I thought I could discern the faintest possible belt half way between south pole and equatorial belt, and each time ~~or~~ more on the following side than on the preceding one. That part of the north pole which is seen has a very faint bluish appearance contrasting with the slight reddish tinge of equatorial belt. The part of the ring between them is yellowish as are the remaining parts of the system of Saturn

(turn to end of obs.)

Division of rings It I could trace them ^{it} all round except near the north pole where I am not confident of having seen it though the impression was left now & then that I could. It is slightly more apparent from a point 20° north preceding left hand axis to 70° south preceding and on the other side from near

Saturn continued

1860 March 17

the eastern axis, north following, to shadow, than elsewhere - giving the whole southern hemisphere a better definition than the northern - this may possibly be owing to the effect the body of the planet has on the division at the north pole - There was a curious phenomena of the dusky part of ring B seeming on preceding side to overlap slightly ring C but by this time the vision had deteriorated so much that nothing could be made out of it with certainty.

Shadow I have not seen ^(tonight) the slightest trace of a shadow or shading of any kind to the left; nor suspected it. The right hand shadow is dark - as black I should say as crescents. After a long and attentive scrutiny of it I feel confident that it has assumed a new shape not noticed before - At a b it is as broad as inner ring at major axis. In those moments when the vision is particularly

Saturn continued

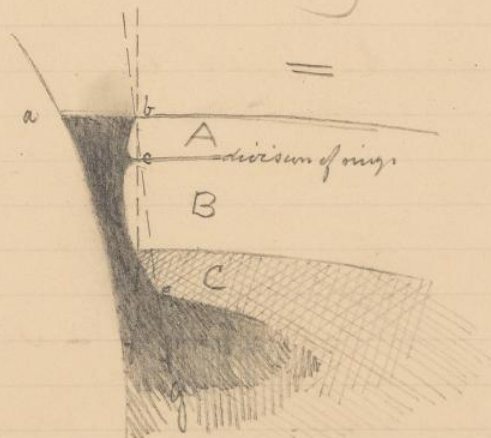
1860 March 17

fine the shadow
first on ring it

and then on ring

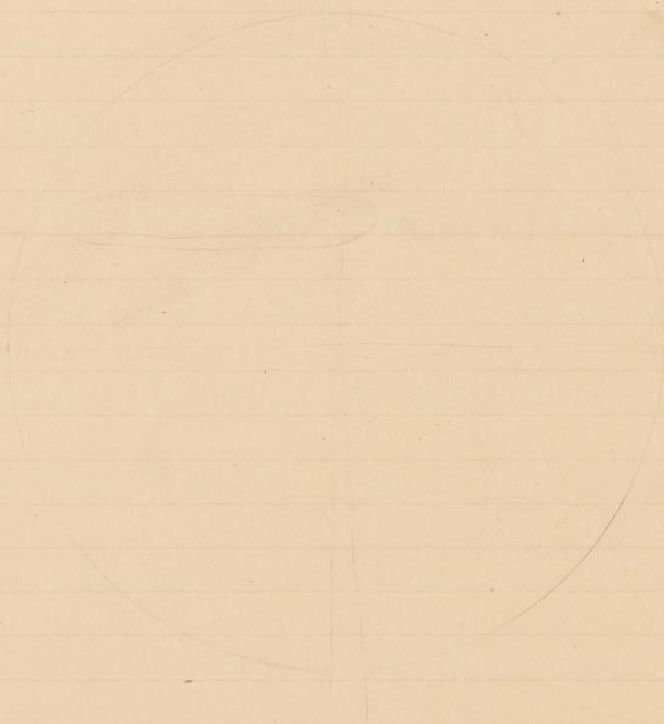
d. A line passing through b and d would be perpendicular to the axis of ring ^{b+} but passing it through b and e (for the shadow is plainly seen on inner ring it would ~~for~~ be oblique b.g but by a cursory glance I estimated the distance at which this line second fine prolonged would meet the polar axis of planet also prolonged at some quantity near twice diameter of planet from apparent Southern pole, but of estimation is very doubtful.

Ball) The belt
of Saturn can be
perceived decidedly



and shaded portion
followed up to the very edges, dif-
fering in this respect from Jupiter

6



1860 March 18

Solar Spots

Looked at the sun at 9-10-11^{AM} and 1 PM, with fine port.
equatorial. Saw all the at one PM that were there
at 9 AM.

Photometry

March 19, 1860

Noon

G.P.B. obs.

Clear but ^{East wind & at S. hori.}
^{from some mass.}

Obs. on Sun from

11^h 30^m to1^h 30 P.M.

Clear but

Power 206

Object glass aperture 0.022

Focus. aperture (0.044 throughout)

Sun

Seen with A + K but not very early, less so

than with Jupiter. Seen with E. - the red tinge barely distinguishable and much less evident than with Jupiter.

Seen with F and G. more early with G. Faint moisture

here gathering for second time on object glass, cleaned &

repeated - Disc now about equal_{K?} Jupiter. but is perhapsless intense with E (red) and A + E⁺ (Sun's centre always used) ^{Examined} No moisture
Five Inches Aperture^{new} On white house near Tufts College facing towards telescope.Sun. With all the screens fainter than Sun. $\omega = \odot + 180^\circ$

Nine Inches Aperture

Tufts College itself, unpainted brick seems brighter

than $\odot + 4$ slightly air quite clear in this direction

Nine Inches Aperture

Old plowed field, near Tufts College, just visible with
A ⁺ and K

Photometry

March 19. 1860

0^h 30^m to 1^h 00^m

Nine Inches Aperture

Focus unchanged
as before 0.004

Myth's house, painted white, rather brighter than Jupiter
but not much - side presented to Sun & telescope Found this side
of the House ~~is~~ in plane having az 27° N. of East.

Five Inches Aperture

Myth's house equal to Jupiter

5ⁱⁿ

Same Aperture as before

Apple trees much fainter than Jupiter, barely discernible with E
could not be seen with A + K Distant 9500 ft

Same Aperture as before 5ⁱⁿ

Dead grass 2000 ft off fainter than Jupiter, just seen with
A + K

In the preceding observations the azimuth was
that of the Sun + 180°

Photometry

March 19, 1860

9th Apr.1^h 00^m to 1^h 15^m

31000 ft. Marsh Grass, same azimuth, as Sun, barely seen with
 $A + R$. Nine inches Aperture. Not visible with E. Twice
 tried.

Grass, trees and fence about 2000 ft distant, visible
 with A , but not with $A + R$ or with E. Nine inches Aperture.
 Same azimuth as Sun.

Eye carefully guarded from light during whole interval from
 11^h 30^m to 1^h 15^m.

Sky Clear. N. East wind force 1. a few clouds in
 horizon & to S.E. smoke from Boston but the atmos-
 phere is perfectly clear towards Tufts college & but a
 little haze towards az of Sun. I think however
 that we often have more transparent skies.

The impression left on my mind is that with
 0.022 of Object glass & 0.044 front of Jupiter & Sun
 are nearly equal. at their respective altitudes. The
 distance of Sun being always taken. Telescope often mo-
 ved to avoid possible spots on Sun and Object glass aperture
 shifted to different parts of glass near centre.

Photometry - Sun & Jupiter

The red screen seems to absorb more of Sun & Earth light than of Jupiter - perhaps this may want further confirmation.

Examined many objects near zenith of Sun such as trans-fences - field stones &c. & found general illumination of Earth's surface (excepting white houses &c) decidedly less bright with 9^{th} than 4 with 15^{th} . $\odot$'s are same as objects about as bright $\frac{1}{2}(15+9)$ as " $\odot$'s at 180°

Average ill. Earth $\frac{1}{16} \left(\frac{15}{8}\right)^2$ compared with 4 or say 5

Jupiter

Not perfectly clear

At $7^{\text{h}} 10^{\text{m}}$ Sid. time With 15^{th} ap - & 0.044 focus aperture for reexamined light of disc. Seen through A+K not without difficulty but still distinctly - With E (red) the tint is decided & seen without difficulty

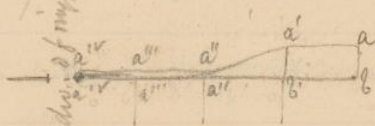
Again at $9^{\text{h}} 30^{\text{m}}$ Sid. Sun readily with A+K and the redness quite distinct with E. But on the whole Jupiter is not quite as bright as I had fancied at the Noon observations but it may not be perfectly clear

Saturn

1860 March 19thpowers 141, 401, 680
 $8^h 9^h (326)$

vision tolerably good

Ring A I tried in vain to see the pencil line to night - on the preceding side it was impossible to suspect it - on the following one single instant seemed to show it excruciatingly faint but it could not be verified and I left with a decided impression that it was not there. Instead of ~~that~~ it however, I noticed that the outer half of this ring is darker than inner half and once or twice it seemed to me that ^{supposing the ring to be divided into 4 parts} the outer ^{fourth} ~~quarter~~ of ring was ~~at~~ did not shade off. - representing the comparative intensity of different parts of ring by the perpendicular distance, from ab it would be



(section of darkness of ring A)

Ring B The vision was not sufficiently good to see the inner shading quite up to the middle of ring. It seemed also to

Saturn continued

1860 March 19th

faded away rather irregularly without the weather affording me a single opportunity to verify it. The outer half is the brightest part of the planet - the difference between it and the bright Equatorial zone is slight. Ring C It is quite dusky. I could not separate it from ring B - but vision was not equal to it. The inner ellipse is sharply defined. It does not quite cover one half of crescent.

Division of rings It was plainly darker in the south following quadrant (slightly encroaching ~~on~~ on the north following one) than elsewhere, it was ^{here} on an average half as broad again as north following. The same is to be remarked with regard to the South preceding ~~quadrant~~ and ~~South~~ 'north preceding quadrants. The south preceding one ~~is~~ ^{is not} as dark, I am confident, as dark as south following though it is nearly if

Saturn continued

1860 March 19th

not quite as broad. It is invisible over north pole
Crescents. To night both crescents
 seemed to me to be perfectly equal. I
 could not make out a difference in size
 in favor of either. They also seemed as
 dark as the back ground of the sky but
 not darker.

Ball

The equatorial zone is as broad
 as ring C at major axis. South of it
 comes the equatorial belt which is about
 $\frac{2}{3}$ ds as wide. This belt is very indistinct,
 and on moments of best vision gave no red-
 dish tinge to it, — south of it is a very
 faint dusky cap that reaches up to pole
~~It is~~ On it at about half way from belt
 is a very faint illdefined belt not seen
 mostly on the preceding side. The equato-
 rial belt to night as formerly shades off
 towards the limbs while the zones shades on

Saturn continued

1860 March 19th

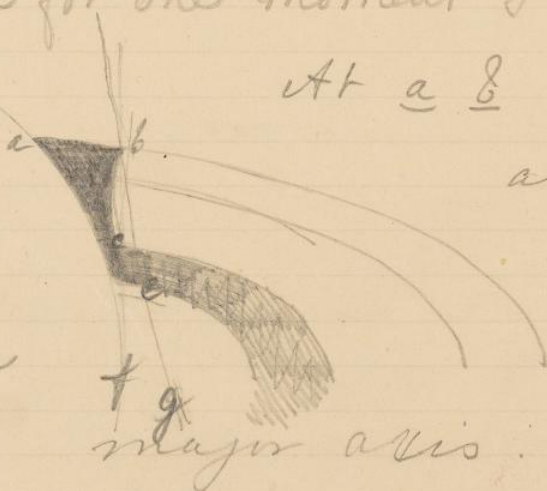
The beginning of the shading off of belt does seems to commence at between $\frac{1}{3}$ & $\frac{1}{2}$ of the radius - it is impossible to ~~come~~^{decide} nearer upon such a question. The zone seems to shade gradually from centre. The whole of the north pole is uniformly whitish. At a first glance it appears to have a bluish appearance, even though equatorial belt has no trace of its usual brickred^{colour} and after a careful investigation I cannot decide whether there is any bluish colour or not. The different shadings on the ball can easily and with certainty be traced up to limbs with the exception of the belt south of main one especially seen on preceding side of ball. It is very hard to see this thing by direct vision.

Shadow I could see nothing that could possibly be converted into a shadow or spot on the preceding side nor is there

Saturn continued
March 19th

any penumbra or duskiness on the ball
adhering to following shadow. The ball is
finely cut by shadow and outline is well seen
I could not see to right the double curvature
of shadow, though for one moment I suspected
it.

is not quite
as wide
but seems broader
At both at



major axis. $b c f$ is
perpendicular to major axis $g e b$ would meet
polar axis at about $1\frac{3}{4}$ diameter of ball. The
point e is determined from curve $b c$ for I
could not ~~quite~~ see shadow across C though
I certainly saw it on it. The shadow on $a b$
A & the greater part of B seemed quite
as dark as crescent or back ground of sky
but I suspect a slight diminution in dark-
ness on lower part of B. and on ring G. C.

1860 March 19th Jupiter

power 141
vision indifferent and
deteriorating

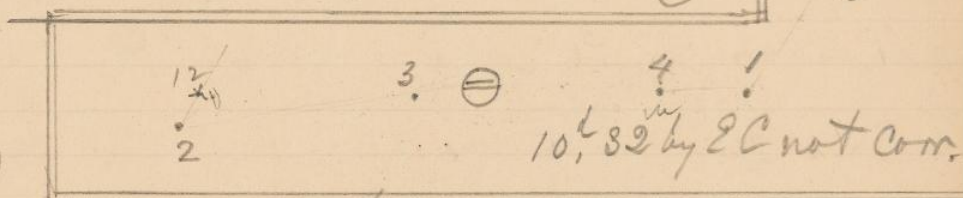
$$S N = 41''$$

S
A A'
B B'
N

4' 53''
5' 07''
5' 12''
5' 32'' $\frac{1}{2}$

}

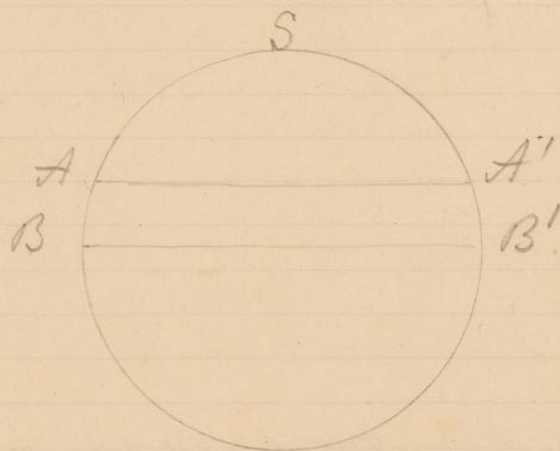
hard to observe



S
A A'
B B'
N

5' 39''
5' 42'' $\frac{1}{2}$
5' 47'' $\frac{1}{2}$
6' 20''

S was first observed then N
then it it' & finally B B'
I think more reliable than first



By the time I had obtained breadth of main belt
and of planet by reading their positions through
micra scale the vision had become so bad that
I had to give up sketching the planet. There
is little difference between 1x2 and 3x4

R

Urania

160 March 19

86 10^h 89

Clouded unexpectedly
up as instrument
was being set.

Photometry

1860 March 20th

Lamp I four feet from bulb 1371

I eye at lamp I

Lamp I to lamp S 52 ft. 10 inches

Place of I altered

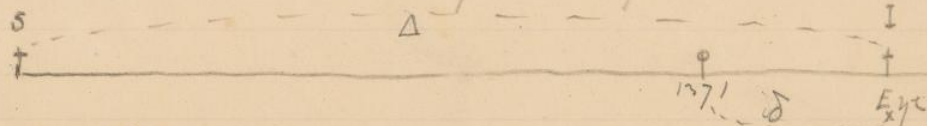
G P B

I from bulb 1371 3 feet 10 in.

Contrast of lamps found too great for distance of equalisation in room - a too much wind for comparison out of doors

The Lamp I (Illuminator) was a French Moderation with hole made in tin-foil full flame Lamp S (artificial star) was French Moderation of same size as I but glass was covered with two or three layers of tin foil to exclude passage of light excepting through a hole of about 0.02 diameter afterwards changed to others from 0.01 to 0.03 diam - made opposite to center of flame -

The 2 lamps, thermometer bulb No 1371 & eye in horizontal plane



The image of I reflected from 1371 seen from Eye at I was equalised with S seen from I as noted on next page + Next S was moved towards I by amounts recorded and $\frac{d}{x}$ Eye placed at point where S had been S and I were then equalised by moving S towards or from I

Photometry cont.

860 March 20th

(a)

I to S constant distance = 54

I from 1371 $\delta = 2\frac{1}{2}$ in

Lights equalized

I from S $\Delta = 5-4\frac{1}{2}$

$$I : S = (54)^2 : (4\frac{1}{2})^2$$

Lights equalized
G. P. B.

S at 1 ft 1 in = I at 54 ft.

I from 1371 $5\frac{1}{2}$ 10 in.

New diaphragm for S

not sufficient space to compare

G. P. B.

(b) =
I from 1371 $\delta = 4\frac{1}{2}$

Diaphragm again changed

$$I : S = (54)^2 : (2\frac{1}{2})^2$$

G. P. B.

(c) =
I from 1371

$3\frac{1}{2}$ 10 in G. P. B.

$3\frac{1}{2}$ 10

and 2 ft 0 in S.C.

$$I : S = 54^2 : (2\frac{1}{2})^2 \quad S.C.$$

See also Diaphragm Notes, p. 10. H. K. M. 1863.

$$I : S = 54^2 : (2\frac{1}{2})^2 \quad G. P. B.$$

Most of the stray light was excluded by screens. I & S frequently altered but kept constant for each set. unaided eye & dark glasses alternately used in judging of equality. Images both nearly points

for comparison of 1371 & S. & of nearly equal diameter for I & S difference of focus alone affects comparison. But distant light is whitest apparently.

Photometry.

Computed on other sheet

light emitted from S with 1st diaphragm i_1 from 2nd, i_2 from 3rd
 i_1, i_2, i_3 the quantities from I At unit of dist. on unit of surface perp

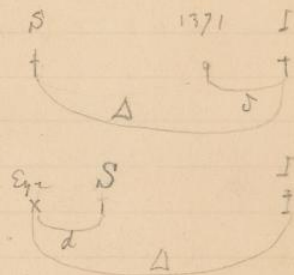
Set (a) $\frac{i_1}{d_1} = \left(\frac{54}{4.08}\right)^2 = (13.23)^2 = 175.0 = \frac{\Delta^2}{d^2}$

Let $\frac{b_1}{i_1}, \frac{b_2}{i_2}, \frac{b_3}{i_3}$ be the ^{relation} quantities of light incident on bulb 1371 & reflected back to eye at I assuming no absorption and let $\frac{Bb_1}{i_1}, \frac{Bb_2}{i_2}, \frac{Bb_3}{i_3}$ be the actual amounts received by eye

Let Δ = dist S to I when bulb image is compared
 δ = " Eye to 1371
 d = " Eye to S' when lamps are compared

$$\frac{i}{d} = \frac{\Delta^2}{d^2}$$

R = distance of Lamp I from Eye



h = angular semidiameter of bulb 1371 seen from I then (vide notes

relation to Comp. of 4 and Sun-) $\frac{b}{i} = \frac{R^2}{\delta^2} \sin^2 \frac{1}{2} h$ $\frac{Bb}{i} = \frac{1}{i} \frac{R^2}{\Delta^2}$ by adjustment

$B = \frac{1}{b \Delta^2}$ & substituting $b = \frac{R^2}{\Delta^2} \sin^2 \frac{1}{2} h$ we have $B = \frac{1}{i} \frac{1}{\Delta^2 \sin^2 \frac{1}{2} h} \frac{\delta^2}{R^2}$

For h I find the radius r of bulb 1371 $r = 0.624, 0.622, 0.624$

subtracting $2 \times 0.01 = 0.02$ which is twice the thickness of a broken thermometer

bulb of usual form as found by examining one & from general recollection

of such as I have seen - we have $r = 0.624 - 0.020 = 0.604$ = diam. of

mercury globule - the spherical shape was quite perfect - Reducing

to feet for unit $r = 0.0503$ and since r is very small

compared with δ we may put $\sin^2 \frac{1}{2} h = \frac{1}{4} \sin^2 h = \frac{1}{4} \left(\frac{r}{\delta}\right)^2$ Hence

Photometry

$$B = 4 \frac{\delta}{i} \left(\frac{\delta}{r} \right)^2 \frac{1}{\Delta^2}$$

$$b = \frac{1}{4} i \left(\frac{r}{\delta} \right)^2$$

$$\frac{i_1}{\delta_1} = \left(\frac{54}{4.08} \right)^2 = 175.0$$

$$\frac{\delta_1}{r} = \frac{2.0800}{0.0503}$$

$$\delta = 0.3181$$

$$r = 8.7016$$

$$1.6165$$

$$\ln \left(\frac{\delta}{r} \right)^2 = 3.2330$$

$$\frac{1}{5}$$

$$2.2430$$

$$0.9900$$

$$4 \quad 0.6021$$

$$1.5921$$

$$\Delta^2 \quad 3.4648$$

$$8.1273$$

$$\frac{i_2}{\delta_2} = \left(\frac{54}{2.83} \right)^2 =$$

$$\frac{\delta_2}{r} = \frac{4.0000}{0.0503}$$

$$0.6021$$

$$8.7016$$

$$1.9005$$

$$3.8010$$

$$54 = 1.7324$$

$$2.83 = 0.4518$$

$$1.2806$$

$$2.5612$$

$$2.5612$$

$$1.2398$$

$$0.6021$$

$$1.8419$$

$$3.4648$$

$$8.3771$$

$$\frac{i_3}{\delta_3} = \left(\frac{54}{2.50} \right)^2 =$$

$$\frac{\delta_3}{r} = \frac{3.7500}{0.0503}$$

$$0.5740$$

$$8.7016$$

$$1.8724$$

$$3.7448$$

$$2.6680$$

$$1.0768$$

$$0.6021$$

$$1.6789$$

$$3.4648$$

$$8.2141$$

$$= 38.92$$

$$54 \quad 1.7324$$

$$2.50 \quad 0.3979$$

$$1.3345$$

$$2.6680$$

Photometry

March 17 Dim Capita Eq. 38.0

	<u>2.3</u>	
Polar	<u>35.7</u>	
Mean	36.9	= 1.56703
4 in. 1"		<u>4.68556</u>
4 in. 36.9		<u>6.25259</u>
1 inch		<u>0.00000</u>
		3.74741
1 ft = 12 in		<u>1.07918</u>
465.83		<u>2.66823</u>

Photometry

860 March 21st1371 from smallest sized chalk ball (m) $0. \frac{875}{1000} f$ ($10 \frac{1}{2} in$)

eye from 1371

 $19. \frac{7}{10} f$

eye from m

 $20 \frac{575}{1000} f$

S from 1371

 $23. \frac{1}{10} f$

S from m

 $24 \frac{1}{20} f$ phase of m corresponds to $4^{\circ} 30'$ elongation
the1371 equally distant with m from S. m
very slightly brighter.

1371 from object glass

 $18. \frac{6}{10} f$

m from object glass

 $19 \frac{2}{10} f$

1371 from m horizontal distance

 $0.85 \frac{f}{100}$

1371 is one or two inches too near observer

diameter of 1371 about $0.68 in$ diameter of m about $0.38 in$

Photometry

Found diam. of 1371 = $0''.623$ well determined
 " " " " " $0.365, 0.367, 0.360, 0.363 = 0.364$

Photometry

1860 March 22nd

Round white paper painted with Chinese white Flake white was whiter than snow just fallen but the body of snow was scarcely of sufficient depth. However I still think the water color is sensibly whiter - Flake-white & Chinese white are as equally white to my eye.

Very white lacquer (old BrandKerching) was almost as white as the water color.

G. P. B.

March 24 Distance of trellis in front of centre of Wyeth's house
S.E. face to object glass of Great Refractor directed upon it

Measured dist 1336 feet roughly measured by tape
April 2nd 1338
many obstructions in way -

By triangulation 1284² feet. (must be an error)

Photometry

1860 March 23rd 1^h PM Sky perfectly clear between clouds N.W. wind

9^m App. Red Glap screen E

For (1) add to area of

9^m diam as diminished

0.45 x area diam 2.5

For (5) add 0.55 x area 2.5

For 2 & 3 & 4 no addition

For (5) red. tint not distinguishable at all -

& all were made at least as faint as Jupiter appeared

March 19th For faintest red was barely distinguishable

With 5^m ap. Could not be discerned with red & doubtful if with A+K

1 & 5	Any Sector	105° 30'	Area = 0.140 x 0.36 + 0.45 $\frac{1}{36}$	for (1)	for 5
4	125	0.217 x "	0		+ 0.55 $\frac{1}{36}$
2 & 3	149 45,	0.336 x "	0		

Exposed area for (1) = 0.063 of whole object glap

(2) 0.121

(3) 0.121

(4) 0.078

(5) 0.066

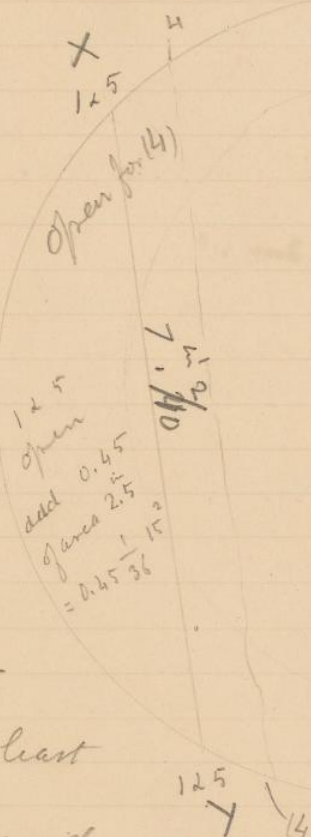
For (5) Eye piece just cleared - & eye had been in dark for 20^m Image carefully adjusted to centre of clapboards & found very decidedly fainter than Jupiter

Whitest part of A Wyeths house - dead white paint. The whitest

clap boards were selected & the

shadows of edges of clap boards avoided carefully

(2) & 3 Open



Found May 23 that the whitest parts of clap boards of Wyeths House were barely distinguishable from pure white paper attached as noted in 10/11

Found with 5^m ap. that house image was too faint. Eye 10^m in dark.

Photo-metry

The focus for Wyeth's house 4.37 longer than solar focus - The power 206 & focus diaphragm 0.044 same as on previous trials hence intensity of disc is fainter in ratio $\left(\frac{270.0 + 4.4}{270}\right)^2 = (1.016)^2 = \frac{1.032}{1.016} = 1.032$

The side of house used lies in az. $E\ 27^\circ N.$ consequently the Sun was shining on it at an angle of 30° above plane at 1 P.M. and from house az. House $11^\circ E.$ of $N.$ Distance = ?

Subsequently in following evening I examined Jupiter once more with same screens and was satisfied that I had retained a very just impression of its intensity it was rather clearer seen with A+K than House at brightest of foregoing experiments & decidedly so with E = red screen than for (5) - I place most confidence in the latter trial (5)

because the Eyepiece had just been cleaned (though no moisture was found on it) & the house image was made so faint that red tint could not be discerned. Trials were first made with the 5^m aperture & it was found too small but the eye having been but 10^m in dark may not have acquired sufficient sensitivity on the whole I conclude from the above that using diaphragm 0.044 & full aperture [Jupiter filling but very little $1''$ or $2''$ more than diameter] & then $\frac{1}{10}$ of aperture & same focus diaphragm - the image from white painted house inclined was of equal brightness with Jupiter

$$\frac{\text{Albedo Jupiter}}{\text{House}} = \frac{27}{10} = 2.7$$

Add from (5)

$$\frac{\text{Albedo Jupiter}}{\text{House}} > 0.066 \times 27 \text{ or } > 1.8$$

or > 1.8 certainly

We must remember that house has besides direct light of Sun a great deal of stray light

hence small allowance has been made here for inclination of plane of disc towards E to direction of Sun & for thin illumination of Sun derived from earth's shine 3rd for absorption of Jupiter's atmosphere.

Photometry Jupiter

1860 March 23 Perfectly Clear · 9 PM Apr 15th

Jupiter with 206 & diaphragm at focus 0.044

Rather easier seen with A+K than any of these
 Noon comparisons of Wyeth house & red color ^{with E⁺}
 more nearly the same but certain & steadily
 see stronger than as the strongest of Noon
 obs. on house see prev page for Jupiter obs.

At 9^h 15^m ^{Diaphragm first taken off} Placed thr. bulb 1371 in line with
 image of Jupiter in solar focus of Cyr. Eq. Apr 15th
 equalised light with image reflected in bulb of light
 of Moderateur lamp adjusted to flame $1\frac{1}{2}$ 15 1 $\frac{5}{10}$
 Images equal lamp to bulb 2.9 $2\frac{8}{10}$
 Eye to bulb 2 $\frac{9}{10}$

" Lamp to bulb 2 $\frac{8}{10}$
 " Eye to bulb 3 $\frac{2}{10}$

Very Clear

N.B. That Jupiter now nearly fills the diaphragm. 0.044 hence
 the fainter regions on its edges now form part of visible disc and
 tend materially to diminish its general intensity

Jupiter Photometry

March 23

Bulb B_2 diam = $3^{\text{in}}.436$ silvered surface.

Images equal

Eye to bulb $6^{\text{ft}}.92$ nearest partLamp to bulb 8.47 of bulbEye to solar focus
image of 2 6.92

Clouded immediately.

B_2 is a bulb of glass silvered on inside by Liebig's process at the
N.E. Glass Co. Diam $3^{\text{in}}.436$ with a few pages on—

In the above image of 2 formed in solar focus & seen by
eye $6^{\text{ft}}.92$ from it was equal to image of lamp reflected from bulb B_2
placed nearly in same direction with image of Jupiter seen directly

Photometry

Lamp & glasses well cleaned. & wick trimmed & set.

For comparison of I & S
 $B_1 = 15$ bulb 1371 from S --- 5^h 8 6.1 Image I = S
 Mercury Diam

" 1371 Eye from B_1 3^h 15 Image of S
 S from B_1 2.60 ~~2.70~~ = B direct

Measures to
 center of Bulbs

Eye from B_1 3.90
 S from B_1 3.40

where
 Screen used

Eye 4.05
 S 3.50

Returned & measured intensities as follows

For comparison of I & S

Images of I & S equal when Bulb was 5^h 95 from
 S towards I

For above experiments I to S 81.7

Lamps were then changed to new position

I was in lower north room in west wing. S in Prime Vertical Room

Quantity of I intentionally changed between ~~sets of sets~~ before going
 to transient room where remainder of experiments this evg. were
 made.

The comparisons of S & I are this even-
 ing for first time obtained from comparison

of image of S with image of I both reflected from a bulb at B_1 held in same line
 with I & S and viewed in a line perpendicular to IS - a very pre-
 cise method. & very convenient

S	B_1	I	
1	9	1	
S	B_1	I	Eye
1	9	1	x

The comparisons of I reflected from B_1 with
 S seen directly in line with B_1 - Eye being at x

Photometry

New position of Lamps Bulb B_2 Largest = In W. G. Room -
 diminished & both trimmed & Diameter

For Comp. of I & S Bulb B_2 dist from S towards I 5.43

I to S = 54^{ft}.0 with small bulb B_1 5.63

Image of I = S Eye from Bulb B_2 5.65

I Lamp from " 5.80

Eye to B_2 6.00

Lamp I to B_2 6.40

Eye to B_2 6.40

I " B_2 6.22

Dist I . S shortened 6^{ft} to 54 - 6 = 48 ft
 I S = 48 ft Bulb to Eye 10.15

Image I = S

Lamp 3.93

Dist Changed IS = 50 ft
 I S = 50 ft. B_2 Bulb Eye to I 4.72

Eye to Bulb 9.07

B_2 to I 4.65

B_2 to eye 9.30

Restored to IS = 54 ft

Eye to B_2 6.70

I to B_2 6.12

B_2 to Eye 6.80

I to B_2 6.10

Photometry

For comparison of I with S.

B₂ 4.80 from S wt = 1B₂ 5.40

" = 2

Bulb B₁

5.46

" = 2

B₂

5.30

" = 2

I think it probable that I may have very slightly changed but probably gradually since we moved it from N room entry to entry near W. Tr. Room.

In comparing B₂ I with S by their images reflected both bulbs were used & they were inclined to different positions to obviate effect of inequalities

I find that Jupiter Venus & Moon can be compared together admirably by means of their reflected images & that of lamp-

Photometry

1860 March 24 probably

9 inch Aperture

Sun in cloud versed sine of part exposed 3 inches

Not clear Sun shining chord " " 6.9 " }

Full Aperture

B₂ Bulb at Mr. Wyeth's, chord of part exposed 13.2
 Set time 1^h 20^m, Sun ^{not quite clear say $\frac{3}{4}$ full sunshine} partially cloudy b

9 inch Aperture

(Sun, well in cloud.) Mr. Wyeth's home vers sine 3.8
 not so cloudy " " 2.7
 quite cloudy (very faint) no red tint & scarcely visible 2.7

very cloudy certainly much fainter than 2^d vers sine 4.0
 Ended at 1^h 40^m Set-time.

The above comparisons were made to ascertain

1st whether Sun's image on bulb is bright can be compared well for illumination with Jupiter

2nd What the amount of earth shines on side of house is when Sun is in clouds

With regard to (1) the sunlight was not quite equal

to that of a clear sky but say $\frac{3}{4}$. The aperture was responded to $R = 15^{\circ}$

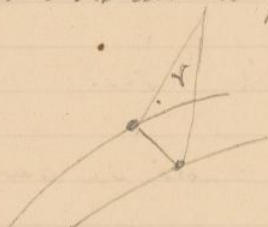
$$2 R \sin \frac{1}{2} \theta = 13.2, \sin \frac{1}{2} \theta = 0.88 = \frac{44}{50}, \frac{1}{2} \theta = 60^{\circ} 35', \theta = 121^{\circ} 16', \text{Area} = 0.196$$

Photometry

$\frac{3}{4} = 0.75$ In this experiment the image of Sun^{wat} reflected from Bulb

B_2 diam. = $\frac{1}{5} \left(\overset{\text{Taken in various directions}}{3.501, 3.506, 3.500, 3.503, 3.510} \right) = 3.504 - 2 \times \text{thickness}$

To find thickness I placed a piece of plate glass 0.135 thick tangent to the outer edge of globe & compared the distance between the direct & reflected image of a line or dot on globe's outer surface reflected from its inner surface



both seen through glass plate

& the distance between direct & reflected image of lines on plate tangent to lines on globe & found thickness of globe $\frac{1}{4} (0.135) = 0.034$ for thickness of globe Hence we have

Bulb B_2 Diam. of Silvered surface = $3.504 - 0.034 \times 2 = 3.436$

There will also be a faint image reflected from 1st surface but besides being faint it will nearly coincide with image from silvered inner surface

The absorption of B_2 may be determined from the observations of last exp.

Photometry

August 1876

1860 March 24

Photometry

1860 March 24

15" aperture

power 206

diameter

x 0.044

15" Moon seen with difficulty with E but certainly and red tinge distinguished alt 15°
 Not visible with Phase of moon measured 1" 45" Moon
 A+K but plainly as with A+K being steady
 One fourth part of the moon's illuminated surface
 as bright as the part measured if we leave the black craters
 as K which is a decided shadow out of consideration
 Madeira red

The smooth part of the moon is more selected & as there are difficult to find of 35" diam on account of dark craters the above is reliable only for the comparatively smooth parts of moon which average brighter for given area

$$\text{Ap. } 2^{\text{nd}} .5 = \frac{1}{36}$$

At 7 40 of 236 Venus with red screen E absolutely invisible and with A+K perhaps discerned

Carefully scrutinised must be fainter than Jupiter by 1/2 almost
 Obs. for comparison of C, Venus & Jupiter. Sirius

Venus 17 paces from steps 8" 11" of 236

236 1st part of 3rd time

O Venus
 brightest at
 crescent edge

C Moon 12 paces 8" 4"

12 8 5 30"

} Rather too low say 7° and a
 cloud not far off but apparently
 clear at Moon

Venus 23^{+8.5} paces 8" 7"

perfectly clear

Jupiter 34^{+8.5} paces 8" 13"

$$C \ 11.7 \text{ paces} = 29.2$$

$$\text{Steps to lamp} \quad 8.5$$

37.7

Jupiter 36^{+8.5} paces 8" 20"

Moon 11^{+8.5} paces 8" 20" 40"

$$4 \ 36.7 = 91.8$$

$$\frac{8.5}{100.3}$$

Venus 17^{+8.5} paces 8" 24" 15"

Reduction for extinction

$$\frac{A}{C} = \left(\frac{37.7}{100.3} \right)^2 \frac{1.016}{3.460} = \frac{1}{24}$$

At 7° 9' Siddeh extinction tables make light transmitted = $\frac{1}{2.46}$ of whole
 60° $\frac{1}{1.016}$

C 2 $\frac{11.3}{24.0}$ days old

L. P. B. obs

Jupiter
 $40^{\pm 8.5}$ paces $\delta^h 27^m$ of 236

Sirius $\delta^h 41^m$ 55 paces $\delta^h 41^m$

Not a reliable comparison

Star too faint & doubtful if the light
 shines direct on bulb trees in way -

6 feet 5 inches to be added to all the distances
 The paces were measured to foot of steps which are 8 ft 5 in from
 Lamp.

The above were made by placing Lamp S with
 zinc aperture as before viz I. - Lamp was in porch
 of West Wing near front door & I took the bulb. Bz in my hand
 and increased distance from lamp till its image & that of star
 were equal. There were some clouds not far to north of Moon
 say 10° or 15° distant but it seemed quite clear where C & Venus were

On the following evening on inspection I thought it probable
 that the position of lamp was too high
 & that the light may have been less intense
 at a distance - but considerable pains
 were taken to try intensity of light by
 moving eye to various positions

descent of ground from
 West door towards R. Cath. Ch.
 not so considerable as
 here represented

Jupiter

1860 Nov 24

4. PM dt

236 9 6 21

Spot 0.4 on northern edge of great belt.

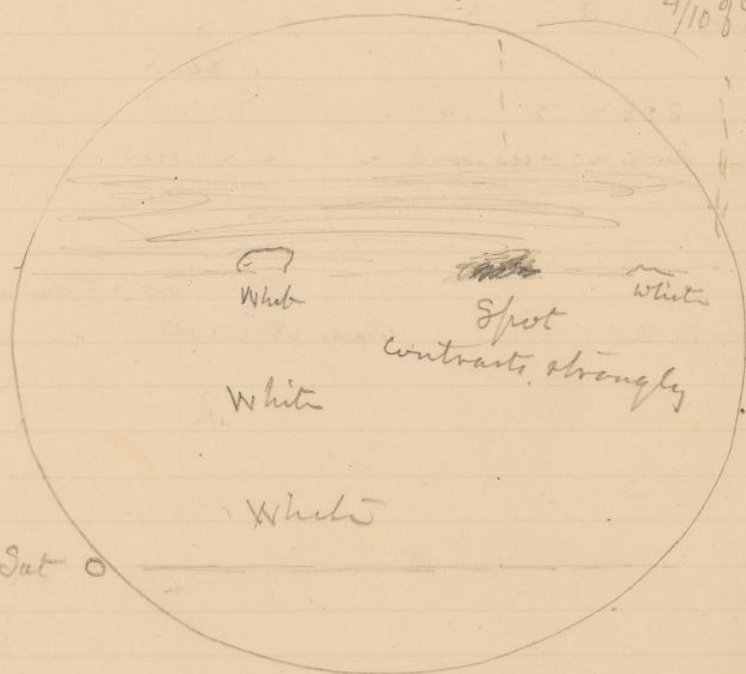
Occultation 4th Satellite

236 = 9 9 30 fourth satellite in contact with Jupiter on north preceding limb

236 = 9 20 48 entrance of fourth sat. 2nd contact

Satellite singularly faint

236 9 6 21 5 4/10 of chord

4th Sat 0

Tried Jupiter over moon

with screens A+K & E strong. red color with latter - more nearly absorbed by A+K. But -

Photometry Jupiter & Os Genimosa

March 24. 1860

Time & Clear.

No focus diaphragm In Dome

Aperture 15 inches. - Lamp diaphragm Z =

$$236 = 9^h 42^m$$

Centre of bulb B₂ to nearest face of microm $5^h 0.7$ Lamp S. distance = 22.1^h

Not Centre of bulb B₂ to nearest face of microm $4^h 1.0$

bulb $4 \quad 0.3 + 1.7$

Lamp $22 \quad 4.8$

Jupiter bulb $4 \quad 3.0 + 1.7$

bulb $4 \quad 3.0 + 1.7$

Lamp $23 \quad 1.0$

bulb $4 \quad 11.7$

Lamp $26 \quad 11.0$

$$236 = 10^h 10^m$$

Changed lamp to new position

To Lamp S.

trap diam. ≈ 0.0210 inch March 27
New Aperture of 0.022 fixed to zinc screen

bulb $8 \quad 7.9$

Jupiter Lamp $22 \quad 8.0$

bulb $8 \quad 11.0$

Lamp $23 \quad 0.0$

$$236 = 10^h 40^m$$

By above obs.

$$\frac{\text{Light trans. through } Z_{0.010}}{\text{diaphragm } 0.0210} = \left(\frac{22.72}{22.82} \right)^2 \times \left(\frac{8.78 - 0.07}{4.17 + 0.07} \right)^2 \left(\frac{\text{Extinction in atmosphere at alt } h}{\text{alt } h} \right)$$

"

$$= 4.22$$

$$\left[\frac{\log \text{ extinction } Z_{0.0210}}{\log \text{ extinction } 0.0210} \right] = 0.004$$

cor to focus of B₂

Photometry

March 24, 1860

Very clear

15^m ap.

Lamp Chicago Mass. 0.022 place of lamp changed

 β Geminoe~~From~~ Solar FocusBulb B₂ to solar focus1st 2.7236 = 10^h 55^m

"

1 2.1

Lamp

14 9.0

~~Jupiter~~236 = 11 5 bulb B₂

1 9.5

Lamp

19 6.0

 β Geminoe

236 = 11 12

1 10.8

21 6.5

All the foregoing by comparing reflected images -
 upon Bulb B₂ Mr. Hale & Mr. Safford at same time esti-
 mated the equalisation of light. Noticed that Jupiter's
 light was whiter than that from lamp. The latter redish by contrast.

Photometry

1860 March 25 Sunday - Cleared suddenly - Denser a pure sky - "Luminous cloud" very beautiful
 remarkably so Moon = 10 feet $7^h 55^m$ of 236

Moon close to
 Venus - I noticed
 a very thin cloud
 not far below the
 two when obs
 began. seemed
 to disappear

Venus $7^h 55^m$

5'0 feet + 8" ?

To be added to all the
 distances - The distances

Moon $8^h 00^m$

8 feet 5 inches

given are to face of pane of
 glass of window
 which is 8" from
 screen

The lamp S
 to night after-
 noon since it
 was placed in
 West window
 of basement
 window glass
 well cleaned 236 =

Venus $8^h 04^m$

5'4 feet + 8"

236 = $8^h 06^m$

Think the posi-
 tion of lamp better
 than on 24th

$9^h 30^m$

9'3 feet 8 inches Jupiter

$8^h 09^m$

Moon lower

11 feet 6" + 8"

$8^h 10^m$

9'3 feet 8 inches + 8" Jupiter

fact & truth

128 feet^{+8"}8^h 17 minute

Lirius not reliable - became trees
prevent a good comparison -

8^h 2094 3^{+8"} Jupiter perfectly clear60 ft 5^{+8"} 8^h 24^m Venus

possibly clouds but if so they
are very thin. I only inferred that there might be a thin
~~abstract~~ veil over Venus from presence of clouds 10° off but to
eye all was clear at Venus -

Think the results to night more reliable as re-
spect to position of lamp than on last evg although then, care
was taken to try light at various elevations of eye & bulb

I always try to keep the eye in a direction
perpendicular to chord joining images in bulb &
in plane with them & bulb centre so that
absorption on two images may be the same -

1860phae:proj...1875

Search for Descarbault's Planet
Solar Spots ^{by} Fine foot Equatorial

The week ending March 24, has been very unfavorable for observing the sun, several days have been cloudy from morning till night, and I have been unable to keep as strict lookout as those days which have been clear, as I ought to have done.

March 23 Fine clear day Looked at the sun at 9-11 A.M. 12 M. and at 1 and 5 P.M. There was nothing on the sun's disc at either of these hours which could have been a planet.

March 24 Looked at the sun at 8-9 and 10 A.M. saw nothing of a planetary character. The rest of the day was cloudy.

March 25 cloudy all day

Vide letter to Prof. Herrick of New Haven for details of search.

Photometry.

1860 Mar. 26.

N.P.D. of ^{A. N.} Mr. Wyeth's house, $44^{\circ} 42'$

Photometry

March 26, 1860
clear blue sky -

Fine & clear sky - latterly a few cumuli in a
Ap. of Obj. glass 5ⁱⁿ throughout.

236 = 1^h 13^m Dist. from Lamp S. ap. 2 6.04
1.5 inch bulb
Dist. from eye piece 5.80

236 = 1 25
Ther. bulb

Lamp S 5.85
eye piece 5.87

Bull turned

1.5 inch bulb
236 = 1 38

Lamp S 6.60
eye piece 5.87

236 = 1 50
1.5 inch bulb

Lamp S 7.20
eye piece 5.87

Found that we had forgotten
to adjust the wick of the lamp to the standard
wick which is 1 1/2 inches from top of wick
to top of flame.

Lamp diaphragm Z Throughout -

Some image reflected from Bull B₂ at Wyeth's house SE window up stairs viewed
from the Opt. Refractor - Dome darkened

Lamp trimmed and wick adjusted - flame 1/2 in from top of wick

236 = 2^h 2^m x Bull to Lamp S 8.17
Diam (1 1/2 in) bulb - 1.5 bulb x Bull to focus 5.85

$$b = \left(\frac{585}{810} \right)$$

236 = 2 10
Ther. bulb & (1.5 diam)

Lamp S 8.13
Lamp S 8.30

236 = 2 16

New Lamp and Chimney. I

from
Image of Bull B₂ were received at distances named from
focus on Bull 1 1/2 in diam & on the bulb & compared with
image, on same bulb, of Lamp aperture at distances named

Photometry

March 26 1860

Obj. glap aperture 5 in. - Focus aperture 0.044

236 = 2^h 26^m

Lamp I } to x bulb & max the bulb 1971 8.30
x Bulb to focus

5.85

1 30?

Lamp I 8.70

5.85

236 = 2 44

Lamp I 7.73

5.85

white centre of claptboard } SE side of Wyeth's house
Sun shines at small angle on it

236 = 2 53

Lamp I } More brightly ill. 6.17
by Sun than

5.85

west side of house } free side

236 = 3 3

Lamp I 7.06

5.85

Very white screen painted with "Flake" white and
"Chinese" white water color on white paper.
held perpendicular to sun's rays (Not quite as brilliant as white or painted chalk)

236 = 3 6

Lamp I 7.30

5.85

white screen perp to sun

236 = 3 21

Lamp I 13.30

5.85

orchard ill. by Sun 180° diaz-

Flame examined & found as nearly as possible to its best adjustment

Examined object glap during observations & found it perfectly free from moisture.

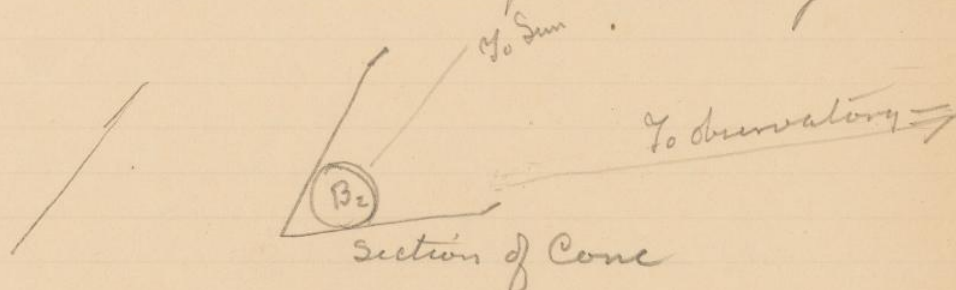
The zinc tube carrying the aperture $\frac{1}{2}$ was frequently varied in position in course of the observations and all other circumstances varied - The Bath was Bulb B₂ used at House & the images at focus compared both on max. The bulb - diam = 2 on

some times on B₁, diam 0.004 sometimes on B₂ 1.760 no difference

Photometry

The foregoing obs. were for the following purpose
 The bulb B_2 was placed at Mr. Wyeth's house, ^{behind the open} ~~in the~~ win-
 dows of 2nd story - the nearest window on S.E. side of house

The Bulb was placed on the apex of a tin cone - painted
 black & smoked well over with lamp-black to give a
 dead-black surface



Care was taken to present bulb both to Sun & tel-
 escope fairly - The blackened cone was intended to
 cut off stray light

Stray light was excluded from dome by closing
 shutters and covering with dark cloth - Aperture of 5 in -
 used throughout on object glass - Aperture of 0.044 in focus
 and aperture $\Sigma =$ for illuminating lamps

The lamps are frequently adjusted to
 new positions diaphragms moved &c

N.B. That the aperture 0.044 is always adjusted to be in focus whether at solar focus or for Jupiter & Moon or at solar focus + increase of focus for an object at small distance

$$\text{At Wyeth's House focus} = 270.0^{\text{in}} + 4.5^{\text{in}} = 274.5^{\text{in}}$$

The focus ~~reading~~ for the diaphragm 0.044 was always adjusted by the focus scale viz

For solar focus	reading 30	=	270.0 ⁱⁿ
" Wyeth's house	" 2	=	274.5

Photometry, Moon

March 27 1860

				Bulb to Lamp	to Lamp	Midway to Lamp
236 = 9	3	Bulb to Lamp. Z diaphragm	4.54	+	0.6	
236 = 9	6	" "	5.05	+	0.6	
236 = 9	9	" "	5.03	+	0.6	
236 = 9	11	Bulb to Lamp. X diaphragm	11.5	+	0.6	
236 = 9	12	" "	11.0			
236 = 9	13	" "	11.5			
236 = 9	16	Bulb to Lamp. full blaze	113. ft			

Distance to extreme point of blaze of Lamp 1.75 inches.
average distance 1.5 inches. Perfectly clear.

Copied twelve pages ahead

1860phae.proj...187B

6

6

Occultation of Pleiades

1860 March 26th

Observer G.P.B.

Imm of Star 8th mag A₁ centre rounded on Spring -
 Gov. pre by 20s followed by 30s.

SC = 10 ^h	15 ^m	30.6	deduct 0.2
SC for 20 ^s time	10	3	47.3
		11	43.3

Imm Star 6th mag 10' S A₁ centre SC = 10

	22	31.3
	3	47.3
10	18	44.0

Imm Star 10th mag A₁ centre followed by break-break Ref
 B.B.B

SC = 10	22	56.4
---------	----	------

	3	47.3
--	---	------

10	19	9.1
----	----	-----

D.B.D

Imm Star 6.7 12' N A₁ centre SC = 10

	35	22.4
--	----	------

	3	47.3
--	---	------

B

10	31	35.1
----	----	------

D

Imm Star 9 2' N A₁ centre SC 10

	36	36.2
--	----	------

	3	47.3
--	---	------

B.B

10	32	48.9
----	----	------

Imm Star 6 3' N " SC = Missed this star

B.B.D

Imm Star 10th 10' N " SC = 10

	43	15.4
--	----	------

	3	47.3
--	---	------

10	39	28.1
----	----	------

Occultation of Phidias

March 26 1860

Sid Time of obs. by G.P.B.

				Mag	Sid Interval		Reduction
(1)	10 ^h	11 ^m	43.1	8.	9 ^h 54 ^m	20.27	- 1 ^m 37.37
(2)	10	18	44.0	6.	10 1	21.17	1 38.52
(3)	10	19	9.1	10-11	10 1	46.27	1 38.59
(4)	10	31	35.1	6-7	10 14	57.27	1 40.62
(5)	10	32	48.9	9	10 15	26.07	1 40.82
(6)	10	39	28.1	10	10 22	55.27	- 1 41.91

Sid Time at M. N

0 17 22.83

Cambridge Mean Time of Immersions

obs by G.P.B.

a (1)	9 ^h	52 ^m	42.90	a	8 ^h mag	
b (2)	9	59	42.65	b	6	10' S Q. center
c (3)	10	30	07.68	c	10-11	0 "
d (4)	10	12	31.65	d	6-7	12 N "
e (5)	10	13	45.25	e	9	2 N "
f (6)	10	20	23.36	f	6	3 N "
				g	10	10 N "
				h	6 ^h	5 " "

Occultation of Pheades

March 26. 1860

obs by H. P. Y.

chem 424

13?

Im. 424 = 10^h 12^m - 58^s (1)

10 19 + 60 (2)

10 32 + 40 (3)

10 39 17.8 (4)

10 52 42.4 (5)

SC = 9

5.5 00

424 = 9

5.1 54.0

SC for

$$\begin{array}{r} 3 \\ 3 \\ \hline 6.0 \\ 47.3 \\ \hline 41.3 \end{array}$$

SC = 11

3 00

424 10

59 53.8

424^h for
$$\begin{array}{r} 3 \\ 2 \\ \hline 6.2 \\ 47.3 \\ \hline 41.1 \end{array}$$

	h	m	s	Int. Interval	Reduction
(1) Sid Time	10	11	43.5	9 54 20.67	- 1 ^m 37.37
(2)	10	18	42.8 + one sec?	10 06 20.97	1 38.52
(3)	10	31	34.6	10 14 11.97	1 40.62
(4)	10	38	36.6	10 21 13.77	1 41.77
(5)	10	52	01.3	10 34 38.47	1 43.97
0	17	22.83			

Cand mean Time of Immersions

obs by H. P. Y.

a (1)	9	52	43.30
b (2)	9	59	42.45
c (3)	10	12	31.35
d (4)	10	19	32.00
e (5)	10	32	54.50

5/6 to mag.

5' N C. Center

Occultation of Pleiads

March 26, 1860

obs by A.H.

chem 276

PC = 10 8 20

276 10 5 9.8

Im 276 = 10 12 45.0 - 10 ^{hms} 8 may (11) 2 50.2

10 19 46.0 - 10 7 (2) 8 11 4 20

276 11 1 9.7

10 32 32.0 - 00 7 (3) 2 50.3

3 47.3

10 33 52.5 - 10 9 (4) faint 276 faint 57.0

10 39 38.3 - 10 6 (5)

Dist Interval

Reduction

(1) Dist Time 10 11 42.9 9^h 54^m 20^s 07^{sec} - 1^{sec} 37.37

(2) 10 18 43.9 10 1 21.07 1 38.62

(3) 10 31 35.0 10 14 12.17 1 40.62

(4) 10 32 50.5 - two surff? 10 15 25.67 1 40.83

(5) 10 38 36.3 10 21 13.47 1 41.77

0 17 22.83

Caml. mean Time of Immersions

obs by A.H.

a (1) 9^h 52^m 42.70b (2) 9^h 59^m 42.45

c (3) 10 12 31.55

d (4) 10 13 44.84

e (5) 10 19 31.70

Photometry

March 27 1860

Measurements of diameters of diaphragms

That commonly indicated as 0.044 was found to subtend an angle of $0' 32'' 47$ final as on next page
 0.0425 inches
 at solar focus by measures on glass scale micrometer.

The diaphragm 0.022 was found to subtend an angle of $0' 16''$ at solar focus.
 0.0210 inches

April 2 The Lamp diaphragm Z has an aperture of 0.040 by estimate $\frac{1}{6}$ less than Z
 As measured light transmitted 6.95
 Area X = 4.63
 Area Y = 2.59
 Area Z = 0.705
 Area 10 = 0.788
 M. or m. 0.033 ? by estimate $\frac{1}{6}$ less than Z
 Y 0.056 } Cannot be nicely
 X $0.094.087$ } measured without
 a microscope.

The Bull Mar. 14 - Apr 25 B₄
 Diam of large silvered bulb B₂
 " " " " " " B₁
 " " " " " " B₃
 " " " " " " B₅

Chalk Globe - G.
 " Disc D

Diam
 "

0.304 mercury surface Dist surface here
 3.436 silvered surface to center surface of glass
 0.604 Surface of mercury $\tau = 0.034$
 1.760 silvered surface $\tau = 0.070$
 10.16 " "
 1.62 April 3 1.614 April 23
 1.16 " 3

Weyette House (from object glass to window where bulb was exposed) 1336 ft.

Wood aperture of Object glass April 12 0.462

Solar focus 270.0
 Focus used for
 Weyette House 274.4

Venus

1860 March 27 6 P.M.

Saw the planet under singularly fine definition but could discern no spots upon it. The great increase of brightness from m towards a was the most remarkable feature



April 2nd. Moon having about same phase I was struck with its general resemblance to Venus in distribution of its light.

1860 April 12/13 Found by Microscope H of Tr Circle				By glass scale
Diam of Diaphragm	0.044	=	0.0431	0.0419
	.022		0.0209	.0204
UFL	.011		0.0108	

The mean will be adopted

viz

Angle at Solar focus

For diam. of	0.044	=	0.0425 =	32".47
	.022	=	.0210	16.04
	.011	=	.0108	8.25

$$270 = 2.43136$$

$$2\pi 1'' = 4.68556$$

$$4.68556 \times 0.001389 = 7.11692$$

$$0.0425 = 8.62839$$

$$.0210 = 8.92222$$

$$.0108 = 8.03843$$

$$0'' 32.47 \quad 1.51147$$

$$16.04 \quad 1.20530$$

$$8.25 \quad 0.91650$$

For comparison of light transmittance
 Wavelength 0.0210 and Z see March 24 obs on Jupiter

Photometry Lincs

March 27 1860

Lamp diaphragm Z

Dist from microm	⁶⁰ 1.95	Images of Lamp & Star equalized
" "	1.80	on Bulb
Dist of Lamp from Bulb	24.80	

Photometry Jupiter

March 27 1860

236 = 10⁴ 0^m Dist from microm ^{hr} 3.70

Dist from Lamp to Bull 25.80

236 = 10 4 Dist from micr 3.60

Photometry Moon

March 27 1860

With naked eye

236 = 9 ^h 8 ^m	Bullb to Lamp / 2 diaphragm	Bullb to Window at 4.54	Window to Lamp dia- phragm 0.6	4.54 + 0.6
236 = 9 6	" "	5.05	0.6	
236 = 9 9	" "	5.03	0.6	
236 = 9 11	" " / X diaphragm	11.5	0.6	
236 = 9 12	" "	11.0	0.6	
236 = 9 13	" "	11.5	0.6	
236 = 9 16	" Lamp full blaze	113.0	0.6	

For height of flame measured from top of wick
Dist- to extreme point of blaze of Lamp 1.75 inches.

average dist 1.10 inches. Perfectly clear.

Lamp in West wing cellar

March 26-27 Solar Spots Time from Equatorial

26 Looked at the sun at 8-9-10-11 A.M. 12 M. and 3-4-5 P.M.

Saw nothing which could have been a planet

All of the ~~the~~ small spots ill defined, and ^{more of them} on that account could not have been a planet

27 Looked at the sun every hour from 8 $\frac{1}{2}$ A.M. to 5 P.M. Saw nothing of a planetary character

Photometry

1860 March 27/28 pretty clear

Bulb B₂ at Wyeths 5" in apLamp S 236 1^h 5^m 7. 7/10

Diaphragm Z.

Bulb B₂ turned 7. 7/10Distances to Bulb 1371
and 1 1/2 in bulb B₃

236 1. 15 8. 0/10

For all above Focus to 1371 = 5.85

The two bulbs were indifferently used for results on this page - B₃ then sent to Wyeth's house
(received there)

Aperture changed to 15"

Lamp S

236 1. 35

7. 8/10
7. 8/10

Dist 5.85 focus

to bulb
B₃

Dist. changed Bulb to Lamp S 5.05

focus to 1371 ~~at B₃~~ 2.85 2.85

Aperture 15" int.

New Lamp S: Lamp to 1371

7 45/100

Dist / 5.85

7 25/100

Focus to 1371 / B₃

7 55/100

236 1^h 45At Wyeths Bulb B₂pretty clear
throughout

Focus diaphragm 0.044

Photometry

1860 March 28 Cont

Set up screen-painted flake white.
 on best Wartmanns drawing paper
 At Wyeths perp to sun rays ^{dazzling} white.
 Focus diaphragm 0.044 through hole
 Object glass up 15ⁱⁿ Lamp diaphragms Z
 Images on 1371 equal when

Lamp	5 ^{ft} to 1371	6.4 ^{ft}	1371 to focus	5.85 ^{ft}
2 ^h 00	Sid.	6.5		

Bulb B₃ 1 1/2 in diam at Wyeths house

5 ^{ft} to 1371	6.08 ^{ft}	1371 to focus	3.0 ^{ft}
2 ^h 20 ^m	~~5.85~~ 5.80		2.9

Next set up blue black dead lustre
 screen - black linen painted with thin indigo
 Dead

236	2 ^h 40 ^m	Bulb 1371 to Focus	3.1 ^{ft}
			3.1
		Lamp to 1371	11.1 ^{ft}

Clouds troublesome & increasing annoyance

Photometry

1860 March 28 Cont-

The sky not perfectly clear in comparisons with Bull B₂ but almost so - the obstructions were scarcely noticed for it but afterwards they became more frequent

In experiments with blue black screen there were at times thin clouds but the brighter intervals were used & the thin haze obstructed probably not $\frac{1}{4}$ of light or $\frac{1}{5}$.

In order to make ~~flame~~ ~~disappear~~ the light from lamp independent of its position it was frequently taken off & readjusted and Mr Hale held lamp at different elevations above & below plane of telescope focus & bulb.

Sun Observation Fine foot Equatorial
March 28

Looked at the sun every hour from 9 AM till 5 PM

Saw nothing but diffused spots

Jupiter

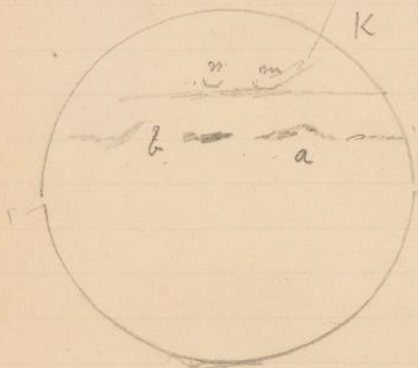
1860 March 29

m a very small point brilliant
 & elongates further towards K

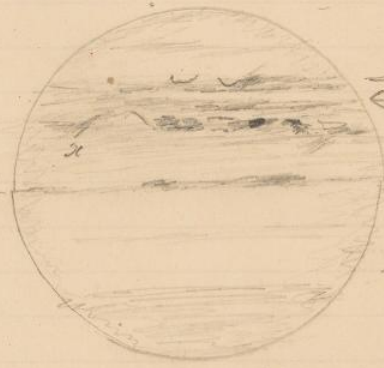
7^h m s. t.

236 = 7^h 40^m 2^s

or too dark



a & b
 white regions

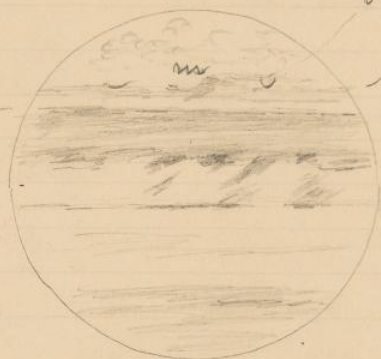


← too broad by $\frac{1}{3}$
 ← wider by $\frac{1}{3}$
 should be
 below equator, that
 is, north of it
) whitest region

At m & n two brilliant white points with apparently
 radiating slightly * *
 or rather blending off from center

236 8^h 12^m

The bright spot at m is like
a bright mountain on Moon duplex (



bright spot p
not as dark as
rest of large belt
whitest part of
duplex as left
m?

1
2

3

2

4

2 & 3 nearly equal

Large belt is too
broad—

Sun Observations True local Equatorial
March 29

Looked at the sun at 9-10-11 and 12. The afternoon
was cloudy

1969phoe.proj...197B