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Comptes Rendus 58, p. 1153
IV . 561

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~~Greater accuracy attainable with ½" objective. Cylindrical Eyepiece used in last setting.~~

Greater accuracy attainable with ½" objective.

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9

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1

2

3

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Recherches sur le Spectre Solaire Ultra-Violet suivies sur la Détermination des Longueurs d'Onde, par M.E. Mascart. Paris 1864.

Brewsterís application of last letters of alphabet to lines in the ultra-red beyond A Phil. Trans. 1860

Stokes extended results in the ultra-violet nearly to Q. (page 4)

Esselbach " " " " " " through R (page 5) Poggendorff's Annalen, t. XCVIII. – Annales de Chimie et de Physique 3e Serie, t. L.

"However, the measurements of Mr. Esselbach do not appear to be very precise, for they differ notably from those of Ruellens (Poggendorff's Annalen CXIV) for the luminous rays, and the results of Ruellens seem very exact." (Page 6)

Müller (Müller-Pouillets Lehrbuch der Physik; 1863) extended the results still further by changing focus & exposure to suit each case. (page 6)

Mascart, Photographing, &

(Page 8) Mascart's Method. Babinet Goniometer constructed by the Mecanic Brunner. Achromatic lenses of collimator & telescope replaced by quartz lenses in which the optical axis coincides with axis of figure. For the line D, focal length of collimator = about 213m.m.2 Of telescope 292m.m.5

Ramsden positive eyepiece. Sensitive plate attachable to eyepiece mounting. (Page 9) Quartz prism, with edges parallel to axis of crystallization, giving superposed spectra. Most deviated examined.

Slit of collimator, refracting edge of prism, and vertical wire brought parallel to axis of rotation of telescope. Plane bisecting refracting angle made to contain this axis. (Page 9)

Circle divided to 10'. Two verniers each reading to 10" directly "et permet d'apprécier aisément 5 secondes". (Page 10)

Angle between telescope and collimator when latter is viewed in focus by reflection on anterior surface of prism, equals refracting angle plus deviation by refraction; when prism is adjusted to

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position of minimum deviation. (Page 10)
Prism placed in position of minimum deviation for line H, with solar rays reflected by heliostat. Move the telescope + set upon to see the slit reflected on the anterior surface of prism, note its position there and replace and set upon to see the line H. Uncertainty due to reflected image being (probably) out of focus & immaterial, since exact adjustment of prism is not necessary to secure practical minimum. (Page 11) It would be best to change focus for this during the experiment. Coat and sensitize the little plate, attach to eye-piece, insert in telescope, expose, develop, wash + fix. (Page 11)
Place telescope a certain distance (say 20') from position in which it formerly saw the slit reflected on anterior surface, and move the prism till set again on reflected slit. This is evidently the position of prism for ray whose deviation is 20' away from the preceding. Then place telescope 20' away from position in which first photograph was taken and expose another plate, having first slightly changed the focus a trifle. This motion to be judged by photographic results. When the field of the telescope can not be moved in far enough, move in the slit of the collimator. Then go on. As the limit of action is neared the slit is widened. Tried placing in front of the apparatus a quartz lens focussing on the slit, thus causing more light to penetrate collimator. But did not sensibly prolong the spectrum, + lost clearness to a considerable extent. This defect due to diffused rays, which could not be excluded in spite of numerous screens in collimator + telescope. Centre sharp, edges of photographs more or less confused. Reticule shows on each plate as a white cross. This fixes position of plate. Were not the reticule a trifle inclined it would be difficult to discriminate between it and the spectrum line when everything works well. (Page 12)

Mapping. To map the spectrum lay off distances proportional to the displacements of the telescope to represent successive positions of the image of the reticule

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Make micrometric measures of most important lines on photograph relative to image of reticule and lay off proportional distances on paper. Intermediate filled in by eye, preserving the form of each group and representing the widths and intensity of each line. (Page 13)

Lettering of Becquerel, Stokes & Esselbach not accordant (Page 13-14)

Rowland take as a guide the spectrum published by Müller in his Traité de Physique. Beyond H the first conspicuous group is I, of most physicists. But its 5 lines double under the a high power, same the 4th, and to this the letter is applied. The 4th of the 5 lines into which M resolves similarly chosen. Becquerel's application of N has not prevailed. N is taken in the group called "N" by Stokes but "O" by Becquerel. Use N for 2nd black line in leaving the violet. & so on. see Page 14 if description of other letters is desired.

Different appearance of groups under different powers - examples. (Page 14-15)

Measuring Deviation

The preceding not sufficiently exact for measuring deviations & why.

It becomes necessary to deflect first to right & then to left (or vice versa) and thus get a measure of the double of the deviation for each line to be directly measured, without directly viewing the slit, and taking care not to touch the collimator in the process. (Page 15, 16) To do this photographically for ultra-violet, set the telescope in a calculated direction successively on each side, and only correct for varying position of reticule shown on the two photographs. But for comparing two spectra it is not necessary to observe on each side. (Page 16, 17)

Graphical.

On rectangular paper lay off abscissae proportional to distances of the lines on the scale, and for a number of lines whose deviation has been measured lay off ordinates proportional to these ascertained deviations. Drawing a curve through these points, the ordinate will in general give the deviation for any line. (Page 17)

Always test that the collimator has not moved during the double experiment.

Special treatment with double refraction (Rowland & Ireland 1st Am.) Pages 18 & 19

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Wave-Lengths. Fraunhofer 1st memoir Paleron Wave-lengths determined with Diffraction-grating (Page 23)
Schumacher's Astronomische Abhandlungen 2e partie.
A following paper in Gilbert's Annalen t. LXXIV (Page 24)
His theodolite "donnait 4 secondes" and allowed angles to be repeated.
Fraunhofer "qu'il faut considérer comme le meilleur juge de ses expériences", thought the "incertitude" did not reach a thousandth of the value of the wave lengths. Fraunhofer determination of C through H. Effect of diagonal position of diamond in ruling the lines. (Page 25)
Babinet (Annales de Chimie & Physique 2e Série t. XL 1829) published in Fraunhofer's experiments. Fraunhofer 2nd memoir little known in France & Germany, but read by the English (Herschel Traité de la Lumière) F's results - both series - in thousandths of millimetre.
Esdaile - Interesting but not sufficiently accurate. (Page 27)
Bernard - (Comptes Rendus 20 juin 1864). Similar method to Esdaile but more exact. (Pages 27, 29)
Disadvantages of Bernard's method. (Page 29)
Orientation of diffraction plate. (Page 30, 32) Advantage of measuring the double deviation i.e. on each side.
Nobert-plate with metallic rays - formulae. (Page 32, 41) This not carefully read.
With sunlight, page 42, 44. "Les résultats que j'ai donnés sont les moyennes de dix séries d'expériences assez concordantes pour que je les croie exacts à moins d'une demi-unité du quatrième chiffre significatif, si ce n'est peut-être pour les dernières rayons ultra-violets." (Page 44) Results all a little larger than those of Fraunhofer 2nd memoir.

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On Fraunhofer-lines with Diagram of Violet-part.
Ångström & Thalén - Translation. Upsala 1866
Communicated Feb. 7, 1865

Kirchhoff's drawings in transactions of Royal Academy of Berlin for 1861 & 2
embrace A to G He used many prisms. Continued
(Page 4) Coincides results on Cit. Explains extraneous lines by using colour
glass. Micrometer measures only relative. Drawings by hand with
compasses & scale. This paper bears principally upon coincidence of
bright-metal lines with dark solar lines, with new coincidences
noted.

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Rutherfurd's Measuring Engine.

Received at H. C. Observatory. Dec. 27/78
Box opened Dec 31/78 by Prof. P. + J. R. E.
Found one eye-piece for inspecting vernier loose in box.
Apparently uninjured.
Notice that circle was spotted, while one vernier was either tarnished or the plating rubbed off.
By trial (Jan 1/79) with finger on a plane surface of the vernier beyond the graduations, find it to be (at least there) tarnish which will rub off. Were the readings of the circle needed it would have to be cleaned.
Tangent-screw to circle - Lubricator gumming.
Circular glass plate apparently sound.
The various sliding motions need to much removed.
Tangent-screw moving microscope perpendicular to scale has much play in socket.
The socket itself to the tangent-screw moving microscope parallel to scale ~~is~~ is not firm.
6 lamps seem all right.
Scale, inspecting microscope & micrometer seem all right.
Objective to other microscope missing. Not in box either.

N. B. This machine was ordered returned and its receipt acknowledged by Mr. Chapman.

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Sur le Spectre Normal du Soleil – Cornu.
in Annales Scientifiques de l'Ecole Normale Superieure, – Paris 2e Serie 3, 1874

Angstrom limites himself to visible spectrum, but introduced the scale of wave-length.
Mascart's plate has inconvenience of an arbitrary scale, and the defect of imperfectly rendering the appearance of the groups.
Cannot go as far as Mascart did as the lenses are glass instead of quartz.
But the achromatic combination has the advantage of a more unchanging focus, so that more can be photographed at once. Thus the space comprising h, H, K, L, M, N, O can be included on 3 plates. Details depend upon fineness of prism. With a good prism, the photographic plate will bear an enlargement of 50 time, i.e. 5 or 6 times that of eye-piece.
Use an exterior porte-plaque instead of fastening sensitive plate to eyepiece as did Mascart. Thus use a plate not inconveniently small and take several exposures on one plate.
Took 3 series of plates. 1st with Nobert grating. 2nd with flint prism, 3rd with prism of Iceland Spar (ordinary ray). The 1st determines directly the wave-length of 36 principal lines. The other furnishes additional details. (The preceding on pages 421–3.)
The focusing make an empirical curve whose abscissa represent the minimum deviation of the ray while its ordinate is the position for focus obtained by experiment. For any case interpolate on this curve. The objective being achromatic for visible rays, this curve is a parabola with vertex in middle of spectrum. For the invisible part extend the curve by the eye, make a preliminary photographic trial on this basis and correct the extension of the curve accordingly. (Pages 424, 5)
Discard the reticule. After taking a photograph with the azymuth position of the telescope noted, place the telescope successively at the position noted about 20' on each side of a position directly opposite to the collimator. And in each case photograph on the plate (already exposed to the spectrum) the direct image of the slit. (Page 425, 6)
Or, successively expose the two halves of the slit with deviation

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respectively to right & to left. The first alternation covers its own scale of proportion; the second does not, but has many advantages. To get a scale of proportion, similarly expose a second plate with telescope in slightly different position. (Page 426, 7)

Mr Eare of examining and magnifying plates. (Page 427)

Details obtained with prism superior to those with plates. (Page 428)

Made no independent determination of width of grating, but for final results measured six principal lines given by Angstrom and deduced scale accordingly. (Page 428)

Place telescope of their collimator and get plate normal by using a collimating eye-piece & reflecting the reticule on the face of the plate.

Determination of factor by comparison with Angstrom. (Page 429)

Correction for difference between optical (Page 430, 2) and photographic results. (Page 430)

Scale of plate identical with Angstrom, i.e. $1^{cm} = \frac{1^{mm}}{1\,000\,000}$

36 rays of table page 431 observed directly. Others interpolated from prism photographs. (Page 432)

Interpolations made with camera drawn. Have no idea of micrometric measurements, 1st "because the number of lines is so great, 2nd", c'est que tout ce travail ne servirait qu'à donner une exactitude illusoire, puisque puis-qu'on peut à peine compter sur une approximation de 0.05 dans la mesure absolue des longueurs d'onde, c'est-à-dire un demi-millimètre sur le tracé graphique." (Page 433)

Comm plate may be considered as a continuation of Angstrom. (Page 434)

Details always comparable with A's. And better in the vicinity of h, H, where the lines are feeble to the eye but strong in the photograph. (Page 434)

"Enfin, comme erreur probable dans la position des raies par rapport aux repères, je ne crois pas que le dessin atteigne 0.05, c'est-à-dire un tiers de millimètre; en valeur absolue, ces repères fondamentaux ne doivent pas s'écarter de 0.10 de leur

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Material for Wave-Length of Principal Lines

Fraunhofer. Results of 1st & 2nd series quoted by Mascart p. 26.

Esselbach. Disparagingly quoted by Mascart p. 27.

Bernard. Quoted by Mascart p. 29. Uncertainty in absolute value of unit.

Mascart. Page 43. Paper in Ann. Sci. de l'Ecole N. Sup. 61, 1864

" Quoted by Angstrom page 33. But why trifling differences in last place?

Von der Willigen Archive du Musée Teyler. Vol I. 64 lines determined.

Ditscheiner. Sitzungsberichte der Akad. der Wissenschaften Wien. Math. & Naturwissenschaftlich 1864 page 296 127 lines determined.

Ångstrom Recherches sur le Spectre Solaire. Spectre Normal du Soleil

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Jan 10/79 Rutherford Plates.
15 in a box. Numbered respectively
in pencil on the paper binding edge,
and all scratched "Lo. M. R. 1875"
(one Lo. M. Ra 1875") on the glass.
The penciled numbers are also
scratched (together sometimes with
adjacent numbers) on the glass.
Other figures and letters are sometimes penciled on the
paper, while straight scratches occur on the glass.
Each plate protects by a covering plate borne upon
which it by the paper edge referred to.
Examine part below 36
Shows granular surface under the microscope accompanying the L. S. engine., whichever side of the plate
be placed, and several extreme lines visible to the naked
eye are not define in the instrument. As these lines
are visible in a ~~simple~~ positive eye-piece, it is evident
that we have too high a power for the extreme of
the photographic series.
The same is true of the other extreme, although possibly
not to so great a degree.

36
37
38
39
39 & 40
40 " 41
41 " 43
43
44
45 " 46
46 " 47
47 " 48
48 " 49
49 " 51
51 ——

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Plate 36 (beginning of well defined end)

Neutral

12-40 P.M. 36 - 27.0 } Bright
- ~~22.0~~ }
- 42.0 } Dark
- 59.5 Neutral
64.9 Dark

Early plate measurements
of
Rutherfurd plates
important historically

37

38

12-52
- 59

39

1-03 40- 03.3

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Plate 36 (beginning of well defined red)

Neutral

12-40 P.M. 36- 27.0 — Bright
- 42.0 — Dark
- 59.5 — Neutral
64.9 — Dark
75.3 — Br (-320)
84.1 — N (eutral)
95.3 — Br.
37- 05.5 — V Brightness decreasing
30.9 — Slightly brighter line - nebulous
Dark
45.0 — Same character as 30.9
Dark
80.0 — Smooth - call it "Ft" (ferric line).
D (ark)
95.3 — Ft.
N.
38- 11.6 — Ft.

12-52 Dark with suggestion of ft. line.
-59

-73.7 } Br.
95.3 }

Dark

39- 03.3

Br.

15.5

D.

56.5

Br.

73.2

1-03 40- 03.3

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Treat the plate as an uneven surface and measure enough abscissæ to define it. For estimating ordinate
Let 0 = absolutely transparent plate.
10 = " opaque "
5 = neutral.
But for practical conception of scale, use
2 = decidedly bright
4 = faintly ~~bright~~ light
6 = slightly dark
8 = decidedly dark
1 & 9 = extreme actually occurring
3, 5 & 7 express doubt between adjacent even numbers.

Plan plate so that increase of reading of screw represents increase of millimetre scale of spectrum.

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Plate 36

Time	Abscissa (Screw)	Ordinate (Estimate)		
1-37	36-37.2	1		Estimates made by reversing the field — not very reliable.
	39-26.3	2		
	42-62.9	4 exc 2½		
	-85.7	6 exc 4		
	43-03.1	5 exc 3		
1-50	-15.8	6 exc 4		
1-52	-03.2		exc	
	-12.8 m	6	4	
	-21.2			
	30.3 m	5-	3	
	34.9			
		6	4	
	66.4			
		5-	3	
	75.6			
		6	4	
	92.5			
		5-	3	
44-07.8				
	39.5 m	7	4½	
	52.0			
	69.9 m	6	3½	
	70.1			
	~~81.9~~	7	4½	
	~~79.0~~			
		6	3½	
	95.2			
45-	30.4 m	8	5-	
	46.8			

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Bt. forward 45-46.8

60.1 m	5	3
69.4		
85.9 m	8	5
92.1		
2-05 46-02.0 m	5	3
2-10 -02.0 m	3	
08.6		
	5	
31.3		
	4	
42.8		
	5	
56.8		
	4	
66.8		
76.4 m	6	
88.0 m	5	
47-13.2 m	7	
25.4		
32.3 m	5	
41.0		
51.4 m	6	
86.9 m	4	
48-06.0		
21.7 m	6	
29.6 m	5	
38.7		
45.6 m	6	

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Bl. for. 48- 45.6 m 6
51.7
63.0 m 4
85.4 m 6
99.0 m 4
49- 03.8
~~11.1 m 6~~
09.8 m 6
17.1 m 5½
23.9 m 6
33.0 m 5½
43.1 m 6
56.7 m 4
69.9
75.2 m 6
84.2 m 5
92.0 m 5½
95.7 m 5
50- 17.9 m 6
23.8
28.7 m 4
42.6 m 6
53.4 m 4
67.2 m 5
78.8 m 4
89.8 m 6
96.6 m 5
51- 03.9 m 6
10.8 m 4
14.4

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Bl. for

51- 14.4	
	6
29.6	
37.2 m	~~5-4~~
44.0 m	6
70.5 m	5½
80.8 m	6
52- 01.9 m	4
09.1	
	6
27.0	
	5
36.5	
	6
56.0	
	4
67.0	
	6
84.8	
	4
93.7	
98.7 m	6
(53)- 32.9 m	~~4~~ 3
51.1 m	6
55.8	
	4
66.8	
75.0 m	6
92.1 m	5
99.4	

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Bl. Ho. 5h 3m - 99.4

6

54 - 05.6

~~15~~ 4

15.5

6

19.5

5-4

35.8

7

44.1

4

50.7

6

73.6

4

84.0

6

97.3

93.0m 5

55 - 03.2m 6

07.3m 5

12.8m 6

24.9m 4

65.2m 6

70.7

75.5m 4

84.0m 5

89.7m 4

99.9m 6

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30. found	55 -	99.6 m	6
	56 -	13.0 m	4
		19.8 m	5
		27.3 m	4
		34.2	~~6~~
		~~41.4~~	6
		~~47~~ 41.4	
		~~47~~	4
		47.6	
		~~48.1~~	6
		6~~8~~8.4	
		~~7~~	5
		72.6	
		78.5 m	~~X~~6
		87.4 m	5
		95.6 m	6
2-57	57 -	02.7 m	4

m = either maximum or minimum.
Settings unaccompanied by "m" or an estimate of illumination are made on apparent line of demarkation between the two grades of illumination indicated by figures placed ~~before and after~~ on lines above and below. Omission of "m" means indicate absence of any particular max. or min.
Omission of means between two m's indicate gradual change. But power is too high, and nothing is well defined.
The scale of brilliancy is also liable to alter in absolute value for diff. parts of plate.

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Appalachian Mountain Club

Eighty-sixth Corporate Meeting,

WEDNESDAY, OCTOBER 12, 1887, at 3 P. M.

Mass. Institute of Technology.

PROF. E. C. PICKERING will present a paper entitled, "Colorado mountains from an astronomical standpoint."

MR. R. B. LAWRENCE will give some notes on ascents of Pike's Peak, and several minor elevations in the West.

The Recording Secretary desires now to arrange the programmes for the Club Meetings during the coming season. Members who have papers to read are therefore requested to communicate with him at their earliest convenience.

ROSEWELL B. LAWRENCE, *Rec. Sec.*,
Boston, 23 Court Street, Room 30.

EXCURSION TO MOUNT WATATIC.

(1847 FEET.)

An excursion party will leave the Fitchburg Station, Causeway Street, on Saturday, October 15, at 8.30 A. M., for Watatic Mountain, in Ashburnham. From West Fitchburg, barges will convey the party to the foot of the mountain, about 9 miles. The path up the mountain is about 1 mile in length. Those who do not care to climb may pass the time in pleasant woods at the base. Returning, the train will be taken at Fitchburg, at 5.00 P. M., due in Boston at 6.35. Those who ascend the mountain will eat their luncheon on the summit.

The Committee will reserve round trip tickets ($3.25 each), including railroad and barge rides, for those who request them *by mail* on or before Friday noon, October 14.

If stormy on October 15, the excursion will be postponed to Saturday, Oct. 22, in which case a new application for tickets will be necessary.

JOHN RITCHIE, JR., *Committee*,
Box 2725, Boston.

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Appalachian Mountain Club.

NOVEMBER, 1887.

CANDIDATES FOR CORPORATE MEMBERSHIP.

Name and Address:	*Nominated by:*
Mr. Philip S. Abbott, Mr. Robert W. Herrick, Cambridge, Mass.	D. C. Gilman, S. H. Scudder, R. B. Lawrence.
Mr. Charles E. Beale, 38 Hancock Street, Boston.	Miss O. Augusta Welch. Gardner M. Jones.
Mr. John Bapst Blake. Mrs. Mary E. Blake, 1330 Washington Street, Boston.	Edward E. Norton, Miss Rachel Norton.
Miss Mary E. Bosworth, Hotel Warren, Somerville, Mass.	John Herbert, A. E. Winship.
Mr. Ezra Brainard, Middlebury, Vermont.	F. O. Carpenter, R. B. Lawrence.
Dr. John B. Brainard, 615 Tremont Street, Boston.	W. S. Stevens, F. O. Carpenter.
Miss Georgia A. Cassidy, Miss Jessie J. Cassidy, 703 Nostrand Avenue, Brooklyn, N. Y.	Miss Emily A. Thackray. Gardner M. Jones.
Mr. Paul Dudley Chase, 104 West 55th Street, New York City.	Eugene B. Hagar, Gætano Lanza.
Miss Lillie J. Davis, Melrose, Mass.	A. Selwyn Lynde, I. Y. Chubbuck.
Rev. Richard B. Grover, 11 Durham Street, Boston.	H. L. Darling, W. S. Stevens.
Mr. Brainard Kellogg, Polytechnic Institute, Brooklyn, N. Y.	F. O. Carpenter, R. B. Lawrence.
Mr. Edmund Sewall Munroe, Englewood, N. J.	Melancthon M. Hurd, James Schouler.
Mr. William D. Serrat, 7 Exchange Place, Boston.	J. F. Frisbie, Mrs. F. D. Sampson.
Miss E. C. Sweetser, Woburn, Mass.	A. Selwyn Lynde, I. Y. Chubbuck.
Mrs. Elizabeth B. Ward, Brookline, Mass.	John Ritchie, Jr., Miss Emma F. Munroe.
Mr. Edward H. Williams, Enfield Street, Jamaica Plain, Mass.	George C. Mann, J. Allen Crosby.
Miss Julia L. Wrightington, Francis Street, Brookline, Mass.	George F. Schermerhorn, Percival J. Parris.

A ballot will be taken upon the above names at the regular meeting in November, provided they are approved by the Council. If members of the Club know any reasons why the candidates should not be admitted to membership, they are requested to communicate with the Recording Secretary, within one week from the regular meeting in October.

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Comparison of Cornu's Plate

40.564

One (1) fine non-accordant

.539

~~.527~~

.527 ~~.527~~ One (1) fine

.517

.512

Blank

.492 }

.486 Double }

.480 Double

Blank except halo from .480

.450 Very broad with halo

.441 Fine, distinct

.431 Fine, distinct

Several lines more distinct than Rutherford

.349 Broad, distinct

.338 " "

.322 "

.327 "

.311 Fine "

.300 V. broad " + halo

Several lines well define

.241

Several lines well define

.199

~~.180~~

.171

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[~~D~~ Time place by H]

with Rutherfurd Negatives.
Plate No (39) Mar. 3/79

3 P. 16.

48.56 5

.9 Two broad gray

49.01 .99

49.18 Very broad faint

49.32 Broad "

.50

.63

Two (2) indistinct

Broad faint & nearer than former together than former

Hardly resolved

50.30 Not resolved

Inspect that less exposure would show something

.92 Very broad - probably overexposed

Indistinct - " "

" " "

" " "

53.04 Broad, indistinct "

.24 " " "

.55 " unresolved "

"

Probably double, v ft. "

54.04 Broad "

Indistinct "

55.23 " "

" "

56.14 " "

.53 " "

.75 " "

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1878phae.proj.1149P

40.169 Fine
.180
.171
Two in halo from .14
Two broad with halo
Five(5) equidistant in halo
.076 Fine
.06 Double
.044 V. Broad
Two(2) fine
.006 Double
39.998
.983 Fine
.975 Broad
Broad
Four in halo
Double. Two near together
" One too broad
.895 Broad
.890 Broad
Three(3) fine.
Two(2) broad. Farther apart than photograph justifies.
Blank
.847 One(1) fine
Blank
.837 Broad
.829 Fine in halo
Blank
.819 Fine in halo
.810 Broad with halo on one side

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Indistinct- Probably one object

56.53 " "

.75 " "

Two (2) " "

" " Nothing to justify halo "

Five (5) " " " " " "

56.57 " "

.83 Broad " Unresolved "

59.17 V. Broad

Two (2) indistinct-

59.98 Hardly resolved

60.15 Broad, indistinct-

~~X~~ Indistinct + nearer .61 Probably resolvable.

.61 ~~Indistinct~~-

Double

Four. Nothing to justify halo

Double Indistinct-

Double "

Five

62.30 Broad

~~Five~~ (11) narrow and one v. fl.

.96 Broad Probably resolvable

63.02 Fine

.15 One ~~and probably others v. fl.~~

.4 Two (2) very faint-

.41 Broad probably resolvable

~~.56 Fine~~

.56 V. Fine ~~Indistinct~~-

.70 " " "

.84 Broad

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1878phae.proj.1149P

39.804 Fine
Blank
.789 Fine at end of halo
Halo .778 Single in halo
.768 Single in halo
.756 Broad at end of halo
Blank
.738 Single Halo from H begins
.730 Single
~~.711~~
.711 Single
.704 Single
.696
.687 Distinct
Blank
Blank
.677 Broad H
Blank
.668 Probably discordance here

.647 Fine
.630 Broad
~~.636 Single~~
.636 Single Halo from H ends
Blank
Blank
.621 Distinct
.617 Distinct
Blank
.606 V. broad
Not distinguished from .606 5-40 P.M.

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V. faint

" "

64.27 Broad, faint

.48 Probably double

.62 Single

.88 Broad

Two (2) ~~at least~~ & One at least resolvable.

65.25 Double

.48 Broad

Possibly something

.72 Double Halo from H begins

.92 Double

66.08

.21 V. faint

.29 Comparatively distinct & broad

.35 " " but v fine

.42 } Pair of lines into which H possibly resolves.

.52 }

.62 Probably very faint pair

.75 V faint

.82 Comparatively distinct & broad

.92 Fine

67.02 V. fine Halo from H ends

.27 Double

.39 Fine

.45 V. fine

.57 Distinct

.58 V. fine

.68 Double, fine but distinct

.84 V. broad

.90 V. fine

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1878phae.proj.1149P

Mar 4 10-30 A.M. Resetting the continua without change of scale reading.

Yesterday	Now	Diff	Rect		Rect	
66.82	~~.838~~ .805	.015	.829	.009		
67.27			.297	.027	.260	−.010
67.51	.506	.004	.536	.026	.511	+.001
67.68			.709	.029	.682	+.002
67.84	.833	.007	~~.864~~	.024	.833	−.007
		.009		.023		.0035

Continuation of Plate (39) 11 A.M.

39.593 Fine
Blank
.569 Single

~~Blank~~
Single broad
.580 ~~Blank~~. Fine
.545 Fine
Blank
.533 Fine
Blank
.520 Broad single
Blank
.500 Fine
~~Blank~~ Blank
.489 Fine
Blank
.480 Broad

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1878phae.proj.1149P

68.06 Fine
One or more other faint
.52 Double
.61 Faint
.73 Fine
.83 Double
.93 Fine
69.16 Distinct
.19 Probably double, faint
.34 Faint
.41 Very faint
.54 Broad double
.73 Faint
.90 Distinct
70.04 Fine
.13 Distinct
.28 Fine
.37 Distinct

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1878phae.proj.1149P

39.469 Broad

.462 Fine

.458 Fine

Blank

.443 Distinct

.432 Broad with halo

B Halo. Blank

.417 Fine

Blank

.401 Distinct

Blank

.377 Distinct Halo from K. begins

Only halo

.353 Distinct

Only halo

.330 Broad band K

Only halo

.298 Broad

.294 Fine

.284 Fine

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1878phae.proj.1149P

70.48 Fine & distinct single
.59 Double
.70 Distinct single
Blank
.92 Very faint
71.10 Quadruple
.29 Broad
.44 Double
.61 Distinct
Three(3) fine lines distinct
.91 Fine
Probably curved
72.30 Broad
.47 Fine
.60 Distinct
.70 Fine
Two(2) probably very fine
.90 Broad probably resolvable - Halo from K. begins
.98 Faint
73.18 Faint on acct of Halo -
.25 Faint on acct of halo
.30 Broad
.38 Broad
.47 Very faint pair
.69 Faint pair
.79 Comparatively distinct pair - Halo from K. ends -
.96 Broad
74.06 Fine
.18 Broad

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1878phae.proj.1149P

39.276 Fine Halo prin K ends
.272 Broad
Blank
.257 Fine
.254 Fine
.250 Fine
.243 Fine Too low on scale
.240 Fine
.237 Fine

.220 Broad
.216 ~~Fine single~~ ~~Halo prin .20 begins~~
.216 Fine single Halo prin .20 begins
.210 Broad in halo
.206 Broad in halo
.200 Broad with halo on one side

Coincidences with photograph not good Comb too compressed

.185 Fine } halo between
.178 V. fine }

.167 Fine
.162 Fine
.157 Fine single
.153 Fine single
Blank
Blank
.134 Broad

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1878phae.proj.1149P

74.31 Distinct
.42 Very broad
Probably Nos (2) & very faint
.72 Faint
.83 Distinct
.89 Fine
.98 Fine
Black
75.11 Distinct
V. fine
Probably v. fine
.44 Perhaps resolvable v. broad
.52 Faint
.60 Faint
.69 Broad perhaps double
.78 ~~Probably double perhaps~~ Broad perhaps double
.87 Broad perhaps double
.97 Broad and conspicuous.
76.07 One or Nos (2) v. faint
.19 Broad
.31 Double
Perhaps one or Nos v. faint
.57 Broad and bright.
.66 Narrow and dull
.78 Broad and dull perhaps double
.86 Broad. double.
.96 Fine, single, faint.
Possibly another
77.13 Broad

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1878phae.proj.1149P

Blank
.129 Broad
Blank
.115 Fine
Blank
Blank
.110 Double
.094 Single
Blank
.079 Single
Blank
.071 Single
Blank
Blank
.059 ~~Broad~~ Fine double
.049 Broad band in halo
.030 Fine
.020 Broad in halo
Blank
.008 Double
Blank
38.995 Fine

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1878phae.proj.1149P

77.20 Faint
.27 Broad
.38 Faint double
.58
.60
.63
.81 Either double or preceded by halo
.90 Double
78.03 Bright double
.13 V. faint
.22 Double
Perhaps one (s) v. faint
.32 ~~Faint~~ dull
.41 Double dull
.49 Single dull
.53 Perhaps v. faint
.57 V. faint
.62 Faint
.70 Bright. broad. perhaps double
.80 Bright
.84 V. Broad
79.01 Fine
.20 Bright
.36 Double + bright and broad
.53 Fine
.61 Dull
.65 Dull
.79 Broad. faint
.87 Bright

12-50 P.M. lunch

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1878phae.proj.1149P

1-575 B. vic.

38.984 Broad in halo

.98 Fine

.970 Similar group more compressed

Blank
Blank
Blank

.952 Fine } halo between
.947 Broad

Blank

.933 Fine
.925 Medium } Slight halo between
.920 Fine

Blank

.910 Fine
.905 Fine single

.900 Fine
.894

Blank
Blank
Blank

.880 Broad
.875 Vs fine

Halo from .86 begins
Halo

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1878phae.proj.1149P

80.03 Broad + bright
.09 Fine + faint
.15 Dull
.27 Dull
.37 Broad
.47 Dull
.59 V. faint
.65 faint
.72 faint
.78 } Very broad
.94 to } Probably resolvable
81.04 V. faint possibly double
.14 Broad + bright
.27 Bright
.35 Broad
.42 Dull
.47 V. faint
.56 Broad + dull
.63 Dull
.68 Dull
.77 Medium
.87 Broad, dull band probably resolvable indistinct
.99 Double
82.08 Dull band almost halo } Unsatisfactory resolution
.16 Indistinct
.23 Broad + bright
.33 Fine, V. faint possibly two (2)
.58 2 Broad + bright
.58 Faint

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1878phae.proj.1149P

.860 Broad with halo on one side
Blank
.851 Broad Halo from .847 begins
.847 Very close double

Non-coincident with Yerkes photograph

.774 Broad pair closer than photo. inclosing halo
Plate reset, but without the care
.762 Fine
.758 Fine
Blank

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1878phae.proj.1149P

82.69 Very broad & bright possibly resolvable
.77 Fine and faint
.83 Distinct
.91 Bright
83.00 Fine
.08 Bright
.19 V. faint
.25 Sharp boundary of bright grading off to
.37 and further resolvable
.42 V. faint
.46 Faint
.50 Faint
.55 Distinct
.60 Distinct
.65 Distinct
.72 Distinct
.79 Distinct
.87 Broader
.92 Same as last
84.00 Dull
.09 Bright
.19 Broad & bright
.27 V. faint
.35 Broad & bright
used at beginning of morning
.44 Faint
.49 V. faint
.56 ~~Dull~~ ~~Distinct~~ Bright broad
.65 Dull ~~broad~~

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1878phae.proj.1149P

.747 Broad
.739 Fine

.733 Fine

.728 Broad
Blank
Blank

.713 Broad. double in halo

.706 Broad
.702 Fine
Blank
Blank
Blank

.693 Fine

.689 Fine

Non accordant with photographic

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1878phae.proj.1149p

84.77	Very broad + bright
.88	Distinct
.93	Distinct
.99	Distinct
85.03	Distinct
.14	Broad
.19	Fine
.22	Fine
.32	Bright
	Halo
.44	Bright + broad
.53	Dull + fine indistinct
.59	Broad
.66	Broad
	Perhaps something
.78	In halo
.84	Line ending halo
.91	Fine, dull
.96	Fine, dull
86.03	Fine, bright
.07	Fine, dull
.13	Not sharp
.19	Dull, not sharp
.24	Dull
.29	Faint
.36	Dull
.41	Dull
.49	Bright + broad
.57	Broad

Resolution unsatisfactory

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1878phae.proj.1149P

Non accordant with photographs

.648 Broad
.645 Fine

.635 Fine

.630 Broad
Blank
.620 Fine double

.608 Broad double halo from .592 begins

Only halo

.592 Broad line in broad band in halo
Blank
.580 Fine
.573 Medium
~~.567 Fine halo from .592 ends~~
.567 Fine halo from .592 ends
Blank

.558 Broad

One line & halo from .558
not accordant
with photographs

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1878phae.proj.1149P

86,66	Dull
.75	~~Bright~~ Broad
.85	Very broad & bright.
.91	~~Fine~~, dull
.97	Fine dull
87,04	~~Fine~~, dull
.08	Dull
.14	Faint
.21	Bright & broad
.28	Dull
.39	Broad, dim halo, probably double line
.48	Broad
.57	V. faint
.64	Bright, broad } Poorly defined halo from .88 to .00
.70	Probably double }
.78	V. faint
.85	Fine
88,00	Very broad band bright
.13	Bright ~~& the first~~
.22	Band probably double
.31	Broad & bright Halo from .88. ends
.38	Faint
.44	Bright
.56	Faint band probably double
.65	Indistinct
.70	Bright & broad
.76	Perhaps v. faint
.80	Distinct fine
.85	Distinct fine

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1878phae.proj.1149P

See previous page
Blank
.537 Broad } Halo
.528 Broad ~~in halo~~ } Halo
.519 Fine } Halo
.510 Fine
.510 ~~Fine~~ Blank
.498 Groups i.e. broad with halo & fine line ~~each~~ one side and two fine lines on other side.
Blank
.473 Fine
.469 Fine
.459 Broad
Blank
Blank
.446 Broad

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1878phae.proj.1149P

88.91 Bright ~~line~~
89.00 Dull
.05 Broad
.10 Broad
Perhaps
.29 Broad-bright
Poorly resolved
.49 Very broad perhaps double
.55 Faint
Perhaps
.67 Dull
.73 ~~Medium~~ Distinct
.82 Bright Broad
V. faint
90.00 Bright-very broad
V. faint
.14 Fine
.20 Broad
.28 Very fine
.34 Distinct
.42 Broad
.54 Very Broad & dull line
.65 Very broad Bright
.75 Broad Very broad line
.82 Broad
.86 Fine
.92 Bright
.98 Bright
91.01 Indistinct

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Not like photograph

.419 Broad too low on the scale

~~.413 Fine~~

.413 Fine

.405 Broad } Halo

.400 Broad }

.391 Fine

.385 Fine

.3~~85~~ 76 Broad band in halo

Blank

Blank

Blank

.358 Fine

.346 Fine

.335 Broad in halo

~~.322 Fine~~

.322 Fine

~~Only halo~~

.315 Group

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1878phae.proj.1149p

91.12	Indistinct
.17	Distinct
.21	Distinct
.29	Bright
.37	Bright
.44	Bright & broad
.64	Broad — Indistinctness due to under exposure commences.
.68	Broad.
	Perhaps
.81	Very broad & bright
	Perhaps
.95	Very broad & bright
	Faint
92.10	Dull, broad probably double
.21	Broad
	Perhaps
.39	Centre of very broad bright band resolvable
.52	Perhaps double
.57	Very faint
.63	Faint
.69	Dull
.78	Dull, very broad
.85	Dull
93.02	Very broad band unsatisfactory resolution
.24	Broad band
.31	Indistinct Broad indistinct line
.43	Moderately distinct
.50	Indistinct in halo
.62	Broad band

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Probably with preceding group }

~~Blank~~

.300 Fine {
Blank
Blank

.290 Broad with halo {

.278 Broad with halo }

.260 Fine

.253 Broad with halo

.241 Broad with halo

One fine line in this interval.

.214 Broad {

.198 Very broad band in halo I.

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Perhaps
93.76 Broad
.89 Fine
.96 Broad
94.03 Faint
.10 Faint
.17 Bright + broad
.25 Bright + very broad
Perhaps
.42 Dull broad
.49 Dull broad
.55 Bright very broad probably resolvable
.61 Perhaps
.68 Dim
.77 Very broad
.84
95.21 } Very broad band resolvable
Perhaps
.26 Very broad band
.31 Fine
.38 Broad
.45 Distinct
.56 Dull broad band
.69 Dull broad line
.79 Broad band
.92 Bright
.98
96.16 } Very broad band resolvable I

There are a few more lines on the plate. 4-50 P.M.

See over

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Finishing plate — conspicuous identification only.

.152 Broad ~~faint~~ with halo
.126 Broad with halo

Mar 6/79 Trial with Plate 36
Considerable difficulty in identifying.
Trouble is change in working length of objective due to dismounting apparatus, that it may be put to its legitimate astronomical use in the evening. This must be remedied before proceeding further. But to save time repetition in identifying on this plate the following are noted roughly.

But how can change in working length of micrometer affect relation between reads of photographic measurement on screw) and scale of photographic lines (as measured on attached scale)?

Corrn	Rutherfurd (screw)	Description of Rutherfurd.
35.646	38.03	Unresolved broad band
.69	.93	
.71	39.33	Barely resolved
.779	40.61	
358.05 .805	41.10	Broad N
.84-5	41.91	Unresolved
.862	42.27	
360.82 36.084	46.60	Broad
.095	.87	Narrow
361.80 .18	48.59	Unresolved

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97.01 Very broad band
.62 Broad double

Continue from lower half of Page 60

	.21	49.07	Poor resolution
	.23	.58	Middle of group
363.08	.31	51.01	Band
	.324	.34	Not broad
	.342	.68	Poor resolution
	.359	52.03	Middle of group
	.377	.31	Band
364.70	.47	54.22	Band
	.777	60.04	Band
	.8	.58	Pair
368.71	.871	61.96	Band
	37.035	65.23	Pair
370.54	.056	.56	Band resolved on photograph
	.077	.93	Pair poorly resolved
	.09	66.26	Band
	.198	68.39	Broad band
	.216	.79	Pair
(372.68 see Page 62)	.27	69.86	Band M
	.357	71.60	Between two bands
	.578	76.15	Band

Use these to fine out place on the plate. 71.60 between bands, but not agreeing with either, and at right distance from 69.86 and 76.15 is characteristic.

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Mar 10/79 Plate (37) ~~(38)~~

	36.018		Barely defined
360.82	.083	55.55	Broad
	.098	.85	
361.80	.18	57.66	Broad unresolved
	.21	58.15	Doubly hardly resolved
	.23	.72	Poorly resolved
363.08	.32[08]	60.21	Band
	3.77	61.54	Single distinct
364.70		63.51	
	7.77	69.47	
368.71	8.71	71.41	
	6.90*	66.82 out of order	Double unfavorable*
		66.75	Not easy to make an identification here
		66.88	which shall be unquestionable.
	9.47	72.72	
	(Very fine) 9.63*	73.39	Distinct, but unlikely to have been chosen by Comm*
370.34			Double
		74.99	
		75.10	
	1.97	77.80	Band
372.65		79.19	M in text.
	2.70	79.30	M on lithograph
	3.43	80.73	Broad with halo ~~Band~~ possibly resolvable
	3.65	81.14	
	4.30	82.40	Distinct
374.52		82.84	Double

*Possibly a typographical error in Comm. (6 + 9 Interchanged.)

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5.77	85.33	Broad
5.81	.54	Fine
376.33	87.43	
6.68	87.11	
378.53 (.56)	90.86	Broad, indistinct, unfavorable
8.70	91.21	Finer, brighter, more favorable
9.49	92.64	Not very bright

The above on lower half of ~~plate~~ lithograph. Below on upper half.
Rutherfurd Plate ~~No~~ probably disturbed.

378.53 (.55)	91.18	See above
8.70	.52	"
9.49	92.96	
9.94	93.87	Broad
0.20	94.28	Rather dim
380.64	95.1(8)	
0.69		Faint undefined band See page 65
1.52	97.14	Bright
381.96	98.07	Band I Text + lithograph
~~2.40~~ 3.35	100.93	Bright
383.75	101.79	

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Mar 11/79 Plate (38) 11 A.M.

	M	
		Just beyond field. [In micrometer the hydrogen system slightly beyond M.
372.43	46.77	Band at edge of ~~field~~ photograph
3.65	47.21	Band
4.30	48.49	Distinct but fine lines near.
374.52	48.96	Double
4.82	49.51	Broad
	.66	Fine
4.95	.77	Broad
5.77	51.57	Broad
5.81	.78	Fine
6.08	52.20	Distinct Fine bright ? Not fine
	.31	Faint
6.14	.40	Fine ? Not fine
376.33	52.78	Broad
6.50	53.07	Fine bright
	.28	Very fine
6.68	.41	Broad
7.89	55.90	Fine bright
8.23	56.71	Fine bright
and halo	57.06	Very faint
	.16	Very fine
378.53	.21	Broad probably double
	.28	Scarcely separated
	.33	Fine
8.62	.45	Fine bright ~~? Not fine~~
8.70	.60	Bright
	58.90	Fine
	.95	Very fine faint doubtful } See above.

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	58.90	Fine	copied from previous page
~~9.44~~ 9.49	.95	Very fine faint doubtful	
	59.03	Bright	
	.12	Faint	
9.87	.74	Bright	
9.91	.87	Very faint doubtful	
9.94	.94	Bright	
9.98	60.01	Faint	
10.31	0 6.83	Not bright	
0.40	.97	Broader	
0.50	61.09	Brighter	
0.58	.26	Faint double	
~~V380.64~~	.36	Bright	
0.69	.44	Bright	
0.75?	.53	Bright	Possibly this belongs with the preceding — Triple corresponding to double.
~~0.20~~	60.29	Faint	
out of order 0.20	.38	Broad not bright	
	.47	Fine	

Noticed per the mistake ~~loss~~ of work of page 63.

1.26	62.96	~~Bright~~ Bright	
	.70	Fine double	
	.81	Distinct	
1.40	61.96	Distinct double	
1.50	63.12	Not distinct	
1.52	.19	Broad	
1.57	.28	Not distinct	

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	63.83	Very faint probably double
	.93	Faint
	64.03	Hardly separated
381.96	.13	Broad band possibly resolvable I.
	.25	Distinct 12.30 P.M.
2.41	.90	Bright
2.76		Resolves into several
2.90	65.88	Double
~~383.75~~ 3.71	67.48	Very faint
3.72	.54	Very faint
383.75 (.76)	.64	Bright
3.78	.69	
3.79	.73	
3.84	.80	Fine bright
4.01	68.05	Bright } Probably further resolvable
4.06	.19	Bright }
4.98		Dissimilar group in same position
5.58	71.19	Broad bright
5.92	.89	Group resolvable
387.74	75.50	Band resolvable
389.47		Group faint probably over-exposed
390.48	81.9	about " " " " "
~~392.21~~	~~83.9~~	~~" " " " "~~
392.21	84.33	Faint probably over-exposed
2.73	85.37	" " " "
393.29	86.57	Band poorly resolved probably over-exposed K.
395.20	90.4	Faint probably over-exposed

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396.07	92.2	Probably over-exposed		
396.76	93.6	Edge of photograph	H.	1.20 P.M.

Find over place on the plate by the H line. There photograph effects commence beyond it. Verify point by K line which is over-exposed

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Mar 1/79 Plate (39 to 40) 38.16.

I. Just off edge of photograph

388.75	47.7	Under exposed
4.01	48.2	" "
4.06	48.3	" "
4.98	50.18	Double
	.32	
5.58	51.49	Broad
5.92	52.2	Broad probably resolvable
6.45	53.33	Bright
.48		
	.43	? Grouped with above.
.72	54.87	Bright and broad
387.74 .98		Very fine and faint
.76	56.01	
		Poor coincidence
389.47	59.37	?
9.69	.80	Fine
9.70	.90	Bright
9.78	.98	Fine
	61.25	Fine
	.32	Very fine and faint
390.48	.40	Broad
	.47	Fine and faint
0.59	.58	Bright
0.60	.63	Fine
1.29	63.01	
1.34	.16	

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392.21	64.87	Bright
2.73	65.85	Bright
	.92	Barely separated from the above
2.76		
	66.00	Fine
2.85	.10	
2.95	.25	Fine
2.98	.33	Bright
393.29	67.	K
4.31	67.07	Bright
~~395.?~~	70.77	Distinct
395.20	.84	Probably double
	72.45	Very fine and faint
6.07	.53	Broad & bright
	.59	Very fine and faint
396.76	72.88	Double H
6.87	74.07	Bright
398.61	~~8.80~~ 77.55	
	8.65 .62	
	81.19	Narrow
400.44	.28	Broad
	.37	Fine and faint
402.99	86.64	Bright
		Over-exposed
~~404.50~~		
404.51	90.9	4.10 P.M.

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Mar. 15/ Decision of position of scale on Bien sample lithograph.
Above = higher on scale.

390.48	Bright with fine above	
2.0 to 2.2	Group	(397.82 6.62)
2.72	Bright but not within the halo	(6.99)
2.97	" at edge of halo	(6.7)
3.3	K	Broad
4.3	Bright with fine on each side	(5.21)
5.2	Bright. Double on negative	(4.74)
6.06	Bright. Not single	(3.73)
6.77	H	(2.6)
8.61	Not very bright. Not single	(0.564)
8.92	" " " " "	(0.28)
400.42	Bright	
391.29 391.33	Double	(8.41 8.51)

The figures at left are readings upon Comu's lithograph.
" descriptions refer to lines found (by superposing) to be the equivalents on the Rutherfurd negatives. Only conspicuous lines are chosen. The Bien lithograph is then substituted for Comu, and the readings upon the false scale of the Bien axis set at right in parentheses.

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391.27/33 = 391.31 — 398.9 — 398.92 — 7.61

398.51 = 398.46 — 390.28 — 7.61) 8.16 (1.07 — 761 — 5500 — 5327 — 173

392.72 — 398.61 — 5.89

394.99 — 390.54 — 5.89) 6.45 (1.09 — 589 — 5600 — 5301 — 299

7.61 — 5.89 — 13.50) 14.61 (1.08 — 1358 — 11100 — 1080

True	80% of False	False Reduced	False Reduce	Sum	
391.31	398.46 / 31.88	~~366.6~~	~~348~~.6	9.9	There 4 will be need to lay off a new correct scale.
2.72	394.99 / 31.76		7.2	9.9+	
5.2	394.74 / 31.58		5.2	X	
8.61	390.54 / 31.24		1.3	9.9+	
8.92	390.25 / 31.22		1.1	10.0−	

~~Total~~ False Scale = 15 in 26 cm

1 on true scale = ~~16 mm~~ 18.7 mm

5)26 — 3)5.2 — 1.08) 1.733 (1.6 — 108 — 653 — 648 — 5

1.08 — 26 — 648 — 216 — 5)28.08 — 3)5.62 — 1.87

18.7 — 3 — 56.11 — 2 — 112.2

18.7/2 — 37.4

18.7/9 — 168.3

18.7/8 — 149.6

From these data a pencil scale is marked upon the edge of the Brun lithograph.

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1878phae.proj.1149P

Mar 20th Comparison of Brin Sample Lithograph with Rowland Plate (39) using Zeiss 2 inch objective

391.3	Fine line omitted
.5	Haze, should be line separated from the Hack.
.57	Should be double
.59	This is right
.98	Should be double
.53	(Out of order) Too Hack
.50453	(out of order) Too high on scale.
2.03	Too Hack & broad
.07	Should be double.
.12	All right
1.93	(out of order) Too broad
2.14	Fine line omitted
.16	Fine line all right
.18	Too Hack & broad
.21	Fine line does not exist.
	Possibly another fine line here.
.30	Very fine line right.
.83	Too Hack.
3.02	Not as black Halo should only extend down to here.
.86 (about)	Another fine line
.1 (about)	Faint hazy line.
.18	Haze suggesting line
.26	K line double Hack or deep halo
.29	Line suggested by haze
.34	Line suggested by haze
.42	Too distinct

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.49 Too black possibly double
Possibly other lines here
.60 Too black Halo should only extend up to here.
.74 Too broad
Ground should be quite white.
There may be lines too fine to show but there should
be no haze.
.90 Too broad
.94 Line right but should be as fine as possible
There may be another line here.
4.00 Too black.
.03 Too broad and black.
.17 All right
May be another line
.22 All right
.25 Little too black.
.30 Rather broad
.4+ Group Black lines too black while haze should be separated
fine lines on each side
.68 Group. Interchange lower and middle line making
middle black as before
.73 Double
.80 Too black
.91 Too black.
5.30 Another very faint line.
.34 Possibly double.
6.05 Fine line too black.
.13 Medium-Double ~~+ not~~ instead of Black and haze

One hour or less observing — Lunch

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2.25 P.M.
F. 49

(out of order) all right
Possibly another line
5.55 (") all right
.57 .58 (") Rather black especially relative to line preceding
.80 (out of order) Possibly another line
6.21 Fine line instead of haze
.47 Too black
.53 Too black
.59 Should be double ~~and higher on scale~~
.66 Too distinct halo should be deeper here
.7 to .8 H line should be double
Halo should be deeper between these lines
.87
7.07 Should resolve into Trio (2)
.18 Double with less difference in blackness of components
.23 Should be very faint
.45 Should be very faint and probably double
.53 Resolution into three (3) doubted. Very double?
.78 Double without difference of components
.82 Not fine. Hazy, probably double -
.60 (out of order) Probably double
8.10 Very faint probably double suspicious fault here
.17 Double & more distinct
.22 Rather too black
.28 Make as indistinct as possible
.32 Too low on scale
.45 Pair should be less distinct
.75 Very fine
.79 Existence of line doubtful

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1878phae.proj.1149P

.90 Rather black
above
From 7.5 the negative is over-exposed hence
criticisms doubtful

3. P. M. -

Comparison of upper end of Bien with plate 40 & 41
(Rather under exposed - chosen as a contrast to preceding)
(Plate adjusted for work in 3 min.)

7.45 Not very faint
.53 Unmistakably double instead of triple
.60 Black line not as wide with possibly very fine
preceding
.62 Fine line with halo
.78 Double without difference of components.
.86 (about) Very fine line
.91 Distinct
.95 Fine possibly double
8.10 Faint broad not surely double nothing black
marked fault here in lithograph
.17 Double with lower of two lines black
lithograph faulty here - Poor
Possibly these two lines were accidentally inter-
changed in lithographing
.22 All right
.28 Double not indistinct
.31 Very fine line
.32 Black line should read .36

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.45 Pair all right
.71 Probably very fine line here
.75 all right
.79 all right
.90 all right
The rest all right –

3.30 P.M. –

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Mar. 22/79 Tests of Settings.

High power eye-piece – 3" objective. Rapid Setting

27.7	59.29	57.506 57.456 57. .050
27.9	62.41	
7.6	57.76	r = .22
7.3	53.29	
7.3	53.29	
7.6	57.76	
7.7	59.29	
7.2	51.84	
7.7	59.29	
7.8	60.84	
75.8	575.16	

Av. = 5745.64

Again

7.7	59.29	61.216 59.598 1.618	61.216 61.152 .064
7.8	60.84		
7.8	60.84	∇ = 1.27	r = .25
7.7	59.29		
7.2	67.24		
8.1	65.61		
8.2	67.24		
7.6	57.76		
7.4	54.76		
7.7	59.29		
78.2	612.16		

~~Av. = 5959.84~~

Av. = 6115.24

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2" objective – Zeiss eyepiece. Rapid Setting

71.2	1.44	~~42.~~
1.2	1.44	1.285
1.1	1.21	1.277
1.1	1.21	.008
1.2	1.44	$\sqrt{}$ = .09
1.0	1.00	
1.1	1.21	
1.3	1.69	
1.1	1.21	
1.0	1.00	
11.3	12.85	

$\sum y_i$ = 127.69

Again

		1.128
1.0	1.00	1.124
1.0	1.00	.004
1.1	1.21	$\sqrt{}$ = .06
1.1	1.21	
1.1	1.21	
1.0	1.00	
1.0	1.00	
1.1	1.21	
1.0	1.00	
1.2	1.44	
10.6	11.28	

$\sum y_i$ = 112.36

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1" objective same eyepiece Rapid setting.

74.8	23.04	
4.7	22.09	21.087
4.6	21.16	21.068
4.5	20.25	.019
4.6	21.16	√ = .13
4.5	20.25	
4.5	20.25	
4.3	18.49	
4.7	22.09	
4.7	22.09	
45.9	210.87	

$\frac{1}{3}$ = 2106.81

With another line - faint setting not so rapid -

34.3		
4.6		
4.6		
3.8		
3.5		

On edge of a line

74.1	16.81	
4.0	16.00	15.390
4.0	16.00	15.366
3.8	14.44	.024
3.8	14.44	√ = .15
4.0	16.00	
3.8	14.44	
3.7	13.69	
4.2	17.64	
3.8	14.44	
39.2	153.80	

$\frac{1}{4}$ = 1536.64

Broad pair of lines set on band

11.4	1.96	
XI.4	1.96	26.77
XI.5	2.25	26.56
XI.7	2.89	.021
XI.8	3.24	√ = .14
XI.7	2.89	
XI.6	2.56	
XI.7	2.89	
XI.7	2.89	
XI.8	3.24	
XI6.3	26.77	

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1" Objective. low power eyepiece Rapid setting

17.9	62.41
18.8	77.44
18.1	65.61
17.7	59.29
18.1	65.61
18.0	64.00
17.9	62.41
17.7	59.29
17.6	57.76
17.7	59.29
79.5	633.11

$\bar{y} = 6320.25$

63.311
63.202
.109

$\sqrt{} = .33$

Discard 18.8: 79.5 − 8.8 = 70.7; 70.7 ÷ 9 = 7.855; 633.11 − 77.44 = 555.67; 555.67 ÷ 9 = 61.741; 61.741 − 61.709 = .032

~~61.6xa~~ 61.709

~~61.650~~ .709

~~.061~~ .032

~~$\sqrt{} = .25$~~ $\sqrt{} = .18$

Note-the 1's in the tens place need not have been crossed out by recorder.

Again

18.0	64.00
18.2	67.24
18.1	65.61
17.9	62.41
18.0	64.00
18.1	65.61
18.0	64.00
17.5	56.25
17.9	62.41
17.7	59.29
79.4	630.82

$S_y = 6304.36$

63,082
63,043
.039

$\sqrt{} = .19$

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2" Objective same low power eye-piece ~~Setting on fine line~~

42.4 Discovered parallax

40.1	.01	.031
0.2	.04	.022
0.2	.04	.009
0.2	.04	$\sqrt{}$ = .09
0.3	.09	
0.0	.00	
0.2	.04	
0.1	.01	
0.2	.04	
0.0	.00	
1.5	.31	

σ_q = 2.25

Again

40.8	.64	
0.7	.49	.667
0.8	.64	.624
0.9	.81	.043
		$\sqrt{}$ = .07

A setting rejected, without looking at reading.

0.8	.64
0.7	.49
0.6	.36
1.0	1.00
0.9	.81
0.7	.79
7.9	6.67

σ_q = 62.41

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1878phae.proj.1149p

Summary

Objective	Eye-piece	Mean Error		Maximum Residuals
3 inch	high power	0.22		.38
" "	"	0.25"		.42
" "	" mean		0.24	
2 "	"	0.09		.17
" "	"	0.06		.14
" "	" mean		0.08	
1 "	"	0.13		.29
" "	"	0.15"		.28
" "	"	0.14		.23
" "	" mean		0.14	
" "	low (10th discarded)	0.18		.25"
" "	"	0.19		.44
" "	" mean		0.19	
2 "	"	0.09		.15"
" "	"	0.07		.21
" "	" mean		0.08	

Setting at rate of about 1 in 10 seconds in one series with recorder. No care was taken to choose same line every time but rather a line of same favorability of appearance under the changing conditions. With 1" obj: + high power eyepiece, all the lines were unfavorably broad. Rutherford photographic plate (40 to 41) was used. The tenths of a division were estimated.

See next Page	.15		.23
"	.14		.28
" mean		0.15	

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1878phae.proj.1149P

Test-Settings on a photograph band 15 divisions broad.
Using in the field a fe band of parallel lines of nearly
equal breadth.
2 inch objective & high power eye-piece

83.5
3.1
3.2
8.6

disturbed

71.5	2.25		1.1	1.21	
1.5	2.25	1.791	1.1	1.21	1.186
1.3	1.69	1.768	1.0	1.00	1.166
1.5	2.25	.023	1.0	1.00	.020
1.2	1.44	$\sqrt{}$ = .15	1.3	1.69	$\sqrt{}$ = .14
1.2	1.44		1.0	1.00	
1.2	1.44		1.1	1.21	
1.1	1.21		0.8	.64	
1.5	2.25		1.1	1.21	
1.3	1.69		1.3	1.69	
13.3	17.91		10.8	11.86	

σ_y = 176.89 σ_y = 11.66

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1878phae.proj.1149P

Mar 25 Trial upon Screw of L. S. Engine. 10½ A.M.
(As it has stood — without overhauling) 6 P.M. Same
Rosin plate of 240 $\frac{th}{in}$ inch.
Longitudinal Screw. ½ inch objective.
Difficulty of setting from motion of due to pressure of hand upon screw or to removal of pressure.
Cannot handle screw as delicately as one could otherwise see to set.

5632.2.
2.4
2.3
2.25
2.1
2.2
2.2
2.3
2.4
2.25 32.26

5532.2
2.4
2.5
2.2
2.1 32.28

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1878phae.proj.1149P

22.2
22.2
22.2 22.20 3.0 rejected

12.7
12.55
12.7 12.68

03.8
3.7
3.6 03.70

5493.5
3.5
3.55 93.52

(82.0)
(82.8)
(82.8)
(83.5)
(83.2)
~~(83.5)~~
~~(83.8)~~

Record of preliminary settings taken before screw had come to a bearing in its new position. In every case it was decided when to commence recording settings (as reliable) before ~~reading~~ setting, so as not to be influenced by anything save particularity. These preliminary settings were taken all along, but not recorded until now. Preliminary settings not taken quite so carefully as the regular ones.

83.3
83.5
83.2 83.33

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1878phae.proj.1149P

(72.0)
(73.0)
(73.0)
73.2
73.25
73.1 73.18

(62.0)
(63.1)
(64.5)
(63.3)
63.25
63.35
63.25 63.28

(51.8)
(53.1)
(52.9)
53.1
53.05
52.95 53.03

(41.3
42.6
42.6)

42.5
42.3
42.3 42.37

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1878phae.proj.1149P

31.0
32.1
32.2

32.2
32.3
32.3
32.15
32.35
32.2
32.35
32.25
32.2
32.4 32.26

5331.0
2.1
2.4

32.15
~~21.5~~
32.3
32.3
32.2
32.35 32.26

21.3
22.4
22.3

22.5
22.6
22.45 22.52

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(11.3
  13.0
  13.2)

13.0
12.9
12.9 12.93

(01.4
  02.9
  03.1)

02.9
03.2
03.1 03.07

(
(5293.2
  93.5)

Heavy footsteps in the room.

93.45 ~~93.48~~
93.3 ~~93.3~~ 93.55
93.9 ~~93.9~~ Heavy footsteps in room above.

(82.7
  82.9
  83.1)

83.0
83.0
82.9 82.97

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(72.7
72.5
72.7)

72.9
72.7
72.8 72.80

(61.6
62.4
62.4)

62.7
62.9
62.7 62.77

(51.5
52.2
52.7)

52.2
52.5
52.6
52.8
52.9 52.60

Series extended on acc
of discordance

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$$\begin{pmatrix} 40.9 \\ 41.7 \\ 41.6 \end{pmatrix}$$

41.8
42.2
41.7
41.7
41.7

41.82

Series extended on % of discordance

$$\begin{pmatrix} 30.6 \\ 31.5 \\ 31.4 \end{pmatrix}$$

31.4
31.5
31.7
31.6
31.5
31.8
31.7
31.7
31.7
31.55

31.61

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(5130.4
31.7
31.6)

~~32.15~~ (32.15
31.6)

31.8
32.0
31.8

31.87
~~31.55~~

(20.7)

(31.6
31.5)

31.55
31.65
31.5
31.75
31.8
31.7
31.8
31.8
31.55
31.6

31.67

Weighted mean of 31.~~55~~87 + 31.67 = 31.72

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1878phae.proj..1149P

20.7
21.8
21.8
21.4

~~21.4~~
21.7
21.6
21.6

21.63

10.9
~~18.0~~ 12
12.4
11.8

~~12.1~~ (12.1)

~~12.6~~ rejected

12.6
12.5
12.3
12.6
12.5

12.50

After this the 1st parenthetical setting will not be used at all.

02.2
02.4
02.5
02.4

02.6

02.9 rejected

02.3
02.35
02.4
02.6

02.45

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1878phae.proj.1149P

After this the 12ᵉ hour Sunmethodical settings will be not read.

5091.9
92.5
92.4

12 oclock

Note. The settings on opposite page were made upon a ruled plate loaned by Prof. Wᵐ A. Rogers.

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1878phae.proj.1149P

After Overhauling Screws & Slider

Mar. 28/79 ~~To Hft~~ Lower Screw – Set in direction of increase of reading 10.16 A.M.

½" objective – Cylindrician eye

After setting for back.	~~After setting~~	After setting slightly back	
6293.62	3844	6293.62	3844
.80	6400	.78	6084
.72	5184	.88	7744
.68	4624	.76	5776
.70	4900	.68	4624
.78	6084	.82	6724
.78	6084	.82	6724
.80	6400	.70	4900
.78	6084	.50	2500
.60	3600	.50	2500
7.26	.53204	7.06	.51420
γ_{mean} =	.52708	γ_{mean} =	.49844
	.00496		.01576
	$\sqrt{}$ = .0704		$\sqrt{}$ = .1255

10.25 A.M.

Influence. 1st "The "Mean Error" setting back about a turn being 0.07 division of head, while the mean error setting back about 0.1 of a turn is 0.125 divisions, the former is the more accurate. 2nd Cause, the fact that the screw does not come to a full bearing (taking out all "back-lash") in the short motions, the exact extent to which the back-lash is eliminated being in that case uncertain. The

2nd The amount of this back-lash to be eliminated by motion of screw (not including "lost motion" proper) is about 0.2 divisions.

Note. Always read in direction of increase of reading. The other shoulder doesn't pretend to be true.

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Settings in the future will be made ~~setto~~ after moving back a little over a half turn, that being a distance which seems very convenient.

~~6294.4~~ 11.04

6292.2 11.06

.15

.2

.2

.15

Other end out of focus

4287.6 .8600 11.12 A.M.

.55 3025 .3380

.55 3025 .3364

.55 3025 .0016 $\sqrt{}$ = .04

.65 4225

5) 2.90 5) 1.6900

.58 .3380

6691.2 .0400

.3 900 .0450

.25 625 .0400

.15 225 .0050 $\sqrt{}$ = .07

.1 100

5) 1.00 5) .2250

.20 .0450

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1878phae.proj.1149P

4284.55 .3025

.65 4225

.55 3025

.6 3600

.55 3025

5)2.90 5)1.6900

.58 .3380

.3380
.3364
.0016

√ = .04

6691.15 0225

.2 400

.2 400

.15 225

.2 400

5)1.90 5).1650

.18 .0330

.0330
.0324
.0006

√ = .02

11.20 A.M.

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1878phae.proj.1149P

Observation	Mean of two adjacent in preceding column.	Mean of two adjacent observations in following column		Difference of preceding numbers on same line	Squares of preceding
~~6691.~~					
6691.0					
~~42~~			~~428~~		
6690.95					11.28 A.M.
	6691.00		4267.45	2403.55	.3025
1.05		4287.55		3.50	.2500
	1.10		7.65	3.45	.2025
1.15		7.55		3.60	.3600
	~~0.80~~ 1.05		7.45	~~3.35~~ 3.60	.3600
~~0.45~~ 0.45		7.47		~~2.98~~ 3.35	.3364
	~~0.75~~ 1.00		7.50	~~3.25~~ 3.50	.2500
1.05		7.47		3.58	.3364
			7.45		11.34 A.M.
1.03			7.50	8) 4.36	8) 2.3978
				.545	.299725
					.297025
					.0027

$\sqrt{} = 0.052$

Thus if we allow the correction of an apparent mistake (correction made in red ink) we find that the accuracy with motion of screw from end to end of the inch is as great as for settings at one end only.

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1878phae.proj.1149P

11.39 A M

4287.45

4387.5

.6 } 87.55

.55

97.55

4407.55

17.55

27.75

.65 } 27.68

.65

37.6

47.65

57.6

67.6

77.65

87.75

.75 } 87.77

.8

4587.95

.65

.85 } 87.81

.7

.9

97.95

4607.8

17.9

27.95

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1878phae.proj.1149P

37.95
47.95
57.9
67.95
78.0
87.95
88.0 } 87.95
87.9
4788.25
.25 } 88.27
.3
98.3
4808.3
18.35
28.3
38.25
48.2
58.25
68.25
78.4 } 78.37
78.35
88.6
.55 } 88.58
.6
4988.6
.75 } 88.67
.65
98.65

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1878phae.proj.1149P

5008.55
18.45
28.45
38.55
48.5
58.5
68.65
78.7
88.85
.9 } 88.88
.9
5189.0
8.8 } 88.90
8.9
98.7
5208.65
18.85
28.85
38.8
48.85
58.8
68.85
78.85
88.95
89.15 } 89.~~10~~ 05
.05
5389.2
.3 } 89.28
.35

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1878phae.proj.1149P

99.35
5 409.30
19.2
29.15
39.2
49.2
59.1
69.1
79.2
69.2
.35 } 89.27
.25
55 89.55
.55 } 89.55
.55
99.55
5609.45
19.55
29.45
39.45
49.45
59.3
69.4
79.65 } 79.67
79.7
89.8
.75 } 89.8
.85

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1878phae.proj.1149P

5789.8	
.9	89.85
.85	
99.7	
5809.6	
19.7	
29.8	
39.95	39.9
39.85	
49.95	
60.0	
70.05	
80.0	
90.2	
.15	90.18
.2	
5990.25	
.4	
.25	90.33
.35	
.4	
6000.35	
10.1	
20.4	
30.45	
40.3	
50.25	
60.25	

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1878phae.proj.1149P

70.4
80.45
90.5
.55 } 90.50
.45
6190.55
.6 } 90.60
.65
6200.55
10.5
20.65 } 20.65
.65
30.45
40.6
50.5
60.45
70.45
80.7 } 80.65
.6
90.6
.6 } 90.62
.65
6390.8
.7 } 90.75
.75
6400.85
10.6
0.75 } 10.68
10.7

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1878phae.proj.1149P

20.75
30.8
40.65
50.65
60.7
70.75
80.85
90.9
.85 } 90.90
.95
65 91.05
1.0 } 91.00
0.95
66 01.05
11.1
21.1
31.1
40.95 } 41.00
41.05
50.85 } 50.90
50.95
60.9
71.0
81.0
91.1
.15 } 91.12
.1

12.32 P.M.

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1878phae.proj.1149P

6691.05 .0025 .0035 12.38 P.M.
1.05 0 25 .0025
1.05 0 25 .0010
1.1 1 0 0
1.0 0 0 $\sqrt{} = .032$
5/1.25 5/.0175
.05 .0035

4287.45 .2025
.5 2500
.45 2025
.45 2025
.5 2500
5/2.35 5/1.1075
.47 .2215
.2209
.0006 $\sqrt{} = .02$

6691.1 .100
1.1 .100
1.0 .000
1.05 .025
1.05 .025
5/1.30 5/250
.06 .050
036
.014

$\sqrt{} = .03$

4287.55 .3025
.6 .3600
.55 .3025
.55 .3025
.55 .3025 12.44 P.M.
5/2.80 5/1.5700
.56 .3140
.3136
.0004 $\sqrt{} = .02$

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1878phae.proj.1149p

2" objective. Cylindrical eye-lens.

1.30	900	3.37 RM
.50	2500	
.30	900	
.38	1444	
.28	784	
.32	1024	
.26	676	
.38	1444	
.42	1764	
.50	2500	
364	13936	
	13250	
	.00686	$\sqrt{} = .083$

Again

.40	1600	
.38	1444	
.46	2116	
.40	1600	
.30	900	
.32	1024	
.24	576	
.38	1444	
.28	784	
.48	2304	
364	13792	
	13250	
	.00542	$\sqrt{} = .074$

Inference. With the 2" objective the accuracy is very nearly equal to that obtained with the ½" objective.

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1878phae.proj.1149P

Summary of observations of length of an inch.

5 settings on each, taken all 5 on one thread then 5 on next & so on	4287.58	6691.20	2403.62	
			.62	
	.58		.60	
		.18		
	.58	.19		2403.61
5 on each, setting alternately on each	4287.50	6691.03		3.53
	4287.55			
50 minutes interval with screw worked			3 settings on each	3.55
		6691.12		
Like field	~~4287.47~~	6691.05	.58	
	4287.47		.59	
		.06	.50	
	.56			

The inference is that we have an arrangement sufficiently stable to allow single measurements to be depended upon without fear of displacement of plate or change of scale due to repeated motions of screw or to duration of the series of observations. But the observations do not seem to justify under such circumstances the getting of a large number of settings in order to eliminate errors of setting, unless the observations also be so arranged as to eliminate effect of displacement and change of scale.

We also infer that we may investigate the constancy of the pitch of the screw, as revealed by the preceding observations without fear that results will have been vitiated by displacement or change of scale.

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1878phae.proj.1149P

Mar 29/79 2" objective, bychromic eyepiece. Similar test to yesterday A.M. Plate re-set.

4234.78
.72
.74
.72
.78
5/3.74
.748

10.45 A.M.

6638.48
.48
.44
.50
.48
5/2.38
~~.48~~
.476

10.49 A.M.

4237.82
.82
.82
.82
.86
5/4.14
.828

Plate re-set 10.58 A.M.

6641.54
.56
.50
.56
.44
5/2.60
.520

11.02 A.M.

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1878phae.proj.1149P

4337.84 } 37.87
.90 }
48.0
57.8
67.9
78.05
88.0
98.15
08.10
17.95
27.9
38.02 } 37.99
37.96 }
4538.18 }
.24 } 38.23
.28 }
4638.42 }
.32 } 38.39
.42 }
4738.48 } 38.48
.48 }
48.55
58.75
68.7
78.75
88.8
98.75
08.6

11.03 A.M

7. changed to 8. by setting back to make sure.

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1878phae.proj.1149P

18.7
28.6
38.78 } 38.79
38.80
4938.95
.90 } 4938.92
.92
5039.22
.26 } 39.25
.28
5139.36 } 39.36
.36
49.35
59.1
69.2
79.2
89.25
99.5 } 99.5
99.5
09.25
19.25
29.35
39.62 } 39.57
.52
5339.82
.72 } 39.75
.70

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1878phae.proj.1149P

5439.92	
.64	39.76
.72	
5539.88	39.83
.78	
49.8	
59.7	
69.65	
79.9	
90.0	
99.8	
09.9	
19.85	
29.9	
40.02	40.02
.02	
5748.22	
.18	40.19
.16	
5840.56	
.54	40.56
.58	
5940.65	40.68
.68	
50.75	
60.7	
70.65	
80.7	

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1878phae.proj.1149P

90.7
00.65
10.7
20.75
30.75
40.86 } 40.87
.88 }
6141.00 }
40.80 }
40.80 } 40.86
40.92 }
40.80 }
6241.08 }
.00 } 41.03
.02 }
6341.28 } 41.21
.14 }
51.15
61.15
71.1
81.25
91.2
01.2
11.1
21.25
31.2
41.36 } 41.32
.28 }

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1878phae.proj.1149P

6541.48 } 41.49
.50 }

51.5

61.6

71.55

81.5

91.4

01.5

11.5

21.45

31.4

41.32

Suspicion of setting after reading gave reason for discarding.

.50 }
.60 }
.54 } 41.54
.52 }
.54 }

11.40 A.M.

4237.92

.88

.88

.94

.92

5/454

.908

11.43 A.M.

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1878phae.proj.1149P

Rate Result

4287.36
.42
.42
.44
.46
5/2.10
.420

6691.08
.10
90.98
90.82
91.16
5/6.44
1.288

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1878phae.proj.1149P

P. M. Vertical Screw. ~~Both~~ edges of lines

Each edge of line separately defined. Settings on one side.

~~6981.49~~ ~~2.12 P.M.~~

.47

~~6981.30~~ ~~2.18 P.M.~~

6978.89	81	3.17 P.M.
.88	64	Setting with ~~backward motion of screw by inadvertence.~~ All right
.88	64	
.85	25	
.86	36	
.86	36	
.83	9	
.80	0	
.86	36	
.88	64	
59	415	
	3484	
	.00067	$\sqrt{} = .026$

These settings seem to demonstrate that the greater power of the ½" objective can be utilized for accuracy by resolving the sides of the cut, ~~and letting the light fall slightly from one side~~, and using the most distinct only of the two lines resulting.

~~4475.40~~ 4475.45 3.08 P.M.

.48	64	
.46	36	
.49	81	
.50	100	
.50	100	
.51	121	
.50	100	
.49	81	
.50	100	
.48	64	
81	847	

$\frac{91}{11)\overline{1001}}$ $\frac{847}{11)\overline{9317}}$

827 7700

$827^2 = 684$

.00086 ~~.00086~~

$\sqrt{} = .029$ .00086

For $m=1$ $+n=1$ $\chi^2 = \frac{3.7}{602}$

$\sqrt{.003182} = .0564$ $\frac{258}{.00318^2}$

.0827

.0263

$91^2 = 8218$

.00019

$\sqrt{} = .014$

Thus Pierces Criterion would throw out an observation below 4475.426

3.11 P.M.

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Plate Re-set

3.16 P.M.

		Rectilinear	Residual
4600.50			
.56	0.53	0.00	0.53
.54			
4700.60		.13	~~0.66~~
.62	0.61	~~0.01~~	0.48
50.90		.27	~~0.85~~
.86	0.88	~~.03~~	0.61
4800.96		.40	~~1.97~~
1.06	1.01	~~.04~~	0.61
4901.08		.53	~~1.0~~
1.16	1.12	~~.05~~	.59
51.14		.67	.50
1.20	1.17	~~.07~~	
5001.20		.80	.36
.12	1.16	~~.08~~	
5101.36		1.93	.41
.32	1.34	~~.09~~	
51.42		1.07	.38
.48	1.45	~~.11~~	
5201.68		1.20	.48
.68	1.68	~~.12~~	
5301.72		1.33	.42
.78	1.75	~~.13~~	
51.80		2.00	
.76	1.78	~~.20~~ ~~2.00~~	
5401.88		2.07	
.90	1.89	~~.27~~	

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5501.96
2.00 } 1.98

Skipped owing to failure to resolve the two edges of the line.

6703.76
.80 } 3.78

53.68
.70 } 3.69

6803.88
.88 } 3.88

6903.90
.92 } 3.91

53.96
.92 } 3.94

7003.88
.90 } ~~3.89~~
.88
.96 } 3.90
.90

4600.68
.66
.58 } 0.60
.52
.58

3.35 P.M

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1878phae.proj.1149P

Apr. 3/79 Subdivision of
into feet
Zero of scales on right. Reading inwards towards left
Prof. Rogers Obs. J.R.E. Record.
From 0 inches to 36 inches

1st " Foot

R	I	
4.0	4.7	-0.7
4.2	4.8	-0.6
4.3	4.7	-0.4
4.4	4.7	-0.3
		-0.50

Adjustin for parallelism of bars.

Means	Residuals
-.50	-.43
-.62	-.55
+.92	+.99
-.07	

2nd " Foot

~~2.8~~ ~~3.6~~
~~3.0~~

2.9	3.4	-0.5
2.8	3.4	-0.6
3.0	3.6	-0.6
2.8	3.6	-0.8
		-0.62

"When the 2nd " reading is greater than the 1st " the count being from the observer left in the yellow micrometer, the space ruled is too short."

3rd " Foot

4.7	3.8	+0.9
4.7	3.9	+0.8
4.8	3.8	+1.0
4.8	4.0	0.8
		+.92

When R-I* is negative the space measured is too short. When R-I is positive the space measured is too long

* After taking out the mean of the R-I for all the feet i.e. the figure in column headed "residuals."

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From 36" to 0

3rd Foot

R	I	
~~5.9~~	5.2	+0.7
5.4	5.2	+0.2
5.8	5.0	+0.8
4.7	5.0	-0.3
		+0.35

2nd Foot

~~6.2~~		
7.8	7.7	+0.1
7.8	8.0	-0.2
7.7	7.8	-0.1
7.6	7.7	-0.1
		~~-0.75~~
		-0.07

3rd Foot

5.8	6.8	-1.0
5.8	6.9	-1.1
5.7	6.7	-1.0
5.8	6.8	-1.0
		-1.02

		Mean of two pages.
-.102	-.77	-.60
-.07	+.18	-.18
+.35	+.60	+.80
-.26		

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J. R. E. Obs. H. G. P. Recorder.

from 0 inches to 36 inches

1st Foot

~~5.0~~
0.
X9 2.9 -2.0
~~2~~1 2.9 -1.8
1.1 2.9 -1.8
0.9 3.0 -2.1
-1.92

-1.92 -0.96
-1.02 -0.06
+0.05 +1.01
-0.96

2nd ~~Foot~~

2.1 3.1 -1.0
2.1 3.2 -1.1
2.1 3.1 -1.0
2.2 3.2 -1.0
~~-1.07~~
~~+1.08~~
-1.02

3rd Foot

6.2 6.1 +0.1
6.2 6.1 +0.1
6.1 6.0 +0.1
6.0 6.1 -0.1
+0.05

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From 36° to 0

3 x 24 Feet

6.1	6.1	0.0
6.2	6.2	0.0
6.2	6.2	0.0
6.0	6.3	-0.3
		-0.07

		Mean of three pages
-1.05	-0.48	-0.69
-0.75	-0.13	-0.09
-0.07	+0.55	+0.78
-0.62		

2nd Foot

3.8	4.4	-0.6
3.8	4.5	-0.7
3.7	4.3	-0.6
3.5	4.6	-1.1
		-0.75

1st Foot

2.3	3.2	-0.9
2.1	3.2	-1.1
2.1	3.2	-1.1
2.2	3.3	-1.1
		-1.05

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Apr 3/79

Mean including page 126

~~Mean including page 126~~

~~332.2~~
~~332.15~~
~~.15~~
~~332.15~~
~~.05~~
~~.05~~
2.5

~~332.1~~
~~2.4~~

332.0
2.2 } 2.07
.1

2.8
3.0 } 2.8
2.8 .5

× 0.1
0.6 } Next page alone gives
0.1 0.07
0.4

Would be well to explain

3.0
3.0 } 3.0
3.0

~~13.15 P.M.~~

Recollect on the space marked × at foot of last column, having referenced to see the difficult line better. But now the other line is out. So give it up and proceed in regular order.

2.6
2.5 } 2.6
2.7

2.7
3.0 } 2.9
3.0

2.9
2.7 } 2.72
2.8

3.0
3.0 } 3.0
3.0

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3.0
3.0
3.0 } 3.0

3.1
3.1
3.0 } 3.05

3.1
3.1
3.1 } 3.07

3.2
3.1 } 3.13

3.0
3.1 } 3.03

Screw stops

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Starting again at level of plate.

32.0

2.5
2.5

30.
3.1
30.
3.1

0.0

3.0

2.~~8~~ 7
2.5

2.8

2.6 Poorly Focussed
2.6 Dark but sharp

3.0

3.0

3.0

3.0

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3.1

3.0

Iron stone

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Apr 4/79 Subdivision of the middle foot into spaces of 2 inches

12 to 24

12 to 14 R L

~~4.8~~ jarred.

3.4	4.6	-1.2
3.5	4.5	-1.0
		-1.1

Again - moved scale intentionally

4.9	6.1	-1.2
4.8	6.0	-1.2
		-1.2

14 to 16

4.9	6.2	-1.3
4.9	6.1	-1.2
		-1.25
5.1	6.3	~~-1.2~~
	7.0	Sun touches end of frame - Creeping distinguishable

1.10
1.20
1.25
0.70
0.85
1.00
1.15
0.35
0.40
1.55
0.48

+.15 0.77
1.08
0.37
1.65
0.48
0.95
6) 5.30
-0.883

Pause to allow equilibrium to reestablish. Here to foot of p 131 in about 1½ hrs

12 to 24

12 to 14

Mean -(-0.88)

4.6	5.3	-0.7	
4.6	5.3	-0.7	
		-0.7	
6.3	7.1	-0.8	+0.11
6.2	7.1	-0.9	
		-0.85	

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Mean
-(-0.88)

14 to 16

7.7	8.7	-1.0
7.7	8.7	-1.0
		-1.0

-0.19

5.9	7.0	-1.1
5.7	6.9	-1.2
		-1.15

16 to 18

4.6	5.0	-0.4
4.6	4.9	-0.3
		-0.35

+0.51

5.8	6.2	-0.4
5.8	6.2	-0.4
		-0.4

18 to 20

~~2.4 Can't focus~~

1.8	2.3	-0.5
1.8	2.3	-0.5
		-0.5

(? 1.50)

~~6.0~~

6.2	7.8	-1.6
6.0	7.7	-1.7
		-1.65 -- -0.77

20 to 22

~~4.5 5.1~~

Poor focus ~~5.1~~

3.7	4.3	-0.6
3.7	4.2	-0.5
		-0.55

+0.41

~~6.7 7.0 -0.3~~

6.3	6.9	-0.3

~~0.37~~ -0.40

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22 & 24

~~X.8~~	2.8	Not sufficiently
1.8	~~2.7~~	equal forces at
		two ends of
8.8		space.
5.3	6.2	-0.9
5.2	6.1	-0.9
		-0.9

-0.07

7.1	8.2	-1.1
7.2	8.1	-0.9
		-1.0

---

24 & 12

Means
-(-0.725)

0.95		
0.57		
1.38		
0.15		
1.00		
0.30		
6) 4.35		
-0.725		

22 & 24

7.9	8.8	-0.9
7.8	8.8	-1.0
		-0.95

-0.23

1.8	2.7	-0.9
1.7	2.7	-1.0
		-0.95

20 & 22

1.2	1.8	-0.6
1.2	1.7	-0.5
		-0.55

~~18~~ +0.15

3.2	3.8	-0.6
3.2	3.8	-0.6
		-0.6

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18 to 20

2.4	3.8	- 1.4
2.6	3.8	- 1.2
		- 1.3
		- 0.65
4.5	6.0	- 1.5
4.5	5.9	- 1.4
		- 1.45

16 to 18

4.2	4.5	- 0.3
4.2	4.2	- 0.0
		- 0.15
4.2		+ 0.57
5.8	5.9	- 0.1
5.7	5.9	- 0.2
		- 0.15

14 to 16

6.2	7.3	- 1.1
6.5	7.3	- 0.8
		- 0.95
		- 0.28
3.9	5.0	- 1.1
4.0	5.0	- 1.0
		- 1.05

12 to 14

4.7	5.1	- 0.4
4.8	5.0	- 0.2
		- 0.3
		+ 0.42
6.0	6.3	- 0.3
5.9	6.2	- 0.3
		- 0.3

Summary of results of Division of Middle Foot

Variation of each nominal length of 2 inches from 1/6 of the foot.

a to b	(a to b) − mean		Diff	Mean
12 to 14	+0.11	+0.42	+.31	+0.26
14 " 16	-0.19	-0.28	-.09	-0.23
16 " 18	+0.51	+0.57	+.06	+0.54
18 " 20	-0.77	-0.65	+.12	-0.71
20 " 22	+0.41	+0.15	-.26	+0.28
22 " 24	-0.07	-0.28	-.16	-0.15

Mean Variation of Middle Foot from 1/3 the yard is (Boys 123 & 121)

$$= \frac{0.18 + 0.09}{2} = -0.135$$

Corresponding variation proportional for 2 inches is $-\frac{0.135}{6} = -0.022$

Total for (18 to 20) is $-(0.71 + 0.02) = -0.73$

.000104
.73
312
728
.000076

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~~Comparison of 12" foot~~

0 to 12

~~0 to 2~~

Apr 4th/79 P.M.

Following page 125 and 127

366.4 ~~Some x shape scratches in this space~~

Following page 125 and 127

The last span measured on pages 125 & 125 has some scratches (by which it may be identified) on the glass between the lines which define it.

2.40 P.M.

33.1
3.1 } 3.1

3.1
3.0 } 3.05

3.0
3.0 } 3.0

3.0
3.0 } 3.0

Peculiar markings in this space.

3.1
3.0 } 3.05

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3.0
3.1 } 3.05

3.05
3.0 } 3.02

3.0
3.05 } 3.02

3.0
2.95 } 2.97

3.2
3.1 } 3.17
3.2

3.05
3.0 } 3.02

3.05 P.M

Edge of Illumination.
are markings,

Within the last span measured, while just beyond the line (in the next span) are other similar markings.

333.05
3.0 } 3.02

Repetition of span last measured above

3.15 P.M

~~85.9~~
86.0

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147.2
47.3

The two preceding make 1 space, the division line an accidental scratch.
Re-assessment of the two combined given on next two lines.

333.05 } 3.05
33.05 }

3.05 } 3.05
3.05 }

32.95 } 3.0
3.05 }

3.05 } 3.07
3.1 }

3.1 } 3.07
3.05 }

Many scratches about line separating preceding & following space

3.7 } 3.7
3.7 }

Line so filled as to make edges ragged.

2.4 } 2.45
2.5 }

Several hard irregular scratches in this space

3.0 } 3.0
3.0 }

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3.0
2.95 } 2.97

3.0
3.0 } 3.0

3.0
3.0 } 3.0

3.0
3.05 } 3.05

3.0
3.05 } 3.07

3.05
3.1 } 3.07

3.2
3.1 } 3.15

3.0
3.05 } 3.02

3.0
3.0 } 3.0

4.07 P.M.

End of series.

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4.22 P.M.

3.05
3.0 } 3.02

3.0
3.0 } 3.0

3.1
3.0 } 3.05

3.0
3.0 } 3.0

2.9
3.0 } 2.95

3.05
3.0 } 3.07

3.05
3.0 } 3.07

2.95
3.0 } 2.97

2.95
3.0 } 2.97

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1878phae.proj.1149P

3.05
3.15 } 3.1
3.1

3.05
3.2 } 3.12
3.1

3.0 } 3.0
3.0

4.48 P.M.

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1878phae.proj.1149P

Apr 5/79 Subdivision of Card into a span of 2 inches
10½ A.M. 60° Fah.

	R	I	R − I	
0 to 2				(15+20) − (a+b)
	8.1	7.7	+ 0.4	
	5.8	5.2	+ 0.6	
			+0.5	−1.00
2 to 4	~~3.7~~			
	3.6	3.7	−0.1	
	5.3	5.2	+0.1	
			0.0	−0.15
4 to 6				
	3.4	3.9	−.5	
	4.8	4.9	−.1	
	8.0	8.7	−.7	
	6.4	6.7	−.3	
better focus	1.9	2.1	−.2	
	4.5	4.7	−.2	
			−.37	+0.07
6 to 8				
	1.2	1.3	−.1	
	2.6	2.8	−.2	
			−.15	−0.10
8 to 10				
	1.0	1.9	−.9	
	2.9	3.4	−.5	
	7.8	8.3	−.5	
	4.5	4.8	−.3	
			−.55	+0.25

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Measurements of Space 18 to 20 taken alternately with the other stars recorded on opposite page.

~~4.1~~	~~4.8~~	
3.7	4.1	-.4
4.2	4.8	-.6
		-.5
4.1	4.4	-.3
9.2	9.2	.0
		-.15
1.0	disturbed	
1.7	2.8	-1.1 (2)
disturbs.	4.0	
2.1	2.8	-.7
7.8	8.3	-.5
6.7	6.8	-.1
		-.3
7.4	7.8	-.4
6.7	7.0	-.1
		-.25
7.0	7.2	-.2
6.7	~~6.9~~ 7.1	-.4
		-.3

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10 to 12

2.3	1.2	+1.1
5.8	4.8	+1.0
		+1.05

−1.6

12 to 14

3.3	3.0	+.3
4.1	3.7	+.4
		+.35

−0.65

14 to 16

4.7	3.9	+.8
6.6	5.8	+.8
		+.8

−0.95

11-35 A.M.

~~20 to 22~~

20 to 22

6.3	5.1	+1.2
7.7	6.8	+0.9
		+1.05

−1.20

22 to 24

6.6	5.8	+.8
7.7	7.1	+.6
		+.7

68° Fah.

11-55 A.M.

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6.1	6.8	-.7
7.3	7.7	-.4
		-.55

8.1	8.6	-.5
6.7	6.7	.0
7.9	8.7	-.8
6.7	6.7	0.0
4.3	4.7	-.4
7.7	7.8	-.1
		-.30

2.2	2.2	.0
3.8	4.1	-.3
		-.15

3.1	3.3	-.2
8.2	8.3	-.1
		-.15

Disturbed ~~(probably)~~ the parallelism of the bar. (11-55:AA.)

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2 to 24 12-10 P.M.

4.8	3.8	+1.0
6.1	5.8	+0.3
		+0.65

---

16 to 18 ~~12h 20m~~ 12h 20m

4.9	3.8	+1.1
5.1	4.0	+1.1
		+1.1

−1.65

22 to 24

6.8	6.1	+.7
9.3	8.9	+.4
		+.55

−1.00

24 to 26

1.3	1.8	−.5 (?)
disturbed	8.1	
7.8	6.9	+.9
2.1	1.1	+1.0
6.0	5.1	+.9
		+0.95

−1.25

26 to 28

7.8	6.7	+1.1
9.5	8.1	+1.4
		+1.25

−1.35

28 to 30

1.1	0.6	+.5
7.0	6.6	+.4
		+0.45

−0.90

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5.6	6.1	-.5
4.2	7.8	-1.6
		-.55

2.3	2.7	-.4
5.1	5.6	-.5
		-.45

7.2	disturbed	
7.2	7.5	-.3
8.4	8.7	-.3
		-.3

5.8	5.9	-.1
7.7	7.8	-.1
		-.1

6.1	6.8	-.7
7.9	8.0	-.1
8.2	8.8	-.6
6.1	6.5	-.4
		-0.45

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1878phae.proj.1149P

30 to 32

6.7	5.9	+.8	
8.1	7.1	+1.0	
		+.9	−1.05

32 to 34

7.8	6.9	+.9	
9.7	9.0	+.7	
		+.8	−1.20

34 to 36

7.7	6.3	+1.4	
7.9	6.8	+1.1	
		+1.25	−1.85

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6.0	6.1	−.1
7.0	7.2	−.2
		−.15

6.8	7.1	−.3
8.2	8.7	−.5
		−.4

3.2	3.6	−.3
4.4	4.7	−.3
		−.6

1 P.M.

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1878phae.proj.1149P

Apr 5/79 P.M. Measurement of 2nd preliminary plate to test constancy of action of ruling machine.

2.15 P.M.

3 3 2.7	2.7	2.85	2.9
2.7		2.95	
2.7	2.7	3.0	3.0
2.7		3.0	
2.8		3.0	2.97
3.0	2.9	2.95	
3.0			
3.0	2.97	3.15	3.08
2.95		3.0	
		3.1	
2.6		3.0	3.05
2.8	2.7	3.1	
2.7			
		3.05	3.05
2.95	2.92	3.05	
2.9			
2.9	2.9	3.0	3.0
2.9		3.0	
		3.1	
2.95	2.92	3.3	3.2
2.9		3.2	

telltofocus

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1878phae.proj.1149P

2.8
3.0 } 2.92
2.95

3.2 } 3.2
3.2

3.05 } 3.1
3.15

3.15 } 3.17
3.2

3.0 } 3.0
3.0

3.05 } 3.02
3.0

3.0 } 3.0
3.0

3.05 } 3.02
3.0

3.0 } 3.0
3.0

3.0 } 3.02
3.05

3.0 } 3.0
3.0

Interval 15 minutes

3.05 } 3.02
3.0

3.0 } 3.0
3.0

3.0 } 3.0
3.0

2.95 } 2.97
3.0

3.0 } 3.0
3.0

3.0 } 3.0
3.0

2.95 } 2.97
3.0

3.0 } 3.0
3.0

3.0 } 3.0
3.0

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1878phae.proj.1149P

3.0, 3.1 } 3.05	3.3, 3.3 } 3.3
3.0, 3.0 } 3.0	2.8, 2.9 } 2.85
3.0, 3.0 } 3.0	3.0, 3.0 } 3.0
3.0, 3.05 } 3.02	2.95, 3.05 } 3.0
2.95, 3.0 } 2.97	2.95, 3.0 } 2.97
3.05, 3.05 } 3.05	3.0, 3.0 } 3.0
Interval 20 min.	
3.0, 3.0 } 3.0	3.05, 3.05 } 3.05
3.1, 3.0 } 3.05	3.0, 3.0 } 3.0
2.95, 3.0 } 2.97	3.0, 3.0 } 3.0
	3.0, 2.95 } 2.97

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1878phae.proj.1149P

3.0 } 3.05
3.1 }

Horizontal line stops

3.0 } 3.02
3.05 }

Putting the plate on the B. S. machine and counting, gives 5-5 ~~graduation~~ spaces.
A similar count of 1st plate gives 5-5 ~~spaces~~; also*, some of the last graduations being hidden among random lines. At or near the end of work on this first plate a note as to these lines is remembered to have been made, but it does not seem to have been recorded. However, a count made just after the measurements, which memory was fresh ~~gave~~ as to the last line used, gave 5-3 spaces which is the number of measurements. So the inference is that the last two were omitted, although there is perhaps room to doubt whether the count was correctly kept during measurement in view of the many interruptions and the freshness of the observer with the particular instrument.

* Later inspection shows that but 5-4 really exist on 1st plate - the last line which gave the appearance of the 5-5th space not giving that space the right width.
Last reliable line here another very near it.

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Summary for Length of Space 18 to 20 inches

a	b	a to b	18 to 20	Leathe - Homm
0 to	2	+0.50	-0.50	-1.00
2	4	0.	-0.15	-0.15
4	6	-0.37	-0.30	+0.07
6	8	-0.15	-0.25	-0.10
8	10	-0.55	-0.30	+0.25
10	12	+1.05	-0.55	-1.60
12	14	+0.35	-0.30	-0.65
14	16	+0.80	-0.15	-0.95
				~~0.00~~
18	20			0.00
20	22	+1.05	-0.15	-1.20
Disturbed parallax				Disturbance no hindrance.
16	18	+1.10	-0.55	-1.65
22	24	+0.55	-0.45	-1.00
24	26	+0.95	-0.30	-1.25
26	28	+1.25	-0.10	-1.35
28	30	+0.45	-0.45	-0.90
30	32	+0.90	-0.15	-1.05
32	34	+0.80	-0.40	-1.20
34	36	+1.25	-0.60	-1.85
		+9.93	17) -5.65	17) -18.58
		-0.332	-0.332	
		16) 9.598	+.533	-0.865
		+0.533	-.865	
			.865	

0.8656
.000104

3462 4
8656
~~.0000 9 9 6 6~~
.0000 9 002

Assuming this particular yard as a standard, the correction to this particular two-inch space is $-\frac{90}{1,000,000}$ inch

As the space is ~~2.000000~~ 1.999961 inch.

The previous factoring subdivision reversed gives about ~~2.0000 0~~ 1.99992 ~~0~~

but its accuracy is small compared with the present.

The figure ~~2.000000~~ 1.999991 is ~~probably~~ good to ~~a fine quadrillionth of~~ better than one - one hundred thousandth

of an inch. $\frac{2}{100,000}$ inch

Now assuming 0.2 as a reasonable error in ~~a single~~ mean diff R-L for a single space

we have .00002 $\sqrt{\frac{2}{18}}$ = $\frac{+0}{600,000}$ = .000003, changes of temperature &c being ~~very strongly~~

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Largely eliminated by the method of observation.

Consideration of Signs.

The divisions of scale increase from right to left — actual.
" carriage moves over scale " " " "
" microscope inverts as ordinarily.
" readings of eye-piece scale (on the bar) were taken from " " " — apparent.

Putting eye at microscope and moving carriage from right to left, the scale (on the bar) would apparently move in the field from right to left also.

∴ Readings of eye-piece scale (on the bar) were taken in apparent direction of motion of scale (on the bar) in field corresponding to motion of carriage from right to left ~~is the~~ motion of carriage over microscope reading of scale.

~~The increase in~~ readings for left-hand ~~reading~~ position therefore indicate greater motion of scale for a given distance between stops i.e. the nominal length on scale is shorter. it indicate a shortening of the interval in right hand reading the space called 2 inches whereby a greater nominal length on scale must be taken in order to make up the distance between stops Subtracting R from I, ~~Subtracting I from R then gives~~ would then give the nominal length on scale over and above unity which must be taken to give the distance between stops.

~~So~~ Subtracting I from R gives the distance ~~between stops~~ over and above the nominal ~~length of the particular 2 inches,~~ and ~~;~~ it gives ~~the correction to the length of the particular 2 inches~~ necessary to bring it to the distance between stops. ~~or in other words it gives~~

Or again, had the subdivision been on the bar scale, they ought to have been read from apparent left to right, but being in eye-piece it was proper to read them from apparent

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right to left and then enumerate that;—
The subdivisions were read in such a direction as to be additive to the whole divisions of the scale.
This agrees with the previous statement.
If now we should subtract R from L we should have the distance (measured on scale) ~~corresponding to distance~~ between stops, or rather the excess of that distance between stops over and above the nominal unit-length of scale. So that we should have a correction to the ~~reading~~ which we subtract L from R we obtain the correction to the
length of distance between stops necessary for expressing the same in terms of the unit of the scale.
So when we subtract L from R we obtain the length of a unit of scale over and above ~~a unit of~~ the distance between stops, or a correction to the scale in order to express it in terms of the distance between stops.
When, now, we subtract the correction for [a to b] from the correction for [18 to 20] (obtained immediately afterwards, while the apparatus is in same condition) we have the excess of the correction for [18 to 20] over that for [a to b] for the reduction of both to the ~~length of~~ distance between stops, or to any other distance of the same nominal magnitude. In our case this other distance is the eighteenth of the length of the yard. In other words the correction necessary to reduce [18 to 20] to the eighteenth of the yard will be this last difference plus the correction necessary to reduce [a to b] to the same standard.
This is done for every [three inches] in the yard.
So correction for reduction of [18 to 20] to the eighteenth of the yard = mean of the last nominal differences + mean of correction necessary to reduce [a to b] to the eighteenth of the yard.
But this last mean is zero.

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Accuracy of method. Call unity the error of the given value for R-I for any one space, ~~equal unity~~. n = no of spaces.
The mean of the n-1 determinations of R-I for the same space gives the mean correction to that space to express it in terms of the distance between steps. Error = $\sqrt{\frac{1}{n-1}}$
The mean of the n determinations of R-I for the n spaces (one for each) gives the correction to $\frac{1}{n}$ of the bar, to express it in terms of the distance between steps. Negative error in the one space numbered (n-1) this Error = $\sqrt{\frac{1}{n}}$
The last may be expressed as the distance over and above unity which the distance between steps would measure upon a true scale where unit is $\frac{1}{n}$ of the bar.
Subtracting this from the former gives correction to the above measure to reduce it to $\frac{1}{n}$ of the length of Bar. Error = $\sqrt{\frac{2}{n-1}}$
$\sqrt{\frac{2}{n}}$ may be used approximately. And for n = 18 the error becomes approximately $\frac{1}{3}$.

Now in the set of measures of 18 to 20, tabulated on page 150 the greatest variation from mean are 0.23 and 0.27 on opposite sides of the mean, and so near together that they must be laid to errors which have their effect rather than to changes of condition which eliminate.

$\sqrt{\frac{2}{17}} \times 0.25 = \sqrt{\frac{1}{8 \times 17}} = \sqrt{\frac{1}{136}} = 0.0857$ 3428 857 .000089 126

But the unit is .000104 inch
Error in result is within 0.000009 inch or 0.00001 inch = outside limit.

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154 A. M.

Apr 7/93 3rd ✓ Plate.

Unfilled line - edge of band to edge of fine { 00.5 / .5 / .5 }

fine to fine { ~~07~~ 02.0 / 01.95 / 1.95 } over line

330.3 / 30.25 — 0.27 — } fine to fine over space & line

32.9 / .95 — 2.93 — } " " " " " " "

170.9 / 1.0 — } " " " " " " "

161.8 / .9 — } " " " " " " "

332.9 / .8 — 2.85 — } 2 preceding measured as one.

3.0 / 2.95 — 2.97 — fine to fine over space & line.

3.0 / .05 — 3.02 — " " " " " " "

2.95 / .9 — 2.93 — " " " " " " "

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3.0 ~~0.0~~ 3.0	3.0	fine to fine over sharp + line
3.0 .05	3.02	" " " " " " "

---

1 $\frac{24}{11}$ Plate,
Beginning at the other end. Successive spaces measured each
other in inner order.

	Previous Results	Measured Again	
32.95 .9	2.93	2.95 3.05	3.0
2.95 3.05	3.00	3.0 3.0	3.0
3.0 2.95	2.97	3.12	2.95 3.05	3.0
3.05 3.15	3.10	3.1	3.05 3.1	3.07
2.95 3.0	2.97	2.97	2.95 2.9	2.93
2.95 2.95	2.95	2.97		
3.0 3.05	3.02	3.07		

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Apr 7/79 P.M.

Measurement of plate ruled this noon -

Ends of first band Settings on middle of band

~~32.8~~

332.8	665.5
2.9	5.7
2.9	5.5
2.95	
~~2.95~~	5.9
2.75	5.4
2.9	
2.75	
2.95	
2.95	
2.8	

Settings on left hand fine

332.9	665.6
2.8	5.4
2.9	5.3
2.75	5.6

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9¼ P.M.

Band at other end of plate. Unit and subdivisions

Unit ~~333.8~~

.9

333.5
.6
.6
.6
.6

10 $\frac{1}{2}$ Space i.e. throw reversal the end. 10 Repetitions, some intermediate readings taken as a check.

10 $\frac{1}{2}$	0.3 3.95	67.9	169.6	339.00	-.517	0
9 $\frac{1}{2}$	33.55	67.0	167.9	335.85	-.202	+.517
8	3.15	6.4	66.2	32.95	+.088	+.719
7	3.2	6.4	6.2	30.20	+.183	+.631
6	3.0	6.0	disturbed	~~30.90~~		
6			6.5 2	30.90	+.293	+0.448
5	3.0	6.05	5.7	31.05	+.278	+0.155
4	3.0	6.05	5.5	30.90	+.293	-0.123
3	3.35 ~~25~~	6.9	7.1	34.65	-.082	-0.416
2	3.5	7.0	7.8	35.50	-.167	-0.834
1	3.5	7.0	7.7	35.50	-.167	-0.167
				333.83		

Unit. 3.85

Obs. taken before the above were added to get total .7 .7 .75 .65

11 P.M.

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	Excess of Magnitude of Space from p. 157	Summation in Division of Comparation	Per Division of C. S. Scale.
line 10		- .155	-.05
	space -.517		
9		+ .362	+ .11
	-.202		
8		+ .564	+ .17
	+.088		
7		+ .476	+.14
	+.183		
6		+ .293	+.09
	+.293		
5		0.000	.00
	+.278		
4		- .278	- .08
	+.293		
3		- .571	- .17
	-.082		
2		- .489	- .15
	-.167		
1		- .322	- .10
	-.167		
0		- .155	- .05

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Apr. 8/79 Band at 1st end of plate. In order commencing with 10th space i.e. the one nearest the middle of plate. Also preliminary and fine measurement of unit.

Inspection makes J.R.E. think that he was mistaken in order of spaces in last night's work. Test by measuring the end space again, they luckily being quite dissimilar in error.

True 10th Space.		True 1st Space.	
033.75	wrong piece of line	~~033.15~~	wrong piece of line
.6		033.5	
.8		.6	
033.9		.6	
.95			
.8			

This establishes the correctness of last night's order. But it opens another query.

10th space of band measured last night. Positive measurement of space between parts of lines measured last night, with negative measurement cumulating taken of space between another part of line

[- Last night, and now lack of positivity
| - Now lack of negativity.

Difference in length of space according to which is chosen (of course the same is taken at each end of space) read off on head.

0.00
0.00

This difference is inappreciable as it should be. Hence the difference above due to choosing wrong part of line was because the wrong part of one line as the right part of another were taken.

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Band at 1st end of plate – 10th to 1st space.

10-40 A. M.

10th Span	033.35	66.7	166.6	333.10	
Unit	332.9				
	3.0				
	2.9				
	2.85				
	2.9				
9th Span	033.20	66.7	166.7	333.70	-.085
8	3.05	6.2	6.0	3.00	-.005
7	3.35	6.9	7.0	4.00	-.105
6	3.05	6.1	5.2	0.60	+.235
~~5~~	~~3.15~~	~~6.8~~	Discarded	before proceeding further with it.	
5	3.5	6.9	6.95 7.0	3.75	-.080 Rested 10 min.
4	3.0	6.0	5.6	1.25	+.170
3	3.3	6.85	7.0	4.20	-.125
2	3.6	7.0	7.7	5.20	-.225
~~1~~	~~3.15~~	~~6.7~~	Discarded		
~~1~~	3.3	6.85	7.0	~~4.3~~	Will try re-focusing
1 Seems much improved	3.25	6.6	6.9	3.80	-.095
				~~2.95~~	
				333.26	

Unit 332.95
3 .95
.95

Observations for the sum of the above was taken.

3.00
2.1
5.1
6th 2) 2.55

The 6th span seems poor. Let us do it over.

6th Span	3.01	6.0	5.3	330.8	0.60
8th "	3.05	6.2	6.0	2.1	6th 0.7

12-10 P. M.

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So Take
Sum 10 ¼

Sum 33.31 + .01¼ + .20¾

9 ¼

.37 − .04¾ + .19½

8

.255 + .06¾ + .24¼

7

.40 − .07¾ + .17½

6 .07

.07 / 166.405 + .25¼ + .25¼

5 ~~133.105~~ 0

.375 − .05¼ + .05¼

4

.125 + .19¾ − .14½

3

.420 − .09¾ − .04¾

2

.520 − .19¾ + .15

1

.380 − .05¾ + .20¾

0

10) 3.225 166.820

33.32¼

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1st	1/5 thr 5th	1/10 thr 10th	Diff 5th	Diff 10th	Resid 5th	Resid 10th	Diff 5th + 10th
33.35	33.32	33.31	+ .03	+ .04	.02	.02	+ .01 .02
33.20	33.34	33.37	- .14	- .17	.09	.11	- .03 2
3.05	3.20	3.30	- .15	- .25	.10	.19	- .10 9
3.35	3.40	3.40	- .05	- .05	0	1	0 1
3.05	3.04	3.06	+ .01	- .01	4	5	- .02 1
3.5	3.40	3.37	+ .10	+ .13	5	7	+ .03 3
3.0	3.12	3.12	- .12	- .12	7	6	0 1
3.3	3.40	3.42	- .10	- .12	5	6	- .02 1
3.6	3.54	3.52	+ .06	+ .08	1	2	+ .02 3
3.25	3.38	3.38	- .13	- .13	8	7	0 1
			-.049	-.060	.51	.66	-.011 .25

Thus the taking of 10 settings does not seem to be ~~any~~ better than taking 5. This however is rather a rough test and no general reasoning should be based on it.

Middle Band. 2-50 P.M. 5 Repetitions of each star

	1/5 thr 5th					
10th	33.3	66.7	166.75	33.35	-.03	+.21
9	3.35	6.8	7.00	3.40	-.08	+.24
8	3.25	6.7	6.55	3.10	+.22	+.32
7	3.35	6.9	7.0	3.40	-.08	+.30
6	3.0	6.1	5.7	3.14	+.18	+.18
5	3.15	6.5	6.45	166.39 3.29	+.03	0
4	3.0	6.0	5.3	3.06	+.26	-.03
3	3.1	6.4	7.05	3.41	-.09	-.29
3 again	3.3	6.9	7.1			
2	3.6	7.0	7.9	3.58	-.26	+.20
1	3.55	7.0	7.35	3.47	-.15	+.06
			166.81	33.32		+.21

3-25 P.M.

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Apr. 10/79

4½ P.M. All the mic. spaces commence with $1\frac{21}{11}$

Subdivisions will put in as they occur are so marked.

332.9

.95

Subdivisions { 332.8 / .85 / .8

3.0

2.9

4-50 P.M.

3.1

.05

3.2

.0

.2

.0

.0

.1

3.1

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Apr 16/79 11 A.M. Plan of previous page corrected over.

332.9 .95	2.92	+ .152	+ 0.152	Note the mean of these and other measurements will be satisfied by calling 2.92, 2.93 and 2.97, 2.96. This brings the $\frac{4^{th}}{11}$ correction +0.162 while the +0.102 remain unaltered.

10 minute delay — Substitutes: 332.9, .8, .9

3.0 .95	2.97	+ .102	+ 0.254
3.05 3.0	3.02	+ .052	+ 0.306
3.05 3.05	3.05	+ .022	+ 0.328
3.0 3.0	3.00	+ .072	+ 0.400
3.15 3.1	3.12	− .048	+ 0.352
3.1 3.1	3.10	− .028	+ 0.324
3.25 .2	3.22	− .148	+ 0.176
3.1 .2	3.15	− .078	+ 0.098

27.56 carried forward

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(27.55) brought forward

3,0 3,0	3.00	+.072	+ 0.170
3,0 3,0	3.00	+.072	+0,242
3,05 3.1	3.07	+.002	+0.244
3.25 3.15	3.20	−.128	+ 0.116 =+0.12 (as from page 164)
	39.82		39.82 +.12 (page 164) 13)39.94 3.072
3.2 3.1	3.15	−.064	+0.056
3.15 3.25	3.20	−.114	−0.058
			10 minutes about here
3,0 3.05	3.02	+.066	+0.008
3.15 3.15	3.15	−.064	−0.056
3.25 3.15	3.20	−.114	−0.170
3,3 .2 .15	~~3.25~~ 3.22	−.134	−0.304
	18.94	carried forward	

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(18.94) brought forward

3.15			
3.3	3.22	−.134	−0.438
3.2			
3.0	3.02	+.066	−0.372
3.05			
3.0			
3.15	3.10	−.014	−0.386
3.15			
3.15	3.12	−.034	−0.420
3.1			
3.05	3.05	+.036	−0.384
3.05			
3.3	3.25	−.164	−0.548
3.2			
3.1	3.17*	−.084*	−0.632* = −0.63 (as per page 184)
3.15			

40.87
−.75 (see page 184)
13) 40.12
3.086

Subdivision { 3.0, 3.15, 3.05

12-50 P.M.

*Reasons mentioned in brace at top of page 164 would lead us to use −.074

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2 P.M. Starlight hazy in middle of sublimation.

3.0 3.0	3.00	+.115	-0.515
3.3 3.3	3.30	-.185	-0.700
3.1 3.0	3.05	+.065	-0.635
3.15 3.05	3.10	+.015	-0.620
3.0 3.15 3.1	3.08	+.035	-0.585
3.0 3.1	3.05	+.065	-0.520
3.05 3.0	3.02	+.095	-0.425
3.05 3.1	3.07	+.045	-0.380
3.15 3.05	3.10	+.015	-0.360

27.77 carried forward.

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(27.77) brought forward

3.0 3.05	3.02	+.095	−0.265
3.0 3.0	3.00	+.115	−0.150
3.05 3.05	3.05	+.065	−0.086
3.05 3.05	3.05	+.065	−0.020 (= as from page 184)
		39.89	
		+.61 (as page 184)	
3.15 3.2	3.17	13)40.50 3.115 −.039	−0.059
3.0 3.0	3.00	+.137	~~+0.072~~ ~~+0.072~~ +0.072
3.05 3.05	3.07	+.061	+0.133
3.05 3.1	3.07	+.061	+0.194
		10 minutes	
3.2 3.2	3.20	−.069	~~+0.120~~ +0.125
3.1 3.0	3.05	+.081	+0.206 ~~+0.222~~
~~24.56~~ 18.		canis femur	

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(18.56) brought forward

3.0 3.0	3.00	+.131	~~+0.347~~	+0.337
3.15 3.05	3.10	+.031	~~+0.376~~	+0.368
3.85 3.1	3.10	+.031	~~+0.408~~	+0.399
3.15 3.1	3.12	+.011	~~+0.420~~	+0.410
3.1 3.25 3.1	3.15	+.019	~~+0.402~~	+0.391
3.15 3.05 3.05	3.08	+.051	~~+0.454~~	+0.442

Subdivided { 3.75 / 3.7 / 3.8

3.5 3.65 3.5 3.65	3.57	-.439	+0.003	Last place manipulated to come out nearly 0.00 instead of +0.01 as per page 184

40.68
+.03 (see page 184)
13) 40.71
3.131

X 3-35 P. 16.

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Apr 17/79 10-25 A. M.

Measurement of fourths of the 52 spaces. i. e. 13 ~~about~~ in one.

Plate ~~carefully~~ aligned each time by using ½" objective, inspecting the constancy of the cross line with motion of screw, and then replacing the ⅙" objective. (With the ⅙" the cross line is not in the field.)

11-25

Delay in adjusting plate parallel to screw, so that it will move over the 13 spaces without having the forces. Zero reading = 2000.0 This is subtracted mentally before recording.

4328.7 } Trouble suspected from looseness of one of the screws
21.6 } due to long run it's end.

~~29.9~~
~~28.9~~
~~29.4~~

Other instrument suggested.

Micrometer is set at the figure + then setting made with the screw.

2000.0 Mean

6328.7 4328.70
6328.7

0.0 Figure not micrometer is a genuine setting given.

0.0

8.8 8.77
8.75

.0

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0.0

8.6 ~~8.7~~ 8.67.5

8.6

1999.85.

Greenwich Mean = 4328.71/4

12 M.

Greenwich Transit.

12-45 P.M.

0.0

29.9 9.90

.9

0.0

~~0.0~~ ~~29.7~~

~~99.7~~ .4

0.0

29.7 ~~9.84~~ 9.75

.7

9.95

0.0

.9.7 9.780

.7

9.9

10.15.

Greenwich Mean = 4329.82

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Blue Quartz 1-50 P.M.

0.0

28.2 8.20
.2

0.0

8

0.0

8.05 8.~~72~~ 20
.05

9.85

0.1

8.1 8.~~75~~ 20
.1

.9

Greenstone = 4326.~~75~~ 20 2 P.M.

Hornblende Quartz

More trouble from varying focus. 2-40 P.M.
3-10 "

0.0

8.7 ~~8.77~~ 8.82
.175

9.9

~~8.0~~

8.6
0.75 .6

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~~0.0~~ 8.6 .65

8.7

~~0.1~~

8.7 ~~8.8~~ 5

.7

0.85

~~0.1~~

8.85 ~~8.9~~ 5

.85

0.9

3-35 P.M.

Grand Mean 4328.8~~8~~ 7

From Detail Measures
(4290 added to each sum)

1st Quarter	4328.71	+0.17	4329.82	+0.50	1.11
2nd "	9.80	-.92	4330.87	-0.56	1.07
3rd "	8.18	+.72	4329.89	+0.43	1.73
4th "	8.85	+.03	4330.68	-0.37	1.83
	4)3.52		4)1.26		
	4328.88		13) 4330.315 (333.101		

39
43
39
40
39
13
13

15

Note. The 2nd quarter appears to be in error 1 division in the observation, 9 being recorded instead of 8. Such is not the case. A re-examination of these spars confirms the figures as recorded. Indeed further examination of the figures shows the appearance to have been deceptive. Considered as bisection of each half, the two independent sets give accordant results. But as a bisection of the

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whole length they give dissimilar results.
The fact that they check as well as bisections of each half is fortunate. This discordance as bisections of the whole makes it advisable to directly bisect the whole.

Apr 18 12 Noon.
1st half of plate (26 spaces in one)

100.0 Considerable trouble from focussing.

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Different Systems of Subdividing.

Let n be the number of true spaces into which a given distance ~~unity~~ is to be divided. So that $n+1$ equals the total number of lines and $n-1$ equals the number to be determined in position relative to the two end lines. ~~Let error of single setting be unity~~

Let error of a single setting on a line be unity. Weight = unity. Practically ~~repeated~~ settings might be taken, but for comparison of different methods suppose ~~a single setting of a~~ each setting satisfactorily made once.

~~The system will involve numerous settings and will give a unity correction~~ The space having been approximately subdivided, a system of m settings is made ~~whereby~~ ~~by~~ a correction to each line will be deduced. Each determination of the value of the a_1 correction will have its weight w.

The efficiency of the system may be taken proportional to the sum of the weights Σw and inversely to the total number of settings required to attain that ~~sum~~ average ~~value~~ of weight. i.e. we may take $\text{Eff.} = \frac{\Sigma w}{m}$

Bisection.

~~Apply some constant length to each half, the length of the two spaces, then the constant length being so small~~ Measure each of the three spaces with the same part of the same scale or screw, or make differential comparisons of each space with a third of about the same length. This requires two settings on each end of each space. i.e. $m = 4$ No. of lines determined, $n-1 = 1$

The value of the correction is the difference between either

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Error in right span $= \sqrt{2}$ Error in mean of two $= 1$

span and the mean of the two. ~~Error in mean of two $= \sqrt{\frac{1}{2}}$~~

Error in determinate $= \sqrt{2+1}$ ~~Weight $= \frac{2}{3}$~~ Weight $= \frac{1}{3}$

Then Eff. $= \frac{1}{3} \div 4 = \frac{1}{12}$

Or. Measure the three lines on a scale or screw and then turn end for end ~~so that~~ the middle line occupying the same place on scale as before.

Value of correction = difference between single span and mean of both, ± error of scale used. But the latter eliminates from the mean of the two series.

Error in determinate from one series $= \sqrt{3}$ as before. Weight $= \frac{1}{3}$

But there are only 3 settings per series. $n = 6$

So Eff $= \frac{1}{3} \div 3$ or $= \frac{2}{3} \div 6$ i.e. Eff $= \frac{1}{9}$

So while the number of settings required to get a result equals the first method, the accuracy attainable with a given amount of work is greater with the second.

(Both these methods were explained to me by Prof. Rogers.)

Trisection.

First method. $n = 3$ $n - 1 = 2$ $m = 6$

Error in a determination $= \sqrt{2 + \frac{2}{3}}$ Weight $= \frac{3}{8}$ for each.

$\Sigma w = \frac{3}{8} + \frac{3}{8} = \frac{3}{4}$ Eff $= \frac{3}{4} \div 6 = \frac{1}{8}$

Second method.

I	II	III	IV
1	2	3	4
4	3	2	1
2	3	4	
	1	2	3

Four series as per diagram. $n = 14$

or

I	II	III	IV
1	2	3	4
4	3	2	1
3	2	1	
	4	3	2

Each span is measured on each span of scale. Let "mean ~~Span + 2 Length on scale~~ = scale" after ~~the~~ scale a perfectly divided scale whose ends agree with the ends

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of the scale used.

Span 1-II Weight on mean scale = mean of the differences. Error = $\sqrt{2/3}$ Span 2-4 = Diff

Span II-III Weight on mean scale = mean of two differences + ~~sum of the other~~, and the sum divided by 3

Error = $\frac{\sqrt{1+2+2}}{3} = \sqrt{4/9}\ \sqrt{5/9}$

Error in mean of three spaces = $\frac{1}{3}\sqrt{2/3+5/9+2/3} = \sqrt{25/108}\ \sqrt{17/81}\ \sqrt{17/81}$

Span 1-2

~~Error in determination $\sqrt{2/3+25/108} = \sqrt{97/108}$ Weight = $\frac{108}{97}$~~

Error in determination = ~~$\sqrt{2/3+17/81}$~~ $\sqrt{2/3+7/81} = \sqrt{71/81}$ Weight = $\frac{81}{71}$

Since we deal with position of each line with reference to the end lines, the value just obtained applies to each line, although the error in the span between 2 & 3 is a little larger. ∴ ~~$\Sigma w = \frac{216}{97}$ Eff = $\frac{216}{97} \div 14 = \frac{108}{679}$ or between 1/7 and 1/8.~~ ∴ ~~$\Sigma w = 144$~~

∴ $\Sigma w = \frac{162}{71}$ Eff = $\frac{162}{71} \div 14 = \frac{81}{497}$ or a little less than 1/6.

Trisection is therefore more accurate for a given amount of work than bisection, which the $2\frac{nd}{11}$ method is better than the first in nearly the same proportion for each. Trisection is however open to the theoretical objection (in common with all higher subdivision) that the middle space is not determined with the accuracy of the end spaces.

Quart-section.

~~Final Method.~~ The direct succession measurement of more than 3 spaces is open to the criticism that the corrections for the middle divisions are not determined with the accuracy of those near the end. Indeed, we might have applied the principle that the strength of a chain is the strength of its weakest

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link, and calling w the weight of the ~~proved~~ determined correction, we might have taken $\text{Eff} = \frac{(n-1)w}{m}$

Adopting this, the weight of the correction to the middle line would be only half as great as with direction by the first method. $n-1 = 3$ $m = 8$ $w = \frac{1}{6}$

$\text{Eff} = \frac{1}{16}$

~~First Method Factoring.~~ Making the direction of the ~~Second Method.~~ ~~to~~ halves separate operations would simply shift the ~~poor~~ determination from the ~~line~~ next the end. Let us rather say:

First Method Extended by combining guard-section and bisection.

I	II	III	IV	V
1	2			
	2	3		
		3	4	
			4	5
1		3		
		3		5

~~Weight~~ Error of middle space, determined by bisection measures $= \frac{1}{3}\sqrt{3}$

Ditto determined by guard-section measures $= \frac{1}{6}\sqrt{6}$ ~~Total weight = $\frac{1}{2}$ sum = $\sqrt{9}$~~

~~Error $\sqrt{2}$~~ Total sum $= \frac{1}{2}\sqrt{9} = \sqrt{9/4}$

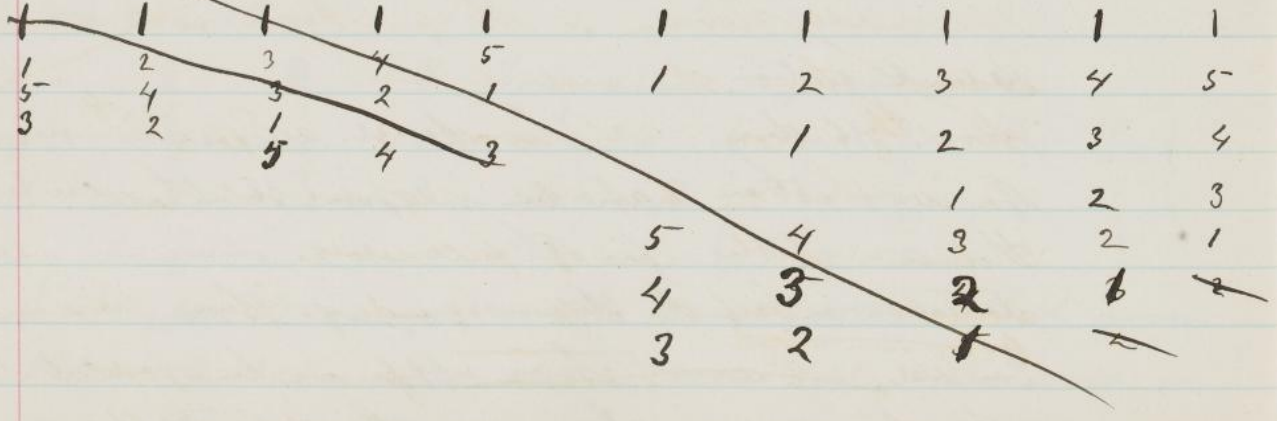
Error of determination of line next end, ~~determined~~ as a bisection of the half length $= \frac{1}{3}\sqrt{3}$. Error due to error of this half length $= \frac{1}{2}\sqrt{9/4} = \sqrt{9/16}$ ~~Total Error = $\sqrt{\frac{1}{3}+\frac{1}{2}} = \sqrt{\frac{5}{6}}$~~

Total Error $= \sqrt{39/16}$

~~Weight~~ $w = \frac{16}{57}$ $n-1 = 3$ $m = 12$

~~$\text{Eff} = \frac{3\times 2}{7} \div 12 = \frac{1}{14}$~~ $\text{Eff} = \frac{3 \times \frac{16}{57}}{12} = \frac{4}{57}$ = a little less than $\frac{1}{16}$

Second method.



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Second Method

I	II	III	IV	V
1	2	3	4	5
5	4	3	2	1
3	2	1		
		1	2	3
3	4	5		
		5	4	3

Notice perfect symmetry, each space being determined from I-II (IV-V the same) with equal accuracy, Error in each of the 8 remains to know whether the pointing of the two middle lines be greater, less or equal might with three weights.

Space I-II (IV-V the same)

Error in determining height with reference to mean scale $= \sqrt{\frac{1}{4}+\frac{1}{2}} = \sqrt{\frac{3}{4}}$

Error in comparing mean scale with I-V $= \sqrt{4 \times \frac{1}{2}}$ (since each space is equally well determined) $= \sqrt{2}$

This for weight space I-II $= \frac{1}{4}$ of $\sqrt{2} = \sqrt{\frac{1}{8}}$

∴ Error in determining I-II with reference to the quarter of I-V $= \sqrt{\frac{1}{2}+\frac{1}{8}} = \sqrt{\frac{5}{8}}$

Weights of lines II+IV $= \frac{3}{5}\ \frac{2}{5}$

Span I-III Error in determination relative to mean scale

Error in comparing mean scale with I-V $= \sqrt{2 \times \frac{1}{2}} = \sqrt{1}$

This for space I-III $= \frac{1}{2}$ of $\sqrt{\frac{1}{4}+\frac{1}{4}} = \sqrt{\frac{1}{4}}$

∴ Error in determining I-III with reference to the half of I-V $= \sqrt{\frac{1}{2}+\frac{1}{4}} = \sqrt{\frac{6}{8}}$

The middle division is therefore known with a little less certainty than the next to ends.

$w = \frac{4}{3}$ $m = 22$ $n-1 = 3$ $\text{Eff} = \frac{3 \times \frac{4}{3}}{22} = \frac{2}{11}$

Consider that we have two independent determinations.

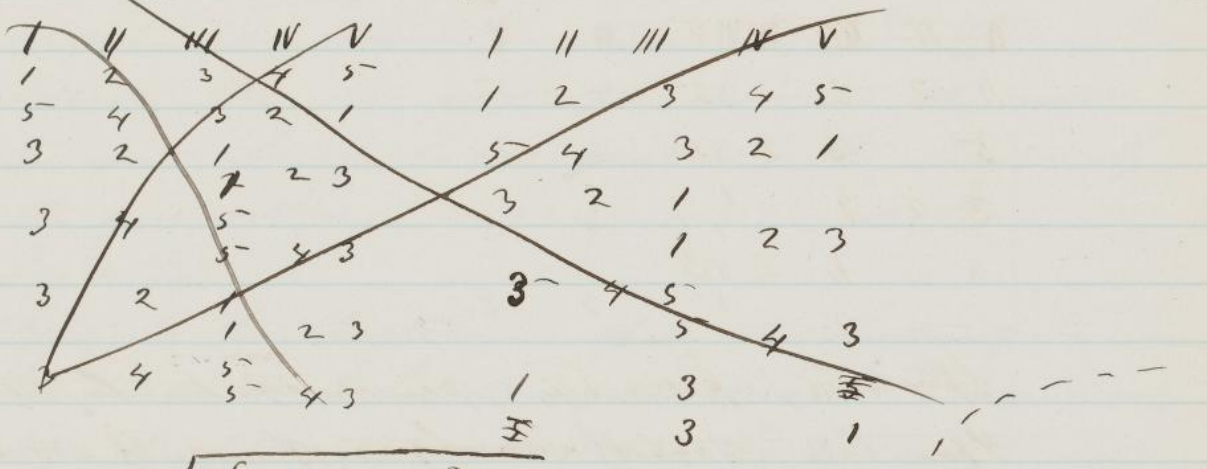
Determine with pair of full series.

Correction = half the difference of ends + difference between middle and one end. Error $= \sqrt{(\frac{1}{2}+a)^2+1}$ for one series added to series for other series and the result divided by 2.

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Second method of weighting



$$\text{Error} = \frac{\sqrt{2\{(\frac{1}{2}\sqrt{2})^2 + 2\}}}{2} = \sqrt{\frac{1}{2}\{\frac{1}{2}+2\}} = \sqrt{5/4}$$

The other determination is simply a pair of directions by $1\frac{1}{11}$ method

Error $= \sqrt{\frac{1}{2}\text{of } 3} = \sqrt{3/2}$

Where there may be combination in proportion to weight:

~~Error of result $= \frac{\sqrt{2 \times 3/2 \times 5/4}}{3}$~~

Error of result $= \sqrt{\frac{2}{3/2 + 5/4}} = \sqrt{\frac{8}{11}}\sqrt{\frac{2}{3/3 + 4/5}} = \sqrt{\frac{15}{11}}$

~~$\frac{5}{8} = 0.625$~~ $\frac{5}{8} = 0.625$

$\frac{8}{11} = 0.72$ $\frac{11}{15} = 0.73$

~~Better So take $w = \frac{11}{8}$~~

So take $w = \frac{15}{11}$ $n - 1 = 3$ $m = 22$ $\text{Eff} = \frac{3 \times \frac{15}{11}}{22} = \frac{45}{242}$

or better $\frac{1}{5}$ and $\frac{1}{5\frac{1}{2}}$.

The Method might be extended by observing in addition, those adding to the relative weight of the middle line. But as m would increase in nearly the same ~~same~~ ratio, little would be gained.

I	II	III	IV	V
1		3		
		3		1

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Second Method, ~~Floating~~ Abridged

I	II	III	IV	V
1	2	3		5⁻
5⁻		3	2	1
3	2	1		
		1	2	3

Span I-III Error $\sqrt{57/4}$ (see dotted line to last page)

Span I-II Consider as a bisect of I-III by 2nd method

Error $= \sqrt{3/2}$ about. ~~It is actually a little less since two of the settings enter the determination of the~~

Now neglecting the fact that the effect of error in ~~two~~ certain three settings is diminished by their being common to ~~I-III and to II-III~~ the double span both in its capacity of big bisector and bisected,

we have Error in line II $= \sqrt{(\frac{1}{2}\sqrt{57/4})^2 + 3/2} = \sqrt{57/16 + 24/16} = \sqrt{29/16}$

$w = \frac{16}{29}$ $n-1 = 4$ $m = 14$

Eff $= \frac{4 \times \frac{16}{29}}{14} = \frac{32}{203} =$ ~~less than $\frac{1}{6}$~~ between $\frac{1}{6} + \frac{1}{7}$

Try

I	II	III	IV	V
1	2	3		5⁻
5⁻		3	2	1
3	2	1		
		1	2	3
	1	2	3	
	3	2	1	

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Apr 19 P.M.

Repetition of quartering of the 5-2 stone.

Same method as page 170

1st Devastin.

2000.0

6328.7

.7

0.75

The trouble is in the mark stage.

Will not try to bring the 1st to setting exactly true, but rather to bring the stage to a prominent bump.

2000.05

6328.95 4328.90

.95

.05

0.0

.85 8.82

.85

0.05

2nd Devastin

0.0

29.45 9.47

9.5

0.0

0.0

9.5 9.47

.45

0.0

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3me Levrier.

0.0

28.5 4328.50
.5

0.0
0.5

8.55 8.50
.6

0.1

4te Levrier

0.0

29.1
.1 Distance

~~0.05~~

0.05

28.95 4328.90
.95

0.05

0.05

29.0 8.95
.0

.05

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Summary of Quarting of Plate.

For 1st II days work assume initial setting already to be worthless, the bearing of lower screw changing before the next reading could be got. But assume no further change, so that the two readings at junction end and the last reading at given end are good. This makes the means slightly different from those quoted on page 173

	1st II Day.	Today	1st II Day	Today	1st II Day	Today
1st II Quarter	8.70 8.77 8.75 4328.74	8.90 8.82 4328.86	+ 0.17	+ 0.08	+0.17	+0.08
2nd II Quarter	9.90 9.75 9.80 9.82	9.47 9.47 9.47	~~+0.09~~ − 0.91	− 0.53	−0.74	−0.45
3rd II Quarter	8.20 8.20 8.20 8.20	8.50 8.50 8.50	+ 0.71	+ 0.44	−0.03	∓ 0.01
4th II Quarter	8.82 8.85 8.95 8.87	8.90 8.95 8.92	+ 0.04	+ 0.02	+0.01	+0.01
	4) 3.63 8.91	4) 3.75 8.94				

Summary, including next page

	1st II Series	2nd II Series	3rd II Series				Mean	Summation
1st II Quarter	4328.74	8.86	8.89	+ 0.17	+ .08	+ .11	+ .12	+ 0.12
2nd II "	9.82	9.47	9.82	− 0.91	− .53	− .82	− .75	− 0.63
3rd II "	8.20	8.50	8.32	+ 0.71	+ .44	+ .68	+ .61	− 0.02
4th II "	8.87	8.92	8.97	+ 0.04	+ .02	+ .03	+ .03	+ 0.01
			4) 4.00					
Mean	8.91	8.94	9.00					

~~A variation of 0.04 corresponds to 0.000 of 1 per cent~~ 0.
~~0.16~~ ~~0.00001 of the whole length.~~

Were this A variation of 0.2 corresponds to about 0.00005 of the whole length. Assuming this to variation between hypothenuse and base would call for a perpendicular of 1 in 100

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Again as before (Evening)

4th Quarter.

0.0
8.7
.7
0.7
0.0

0.0
9.0
8.95
28.97
0.0

8.95
9.0
0.0
8.3
.35
0.0
0.0
8.3
.35
0.0

28.98
Recorded in wrong column by mistake

3rd Quarter

0.0

28.32

28.33

2nd Quarter

0.0
29.85
.9
0.1
0.1
9.9
.9
0.5

29.83

29.82

1st Quarter.

0.05
29.0
8.95
0.05
0.1
8.95
8.95
0.1

28.92

28.85

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Quartering of the double spaces containing the subdivision spans.

Observe Downward

Quarters observed in upward order.

1st" End

1st" Quarter

2000.05

~~2A~~ 2166.4

6.4

6.35

.05

2nd" Quarter

0.0

6.6

6.6

.6

0.0

3rd" Quarter

0.0

6.15

6.2

6.175

0.0

4th" Quarter

0.0

6.75

.75

6.75

0.0

~~2nd" Quarter~~ 1st"

9.95

6.15

.15

6.225

.9

2nd"

0.0

6.5

.55

6.575

0.0

3rd"

~~3rd"~~

0.05

6.25

.25

6.20

0.05

4th"

0.0

6.8

.8

6.80

0.0

1st" Qu.	1st" Quar 2nd"	1st" Quar 3rd"	1st" Quar 4th"	Middle 1st"	Middle 2nd"	Middle 3rd"	Middle 4th"	2nd" Quar 1st"	2nd" Quar 2nd"	2nd" Quar 3rd"	2nd" Quar 4th"
166.29	6.59	6.19	6.77	6.41	6.66	6.31	6.66	6.35	6.62	6.96	6.30

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Middle

1st " Quarter

0.0 0.0

6.6 6.575 6.2 6.25

.6 6.25

0.5 9.95

2nd "

9.95 0.05

6.5 6.525 6.85 6.80

.45 .8

.95 0.0

3rd "

0.0 0.0

6.3 6.30 6.3 6.325

6.3 6.4

0.0 0.05

4th "

0.1 0.05

6.7 6.625 6.75 6.70

.7 .75

0.05 0.05

2nd End

0.0 0.0

1st " Quarter

6.3 6.30 6.4 6.40

.25 .4

9.95 0.0

2nd "

0.0 0.0

6.65 6.625 6.65 6.625

.6 .6

0.0 0.0

3rd "

0.05 0.0

7.0 6.95 6.95 6.975

.05 7.0

.01 0.0

4th "

0.0 0.0

6.35 6.30 6.3 6.30

.25 .3

.0 0.0

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Sums from page 184

	1^{st} Diff.	2^{nd} Diff		$-\frac{1}{8}$th 2^{nd} Diff	$+\frac{1}{16}$ 4^{th}
0					
+0.12	+.12	-.87		+.11	+.14
-0.63	-.75	+1.36	+ 2.23	-.17	-.12
-0.02	+.61	-.58	- 4.17		
+0.01	+.03		-1.94		

For the 1^{st} Diff -.75 the next-preceding consecutive 2^{nd} Diff's are respectively -.87 and +1.36. Mean = +.49

Then correction for half way point $= \frac{-.75}{2} - \frac{+.49}{8} + \frac{+2.23}{16}$

$= -\left\{\frac{.75}{2} + 0.06 - 0.14\right\} = -\left[\frac{.75}{2} - 0.08\right]$

For 1^{st} Diff +.61 Mean of consecutive 2^{nd} diffs $= \frac{+1.36 - .58}{2} = \frac{+.78}{2} = +.39$

For correction for half way point $= \frac{+.61}{2} - \frac{+.39}{8} + \frac{-1.94}{16} = +\left\{\frac{.61}{2} - .05 - .12\right\}$

$= +\left[\frac{.61}{2} - 0.17\right]$

	From page 184 (sum of 3 results quoted on p 184)	From Geometry	From Details	Difference Geometry	Difference Details
1^{st} Result	+.12	4328.83	4329.82	+0.44	+0.52
2^{nd} "	-.75	9.70	30.87	-0.43	-0.53
		2) 18.53	2) 0.69		
		9.27	30.34		
3^{rd} "		4328.34	4329.89	+0.29	+0.40
4^{th} "		8.92	30.69	-0.29	+0.40
		2) 1.26	2) 0.58		
		8.63	30.29		

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Quarting of the ~~track~~ pairs with subdivisions.

	Quarting Jupe 186	~~Detail~~		Detail	~~Detail~~	1st End. Sub.
1st Quarter	166.29			332.92		
		1st+2nd 332.88			~~2.87~~ 2.87	333.22
2	6.59		2nd+3rd 332.78			
3	6.19	3rd+4th 2.96		2.97		
4	6.77					
		2)665.84		2)665.89		
		332.92		332.94		

	Quarting	Detail
1st+2nd	+.04	+.02
3 + 4	−.04	−.02

Quarters adjusted

1st	~~+66.29~~	166.30
2nd		6.62
3		6.23
4		6.8

Since the Quarting corrs within .01 of the mean of quarting and detail means, and since the detail means will be adjusted this .01, we may avoid what must be a troublesome process of adjusting

Quarters adjusted

1st	+66.29	166.29	~~+.30~~ +.30	~~+.17~~ +.18	+.18
2	.59	.59	+.30	−.12	+.06
3	.21	.21	+.01	+.26	
4		.80		−.33	
		4)11.89			
		.47			

~~Detail~~ ~~End~~

~~Quarts~~ Subdivisions

~~2nd+3~~

2nd

Quarters adjusted

1	166.30	+.16	+.16
2	.62	−.15	+.01
3 4	.19	+.28	+.29
	.77	−.30	−.01
	4)14.89		
	3.47		

	Quarting		Subdividing
2nd	166.59	∓.20	166.~~70~~ 82
3	166.19		166.~~42~~ 40 ∓.21
	.39		.61

The halves of the subdivisions also agree within .01 of the results of quarting, showing more trouble.

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Middle

	Quarter	Subdivis	Detail →
1	166.41	333.07	1 + 2 333.17
2	.66	166.51	~~2 + 3 333.07~~
3	.31	332.97 .39	2 + 3 333.07
4	.66	3 + 4 333.00	
	4)2.04	3)0.04	3)333.20
	166.51	333.02	166.60
		3)1.17	
		333.08	

	Quarter	Subdivis	Detail
1	+.10		
	-.05		-.09
2	-.15	-.21	
	+.05		+.01
3	+.20	+.21	
	+.05		+.08
4	-.15		

1 + 2	333.07	-.05	333.17 -.085
3 4	332.97	+.05	333.09 +.085

Trial Adjustment. Add .04 to 2 + Quarter

				Subdivis	Detail
1	166.41	+.11			
			333.11	-.07	-.09
2	.70	-.18			
			333.01	+.03	
3	.31	+.21			+.01
					+.21
4	.66	-.14	332.98	+.06	+.08
	4)2.08		4)4.09		~~+.04~~
	166.52		332.04		

Detail

1 + 2	(.01 ~~added~~)	333.16	-.075
3 4	(.01 added)	332.92	+.075
		1.17	
		333.085	

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~~Last line. Not yet known~~

When the Quartings of the Middle ~~and 1st End~~ bands, adjusted to being sensible coincidence with a mean between the unadjusted quartings on the ~~outer~~ ~~adjac~~ 1 measurements unadjusted, were so;—

	Quarting			Subdivid	
1st	166.41			~~166.84~~	
2	.70	.70	−.20	166.51	−.21
3	.31	.31	+.19	.39	+.21
4	.66	2)1.01		2)1.30	
		166.50		166.60	

Notice that ~~it is~~ the adjustment to half coincidence with detail measures is practically ~~is~~ the mean of quarting and detail, the exact mean not being easy to obtain. And this approximate mean practically agrees with the subdivision thus saving further work. Hence, subdivision measures for both the 1st End and the middle bands need no adjustment, ~~and the quartings need not be further referred to, being useful in proving the points.~~

The quarting will still serve to locate the ends of the bands.

1st End Length of term spaces in which band is situated.

Correction = +.25 ~~(by ratio multiplications of Prof. Rowe, interpolating with 2nd differences, from the +.254 of page 164)~~ See page 164.

1	166.41	+.11	+.11	+.167	+.167
2	.70	−.18	−.07	~~−.129~~	+.044
3	.31	+.21	+.14	+.267	+.311
4	.66	−.14	0	−.083	+.238
	4)2.08				
	.52	2.08			
		+.23			
		4)2.31			
		.577			

1	166.29	+.232	+.232		+.25
	.59	−.068	+.164	or	+.15
	.19	+.332	+.496		+.50
	.77	−.248	+.248		+.25
	1.845				
	+.23				
	4)2.075				
	.519				

0 → These three are identical with those adopted.

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Corrections in Chronometer Book Engine.

Lowe of Yukon — 1st & 2nd Ends

	From page 161					(.02.25)		
0	+.20 3/4	+.23	+2 1/4	+3.75	2 1/4	+2.25	+.23	+7.
1	+.15	~~+.16~~		+6.30	29 1/4	4.95	+.20	+6.
2	-.04 3/4			9.85	56 1/4	7.65	+.03	+1.
3	-.14 1/2			14.40	83 1/4	10.35	-.04	-1.
4	+.05 1/4			13.95	110 1/4	13.05	+.18	+5.5
5	0	+.16	+16	16.50	137 1/4	15.75	+.16	+5.
6	+.25 1/4			19.05		18.45	+.44	+13.
7	+.17 1/2			21.60		21.15	+.39	+11.5
8	+.24 1/4			24.15		23.85	+.48	+14.5
9	+.19 1/2			26.70		26.55	+.46	+14.
10	+.20 3/4	+.50	+29 1/4	29.25		29.25	+.50	+15.

From p 162

Middle

0	+.21	-46	-67	-.46	-14
1	+.06		-66	-.60	-18
2	-.20		-65	-85	-25
3	-.29		-65	-94	-28
4	-.03		-64	-67	-20
5	.0	-63	-63	-63	-19
6	+.18		-63	-45	-13
7	+.10		-62	-53	-16
8	+.32		-62	-30	-09
9	+.24		-62	-38	-11
10	+.21	-41	-62	-41	-12

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Middle band

Adjustment Quantity

0		0	-.554	
166.41	+.11			
.70	-.18	333.11	-.63	
.31	+.21			
.66	-.14	333.97	-.589	
2.08		2)666.08		
-.035		.04		
4)2.045				
.511				

-.554
-.589
-.035

0		-.554	-.554 -.574 -.55	As adopted
166.41	+.102	-.453	+.119	-.435 -.459 -.44
.70	-.199	-.652	-.171	-.606 -.630 -.61
.31	+.211	-.451	+.219	-.387 -.411 -.39
.66	-.149	-.600	-.131	-.518 -.542 -.52 As adopted.

The figures to be used - not a candidate for adjustment

2.08
+.035
4)2.115
+6 6.511
166.529

~~Notice that -61 varies 02 from the -63~~

The run here

-.58	Of which -.58 and -.54
-.46	vary 03 from what was
-.63	chosen from datair
-.41	means
-.54	

This is not very satisfactory

No adjustment quantity		-.598	This varies more; in
166.41	+.109	-.489	other words the
.66	-.141	-.630	adjustment was a half
.31	+.209	-.421	correction to the datair
.66	-.141	-.562	means.
2.04			
+.035			
4)2.075			
.519			

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Apr. 22/79 Last Bar of Tubidium

P.M.

1st Space	2nd "	3rd "	4th "	5th "	6th "
~~0.15~~ 0.05	0.0	0.0	0.1	0.1	0.05
~~33.75~~ 33.6	33.65	33.45	3.2	3.25	3.15
~~33.75~~ 33.6	33.65	33.5	3.1	3.2	3.15
0.05 0.05 33.55	0.0 ~~33.65~~	0.0 33.475	0.05 33.075	0.1 33.125	0.05 33.10
0.0	9.95	0.0	0.0	0.1	0.0
3.65	33.45	33.4	3.05	3.25	3.0
3.6	33.5	33.5	3.05	3.2	3.0
0.0 33.625	9.95 33.525	0.0 33.45	0.0 33.05	0.5 33.15	9.95 33.025
33.59	33.59	33.46	33.06	33.14	33.06

		0	+.49 (+.49)		+.49	+.49 +15
33.59	-.19	-.19		-.256	+.234	+.23 +7
33.59	-.19	-.38		-.256	-.022	-.02 -1
33.46	-.06	-.44		-.126	-.148	-.15 -4
33.06	+.34	-.10		+.274	+.126	+.13 +4
33.14	+.26	+.16	+.33 (+.17)	+.194	+.320	+.33 +10
33.06	+.34	+.50		+.274	+.594	+.60 +18
33.27	+.13	+.63		+.064	+.658	+.66 +20
33.26	+.14	+.77		+.074	+.732	+.78 +22
33.61	-.21	+.56		-.276	+.456	+.46 +14
33.96	-.56	0	-.17 (-.17)	-.626	-.170	-.17 -5

33.40

~~.56~~ 33 4.00
-.66
10) 333.34
33.334

+49 32
+17 34
-17

2nd " difference so small that it need not be taken account of

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7 h 11 m	8 h 11 m	9 h 11 m	10 h 11 m	
0.0	0.0	~~0.5~~ 9.95	0.0	Observations taken
3.25	3.3	~~3.2~~ 3.55	3.95	succeeding from 1 h 11 m to 10 h 11 m
3.25	3.2	~~3.1~~ 3.55	4.0	
0.0	0.0	~~0.0~~ 9.95	0.0	.405
33.25	33.25	~~33.125~~ 33.60	33.975	Observations succeeding from 10 h 11 m to 1 h 11 m
0.1	0.1	0.1	0.0	.347
3.45	3.3	3.7	3.95	Summation in expanded
3.35	3.25	3.7	3.95	series.
0.1 33.30	0.0 33.275	0.05 33.625	0.0 33.95	

	sum		sum
-.145	-.145	-.228	-.228
-.245	-.390	-.128	-.356
-.070	-.460	-.053	-.409
+.330	-.130	+.347	-.062
+.280	+.150	+.247	+.185
+.305	+.455	+.372	+.557
+.155	+.610	+.097	+.654
+.155	+.765	+.122	+.776
-.195	+.570	-.228	+.548
-.570	0	-.553	-.005

33.27 33.26 33.61 33.96

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Last-end band

Quarters	Solar	Lun.	Dl.
166.35	332.97	333.08	+.11	+.27
.62	333.58	333.75	-.47	-.43
.96				
.30	333.26	333.51	-.15	-.25
	4.23	4.65		
	333.11	333.32		

Quar.	Subdiv.	Qu.	Sub.
166.62	166.84	+.17	+.16
.96	167.16	-.17	-.16
3)1.58	3)2.00		
166.79	167.00		

Thus the Quarters agree with the subdivisions

Solar		Lunar		Lunar adjusted	
333.13	+.00	333.03	+.20	333.18	+.14
333.52		333.62		333.47	-.15
3)1.65		3)1.65		3)1.65	
.325		.325		.32	

This would be to ~~change~~ subtract -.1 from the last correction (the one before the zero)

0	+.38	+.38	+.38
166.35		+.30 +.01	+.08	+.49
.62	+.33	+.03 +16		+.33
.96		-.31 -50		-.17
.30	0	-.35 +16		-.01
2.23				
-1.38				
4)2.61				
.65				
4)1.85				
166.46				

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		0	+.38	+.38
166.35	+.19	+.19		
.62	−.06	+.13	+.33	+.20
.96	−.40	−.37		
.30	+.26	−.01	0	0
4)2.23				
.56				

The last column gives the number between which we ought to interpolate by 2nd diffs. The 2nd differences on the chosen to be as small as we can warrantably do.

Note. The results of the preceding pages were worked up when slides of proper comparison for Prof. P's use to get a table of corrections while the Fifth Preliminary Plate was ruled. This fifth plate is the one whose measures are recorded in the next book.

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Memoire sur la Détermination des Longueurs d'onde du Spectre Solaire, ~~presenté à M. le Directeur de la Fondation~~ par V. S. M. van der Willigen.

Archives du Musée Teyler Vol I pp. 3 to 33

Mentions Fraunhofer, Esselbach, Ångström and Bernard as predecessors with reference to their papers. (page 3)

Depends upon Nobert's statement of no of lines on grating, since an error of a single line would cause a greater error in result than the actual discrepancies in the measurements upon the different plates. (page 3)

Nobert plate, + Meigsstein spectrometer.

"Le spectromètre donne les angles à deux secondes près, au laide de deux microscopes à vis micrométrique diamétralement opposés." The central "plate-forme" has a circle reading to minutes on a single vernier.

Divided circle and observing telescope connected.

Plate adjusted by reflection with collimating eyepiece. (page 4)

(Prismatic form of glass plate. And obliquity of ruling diamond.)

Uses 4 positions of grating to eliminate various errors. (page 5?)

But the 4 positions show no systematic difference of result (page 18)

Note temperature of air surrounding plate as an approximation to that of the plate.

Effect of motion of earth (pages 9 to 11)

Adjust telescope perpendicular to axis of circle. Adjust face of grating parallel to axis of circle. Telescope previously focused for distant objects. Collimation to correspond.

Place slit of collimator parallel to vertical spider-line of telescope. page (11)

Exchange collimating eyepiece for plain eyepiece of greater power.

Last on slit produces longitudinal line across the spectrum perpendicular to the vertical thread, by which the lines of the grating are adjusted parallel to slit. (page 11)

Does not use the position of mean deviation. (page 12) Plate placed perpendicular to telescope (pages 11+12) Observations made by deviation to one side from a zero reading on non-diffracted slit, with proper correction (page 15)

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Doubling of lines due to form of diamond-scratches (Page 13)
Dividing the corrected sine by the number of the order of the spectrum used, reduces the result to the equivalent-sine for a spectrum of the 1st order. The means of all three plates and all orders of spectra thereon are given, distinguishing between the four positions of the plate. (Page 14) Observations extend to the fifth and sometimes to the sixth spectrum.
Details of Lines. (Pages 14 to 20)
Measurement of size of grating. (Pages 20 to 28)
Wave-lengths (Pages 28 to 30)
Comparison with prism-refraction. Deviation with prism increases 0".72 per degree Centigrade. (Page 31) Reference to Fizeau in Poggendorff's Annalen T. CXIX p587 & 297. 1863.
Comparison of 3 formulae for relation of refraction to wave-length (Pages 31,32)
2" on divided circle corresponds to ~~0.7~~ 0.6 dix-millionièmes du millimètre in wave-length; and to 0.00001 in index of refraction.

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Measurement of Rutherfurd Plates.

Dec. 31/78	Counting, Unpacking Rutherfurd Phot. &c.	1 hour
Jan. 1/79	Examining the Phot. & describing condition	1/2 "
" 3 "	Meeting the Committee	1 "
" 10 "	Measuring &c. 12 M. till 3 P.M.	3 "
	Don't count sundry plannings & consultations about microscope	
" 17 "	At Obs'y & Fairbank Shop concerning microscope (middle of day)	2 "
" 21 "	" " " " "	1/2 "
	In other intervals come about an hour comparing lithograph - - - - - - - -	1/2 "
Feb. ?	Some time at Fairbank's not made minute of ? hrs.	1/2 "
" 20	At Obsy & with Fairbank (1 hr. M. 1/2 & 2 hrs. P.M.)	3 "
" 21	" " P.M.	1 3/4 "
" 22	" " arranging optical apparatus for comparing	6 "
" 25	" " using and showing Dr. G. & going to Lo. S. S.	6 "
" 26	" " " " " Prof. T.	1 3/4 "
" 28	" " with return to same apparatus	1 "
		21 1/2 "

Mar 3	9 1/4 to 1 & 1 3/4 to 6 1/4 with 2 hrs. out on other work	6 1/4 "
" 4	9 1/4 to 12 3/4 & 1 1/2 to 5 3/4 " 1/2 " " " " "	7 1/4 "
" 5	1 1/2 hrs. taken from other work	
" 6		
Mar 7	On other work	
Mar. 8	9 1/2 to 5; 1 hr. out for lunch. 2 1/2 hr. on attmos. refrac.	4
Mar. 10	9 1/4 to 6; 3/4 hr. out for lunch. 1 1/2 out: on atmos. refrac.	6 1/2
Mar. 11	9 3/4 to 5 3/4; 3/4 hr. out for lunch. 1/2 out on atmos. refrac.	5 3/4
" 13	Concerning cylindrical lens (don't count time walking Clarke's & back)	1
" 14	" Brien lithograph	3 1/3
" 15	" " " & moving apparatus down stairs	2 3/4
"		

Carried forward 41

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	to Boston for objective & Brought home	41
Mar. 18	Don't count visit to Inst. Technology mainly to get cylindrical lens.	
" 19	Experiment with trial objective, cylindrical lenses &c. 2 hr. A.M. }	6 hr.
" "	Writing out statement of work for committee 4 " P.M. }	
" 20	At Obs. 9½ to 11¼ & 2 to 5. Also 10 to 11 P.M.	7¾ "
" 21	" Obs. & Lt. S. S. ⅓ of 9 A.M. to 1½ P.M. (¾ hr. out) = 1¼ hr. Also 3 to 5 P.M. & the Spectrum tube ¾ hr	~~4½~~
" 22	" Obs. 9½ to 5¾, ¾ out	7½ "
" 24	Errands in town and previously at Obs? relating thereto. Fraction of time	2 hr.
" 25	9½ to 6½, ¾ hr out. Don't count ¼ hr. time going to Clarke's	7¼ "
" 26	8¾ A.M. to 11¼ P.M. Say ½ overseeing and assisting Clarke's man overhauling screw	2¼ "
" 27	8¾ " " 11¾ " " " " " " " "	1½ "
" 28	9¼ " " 5¾ " ¾ hr. out 1 hr in evening	8¾ "
" 29	9½ " " 6 " " " "	7¾ "
" 31	At Obs. about 1 hr. and at Painter's relating to micrometer (copy) ½ hr	1½ "
		97¼
Apr. 1	At Obs about 2 hr. ~~and at Painter's relating to~~	2 "
" 2	" " " 2 " and at Painter's relating to micrometer ½	2½ "
" 3	" " 8½ to 6 ¾ hr. out	8¾ "
" 4	" " 9 " 6 " " " Don't count evening	8¼ "
" 5	" " 9½ " 6 " " " And 1 hr. in evening	8¾ "
" 6	Don't count, studying results of subdivision of bar.	
" 7	" " 9½ to 1, 2½ to 5, 9¼ to 11 P.M.	7¼ "
" 8	" " 9 to 1 & ¾ hr. in afternoon	4¾ "
" 10	Don't count	
" 16	" " 10¼ to 4, ¾ hr. out	5 "
" 17	" " 10 to 5 ¾ hr out	6¼ "
" 18	" " 10½ to 1, 2 to 4½ P.M. Don't count evening on "subdividing"	5 "
" 19	" " 11 A.M. to 1, 2 to 6 P.M., 8 to 11 P.M.	9 "
" 21	" " 9½ to 6, ¾ hr out. Don't count ½ hr	7¼ "
" 22	" " About 6 hr.	6 "
" 23 & 24	Time gratuitously given on standard plate.	
" 25 to 29 incl.	About 5 hours upon apparatus	5 "
		85¾

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Studying Wave-length matter.

Dec. 27/78	Collecting Books + Papers	About	3 hours
	Don't count reading Roscoe's Lectures at sundry times.		
Dec. 31 "			
Jan 1/79	Reading + Annoting Moscart.	About	10 "
" 2 "	" " " Cornu	"	5 "
" 3 "	Collecting Books + Papers		1 "

Dec. 26/79 to " 30/79	While confined to house	Reading (Dr Hochheim) Van der Willigen &c.	About	20 "

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B 595.
C 694.
711.5

6874.8 6870.6 6866.8
6565.6 6559.5 6561.8
6519.4 6513.7 6513.9
6497.7 6493.4
6335.5
6281.1
6280.0
6194.5 6189.4
6168.2
6164.9 6160.5
6140.6
6139.6 6135.7
6125.2 6120.9
6105.2 6101.5
5974.8
5898.6 5894.4
5856.2
5760.9
5751.5
5708.8
5680.8
5657.1
5627.0 5623.5
5618.0 5613.6
5601.5
5585.2
5571.6
5531.9 5526.6
5505.2

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5478.6 5475.3
5461.8
5458.3 ~~5444.8~~
5444.3
5428.2
5403.2
5381.9
5373.8 5369.3

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