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Some Thought on Physics, Chemistry, etc.

B

On the term "Vital Force."

Oct. 24, 1877.

The use of the term "Force" in science is very ambiguous and it seems to me should be discountenanced. It means at least three different things viz. Property, Pressure produced and Energy produced. Thus we speak of the Force of Adhesion or the Force of Gravitation; which means the Property of Adhesion and the Property of Gravitation, which all bodies possess. We also say the Force with which two bodies are attracted; in other words the Pressure produced when two bodies are attracted. We sometimes say the Force with which one body strikes another meaning the Energy produced in that case.

In the term "Vital Force" the word "Force" evidently has the first meaning viz. Property; and what we mean is the "Vital Property" of which certain organic compounds sometimes possess. Owing to this Property the chlorophyll of plants by means of the energy derived from sunlight can separate CO_2 into carbon and oxygen. If deprived of the sunlight no ~~decomp~~ separation can take place. ~~In the same manner~~ Thus a man may be compared to a steam engine placed near a heap of coal, which automatically three times a day shovels coal into its furnace. A blower is attached to it which constantly pours in a blast of air. The engine will then keep running as long as the coal

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last, supposing a constant water supply. The water and steam will here correspond to the protoplasm etc. and the Property of Expansion to the Property of Life. For Life is not an Energy but a Property of matter. If anything in the machine clags, the blower stops; fresh air ceases to come in contact with fresh coals; expansion ceases — life ceases.

The steam escaping into the air, and condensing at regular intervals of time, previous to the stoppage of the machine, produced uniform motions in the atmosphere, precisely like sound waves in fact — a regular expansion and contraction of the air. These waves continue after the machine ceases to work. They are a form of expansion, but differ somewhat from the other, being independant of heat or energy and (supposing the atmosphere to be a perfect gas) would continue to infinity, in the case of the machine.

Apr. 12, '80. And yet they are totally invisible and in a ~~considerable~~ less advanced state of Science we could not conceive of their existance without using up energy and without the presence of visible matter. (Suppose we knew something of energy but nothing of steam or air. We then could not explain the Steam Engine but should know that it worked, + that when it stopped expansion [or better evaporation] of the water ceased.

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On a new Undulatory Theory of Light.

Oct. 26, 1877

It is generally considered that there are two strong objections to the ordinarily accepted undulatory theory of light. (1) The wave motion is transverse to the line of propagation. In all bodies of slight rigidity like the gases the wave motion is in the line of propagation. How much more then should it be so in the case of the ether which is far ~~less~~ more mobile, ~~rigid~~ than the most mobile gas. Indeed it is only in the most rigid bodies that the motion can be transverse. (2) The enormous ratio of elasticity to density. By Newton's formula $v^2 = \frac{e}{d}$ where v = velocity of transmission, e = elasticity and d = density. Comparing the ether to air let v = velocity in miles of undulations; then $v^2 = \frac{1}{25} = \frac{e}{d}$ in air. In the case of light $v_1^2 = 40\,000\,000\,000 = \frac{e_1}{d_1}$. Make $d = d_1$, and we have $d : e = 1 : \frac{1}{25}$ and $d_1 : e_1 = 1 : 40\,000\,000\,000$ hence the elasticities are in the ratio of $\frac{1}{25}$ to $40\,000\,000\,000$ or 1 to $1\,000\,000\,000\,000$. So that if a column of air 16 inches long is shortened one inch by a pressure of one pound the same effect would be produced on a similar column of ether by the pressure of a column of water 6000000 miles in height or reaching to 25 times the distance of the moon. Of course the density is nothing like as great as air but the ratio will remain the same.

I do not pretend to do away with this second difficulty altogether but only to try to explain why this enormous ratio exists. From the phenomena of interference and diffraction it is pretty certain that light must be accounted for by some form of wave motion, and it is certain that the corpuscular theory is wrong; hence if the waves are not transverse (in some form) they must be longitudinal. Now suppose that the

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ether consists not of little spheres as is often imagined but of little discs or rings. A ray of light will then consist of a string of these little rings, with their axes lying in all directions but all vibrating backwards and forwards in the same straight-line. If the axes of these rings all become parallel, the ray is polarized. If they become placed at right angles to the direction of vibration, we have plane polarized light, if parallel, circularly polarized and if oblique, elliptically polarized light.

Now as to the enormous ratio above referred to, make $e = e_1$ the $\frac{d}{d_1} = 10^{12}$ which expresses the density of air in terms of the density of ether. Now suppose the ether to consist of very fine and ordinary matter of much coarser particles as does Thompson.

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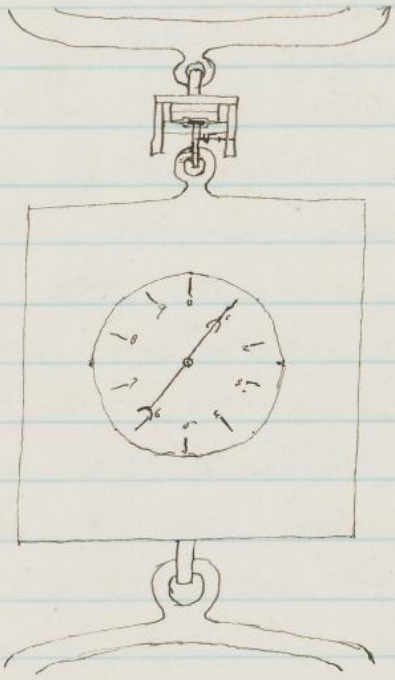
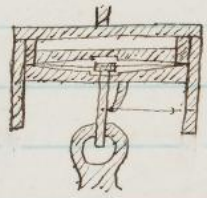
Aneroid Barometer
May 27, '77.





The chief fault with the present Aneroid is its inaccuracy owing partially to the form of spring employed (a flat disc) and partly to the attempt to weigh ~~the~~ large a weight as 7000 gms with such accuracy, (2 gms corresponds to .01 inches). Both these difficulties are obviated by my instrument though at the expense of somewhat greater weight.

It consists merely of a vacuum box to one side of which is attached a handle and to the other side a spring balance also with a handle. The vacuum box represented on an enlarged scale at one side consists of an exhausted cylindrical box covered by an exceedingly thin piece of sheet steel of about one half a square inch of surface. To the middle of this is attached a rod which connects it directly with the framework of the balance. Immediately above & below the sheet steel are two

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discs of metal which support it & prevent it from being bent too much in either direction. To the rod is attached a long pointer which indicates when the forces acting on the sheet steel ~~is not bent in either direction~~ are balanced.

The balance and lower handle are made of some definite weight at 2000 gms and the balance is so made that weights may be placed inside of it till the united weights come within about 100 gms of equaling the upward pressure of the air on the sheet steel. The spring in the balance is so adjusted as to read 200 gms with an accuracy down to gms. If now the instrument be held or suspended by the upper handle and the lower handle pulled <u>vertically downwards</u> till the pointer on the vacuum box crosses the mark the reading of the lower pointer added to the united weights will give the pressure on the disc of sheet steel. Instead however of having to calculate this the scale should be attached directly to the balance so that the pressure may be read off it as in the ordinary barometer in millimeters.

The barometer as thus constructed would measure to .25 mm. corresponding to about 3 meters elevation — quite near enough for all practical purposes, and by making the disc somewhat larger and increasing the delicacy of the balance almost any accuracy

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might be reached. The balance would then however have to be somewhat heavier of course. The weight of the instrument as here proposed would be somewhat less than that of a mercurial barometer but it would be a much more convenient shape to carry and with no danger of any air getting in. The vacuum box might be made to unhook from the rest. Very likely it would be found practicable to make the disc smaller & the instrument proportionally lighter therefore. The instrument if successful would be particularly convenient to the mariner where the mercurial is inconvenient & the ordinary aneroid inaccurate. For some previously invented forms see Vol. 6. p. 2.

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The Great Comet of 1858.

Fri. Mar. 28, 1879. It occurred to me that the tail of a comet was probably in the form of a parabola, and if this were so, knowing the velocity of the nucleus in its orbit the velocity of projection of tail could readily be calculated. To this end made some measurements of the drawings of the comet of 1858 in the Observatory Report on that object.

Sat. Mar. 29, Calculated the form from the measurements. It coincided very nearly with a parabola and I obtained the following results:—

Daily motion in orbit — 3 000 000 m. or 35 miles per. sec.

Earth in orbit 19 m. per sec. Venus 22 m. per sec. Mercury 30 m. per. sec. Comet of 1843 350 m. per. sec. Corona if thrown up from Sun 200 m. per sec. Velocities observed in protuberances 150 m. per sec.

In the first 4 sec tail moves 100 000 miles or 25 000 per sec.

In 16 sec. 200 000 miles or 12500 per sec.

In 30 min. 2000 000 " " 1100 " " or

From 1000 000 to 2 000 000 miles it moves 750 m per sec.

" 6 000 000 " 12 000 000 " " " 120 " " "

" " " " " Secondary " 10 000 " " "

After 20 000 000 its speed is 59 m. per sec.

In first day it moves 14 400 000 miles.

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Wed. June 18, 1879. Plans were formed for the best method of continuing the work and bringing it to a more complete and accurate form. It was decided to commence reading the Observatory Report from the begining, and to take notes; also to calculate and draw the shape of the tail from observations there contained or obtained elsewhere.

Note on the Report.

Introduction speaks of remarkably favorable conditions under which this comet was viewed.

Page 1 Discovered June 2 1858.

"First appearance of tail Aug 14"

2 Tail full breadth head when seen end on. If seen sidewise it might have appeared narrower. "In Comet of 1861 tail was narrower than head."

3 Shows conclusively that if tail was flat its plane near the nucleus was strongly inclined to plane of orbit. It seems more likely to have been conoidal in form.

4 Aug 30. "just visible to the naked eye."

6 Sept 2. It would seem as if the plane of curvature of the tail did not lie in the plane of the orbit i.e. when near the head and when first formed.

7 Sept 5. "Confirms observation of Sept 2.

8 Sept 8. Earth crossed plane of orbit. Tail 4° in length.

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Page 10 Sept 12. Faint-ray of light- from head towards Sun.

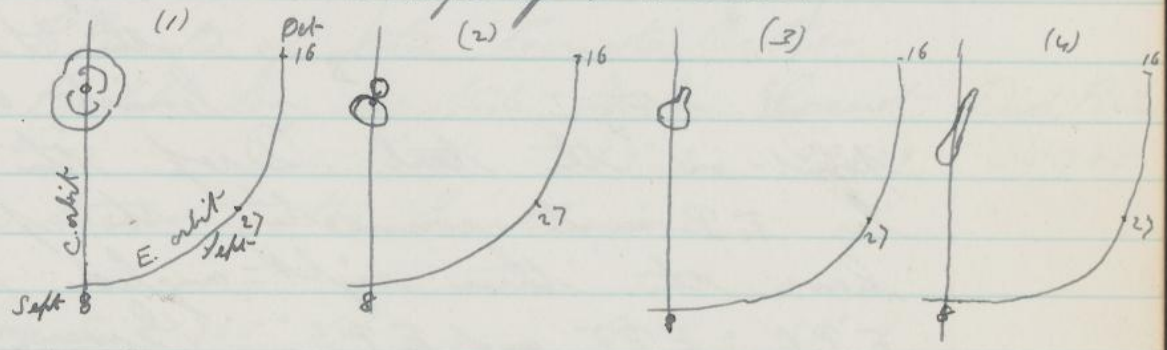
15 Sept- 17 A tail(?) 3' long pointed towards the Sun. Secondary tail first- noticed.

17 Sept: 21. A dark space followed the nucleous.

24. Sept- 28. A sharp deflection of the convex side was noticed.

24 Pape. The dark zone was almost of a parabolic form."

Probable shape of the Tail



Sections of the Tail (1) Nucleous. (2)(3)(4) Tail.

Continuation of the Notes. Thurs. June 19, '79.

Page 29. Sept. 30. "Well defined conical shadow 18' in length.

Page 25 Sept 29. The outline of the dark axis is 20" broad at 4' from the nucleous.

Page 29. Sept-30. On Oct- 8th the darkness of the central band was increased." Perhaps there was less material on which the shadow could be cast.

"A dark band passed from the nucleous through the center to the extreme end of

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the tail." This might indicate that the earth was about at right-angles to the plane of the tail.

Calculations on the True Shape of the Tail.

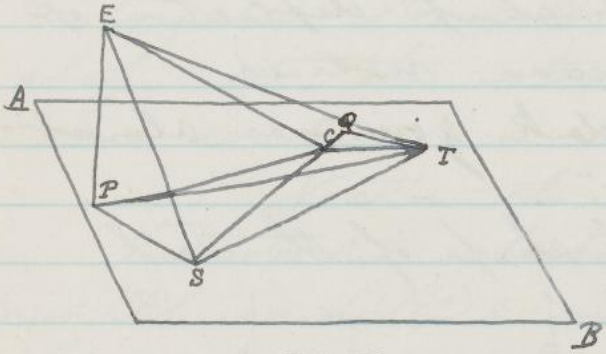

Fig. I.

Let AB be the plane of the Comet's orbit, E the position of the Earth, S the Sun, C the Comet, and T a point on the tail. Drop the perpendicular EP and connecting the points we have the three right-angled triangles EPC, EPT, and EPS. Given EPS and all the angles about E we obtain first EP, then EC, ET, PC, and PT. By means of these we solve the right triangle QTS (right-angled at Q), whence these points may be plotted.

We have given the right-ascension (α) and declination (δ) of C, T, and S, now to find that of P.

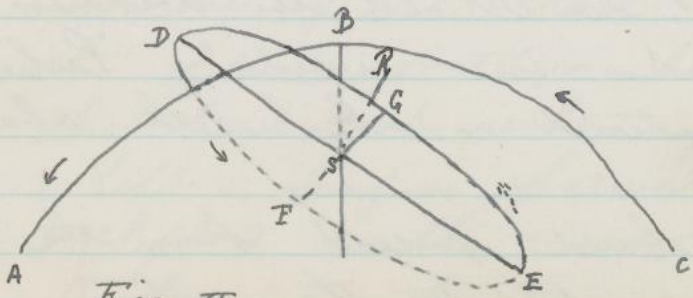

Fig. II.

Let ABC be the Comet's orbit, DFEG that of the Earth, S the position of the Sun, and DE the

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line of nodes. Given the longitude of the ascending node (E as seen from S) and the inclination of the orbit - RSG, to find the lat. & long. of the point of intersection of the celestial sphere, and the perpendicular to the plane of the Comet's orbit, drawn through the Earth. Long E + 90° = long G. lat G + RSG − 90° = lat. pt. of intersection long G = long pt. of intersection. Knowing the lat. & long. we can readily find the α & δ.

Elements of the Comet's Orbit.

Long Perihel.	Long Asc. Node.	Inclin.	Excent.	Dist. Perihel.
36° 13′	165° 19′	63° 2′	.99629	.5785

According to Guillemine.

long E = 165° 19′ + 90° = long. P = 255° 19′

RSG = 63° 2′ + 90° = lat. P = 26° 58′ S

To convert lat. & long. to α & δ.

ω = inclination of ecliptic = 23° 27′ 37″

tan B = sin lon. cot lat.

$$\tan \alpha = \frac{\sin (B - \omega) \tan \log}{\sin B}$$

$$\tan \delta = \cot (B - \omega) \sin \alpha$$

360
255 19
104 41

255 19
180
75° 19′

sin long = − 9.985580
cot lat = + 10.293459
tan B = − 10.279039
B = − 62 15 30

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$B = 62\ 15\ 30$ $\qquad$ $\sin B = 9.946970$

$\omega = 23\ 27\ 40$

$(B-\omega) = 38\ 47\ 50$ $\qquad$ $\sin(B-\omega) = 9.796967$

$\tan \text{lon.} = 10.518642$

$\cot(B-\omega) = 10.094776$ $\qquad$ $\text{a.c.} \sin B = 0.053030$

$\sin \alpha = -9.972120$ $\qquad$ $\tan \alpha = 10.431639$

$\tan \delta = -10.066896$ $\qquad$ $\alpha = 69\ 41\ 20$

6881 $\qquad$ 180

$\delta = 49^\circ\ 23'\ 40''\ S$ $\qquad$ $\alpha = 249^\circ\ 41'\ 20''$

Gives the α and δ of P.

For corrected values see pages 19 & 20.

To find the α & δ of the Sun at 7 hrs. m. s. t. Harvard Observatory.

Long. from Greenwich of Harv. Obs. $4^h\ 44^m\ 32^s$

$\therefore$ 7h m. s. t. at Greenwich $= 11^h\ 44^m\ 32^s$

Hence take mean of results for the day and that following & subtract readings for one quarter hour.

Dist. Comet to Sun at Perihelion.

$\log .5785 = 9.762303$

$\log 92\,300\,000 = 7.965202$

7.727505

75.41

$53400\,000$ miles

Order in which the angles and sides of Fig I should be solved. SEP, CEP, CES, TEP, TES, TEC, EP, EC, SC, ET, ST, CT, ~~SCT~~, ~~QCT~~, QC & QT.

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Position of Tail for Sept. 29, '58.
June 20, '79.

Sums α & δ.

α

Sept. 29		12	22	10
30		12	25	47
	2		47	57
		12^h	23^m	58^s
				2^s

$12^h\ 23^m\ 56^s$ at 7^h m s t Harv. Obs.

$3^m\ 37^s = 217^s \div (4 \times 24 = 96) = 2^s$

$12^h\ 23^m\ 56^s$
15
180
5 59 00
$185^\circ\ 59' = $ Sums α

δ

Sept. 29		2	23	58 S
30		2	47	20 S
	2		70	78
		2	35	39
				14

$2^\circ\ 35'\ 25''$ S = Sums $\delta = 2^\circ\ 36'$ S

$23'\ 22'' = 1402'' \div 96 = 14''$

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Quantities Given

Object –	α		δ		
P	~~249°~~	~~41'~~	~~49°~~	~~23'~~	~~S~~
S	185	59	2	36	S
C	195	20	31	0	N
T_1	190	20	51	0	
T_2	195	20	51	0	
T_3	190	20	31	0	
T_4	195	20	41	0	
T_5	200	20	51	0	

$ES = 92\,300\,000.$

Given $\alpha, \delta, \& \alpha\delta$ to find ang. dist: φ.

$\cot B = \cos(\alpha - \alpha_1) \cot \delta$

$\cos \varphi = \dfrac{\cos(\delta_1 - B) \sin \delta}{\sin B}$

SEP		CEP	
$P\alpha$ =	249 41	$P\alpha$ =	249 41
$S\alpha_1$ =	185 59	$C\alpha_1$ =	195 20
$\alpha - \alpha_1$ =	63 42	$\alpha - \alpha_1$ =	54 21
$\cos \alpha - \alpha_1$ =	9.646474	$\cos(\alpha - \alpha_1)$ =	9.765554
$\cot \delta$ =	−9.933289	$\cot \delta$ =	−9.93329
$\cot B$ =	−9.579763	$\cot B$ =	−9.69883
B =	−69 12	B =	−63 26
δ_1 =	−2 36	δ_1 =	31 0
$\delta_1 - B$ =	+66 36	$\delta_1 - B$ =	180° − 94 26 = 85° 34'
$\sin B$ =	−9.97073	$\sin B$ =	−9.95154
$\cos(\delta_1 - B)$ =	9.59895	$\cos(\delta_1 - B)$ =	−8.88817
$\sin \delta$ =	−9.88029	$\sin \delta$ =	−9.88029
a.c. $\sin B$ =	−0.02927	a.c. $\sin B$ =	−0.04846
$\cos \varphi$ =	9.50851	$\cos \varphi$ =	−8.81692
φ =	71° 11' = SEP	φ = CEP =	180° − 86 14 = 93° 46'

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	CES
$C\alpha =$	195° 20
$S\alpha_1 =$	185 59
$\alpha - \alpha_1 =$	9 21
$\cos \alpha - \alpha_1 =$	9.99419
$\cot \delta =$	10.22123
$\cot B =$	10.21542
$B =$	31 20
$\delta_1 =$	-2 36
$\delta_1 - B =$	-33 56
$\sin B =$	9.71602
$\cos(\delta_1 - B) =$	9.91891
$\sin \delta =$	9.71184
a.c. $\sin B =$	0.28398
$\cos x =$	9.91473
$x = CES =$	34° 45′

The angle CEP comes out an impossible quantity although there seems to be no mistake in the calculations. The only way of accounting for this that I can think of is to suppose the Comet's motion retrograde. An examination of the second figure on plate I in the Observatory Report shows this to be the case, although the first figure contradicts it and represents a direct motion. In the Elements given by Guillemin, the direction of the motion should have been stated — particularly if retrograde, but nothing is said of it. Working however on that supposition I shall calculate anew the required angles and prove the work by comparing CS with the perihelion distance given by Guillemin.

Fig. II

long. E = 165 19   RSG = 63° 2

90   90

long P = 255° 19′   180° − 153° 2′ = 26° 58′ N

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EP

~~$EP = ES \cos \angle EP$~~

~~$ES = 1 \therefore$~~

~~$EP = \cos \angle EP = .3225$~~

EC

~~$EP = EC \cos \angle EP$~~

~~$EC = \dfrac{EP}{\cos CEP}$~~

~~$\log EP = 9.50853$~~

~~$\cos CEP = -8.81752$~~

~~0.69101~~

~~4909~~

~~There is probably an error in my data.~~

To convert the lat & long to α & δ.
Using the same ~~fig~~ numbers as before but changing their signs we get

$B = -62^\circ\ 15'\ 30''$

$\omega = \underline{23\ \ 27\ \ 40}$

$(B-\omega) = -85^\circ\ 43'\ 10''$

$\sin(B-\omega) = -9.998787$

$\tan \text{lon.} = 10.581642$

$\text{a.c.} \sin B = \underline{-0.053030}$

$\tan \alpha = 10.633459$

$\alpha = 76^\circ\ 54'\ 30''$

$\underline{180}$

$\alpha = 256^\circ\ 54'\ 30''$

$\cot(B-\omega) = -8.874187$

$\sin \alpha = \underline{-9.988563}$

$\tan \delta = 8.862750$

$\delta = 4^\circ\ 10'\ 10''\ N$

Substituting these values of P for those formerly given we obtain the following results. The value of CES of course remains unchanged.

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$P\alpha$	=	256° 54′	$P\alpha$	=	256 54
$C\alpha_1$	=	195 20	$S\alpha_1$	=	185 59
$\alpha-\alpha_1$		61 34			70 55
$\cos(\alpha-\alpha_1)$		9.677731			9.514217
cot δ		11.137567			11.137567
cot B		10.815298			10.652204
B		8° 42′			12 34
δ_1		31 0			− 2 36
$\delta_1 - B$		22 18			−15 10
sin B		9.179726			9.33761
$\cos(\delta_1 - B)$		9.966240			9.984160
sin δ		8.861283			8.86128
a.c. sin B		0.820274			0.66239
cos CEP		9.647797			9.50827
CEP	=	63° 37′	SEP	=	71° 12

$P\alpha$	=	256° 54	$T_1\alpha$	=	190 20
$T_1\alpha_1$		190 20	$S\alpha_1$		185 59
$\alpha-\alpha_1$		66 34			4 21
$\cos(\alpha-\alpha_1)$		9.599554			9.998755
cot δ		11.137567			9.90837
cot B		10.73711			9.90712
B		10 23			51 5
δ_1		51 0			− 2 36
$\delta_1 - B$		40 37			− 53 41
sin B		9.25583			9.89101
$\cos(\delta_1 - B)$		9.88029			9.77250
sin δ		8.86128			9.89050
a.c. sin B		0.74417			0.10899
cos TEP		9.48574			9.77199
T,EP	=	72° 11′	T,ES	=	53° 44′

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EP

$EP = ES \cos SEP$

$ES = 1 \therefore$

$EP = \cos SEP = .3223$

EC

$EP = EC \cos CEP$

$EC = \frac{EP}{\cos CEP}$

$\log EP = 9.50826$

$\log \cos CEP = 9.64775$

$\log EC = 9.86051$

$EC = .7253$

SC

$CES = 34° \; 45'$

$ECS + ESC = 145° \; 15' = C + S$

$ES + EC : ES - EC = \tan \frac{S+C}{2} : \tan \frac{C-S}{2}$

$ES + EC = 1.7253 \qquad ES - EC = .2747 \qquad \frac{S+C}{2} = 72° \; 37'$

a.c. $\log ES + EC = 9.76314$

$\log ES - EC = 9.43886$

$\log \tan \frac{C+S}{2} = 10.50437$

$\log \tan \frac{C-S}{2} = 9.70637$

$26° \; 57'$

72 37	72 37
26 57	26 57
99° 34'	45° 40'
ECS	ESC

$EC : SC = \sin ESC : \sin SEC \qquad \sin ESC = 9.85448$

$\log EC = 9.86052$

a.c. $\log \sin ESC = 0.14552$

$\log \sin SEC = 9.75587$

$\log SC = 9.76191$

$SC = .5780$

Proof of all the previous work.

$SC = .5780$ as I have determined it.

$SC = .5785$ according to Guillemin.

$.0005$ difference $= .1\%$

~~One cause of the difference is that I did not know the exact hour of perihelion but calculated it for 7h H.O. time.~~ This concordance settles the question of retrograde motion. ~~* Note. Five hours would make very little difference.~~

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Notes on the Observatory Report.
Fri. June 20, '79.

Page 36. Oct. 2, '58. "The excess of brightness of the right-hand stream attained its maximum about Oct. 2 then diminished till by the 11th, 15th, & 16th, the two streams were about equal. The dark band had definite boundary on Sept 30 & Oct 2 & as time became more indefinite angular divergence of the two streams increased.
41 Oct 4. Dark zone more indistinct and less dark than before.
41. Oct 4. Outline of upper side indistinct — decided change since last night.
42 Second secondary tail appeared" There is now one for each side.
43 Oct. 5. "Edge of outer sector much more indistinct than some days ago also edge of eastern side. Inner sector astonishingly enlarged since Oct. 2. Dark spot & bright spot noticed. Crosses Arcturus at 7h 11m G.M.T.
45 Columnar structure of tail first noticed.
46 The two branches of the tail were never more strongly marked & the dark zone between them clearer than earlier.

Sunday. June. 22, 79.

48 Oct 5, Appearance of explanation beyond a certain distance, of the projectile force forming sharp bend in tail.
49. Oct 6, Maximum length.

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Mon. June 23, '79.

$C\ \alpha$ =	195 20	ET_1
$T_1\ \alpha_1$	190 20	$EP = ET_1 \cos T_1EP$
$\alpha - \alpha_1$	5 0	$ET_1 = \dfrac{EP}{\cos T_1EP}$
$\cos(\alpha - \alpha_1)$	9.99834	
$\cot \delta$	10.22123	$\log EP = 9.50826$
$\cot B$	10.21957	$\log \cos T_1EP = 9.48568$
B	31 6	$\log ET_1 = 0.02258$
δ_1	51 0	$ET_1 = 1.0534$
$\delta_1 - B$	19 54	
$\sin B$	9.71310	ST_1
$\cos(\delta_1 - B)$	9.97326	$T_1ES = 53° \ 44'$
$\sin \delta$	9.71184	$EST_1 + ET_1S = 126 \ 16 = S + T_1$
a.c. $\sin B$	0.28690	$ES + ET = 2.0534$
$\cos T_1EC$	9.97200	$ET - ES = .0534$
T_1EC =	20° 21	$\dfrac{S + T_1}{2} = 63° \ 8'$

$$ET_1 + ES : ET_1 - ES = \tan \frac{S+T_1}{2} : \tan \frac{S-T_1}{2}$$

a.c. $\log(ET_1 + ES)$ =	9.68753	63 8	63 8
$\log(ET_1 - ES)$ =	8.72754	2 55	2 55
$\log \tan \frac{S+T_1}{2}$ =	10.29534	66° 4'	60 12
$\log \tan \frac{S-T_1}{2}$ =	8.71041	EST_1	ET_1S
$\frac{S-T_1}{2}$ =	2° 55'		

$$ES : ST_1 = \sin ET_1S : \sin T_1ES$$

$\log ES$	= 0.00000
a.c. $\log \sin ET_1S$	= 0.06150
$\log \sin T_1ES$	= 9.90648
$\log ST_1$	9.96808
ST_1	= .9291

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CT_1

$T_1EC = 20°\ 21'$ $\qquad ECT_1 + ET_1C = 159°\ 39' = C + T_1$

$ET_1 + EC = 1.7787$ $\qquad ET_1 - EC = .3281$ $\qquad \frac{C+T_1}{2} = 79°\ 49'$

a.c. $\log (ET_1 + EC) = 9.74990$ $\qquad \log (ET_1 + EC) = 0.25010$

$\log (ET_1 - EC) = 9.51600$ $\qquad 79\ 49 \qquad 79\ 49$

$\log \tan \frac{C+T_1}{2} = 10.74563$ $\qquad 45\ 46 \qquad 45\ 46$

$\log \tan \frac{C-T_1}{2} = 10.01153$ $\qquad 125°\ 35' \qquad 34°\ 3'$

$\frac{C-T_1}{2} = 45\ 46$ $\qquad ECT_1 \qquad ET_1C$

$\log EC = 9.86051$ $\qquad EC : CT_1 = \sin ET_1C : \sin T_1EC$

a.c. $\log \sin ET_1C = 0.25188$

$\log \sin T_1EC = 9.54127$

$\log CT_1 = 9.65366$

$CT_1 = .4505$

Q_1C & Q_1T_1

$SC : ST_1 + CT_1 = ST_1 - CT_1 : SQ_1 - CQ_1$ $\qquad SC = .5780 \quad ST_1 = .9291 \quad CT_1 = .4505$

$ST_1 + CT_1 = 1.3796$ $\qquad ST_1 - CT_1 = .4786$

a.c. $\log SC = 0.23809$ $\qquad \frac{SQ_1 + CQ_1}{2} = .2890 \qquad .2890$

$\log (ST_1 + CT_1) = 0.13975$ $\qquad \frac{SQ_1 - CQ_1}{2} = .5712 \qquad .5712$

$\log (ST_1 - CT_1) = 9.67997$ $\qquad .8602 \qquad -.2822$

$\log (SQ_1 - CQ_1) = 0.05781$ $\qquad SQ \qquad CQ$

$SQ_1 - CQ_1 = 1.1424$ Continued on Page 36

$\log CT_1 = 9.700271 \times 2 = 9.400542$ $\qquad 9.313656 \times 64 = 9.313820$

$\log CQ_1 = 9.330211 \quad " \quad = 8.660422$

$0.74012 \div 2 = 0.37006$

$CT_1^2 = .25150$ $\qquad .2545$

$CQ_1^2 = .04553$ $\qquad \log TQ_1^2 = 9.313820 \div 2 = 9.656910$

$T_1Q_1^2 = .20597$ $\qquad T_1Q_1 = \pm .4539$

$Q_1C = -.2139$ $\qquad Q_1T_1 = \pm .4539$

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Tues. June 24, '79.

Page 51. Oct. 6. "Tail 50° long. Deflection of front edge 25° from nucleus where the outline is broken by the streamers. One of the rays seems to be the same with the new secondary tail seen on the preceding evening.

Page 52. Oct 7. The dark space between the two branches increased in breadth & appeared somewhat clearer & filled with a light misty material. All the parts of the tail appeared of a more uniform brilliancy.

Page 54. Oct 8. Tail appeared more diffused than on 5th, especially at its extremity.

Page 55. Sharp transverse line of demarkation between brighter & fainter portions of the tail.

Page 56. Darkness not so clear as before. Nucleus about as bright as α Lyra.

Page 57 Nucleus brighter, tail apparently more condensed on brighter side & fainter in its upper part.

58 Oct 9. Tail fainter & more diffused than on 8th.

59 The light of the secondary tail was brighter than the surrounding portions of the primary.

60 Three perhaps five dark strips visible in tail.

61 Tail appeared divided into four branches for the last 10° of its length.

Columnar structure rapidly shortened & lengthened."

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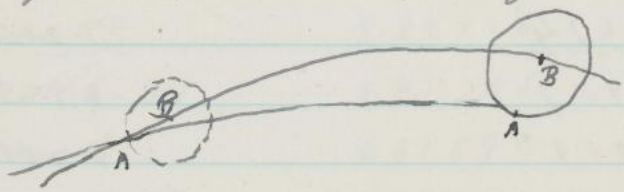
Wed. June 25. '79.

It occurs to me that the force which causes the projection of the Comet' tail is nothing more peculiar than the centrifugal force, which is not held in check owing to the small mass of the comet. That the tail does not point away from the Sun in the sense usually supposed is very evident. Observation of Sept 2 only goes to show that tail was nearly parallel to orbit but in the plane, and not inclined to it as then stated.

Particles on the side nearest the Sun are pulled out by his attraction & thus gain a greater velocity describe hyperbolic paths. These paths have their perihelion distance greater than that of the nucleus consequently the tail lies outside the orbit. The path is longer they therefore fall behind & finally reach again the orbit of the nucleus which would pull some of them after it, but many would be so far behind as not to feel this influence and follow their new path into infinite space. This then explains the motions the envellopes and an inspection of the Plate shows that



at first the front side of the tail would contain most matter & later the rear.

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$P\alpha$ =	256 54	$P\alpha$ =	256 54
$T_2\alpha_1$ =	195 20	$T_3\alpha_1$ =	190 20
$(\alpha-\alpha_1)$	61 34		66 34
$\cos(\alpha-\alpha_1)$	9.67773		9.59954
cot δ	11.13757		11.13757
cot B	10.81530		10.73711
B	8 42		10 23
δ_1	51 0		31 0
$\delta_1 - B$	42 18		20 37
sin B	9.17973		9.25583
$\cos(\delta_1 - B)$	9.86901		9.97125
sin δ	8.86128		8.86128
a.c. sin B	0.82027		0.74417
cos T_2EP	9.55050		9.57671
T_2EP =	69° 11′	T_3EP =	67° 50′

$T_2\alpha$ =	195 20	$T_3\alpha$ =	190 20
$S\alpha_1$ =	185 59	$S\alpha_1$ =	185 59
$(\alpha-\alpha_1)$	9 21		4 21
$\cos(\alpha-\alpha_1)$	9.99419		9.99875
cot δ	9.90837		10.22123
cot B	9.90256		10.21998
B	51 22		31 4
δ_1	− 2 36		− 2 36
$\delta_1 - B$	− 53 58		− 33 40
sin B	9.89274		9.71268
$\cos(\delta_1 - B)$	9.76957		9.92027
sin δ	9.89050		9.71184
a.c. sin B	0.10726		0.28732
cos T_2ES	9.76733		9.91943
T_2ES =	54° 11′	T_3ES =	33° 50′

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$P\alpha$ =	256	54	$P\alpha$ =	256	54
$T_4\alpha_1$ =	195	20	$T_5\alpha_1$ =	200	20
$(\alpha-\alpha_1)$	61	34		56	34
$\cos(\alpha-\alpha_1)$	9.67773			9.74112	
$\cot\delta$	11.13757			11.13757	
$\cot B$	10.81530			10.87869	
B	8°	42′		7°	32′
δ_1	41°	0′		51°	0°
$\delta_1 - B$	32	18		43	28
$\sin B$	9.17973			9.11761	
$\cos(\delta_1 - B)$	9.92699			9.86080	
$\sin\delta$	8.86128			8.86128	
a.c. $\sin B$	0.82027			0.88239	
$\cos T_4EP$	9.60854			9.60447	
T_4EP =	66°	3′	T_5EP =	66°	17′

$T_4\alpha$ =	195	20	$T_5\alpha$ =	200	20
$S\alpha_1$ =	185	09	$S\alpha_1$ =	185	09
$(\alpha-\alpha_1)$	9	21		14	21
$\cos(\alpha-\alpha_1)$	9.99419			9.98623	
$\cot\delta$	10.06084			9.90837	
$\cot B$	10.05503			9.89460	
B	41°	23′		51	53
δ_1	-2	36		-2	36
$\delta_1 - B$	-43	59		-54	29
$\sin B$	9.82026			9.89584	
$\cos(\delta_1 - B)$	9.85706			9.76413	
$\sin\delta$	9.81694			9.89050	
a.c. $\sin B$	0.17974			0.10416	
$\cos T_4ES$	9.85374			9.75879	
T_4ES =	44°	26′	T_5ES =	54°	59′

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$C\ \alpha$ =	195 20	$C\ \alpha$ =	195 20
$T_2\ \alpha_1$ =	195 20	$T_3\ \alpha$ =	190 20
$(\alpha - \alpha_1)$	0 0		5 0
$\cos(\alpha - \alpha_1)$	0.00000		9.99834
$\cot \delta$	10.22123		10.22123
$\cot B$	10.22123		10.21957
B	31° 0′		31° 6′
δ_1	51° 0′		31° 0′
$(\delta_1 - B)$	20° 0′		− 0° 6′
$\sin B$	9.71184		9.71310
$\cos(\delta_1 - B)$	9.97299		9.99999
$\sin \delta$	9.71184		9.71184
a.c. $\sin B$	0.28816		0.28690
$\cos T_2 EC$	9.97299		9.99873
$T_2 EC$ =	20° 0′	$T_3 EC$ =	4° 23′

$C\ \alpha$ =	195 20	$C\ \alpha$ =	195 20
$T_4\ \alpha_1$ =	195 20	$T_5\ \alpha_1$ =	200 20
$(\alpha - \alpha_1)$	0 0		− 5 0
$\cos(\alpha - \alpha_1)$			
$\cot \delta$			
$\cot B$			
B	31 0		31 6
δ_1	41 0		51 0
$(\delta_1 - B)$	10 0		19 54
$\sin B$			9.71310
$\cos(\delta_1 - B)$			9.97326
$\sin \delta$			9.71184
a.c. $\sin B$			0.28690
$\cos TEC$			9.97200
$T_4 EC$ =	10° 0′	$T_5 EC$ =	20° 21′

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	ET_2	ET_3
	$ET = \frac{EP}{\cos TEP}$	
lg EP =	9.50826	9.50826
lg $\cos T_2EP$ =	9.55055	9.57571
lg ET_2 =	9.95770	9.93155
ET_2 =	.9072	ET_3 = .8542

	ST_2	ST_3
	$ES + ET : ES - ET = \tan\frac{T+S}{2} : \tan\frac{T-S}{2}$	
TES =	54 11	33 50
$ETS + EST$ =	125 49	146 10
$ES + ET$ =	1.9072	1.8542
$ES - ET$ =	.0928	.1458
$\frac{T+S}{2}$ =	62° 54′	73° 5′

a.c. lg $ES + ET$	9.71960	9.73184
lg $ES - ET$	8.96755	9.16376
lg $\tan\frac{T+S}{2}$	10.29096	10.51692
lg $\tan\frac{T-S}{2}$	8.97811	9.41252
$\frac{T_2-S}{2}$ =	5° 26′	$\frac{T_3-S}{2}$ = 14° 30′

62 54	62 54	73 5	73 5
5 26	5 26	14 30	14 30
68 20	57 28	87 35	58 35
ETS	EST_2	ETS	EST_3

$ES : ST = \sin ETS : \sin TES$

lg $\sin TES$	9.90896	9.74568
lg $\sin ETS$	9.96818	9.99951
lg ST_2 =	9.94078	lg ST_3 = 9.74607
ST_2 =	.8725	ST_3 = .5573

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	ET_4		ET_5
lg EP =	9.50826		9.50826
lg cos TEP =	9.60854		9.60447
lg ET =	9.89972		9.90379
ET_4 =	.7938	ET_5 =	.8013

	ST_4	ST_5
TES =	44 26	54 59
T + S =	135 34	125 1
ES + ET =	1.7938	1.8013
ES − ET =	.2062	.1987
$\frac{T+S}{2}$ =	67 47	62 30

a.c. lg ES + ET =	9.74623	9.74441
lg ES − ET =	9.31429	9.29820
lg tan $\frac{T+S}{2}$ =	10.38888	10.28352
lg tan $\frac{T-S}{2}$ =	9.44940	9.32613
$\frac{T-S}{2}$ =	15° 43	11 58

67 47	67 47	62 30	62 30
15 43	15 43	11 58	11 58
83 30	52 04	74 28	50 32
ET_4S	EST_4	ET_5S	EST_5

lg sin TES =	9.84515		9.91328
lg sin ETS =	9.99720		9.98384
lg ST =	9.84795		9.92944
ST_4 =	.7046	ST_5 =	.8500

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		CT_2		CT_3	
		$ET + EC : ET - EC = \tan\frac{C+T}{2} : \tan\frac{C-T}{2}$			
TEC	=	20	0	4	23
$ETC + ECT$	=	160	0	175	37
$ET + EC$	=	1.6325		1.5795	
$ET - EC$	=	.1819		.1289	
$\frac{T+C}{2}$	=	80°	0′	87	48

log $(ET + EC)$	=	0.19167		0.17647
a.c. lg $(ET + EC)$		9.80833		9.82353
lg $(ET - EC)$		9.42423		9.82654
lg $\tan\frac{C+T}{2}$		10.75368		11.41549
lg $\tan\frac{C-T}{2}$		9.98624		10.56556
$\frac{C-T_2}{2}$	=	44° 6′	$\frac{C-T_3}{2}$ =	74° 47′

80	0	80	0	87	48	87	48
44	6	44	6	74	47	74	47
124	6	35	54	162	95	13	1
ECT_2		ET_2C		ECT_3		ET_3C	

$$EC : CT = \sin ETC : \sin TEC$$

log sin ETC		9.26817		9.35263
lg EC		9.80929		9.80929
a.c. lg sin ETC		0.23183		0.64737
lg sin TEC		9.53405		8.88326
lg CT		9.57517		9.33992
	CT_2 =	.3760	CT_3 =	.2187

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CT_2 Continued.		CT_3
$\log(ET+EC)$	0.21285	0.19852
a.c. $\log(ET+EC)$	9.78715	9.80148
$\log(ET-EC)$	9.25983	9.11025
$\log \tan \frac{C+T}{2}$	10.75368	11.41549
$\log \tan \frac{C-T}{2}$	9.80066	10.32722
$\frac{C-T_2}{2}$	= 32 17	$\frac{C-T_3}{2}$ = 64 48

80 0	80 0	87 48	87 218
32 17	32 17	64 48	64 48
112 17	47 43	152 36	23 0
ECT_2	ET_2C	ECT_3	ET_3C

$\log \sin ETC$	9.86913	9.59188
$\log EC$	9.86051	9.86051
ac $\log \sin ETC$	0.13087	0.40812
$\log \sin TEC$	9.53405	8.88326
$\log CT$	9.52543	9.15189
	$CT_2 = .3353$	$CT_3 = .1419$

q_2C, q_2T_2 & q_3C, q_3T_3

$SC = SQ + CQ : ST + CT = ST - CT : SQ - CQ$ $\qquad SC = .5780$

$ST_2 = .8725$	$CT_2 = 3353$	$ST_3 = .5573$	$CT_3 = .1419$
$ST + CT$	1.2078	.6992	
$ST - CT$	.5372	.4154	
a.c. $\log SC$	0.23809	0.23809	
$\log(ST+CT)$	0.08199	9.84460	
$\log(ST-CT)$	9.73014	9.61847	
$\log(SQ-CQ)$	0.05022	9.70116	
$(SQ-CQ)$	1.1226	.5025	

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Q_2C, Q_3C & Q_2T_2, Q_3T_3

$SC = SQ + CQ : ST + CT = ST - CT : SQ - CQ$ $\qquad SC = \cdot 9968$

$ST_2 = \cdot 8737$	$CT_2 = \cdot 3760$		$ST_3 = \cdot 5574$	$CT_3 = \cdot 2187$
$ST + CT$	$1\cdot 2497$			$\cdot 7761$
$ST - CT$	$\cdot 4977$			$\cdot 3387$
a.c. $\log SC$	$0\cdot 22418$			$0\cdot 22418$
$\log (ST+CT)$	$0\cdot 09681$			$9\cdot 88992$
$\log (ST-CT)$	$9\cdot 69697$			$9\cdot 52981$
$\log (SQ-CQ)$	$10\cdot 01796$			$9\cdot 64391$
$(SQ-CQ)$	$1\cdot 0422$			$\cdot 4405$
$SQ + CQ$	$\cdot 5968$	$\cdot 5968$	$\cdot 5968$	$\cdot 5968$
$SQ - CQ$	$1\cdot 0422$	$1\cdot 0422$	$\cdot 4405$	$\cdot 4405$
	$1\cdot 6390$	$-\cdot 4454$	$1\cdot 0373$	$\cdot 1563$
	SQ_2	CQ_2	SQ_3	CQ_3
$\cdot 2984$	$\cdot 2984$		$\cdot 2984$	$\cdot 2984$
$\cdot 5211$	$\cdot 5211$		$\cdot 2202$	$\cdot 2202$
$\cdot 8195$	$-\cdot 2227$		$\cdot 5186$	$\cdot 0782$
SQ_2	CQ_2		SQ_3	CQ_3

$\log CT_2 = 9\cdot 575188 \times 2 = 9\cdot 150376 = \log \cdot 14138 = l\overline{CT_2}^2$

$\log CQ_2 = 9\cdot 347720$ " $8\cdot 695440 = \log \cdot 04960 = l\overline{CQ_2}^2$

$\cdot 09178 = \overline{Q_2T_2}^2$

$\log \overline{Q_2T_2}^2 = 8\cdot 962748 \div 2 = 9\cdot 481374 = \log \cdot 3030 = lQ_2T_2$

$\log CT_3 = 9\cdot 339849 \times 2 = 18\cdot 679698 = \log \cdot 04783 = l\,\overline{CT_3}^2$

$\log CQ_3 = 8\cdot 893207$ " $17\cdot 786414 = \log \cdot 00612 = l\,\overline{CQ_3}^2$

$\cdot 04171 = \overline{Q_3T_3}^2$

$\log \overline{Q_3T_3}^2 = 8\cdot 620240 \div 2 = 9\cdot 310120 = \log \cdot 2042 = l\,Q_3T_3$

$Q_2C = -\cdot 2227 \qquad Q_2T_2 = \pm \cdot 3030$

$Q_3C = +\cdot 0782 \qquad Q_3T_3 = \pm \cdot 2042$

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Q_1C & Q_1T_1 continued from Page 25

$$\lg CT_1 = 9.653660 \times 2 = 19.307320 = \lg .20292 = l\,\overline{CT_1}^2$$
$$\lg CQ_1 = 9.450557 \quad \text{"} = 18.901114 = \lg .079637 = l\,\overline{CQ_1}^2$$
$$.12328 = \overline{Q_1T_1}^2$$

$$\lg \overline{Q_1T_1}^2 = 9.090892 \div 2 = 9.545446 = \lg 3511 = l\,Q_1T_1$$

Continued from P. 34.

$\frac{SQ+CQ}{2}$	.2890	.2890	.2890	.2890
$\frac{SQ-CQ}{2}$	.5613	.5613	.2512	.2512
	.8503	−.2723	.5402	.0378
	Q_2S	Q_2C	Q_3S	Q_3C

$$\lg CT_2 = 9.525430 \times 2 = 9.050860 = \lg .11242 = l\,\overline{CT_2}^2$$
$$\lg CQ_2 = 9.435048 \times 2 = 8.870096 = \lg .07415 = l\,\overline{CQ_2}^2$$
$$.03827 = \overline{Q_2T_2}^2$$

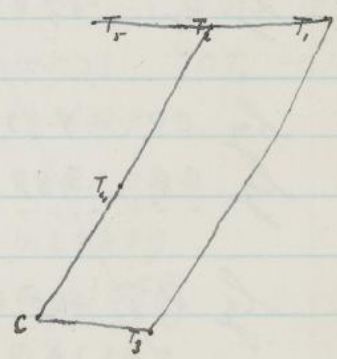
$$\lg \overline{Q_2T_2}^2 = 8.582858 \div 2 = 9.291429 = \lg .1956 = l\,Q_2T_2$$

$$\lg CT_3 = 9.151890 \times 2 = 18.303780 = \lg .02013 = l\,\overline{CT_3}^2$$
$$\lg CQ_3 = 8.577492 \quad \text{"} = 17.154984 = \lg .00143 = l\,\overline{CQ_3}^2$$
$$.01870 = \overline{Q_3T_3}^2$$

$$\lg \overline{Q_3T_3}^2 = 8.271842 \div 2 = 9.135921 = \lg .1368 = l\,Q_3T_3$$

Preliminary Coordinates.

Point	$QC = y$	$QT = x$
C	0	0
S	+.5780	0
T_1	−.2822	.3511
T_2	−.2723	.1956
T_3	+.0378	.1368
T_4	−.1212	.8866
T_5	−.2683	.0796



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Thurs. June 26. '79.

Page 61. Oct 10. "Brightness of two sides more nearly equal. A measurement of the tail gives 64° - the maximum length observed. Perigee today.

62 Breadth reached its maximum of 10°. Brightest on convex side but difference was less than formerly.

64 ~~#~~ Oct 11. Maximum breadth observed 18°

64 Oct 12 Dark & light bands not so evident as before.

66 Brilliancy of tail much less, axial darkness not visible.

68 Oct. 15. Dark stripe in axis very distinct; traced for more than half a degree. Its deviation to right of axis very striking.

70 Oct. 18. Near the nucleus the northern (i.e. the following ~~one~~) branch of the tail brightest.

70 Oct. 19. Only 5° or 6° of tail is ~~x~~plainly seen. No difference in brightness of two sides noticeable. ~~Looks~~ much more compressed towards the axis than usual. In Comet II of 1861 a similar change occurred. Tail had apparently collapsed within distance of half a degree from the nucleus, to scarcely 1/3 of its previous width. But former outlines really remained although easily overlooked under the unfavorable atmosphere." On my theory the Tail would now be seen nearly edgewise.

71 Oct. 21. Tail at least 12°

71 Oct 22 Tail appears about 4°"

71 Oct 24 Fig 8a represents tail when seen nearly

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Extract from Nautical Almanac: 1858

Date	α	d.1h	δ	d.1h	lg dist E.
Sept 16	11h 35m 24s	8.9s	N 2° 39′ 41″	58″	.00203
17	11 39 0		2 16 28		.00191
18	11 42 35		1 53 13		.00179
29	12 22 10	9.0	S 2 23 58	58	.00044
30	12 25 47		2 47 20		.00082
Oct 6	12 47 36	9.1	5 6 48	58	9.99958
7	12 51 15	9.2	5 29 51	57	9.99946
12	13 9 39	9.3	7 23 57	56	9.99883
13	13 13 21		7 46 29		9.99870
16	13 24 30		8 53 25	55	9.99832
17	13 28 15	9.4	9 15 28		9.99820
18	13 31 59		9 37 24	54	9.99807

edgeways." The curve of the tail tends slightly in a direction opposed to that which had hitherto distinguished it. The northern edge near the nucleus is also brighter than the southern. The drawing on Nov. 7, Fig. 9, indicates the same peculiarity but more strongly marked. It indicates an anomaly resembling that noticed about Sept 1st.

72. Oct 24. A series of views shows bifurcation of tail on Oct 12th, and on 13th & 17th though less strongly – the two diverging at angle of from 4° to 7° or 8°. On Nov 12 there is no indication of division into two branches

Tail subtended an arc of about 10°

Seen at an altitude of 3° tail was 1° long

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72 Oct 27 Tail 4° to 5°.
Oct 30 Tail inclined northwards of the parallel 7°
Oct 31 End of tail on north side appears like a feather edge torn off.
73 Dec. 3. Length of tail reduced to 55'. This tail disappeared from the 3d to the 6th, the comet taking the form of a sphere with the nucleus a little excentric and placed on the side from the sun
Dec 8. A little conical tail appeared to wish to reform but disappeared by the 10 th.
74 Dec 23. Comet is now merely a faint nebulous body about 90" in diameter with a slight central condensation of light. No trace of a tail.
Feb. 7 There was an appearance of a Tail which now wholly disappeared.

Observations upon the Secondary Tails.

74 Sept 11 Right hand side of head a short cloudy tail making angle with axis of chief tail of 45° to 50°. Next day disappeared & not again visible.
Sept 12 Faint ray emanated towards Sun & possibly a short horn or sector issued from it at a right angle
75 Sept 17 Faint secondary tail length 8'.0"
Secondary continued visible on 18th & 19th then disap-

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	CT_4	CT_5
TEC =	10° 0′	20° 21′
ETC + ECT =	170° 0′	159° 39′
ET + EC =	1.5191	1.5266
ET − EC =	.0685	.0760
$\frac{T+C}{2}$ =	85° 0′	79° 49′

lg (ET+EC)	0.18159	0.18373
a.c. lg (ET+EC)	9.81841	9.81627
lg (ET−EC)	8.83569	8.88081
lg tan $\frac{C+T}{2}$	11.05805	10.74563
lg tan $\frac{C-T}{2}$	9.71215	9.44271
$\frac{C-T_4}{2}$ =	27 16	$\frac{C-T_5}{2}$ = 15 29

85 0	85 0	79 49	79 49
27 16	27 16	15 29	15 29
112 16	57 44	95 18	64 20
ECT_4	ET_4C	ECT_5	ET_5C

lg sin ETC	9.92715	9.95488
lg EC	9.86051	9.86051
a.c. lg sin ETC	0.07285	0.04512
lg sin TEC	9.23967	9.54127
lg CT	9.17303	9.44690
	CT_4 = .1490	CT_5 = .2798

Q_5C, Q_5T_5 & Q_4T_4, Q_4C

ST_4 = .7046	CT_4 = .1490	SC = .5780	ST_5 = .8500	CT_5 = .2798
ST + CT	.8536		1.1298	
ST − CT	.5556		.5702	

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a.c. lg SC	0.23809	0.23809
lg (ST+CT)	9.93125	0.05300
lg (ST−CT)	9.74476	9.75603
lg (SQ−CQ)	9.91410	0.04712
SQ−CQ	.8205	1.1146

$\frac{SQ+CQ}{2}$	.2890	.2890	.2890	.2890
$\frac{SQ-CQ}{2}$	.4102	.4102	.5573	.5573
	.6992	−.1212	.8463	−.2683
	Q_4S	Q_4C	Q_5S	Q_5C

$\lg CT_4 = 9.173030 \times 2 = 8.346060 = \lg .02219 = \lg \overline{CT_4}^2$

$\lg CQ_4 = 9.083503 \;\text{"}\; = 8.167006 = \lg .01469 = \lg \overline{CQ_4}^2$

$.00750 = \overline{Q_4T_4}^2$

$\lg \overline{Q_4T_4}^2 = 17.875061 \div 2 = 8.937530 = \log .0866 = \lg Q_4T_4$

$\lg CT_5 = 9.446900 \times 2 = 8.893800 = \lg .07831 = \lg \overline{CT_5}^2$

$\lg CQ_5 = 9.428621 \;\text{"}\; = 8.857242 = \lg .07198 = \lg \overline{CQ_5}^2$

$.00633 = \overline{Q_5T_5}^2$

$\lg \overline{Q_5T_5}^2 = 17.801404 \div 2 = 8.900702 = \lg .07956 = \lg Q_5T_5$

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peared till 27th probably owing to bright-
ness of moon.
75 Sept 27 "There started from the Comet
a light-smokey object in a direction diametri-
cally opposite to the tail.
76 Sept 28 Tail whose axis makes angle of 147°
with main one. Length 8' to 10'.
Sept 29. Noticed ζ D'Arrest.
78 Oct 1 Length 27° breadth 3° from Nucleus
1/4° at end 1°.
79 Oct 2. The secondary is little if any brighter
near the chief tail than elsewhere.
Oct 4. Secondary much brighter than last evening.
There seem to be two of them.
80 Oct 6 Several secondaries seen.
81 Oct 10. More sharply bounded on the north side.
82 The billiancy of the secondary was equal
throughout its whole length & breadth.
84 Secondary tails of other comets are referred
to, in some of which the secondaries (if
they were really secondaries in these cases) were
more bent than the primaries.
In the Comet-II of 1861 there were two
principal tails, one strongly curved the
other narrow & straight- and the
latter was by far the most con-
spicuous of the two.

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Calculation of final Coordinates for Sept. 29, '58.

log $ES_A^{\text{uncor.}}$ = 7.965202 log cor. for excen. = 0.00044

(ES uncorrected = 92 300 000 miles) 7.96520

corrected log ES = 7.96564

SC

9.76191

7.96564

7.72755 = log 53.40 millions of miles

	QT = x		QC = y	
T_1	9.54545		9.45056	
	7.96564		7.96564	
	7.51109	32.44	7.41620	26.07
T_2	9.29143		9.43505	
	7.96564		7.96564	
	7.25707	18.07	7.40069	25.16
T_3	9.13592		8.57749	
	7.96564		7.96564	
	7.10156	12.63	6.54313	−3.49
T_4	8.93753		9.08350	
	7.96564		7.96564	
	6.90317	8.00	7.04914	11.20
T_5	8.90070		9.42862	
	7.96564		7.96564	
	6.86634	7.35	7.39426	24.79

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July 19, 79.

To obtain an idea of the density of the Comet's tail. ~~assume the diameter of the particles &c.~~ If the intrinsic brilliancy of each particle is equal to that of the moon and the intrinsic brilliancy of the tail is .000001 of that of the moon then supposing the particles all situated in a plane at right angles to the observer their intermediate distances will be 1000 diameters of the particles. Then given the thickness or volume of the tail we can calculate their true distances from one another in diameters and assuming the limits of probable diameter obtain an idea of the density of the tail.

July 20, 79.

On the repulsion of the Tail by the Sun.

That the Comet attracts its own tail, previous to approaching the sun, is clear, since it forms part of it and holds together. It is evident that the tail forms a very small part of the mass of the comet since the latter continues in almost exactly the same orbit after throwing off its tail as before. It leaves a large portion of its tail behind it & consequently must lose it. Whatever attraction the comet may have for its tail due to gravitation is soon lost ~~due~~ owing to the small mass of the former compared with that of the sun and planets.

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If the comet's mass is $\frac{1}{100}$ that of the earth the latter will attract ~~it~~ the tail equally when 22 times as distant.

Whatever the repulsion may be, (supposing it to really exist) it is clear that it is not continuous, but instantaneous in its action, or nearly so. If continuous the particles would move away with ever increasing velocity and the tail would be curved in the opposite direction to what it really is. That the sun should repel it for an instant only, and then attract it again, or cease to affect it, seems improbable, hence if any repulsion really takes place it must be due to the comet acting under the influence of the sun. That the sun really attracts the tail instead of repelling it, is shown not only by its first action on the envelopes, but by the shape of the tail which indicates a rapid decrease ~~of repulsive~~ in the velocity caused by the repulsion, ~~or in other words a rapid fall towards the sun, or else~~ which could only be owing to the existance of a resisting medium in space, ~~which is perhaps more probable as the centrifugal force would tend to neutralize the attraction of the sun.~~ On the hypothesis that Encke's Comet is delayed merely by motion encountered near its perihelion, if delayed at all a resisting medium seems improbable, particularly such a dense one as this would indicate, & hence the repulsion theory falls to the ground.

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Appearance of the Comet Oct. 17, '78.

Quantities Given

Point	α		δ		
P	256	54	41	10	N
S	202	31	9	26	S
C	246	45	19	35	S
T_1	251	45	19	35	
T_2	251	45	17	35	
T_3	256	45	19	35	

Sums α & δ

α

Oct 17	13	28	15	13	30	5
18	13	31	59	15		
2		59	74	195		
	13	29	67	7	31	
			2	202°	31′	at 7h H.O.T.
	13h	30m	5s			

δ

Oct 17	9	15	28	
18	9	37	24	
2		52	52	
	9	26	26	
			13	
	9°	26′	13″ S	at 7h H.O.T.

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$P\alpha$	256	54	$P\alpha$	256	54
$C\alpha_1$	246	45	$T_1\alpha_1$	251	45
$(\alpha-\alpha_1)$	10	9		5	9
$\cos(\alpha-\alpha_1)$	9.99315			9.99824	
$\cot\delta$	11.13757			11.13757	
$\cot B$	11.13072			11.13581	
B	4	14		4	11
δ_1	-19	35		-19	35
$\delta_1 - B$	-23	49		-23	46
$\sin B$	8.86816			8.86301	
$\cos(\delta_1 - B)$	9.96135			9.96151	
$\sin\delta$	8.86128			8.86128	
a.c. $\sin B$	1.13184			1.13699	
$\cos CEP$	9.95447			9.95978	
CEP =	25	47	T_1EP =	24	17

$P\alpha$	256	54	$P\alpha$	256	54
$T_2\alpha_1$	251	45	$T_3\alpha_1$	256	45
$(\alpha-\alpha_1)$	5	9			9
$\cos(\alpha-\alpha_1)$				9.99999	
$\cot\delta$				11.13757	
$\cot B$				11.13756	
B	4	11		4	10
δ_1	-17	35		-19	35
$\delta_1 - B$	-21	46		-23	45
$\sin B$	8.86301			8.86128	
$\cos(\delta_1 - B)$	9.96788			9.96157	
$\sin\delta$	8.86128			8.86128	
a.c. $\sin B$	1.13699			1.13872	
$\cos T_2EP$	9.96615			9.96157	
T_2EP =	22	20	T_3EP =	23	45

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C α	246 45		T, α	251 45
S α,	202 31		S α,	202 31
(α − α,)	44 14			49 14
cos (α − α,)	9.85522			9.81490
cot δ	−10.44885			−10.44885
cot B	−10.30407			−10.26375
B	−26 24			−28 35
δ,	− 9 26			− 9 26
(δ, − B)	+ 16 58			+ 19 9
sin B	−9.64800			−9.67982
cos (δ, − B)	9.98067			9.97528
sin δ	−9.52527			−9.52527
a.c. sin B	−0.35200			−0.32018
cos CES	+9.85794			+9.82073
CES =	43 52		T, ES =	48 34

P α	256 54		T, α	251 45
S α,	202 31		C α,	246 45
(α − α,)	54 23			5 0
cos (α − α,)	9.76519			9.99834
cot δ	11.13757			−10.44885
cot B	10.90276			−10.44719
B	+ 7 8			−19 39
δ,	− 9 26			−19 35
(δ, − B)	−16 34			+ 4
sin B	+9.09405			−9.52669
cos (δ, − B)	9.98159			0.00000
sin δ	8.86128			−9.52527
a.c. sin B	0.90595			−0.47331
cos SEP	9.74882			9.99858
SEP =	55 53		T, EC =	4 38

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$T_2\ \alpha$	25-1	45-	$T_3\ \alpha$	25-6	45-
$S\ \alpha_1$	202	31	$S\ \alpha_1$	202	31
	49	14		54	14
	9.81490			9.76677	
	-10.49908			-10.44885-	
	-10.31398			-10.21562	
	-25-	53		-31	20
	-9	26		-9	26
	+15	27		+21	54
	-9.64002			-9.71602	
	9.98185			9.96747	
	-9.48014			-9.5-25-27	
	-0.35998			-0.28398	
	+9.82197			+9.77672	
T_2 ES	48	25	T_3 ES	53	16

$T_2\ \alpha$	25-1	45-	$T_3\ \alpha$	25-6	45-
$C\ \alpha_1$	246	45-	$C\ \alpha_1$	246	45-
	5	0		10	0
	9.99834			9.99335-	
	-10.49908			-10.44885	
	-10.49742			-10.44220	
	-17	39		-19	52
	-19	35-		-19	35-
	-1	56		+	17
	-9.48173			-9.53126	
	9.99975-			9.99999	
	-9.48014			-9.5-25-27	
	-0.51827			-0.46874	
	9.99816			9.99400	
T_2 EC =	5-	16	T_3 EC =	9	30

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?

EP

Excent: ES = 9.99820

cos SEP = 9.74882

lg EP = 9.74702

EP = .5585

	CT_1	CT_2
TEC	4 38	5 16
T + C	175 22	174 44
ET + EC	1.2329	1.2240
ET − EC	−.0075	−.0164
$\frac{T+C}{2}$	87 41	87 22

lg (ET + EC)	.09093	.08778
a.c. lg (ET + EC)	9.90907	9.91222
lg (ET − EC)	−7.87506	−8.21484
lg tan $\frac{C+T}{2}$	11.39302	11.33731
lg tan $\frac{C-T}{2}$	−9.17715	−9.46437
$\frac{C-T}{2}$	−8 33	−16 15

87 41	87 41	87 22	87 22
−8 33	−8 33	−16 15	−16 15
79 8	96 14	71 7	103 37
	83 46		76 23

ECT_1	Sup. ET_1C	ECT_2	Sup. ET_2C
lg EC	9.79255	9.79255	
lg sin TEC	8.90730	8.96280	
a.c. lg sin ETC	0.00258	0.01238	
lg CT	8.70243	8.76773	

CT_1 = .0504 CT_2 = .0586

Excent − E = 9.99820 = lg ES = lg .9959 ES = .9959

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	EC		ET,
lg EP	9.74702	lg EP	9.74702
lg cos CEP	9.95447	lg cos TEP	9.95978
lg EC	9.79255	lg ET	9.78724
EC = ·6202		ET, = ·6127	

	SC	ST,
CES	43 52	48 34
C + S	136 8	131 26
ES + EC	1·6161	1·6086
ES − EC	·3757	·3832
$\frac{S+C}{2}$	68 4	65 43
~~ac~~ lg ES + EC	0·20847	0·20645
a.c. lg ES + EC	9·79153	9·79355
lg ES − EC	9·57484	9·58343
lg tan $\frac{S+C}{2}$	10·39505	10·34566
lg tan $\frac{C-S}{2}$	9·76142	9·72264
$\frac{C-S}{2}$	30° 0′	27° 50′

68	4	68	4	65 43	65 43
30	0	30	0	27 50	27 50
98	4	38	4	93 33	37 53
180	0			180 0	
81	56			86 27	

Sup. ECS	ESC	Sup. ET,S	EST,
lg ES	9.99820	9.99820	
lg sin CES	9.84072	9.87490	
a.c. lg sin ECS	0.00432	0.00083	
log SC	9.84324	9.87393	
SC = ·6970		ST, = ·7480	

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	ET_2	ET_3
lg EP	9.74702	9.74702
lg cos TEP	9.96615	9.96157
lg ET	9.78087	9.78545
	$ET_2 = .6038$	$ET_3 = .6102$

	ST_2	ST_3
TES	48 25	53 16
T+S	131 35	126 44
ES + ET	1.5997	1.6061
ES − ET	.3921	.3857
$\frac{T+S}{2}$	65 47	63 22

lg ES+ET	0.20404	0.20572
a.c. lg ES+ET	9.79596	9.79428
lg ES − ET	9.59340	9.58625
log tan $\frac{T+S}{2}$	10.34701	10.29974
lg tan $\frac{T-S}{2}$	9.73637	9.68022
	$\frac{T-S}{2} = 28\ 35$	25 35

65 47	65 47	63 22	63 22
28 35	28 35	25 35	25 35
94 22	37 12	88 57	37 47
180			
85 38			

	EST_2	EST_3
Sup ET_2S		ET_3S
lg ES	9.99820	9.99820
lg sin TES	9.87390	9.90386
a.c. lg sin ETS	0.00126	0.00007
lg ST	9.87336	9.90213
	$ST_2 = .7471$	$ST_3 = .7982$

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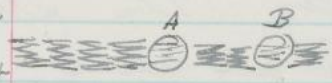
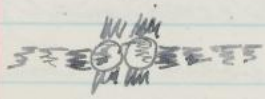
Feb. 21, 1880.

From pages 53 – 55 the theory must be modified as shown on P. 134. For the beginning of this theory see P. 131.

A Theory of Gravitation as applied to Comets.



Let A & B be two bodies, the zig-zags representing the mean paths of the ether particles. These vibrations exist also within the bodies (?) but not with equal force (?). The ~~from~~ effect of the blows on the bodies is inversely as the square of their distance from them ~~bodies~~. A is struck harder on the left and is thus forced towards B. So far this is taken from "Late Recent Advances in Phys. Science." If now A & B are heated to temperatures above the surrounding medium the ether particles immediately surrounding ~~within~~ them ~~may~~ will acquire a greater force than those outside so that attraction may ~~gravitation will~~ be neutralized & even repulsion exist. This might still be called gravitation. For proving this hypothesis apparatus has been devised. See Diary under date.



The vibrations about a heated body are more intense just outside of it than anywhere else; but if two bodies are placed too near together they will attract. There is therefore a place of unstable equilibrium. Its position will vary with the temperatures of the bodies. ~~Another on these would be a place of stable equilibrium & then attraction. The two bodies if the vibs. inside the heated body are less than those on the other side of the at some distance on the two sides of them.~~ The effect ~~may~~ will always remain an attraction if the heating is slight.

If the planets are repelled by the sun, the sun is attracted by them so that the effect is more than counterbalanced. In the case of a hot meteor

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both repel. Double stars ~~seem~~ to attract, perhaps from their great ~~mass~~ and ~~that~~ because they come within the unstable equilibrium limit. The stars generally are kept apart & ~~at all events~~ so are the meteors composing the comet ~~are~~ when it is far removed from the sun. ~~There comes an explanation of Sirius. Its companion is at such a distance that Sirius attracts it but slightly, it however is cold & though perhaps small attracts Sirius ~~enough~~. We thus find a large body revolving around a smaller one.~~

The stones in a comet are kept apart by something in their long interstellar journeys. The only adequate physical forces we know of are the centrifugal & heat. The latter is I think the more probable. They vibrate easily among themselves ~~but once in a while~~ in mean paths of perhaps 10 000 ~~miles~~ — 100 000 miles, and mutually repelling one another. Occasionally two get within the limit & revolve around one another & occasionally two collide with enormous production of heat & light (like new stars?). These being heated are expelled from the mass & increase their mean paths to perhaps 1 000 000 miles but finally on losing their heat fall back into it. We thus have a cluster traversing space surrounded by numerous outlying bodies. As they approach the sun the outliers find the near side is getting about as hot as

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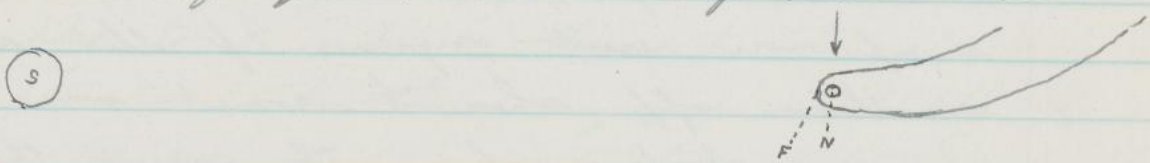
the center so that the nucleus becomes excentric. As they approach the sun their velocities become increased owing to the heat & collisions become more frequent. Quantities of meteors shoot out



towards the sun but when they reach F they find the heat begins to increase again and stop. This gives the point of equal repulsion from the nucleus & sun or the point of equal gravitation. (This determines the Comets mass). From F they spread out laterally & then move at right angles to their original course not backwards. The front edge of the tail would be the most condensed. The matter forming the tail is not constantly changing but increases & then diminishes. It has a longer orbit to follow & therefore falls behind.

~~According to the above theory it does not at all follow because A attracts B that B attracts A. A body lying in ether capable of producing the same temperature as the body, as the earth, attracts all bodies whether hot or cold indifferently. A body hotter than the surrounding ether (the sun or a coal) within a certain distance attracts all bodies whose temperatures do not exceed [greatly?] that of the ether wherein they are situated but repels all others.~~

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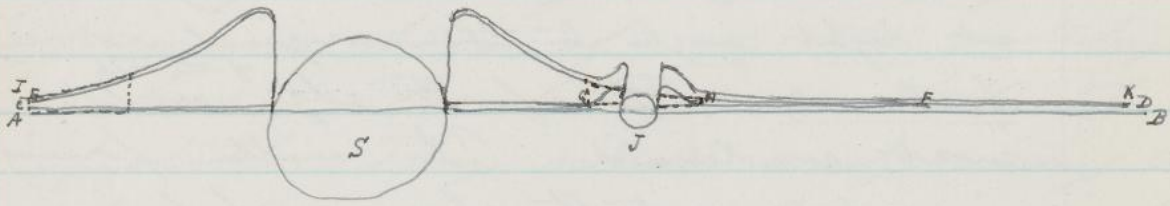
Feb. 22, 80. The shape of the tail - flat at the extremity & lying in the plane of the orbit, but cylindrical near the head - shows that the end was produced when the comet was about that distance from the sun & the front portion is of more recent origin. If the whole tail was thrown off when the comet was at about the same distance from the sun & the matter was constantly changing the section of the tail at all points would be cylindrical or conical. The tail does not continue to recede from the sun but is soon attracted by it because it cools off.



The whole theory may be represented by the above figure. To fix our ideas we will call S the sun & J Jupiter. AB is the line of absolute zero or no vibration. CD is the temperature of interstellar space. EF the line of vibration of the sun, & GH that of Jupiter. The upper line IK shows the total effect of all the vibrations. If the temp. of J. more than makes up for the deficiency owing to its size, S would be pushed away - J would not attract S. Otherwise it would. The Sun is of such size that the ether waves do not effect it perceptably beyond the point F, while J is of such size

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that it is not effected perceptably beyond G + H no matter how heavy the blows might be. ~~repels Jupiter~~ ~~If the amount that dotted area G exceeds dotted area H~~ ~~Jupiter is repelled from~~ ~~Jupiter~~ ~~is something useful.~~ Consequently the Sun ~~does not attract Jupiter at all~~ ~~Jupiter however attracts the Sun~~ ~~If the amount that dotted area E exceeds the area between G + H~~ and the same may be said of the other planets. They simply attract the sun, and + added to 0 makes +. Hence the total effect is an attraction. This theory may give incidentally an explanation of the comparative lightness of the four outer planets. These planets are not very hot but in the case of Saturn if we suppose a deep atmosphere and a nucleus of the density of the earth; the diameter of the nucleus will be only half that of the entire planet. Such an atmosphere would not readily maintain a spherical form. The mutual attractions of the planets I think would be found to agree with observation.

In regard to the double-star question. If motion 1 can raise a body at a one degree, motion 4 ~~would~~ the same temperature ~~over 4 times the area~~ the heat mountain being 64 times the ~~can do it at 4 four times the distance~~. Therefore its repulsion is ~~4~~ 16 64 times as great ~~but~~ and its bulk or attraction is 64 times as great ~~hence the whole effect is an attraction 4 8 times as large~~ ~~as the repulsion~~ ~~and would be equal to 1 at four times the distance~~ ~~hence in order that they should be the same the excess of temperature must be~~ 4 ~~times as great~~

× is attracted in the direction of Jupiter. Jan. 28, '81.

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Continued from page 52.
Sept. 11, '81.

CT_3			CST_1	
TEC	9	30	SC	·6970
T + C	170	30	ST	·7480
ET + EC	1·2304		CT	·0504
ET − EC	−·0100		2S	1·4954
$\frac{T+C}{2}$	85	15	S	·7477
			S − SC	·0507
lg (ET + EC)	·09004		S − ST	−·0093
a.c. lg (ET + EC)	9.90996		lg S − SC	8.70501
lg (ET − EC)	− 8.00000		lg S − ST	− 6.47712
lg tan $\frac{C+T}{2}$	11.08043		a c lg SC	0.15676
lg tan $\frac{C-T}{2}$	−8.99039		a c lg ST	0.12607
$\frac{C-T}{2}$	− 5	35	lg $\left(\sin \frac{CST}{2}\right)^2$	−15.46496
85 15	85	15	lg sin $\frac{CST}{2}$	− 7.73248
− 5 35	− 5	35	$\frac{CST}{2}$	− 0 19
79 40	90	50		
	89	10	CST_1 =	−10′

ECT_3		Sup ET_3C
lg EC	9.79255	
lg sin TEC	9.21761	
a.c. lg sin ETC	0.00005	
lg CT	9.01021	

CT_3 = ·1024

Q_1S

lg ST	9.87393
lg cos CST	−0.00000
lg QS	9.87393

Q_1S = ·7480

Q_1T_1

lg ST	9.87393
lg sin CST	−2.46373
lg QT	−7.33766

Q_1T_1 = −·0022

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CST_2	CST_3
·6979	·6970
·7471	·7982
·0586	·1024
1·5027	1·5976
·7513	·7988
·0548	·1018
+·0042	+·0006
8·73480	9.00775
7·62325	6·77815
0.15676	0.15676
0.12664	0.09787
16·64145	16·04053
8·32072	8·02026
+1 12	+0 36

$CST_2 = 36'$

$CST_3 = 18'$

Q_2S	Q_3S
9.87336	9.90213
9.99997	0.00000
9.87333	9.90213
$Q_2S = ·7471$	$Q_3S = ·7982$

Q_2T_2	Q_3T_3
9.87336	9.90213
8.04350	7.71900
7.91686	7.62113
$Q_2T_2 = +·0083$	$Q_3T_3 = +·0042$

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Final Coördinates for Oct. 17, '58.

QS	·7480	·7471	·7982
SC	·6970	·6970	·6970
QC	·0510	·0501	·1012

E Sun (uncorrected) = 92 300 000 miles

lg E Sun (uncor) = 7.96520
lg E Sun cor for excent = 9.99820
cor. lg E Sun 7.96340
True dist. Earth = 91 900 000 miles

Sun C

log E Sun = 7.96520
lg S C (cor for excent) = 9.84324
cor. lg C. Sun 7.80844
True dist Comet = 64 300 000 miles

Jan. 27, '82.

lg E Sun (uncor) =	7.96520	7.96520	7.96520
lg QT (cor)	−7.33766	+7.91686	+7.62113
cor. lg QT	−5.30286	+5.88206	+5.58633
True dist QT =	−200800 miles	+762000 miles	+386000 miles

lg E Sun (uncor) =	7.9652	7.9652	7.9652
lg QC (cor)	8.7076	8.6998	9.0052
cor. lg QC	6.6728	6.6650	6.9704
True dist QC =	4710000 miles	4620000 miles	9340000 miles

lg EC = 9.79255 — log. lg. EC = 7.75775
lg ES = 7.96520 — lg sin 30" = 6.16270
7.75775 — 3.92045

57250000 miles — 8326 miles = dist cent. mech. to apex

If dist = 33", then dist = 9000 miles.

Assuming the relative masses of the Sun and Comet to be directly as the squares of their distances from the apex, we have $57250^2 : 81 = 343000 : x$
$[\lg 57250 = 4.75778]^2 = 951556$

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log 343000 = 5.535529
log 81 1.90848
a.c. log 57250 = 0.48444
7.92821
.008476 = Mass of Great Comet with the Earth as unity.

Diam nucleus 3" = 800 miles = .001 × Mass Earth if of same density.

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Clair-voyancy.

Dec. 25, '79.

Go to say ten clair-voyants and ask Irene to take notes at each. Ask each if they believe in spirit-rapping etc. Note every thing said, asking chiefly about things which I myself know, such as names of departed friends & past occurrences. Give a false name to five & compare the results. Better speak of a friend with the other name as they may compare notes. Answer five truly, & five false — at least as far as convenient. I consider this justifiable in the present inquiry.

Jan. 20, '80. Ask for some of my ancestors. Think of a message and also repeat one out-loud before going & then ask for it. Ask for any peculiarities. Finally calculate the probability of its being mere guess work. I think one could get along just as well without going to the five which were to be answered falsely. Try ~~them~~ going to one in New York also. Tel page 120.

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Phonetic Spelling

Mar. 12, ~~[illegible]~~ 1879. I would employ the following alphabet: a b c d e f g h i j l m n o p r s t u v w z ah or oi ou ch sh th ng

Rulez. (1) The consonents hav but ~~one~~ sound eche. c az in "cat", g az in "gate", s az in "road" s az in "sat". (2) The vowelz are always short unless the silabel iz followed by an e. This makes them long. Az fat fate met mete mit mite got gote ~~bute~~ + ~~fute~~ but alsa few. ~~Nick~~ Note we ~~relyz~~ relez. hav ~~two~~ similar soundz. ~~There may occasionally be slight ambigu~~ ocashunali be ~~slite ambiguitiz~~ (3) ~~Wh~~ Even in doubt spel the shortest wae az wich for witch.

Od examplz wumun wich hwich iel nu thun zerczez hwat

through	thrue
though	thoe
plough	plou
rough	ruf
trough	trof
thorough	thuru
lough	loc
hiccough	hicup

The abov alfaebet haz 22 literz + 9 dipthongz.

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Financial Problems.

Dec. 6, '79.

The financial condition of a country may have three phases: hard times, average times, & good times. In hard times there is less gold in the country than in the average; that is, gold is high, hence all other articles are low. This is a noticeable condition of hard times – the cheapness of everything. Now although things are cheaper than in the average, they are not so cheap in proportion to the scarcity of gold, because when selling at average prices, only a small margin of profit is made, which can not be diminished beyond a certain point. In good times on the other hand there is more gold in the country than on the average, and gold is cheap, & other commodities high, – but not so high in proportion or we should be undersold by foreign nations. The case is very similar to that of individuals. Gold goes wherever there is the greatest ~~consumption~~ production in proportion to the consumption. Hence war produces hard times, so do large standing armies. The effects may be kept off for a times & to a certain extent tempered by inflation of the currency. Thus we kept it off till '73 & are just getting over the effects. False good times were produced before '73 by inflation but now they are genuine being produced by gold. A European war would lower the average prosperity of the whole world & would increase ours slightly & lower Europes considerably.

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When affairs finally equalized we should be lower than we otherwise would.

Free Trade.

It is always for the commercial interest of a country to have free trade. In hard times it is an advantage to the manufacturing interest to have free trade & in good times a disadvantage. In hard times things are low and foreigners could not undersell us, but we could find a market for our goods & so bring gold into the country. Thus Free trade would keep the manufacturing interest from the alternate rises & depressions, and would always be an advantage to the commercial interests. Therefore it would be an advantage. But even without this argument since it would bring nations into closer relations, facilitate trade, and enable everyone to get the best article at the lowest cost we might know it would be an advantage. But it must be reciprocal to be of real value, & not have it all on one side as at present in the case of England.

Taxes.

These should be laid on all necessary vices ~~and luxuries~~ of civilization :- tobacco, alcohol etc. Large property holding by single individuals should be discouraged as it takes from the property that should be held by the many.

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On this account they should be taxed more heavily; moreover they could better afford to pay the tax than smaller property owners. If a man wishes to endow an institution heavily he should begin during his life and give it a certain amount every year. The income of $1 000 000 would be sufficient to support any family & carry on any private business in as extravagant a manner as desirable, and the taxes should be so apportioned as to make it means impossible for any individual to accumulate more than this or some similar large sum. This should be done by gradually increasing the rate of taxation as the property is increased. This could be best done by means of an income tax. The following rates are suggested as a sample. These could be expressed roughly very well by a curve. For practise a mathematical formula would be required.

Income	Tax %	Tax	Remainder
200 000	60	120 000	80 000
100 000	50	50 000	50 000
50 000	40	20 000	30 000
20 000	30	6 000	14 000
10 000	20	2 000	8 000
5 000	12	600	4 400
4 000	10	400	3 600
3 000	8	240	2 760
2 000	5	100	1 900
1 000	0	0	1 000

By the present methods of taxation a man may become indefinitely rich and his natural ability for money making all goes to his own advantage. It would now

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go to the benefit of his country. Probably no one would be willing to be expatriated for account of the above rates especially if he was brought up to them. If they were universally adopted by all nations no difficulty could arise.

Monometallism & Bimetallism.

For the purposes of trade it is necessary to have some standard of value. ~~This stand is constantly varying~~ In most cases a man's own property is his private standard, and the standard of trade to him fluctuates as his standard increases or diminishes. The nation has another standard which is the sum total of the private standards of all its inhabitants and to it the standard of trade seems to fluctuate according to the good or hard times. So far whether the standard is of one metal or of two it makes no difference so long as it is universal. But besides all this the standard really does fluctuate dependant on the amount of metal produced by the mines and the amount lost or hoarded by misers. If two metals are used they will fluctuate independantly, never bearing the same relation to one another. And even if this relation is fixed by international legislation it will be found difficult to keep it so and it will have to be changed from

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time to time. It is absurd to have more than one standard of length or of weight. But these are constant quantities. Then how much more absurd it is to have two standards of value which are constantly varying independently of one another. Silver is excellently suited for change but for coins of over 50 cents it becomes too heavy. It should be kept in its proper place with copper & nickel.

Investments.

In good times gold is cheap and other articles high. Hence when good times are coming manufacturing and mining stocks with the exception of gold & silver are the most paying investments. In ~~average~~ settled times all kinds of investment are equally good (as far as our present purpose is concerned), and, ~~as~~ at the approach of hard times invest in gold bearing bonds, and reliable gold and silver mines, if such are to be found. By this method in good times you will rise above the standard investment, and in bad times you will not fall below it. The railroads always hold an intermediate place never rising so high, nor falling so low as the manufacturing & mining stocks. Bank stocks rise & fall with the times, always representing a condition a little worse than the average capitalist feels. The above refers ~~solely~~ to the valuation of the stocks, and not to the dividends which they pay, although of course these depend on their valuation. Continued on Page 79.

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Banking.

The Banks carry on two separate kinds of business (1) receiving deposits of money for which they charge the interest they may obtain from it. (2) They deposite gold with the government and receive its equivalent in blank bank note redeemable in greenbacks. These they lend to applicants and receive interest therefor. They likewise obtain interest on the money lent them by depositors besides what they have themselves. Then the government gives them bonds for their gold, in which the principle is cancelled by the blank bank bills, but of which they receive the interest.

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Greenbacks & Bank Bills.

Since Bank Bills are always redeemable in Greenbacks they are of equal value. In order to maintain resumption there must ~~be~~ so few greenbacks in proportion to the gold that all that will ever be presented can be redeemed. Beyond this there is no need for contraction and indeed it would be a positive disadvantage as I shall proceed to show. The National Debt is of two kinds Interest bearing (the Bonds), and Non-interest bearing (the Greenbacks). Now it is better to pay off the interest bearing portion first. ~~Now of the Bonds those held in Europe must be redeemed in gold, but for those held here greenbacks may be used.~~ Now when there is gold enough in the Treasury to redeem the greenbacks outside, there is no need of contraction; and indeed the greenbacks may exceed the gold by a considerable figure.

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Overproduction & Hours of Labor.

Wherever there is the greatest production in proportion to the consumption, there goes the Gold. Consequently it is very ill-advised to diminish the hours of labor. All would find enough to do, if the market where the gold is were only open to them. This it would be, if that nation (where the gold is), whichever it might be, were a free-trader. There may be such a thing as over-production for a few weeks or even months but the balance of supply and demand is soon reestablished and it cannot last for years hence the recent depression could not possibly have been caused by an oversupply. Neither could it have been caused by improvement in machinery, because machinery is more improved at present than ever before. But it was caused as previously shown by the war, nothing more and nothing less.

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Facts that may be taken for granted.

Mankind is constantly improving physically, mentally, and morally.

Whatever facilitates cheap production and cheap transportation is an advantage to mankind.

As men developes mentally + morally their laws and religion must also be changed.

Investments. Apr. 15-80.

Continued from P. 75.

When Inflation occurs whether by paper or gold, speculation follows with good times, + all speculative stocks rise. Hence at the approach of inflation invest in this sort of security. In ordinary times it is about an even chance of success, but now the odds are vastly in its favor. In ~~1879 every~~ Jan 1880 every spec. railroad stock in the country had risen higher than it was in Jan '79, one of them going from $1 to $80 and most of them rising at least 100%, see Stock Speculations. These inflation years are the only ones when it is really safe to speculate, and these occur on the average only about once in 14 or 15 years. Free Trade may stop this in future.

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Average Length of Human Life.

Nov. 1, (approx.) 1879.

Deaths	
7500	die under 1 year
2100	" " 2 "
900	" " 3
700	" " 4 "
500	" " 5 "
1300	10
600	15
1200	20
1700	25
1500	30
1300	35
1200	40
1100	45
1100	50
1100	55
1100	60
1200	65
1300	70
1400	75
1200	80
1000	85
600	90
200	95
100	over 95
31900	Total deaths
45600	Total births
13700	Excess of births

The accompanying table was taken from the Transcript of Oct. 30, '79. Included with it was a quantity of rubbish. The Table came originally from the Returns of Massachusetts in 1874.

The object of this article is to determine what percentage of a generation dies off each year, from the cradle to the grave. No generation can be followed through its course, but by taking all the generations alive in any year, and noting the numbers of deaths in each, as shown by their ages the percentage of deaths can be determined, without otherwise knowing the number left alive in each generation. But to be accurate we must suppose that the population is not increasing, in other words that each generation is fairly represented. But this is not the case, owing to emigration and natural increase, the later generations

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are much more fully represented in proportion than the earlier ones so that a correction must be introduced. We find an excess of births amounting to 13700. These must be scattered along through the generations, most being added to the older & more poorly represented ones.

In the table found on the next page the first column divides the hundred years into twenty equal parts, the second gives the age to which the generation has arrived, the third the number of deaths in one year of the different ages, the fourth the necessary correction to this, the fifth ×100 the corrected number of a generation that die each year in Massachusetts ~~and~~ the sixth the addition of these last figures as they slowly increase year by year. The seventh gives the corresponding percents. This last column probably shows pretty accurately the fate of the generation of 1874 up to the time when in about the year 1974 the last one of the 45-600 drops into the grave. Of the two horizontal lines ruled below the upper one indicates by its length the ~~pers~~ cent that die up to the ages marked on it. The lower one is divided into equal parts. At the age of 35 it will be seen that only half the generation is left. Bisecting this we find it an even chance that such a person will live to be 64. To find the average age of mankind divide the 100 years into periods of 5 or 10 years each. Treat the upper horizontal line as a lever pivoted at the 100 end and loaded at the different points with the weight assigned to each. Then that weight applied at its proper place which will give an equal couple is the average age.

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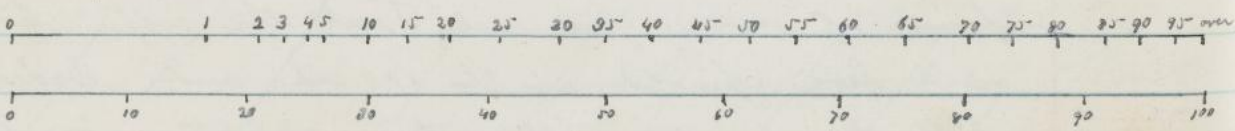
Life Table.

	1	75				75	16
	2	21				97	21
1	3	9	117	4	121	107	23
	4	7				115	25
	5	5				121	26
2	10	13		5	18	139	30
3	15	6		5	11	150	33
4	20	12		5	17	167	36
5	25	17		6	23	190	41
6	30	15		6	21	211	46
7	35	13		6	19	230	50
8	40	12		6	18	248	54
9	45	11		7	18	266	59
10	50	11		7	18	284	62
11	55	11		7	18	302	66
12	60	11		7	18	320	70
13	65	12		7	19	339	74
14	70	13		8	21	360	80
15	75	14		8	22	382	84
16	80	12		8	20	402	88
17	85	10		8	18	420	92
18	90	6		9	15	435	95
19	95	2		9	11	446	98
20	over	1		9	10	456	100



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periods of 5, 10, or 20 years each, as below. Then multiply the years by the number of persons left of that age & dividing by the number of persons gives the average age of each, — 28 years according to this rough calculation. Probably this might be brought up down to 26 years by fuller work.

yrs	persons	
100 ×	0 =	0
80	12	960
60	30	1800
40	46	1840
20	64	1280
0	100	0
	25.2)	5880 (23
		504
		840

The total population of the State in 1875 was 165165.2. Divide this by the number of deaths - 31887, and we get find that the deaths per year are 1 to every 51 persons. Divide by the number of births - 4531 and we get 1 for every 35.

The following statistics were obtained in England & Scotland.

Statement	Eng.	Scot.
Boys M to (F 100)	104.6	105.3
Population Fem. to Males	108.1	121.0
Spinsters to Bachelors	101.1	123.6
Wives to Husbands	101.3	102.3
Widows to Widowers	198.2	271.1
Births per 100 pop.	3.4	3.42
Marriages " " "	.82	.68
Deaths " " "	2.17	1.98
Illegitimate to Leg. births	.65	9.

The lower table gives the ages of people at marriage for England in 1859. It shows that nearly half of each sex marries between 20 and 25.

Age	Males	Females
0 – 20	2.64	13.22
20 – 25	46.90	49.41
25 – 30	25.71	19.80
30 – 100	24.75	17.57

Everybody should live to be within the neighborhood of 100 years old. Only those die a nat-

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ural death who die of old age. But they must die then, and no abetemionanedo can make them live longer. It is merely a question of wearing out. Few men die a natural death, because 100 years is such a long time that there is a great chance of their meeting with an accidental death (disease or otherwise), while with animals that only live a few years more die naturally.

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Formulae for expressing the value of Bonds.
Jan. 25, 1881.

Let p_0 = the value when redeemed, p_n = the present value, c = the rate of coupon interest, and i = the rate of interest that the financial world ~~will~~ expect to receive on perfectly safe loans from the present time, to the date when the bonds are redeemed. For long loans this rate is higher than for short ones.

One year before redemption $p_1 = p_0(1+c)\frac{1}{1+i} = p_0\frac{1+c}{1+i}$

Two years before $p_2 = p_0\left(\frac{1+c}{1+i}+c\right)\frac{1}{1+i} = p_0\frac{1+c+c(1+i)}{(1+i)^2}$

Three years $p_3 = p_0\left(\frac{1+c+c(1+i)}{(1+i)^2}+c\right)\frac{1}{1+i} = p_0\frac{1+c+c(1+i)+c(1+i)^2}{(1+i)^3}$

n years $p_n = p_0\frac{1+c((1+i)^0+(1+i)^1+(1+i)^2\cdots\cdots(1+i)^{n-1})}{(1+i)^n}$

In geometrical progression $s = \frac{a(f^n-1)}{f-1}$ Let $a = c$ & $f = (1+i)$

Then $p_n = p_0\frac{1+\frac{c((1+i)^n-1)}{i}}{(1+i)^n} = p_0\frac{i+c((1+i)^n-1)}{i(1+i)^n}$

$$p_n = p_0\frac{i-c+c(1+i)^n}{i(1+i)^n} = p_0\left(\frac{c}{i}-\frac{c}{i(1+i)^n}+\frac{1}{(1+i)^n}\right) \qquad (1)$$

If $n=0$ $p_n = p_0$ If $n=\infty$ we have $p_n = p_0\frac{c}{i}$ ∴

$i = \frac{p_0 c}{p_n}$ (2) If $i = c$ $p_n = p_0$

To determine the value of i let us take the case of U.S. 4% 30 year Bonds selling at 112 and running for 27 yrs.
$27\times4 = 108 = n$ $c = .01$ $p_0 = 100$ and $p_n = 112$ hence
$i = \frac{100\times.01}{112} = .00893$ or 3.57% per year when $n=\infty$
This is the max value of i supposing that the bonds did sell for 112 when $n=\infty$. There is

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no convenient way of solving for i in equation (1) hence substituting .9% + .8% we get for values of p_n respectively 107 and 114. which indicates that for perfectly sure 30 year bonds the present value of i is 3.3% per annum. The 4½% give the same result.

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To determine Periodicity in a series of apparently irregularly occurring events.

Feb. 22, '84.

As an illustration of the meaning of this article, suppose one wished to determine if there was any other than the eleven year period in the ~~curve~~ curve representing the frequency of sun spots. Let us illustrate by the following example.

Dates.	Day of Year.	1st Diff.	Dates	Day of Year	1st Diff.
Jan 8	8	8	May 29	149	2
20	20	12	31	151	2
22	22	2	June 10	161	10
24	24	2	10	161	0
27	27	3	15	166	5
31	31	4	18	169	3
Feb 10	41	10	25	176	7
16	47	6	July 8	189	13
18	49	2	15	196	7
22	53	4	24	205	9
Mar 7	66	13	25	206	1
8	67	1	Aug 6	218	12
11	70	3	22	234	16
14	73	3	Sept 3	246	12
17	76	3	12	255	9
26	85	9	19	262	7
31	90	5	24	267	5
Apr 10	100	10	Oct 7	280	13
30	120	20	7	280	0
May 2	122	2	Nov 6	310	30
			10	314	4
20	140	18	22	326	12
27	147	7	[illegible] 4	369	43

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Plot the Days of the Year as abscissae and from the middle of the intervening spaces erect ordinates equal to the first differences (see Plate)

By inspection it will appear that there are two series of maxima occurring as marked.

347	12	320	10
14	8	36	9
7 | 333	19	6 | 284	18
$47\frac{4}{7}$	8	$47\frac{1}{3}$	13
	3		16
	9		13
	24		12
	43		7 | 91
	8 | 126		13
	16		

1st Period $= 47\frac{4}{7}$ days begins on the 14th. Ordinate 16
2d " $= 47\frac{1}{3}$ " " " 36th " 13

These when plotted give the 2d curve. Merely subtract these ordinates at the places indicated. When the subtraction does not occur at a plotted point, plot it just the same, and divide its weight also between the two nearest points proportionally. This process will give a broken line of four parts in the place of one of three.

296	240	6
44	44	8
5 | 252	4 | 196	6
$50\frac{2}{5}$	49	6
		12
		11
		18
		7 | 67
		$9\frac{4}{7}$

3d Period = 49 days beginning on the 44th. Ordinate $9\frac{1}{2}$.

Applying this correction the third curve is obtained. The ultimate object of the process is to reduce the sum of the areas above & below the zero ordinate to a minimum.

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Thoughts on a Future Life.

Dec. 25, 1879. A person's theology is chiefly dependant on two things; (1) the theology of his parents, (2) his intellectual capacity. So that knowing a man's creed his intellect may to a certain degree be gauged. Woman's intellect being naturally rather inferior to man's her views are generally more conservative & she is more dependant on the priest. As the man's intellect increases he becomes more & more liberal, till he is so able to distinguish between theology & morality that he is virtuous for virtues sake only, & not at all for the sake of any theological views. After this stage theology is of no more use to him whatever, except as an exceedingly interesting & curious subject for speculation. Prior to this it tends to keep him within the path of virtue.

In order to attain morality a man has simply to follow the rule to do always that which shall be of the greatest advantage to the world at large. In order to follow this rule however 4 other explanatory ones may be necessary ~~such as~~ namely:-

(1) Thou shalt love the Lord thy God with all thy soul, with all thy ~~heart~~ mind, & with all thy ~~minds~~ heart.

(2) Thou shalt love thy neighbor as thyself.

(3) Improve and protect your own moral, mental, and physical condition & health to the uttermost.

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(4) The merciful man is merciful unto his beast.

All morality may be included under the above. These rules are important & true, we now turn to theology which is unimportant and wholly speculative.

Since experiment is here impossible & we have no groundwork of facts self-conviction is impossible; and to win others to our views who have already made up their minds is exceedingly difficult. Of course there is no great advantage in winning others, but it is pleasant to do so. Since experiment is impossible, we are now justified in resorting to comparison; since comparison is better than nothing, and may lead to some true results.

I would classify the universe under five heads.

Ether Energy Life Time Space

Two finite on one side, two infinite on the other. To which branch life belongs, if to either, we cannot say. Energy by its action on the Ether (perhaps throwing it into vortex rings) produces matter.

The following list includes the arguments for and against a future life as far as I am aware.

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Against.

(1) Darwinism. If there is no line dividing man from the beast where do we draw the line of the soul? If we do not draw it - do all the beasts have souls, likewise the trees, grass, flowers and all protoplasmic individualities?

(2) Birth. When does the soul first come into a child?

(3) Thought as we know it can only exist by a transformation of matter, + a transformation of energy. How can we conceive of thought without matter or energy either? (For one cannot exist without the other).

(4) Those who seem most certain of a future life hold the most improbable views with regard to it; such as emerald spires, crystal gates, diamond pavements, and other rubbish. While those who hold the most probable views seem least certain of them. See "Nineteenth Century"

(5) The universal belief in a future life, often quoted, it seems is not universal, but merely very extensive, as are also other beliefs, transmigration of souls, eternal hell, etc. See "Nineteenth Century"

(6) The more one thinks on this subject often the more doubtful he feels.

(7) The aged can hope for it - than the young. "Nineteenth Century"

(8) If there is no God there is no future consciousness probable. It is easier to conceive of original matter than of original consciousness.

May 12, 88 To judge fairly one should endeavor to remove from his mind all prejudices obtained from the New Testament, since Christ knew no more about it than we do. The accomplishment of this object is exceedingly difficult.

(9) Finally simpler + more natural supposition prima facie to have no God + no Hereafter.

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For.

(1) The oft quoted butterfly comparison.

(2) Comparison with a steam engine, (see page 1).

(3) To some minds it seems at certain times as if they were influenced to a certain extent by some external superior agency. I do not refer to Conscience. I think this is a sufficiently common and frequent experience to be classed as an argument.

(4) ~~Some~~ of the clair-voyant ~~sayings~~ which seem to ~~be quite~~ remarkable. This is a ~~subject which~~ I hope some time ~~in~~ the future to ~~investigate.~~ See page 65.

(5) Under the five heads into which the universe is classified, all save life are certainly eternal, and it would seem strange if life the highest manifestation of them all, should cease with each individual forever, and be continually created anew.

(6) The incompleteness of this life and the feeling many have that it is not wholly satisfactory, that life perhaps is not worth living without something more. (9) Bible

(7) The sickness injustice & trouble that some have to contend with throughout their lives which prevent their attaining their highest happiness.

In the 3d I mean such cases as where a man has a sudden desire to visit a certain uninhabited island, & there finds & rescues a starving human being who has been cast on it.

(8) The truths of higher knowledge should always give happiness but agnosticism does not.

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It would seem unless some of the arguments against are answered, as if they had rather the better of it.

I would compare our future existance to waves in an ocean of life advancing in a direction not of space, but of time. Space is entirely left out in the comparison as it should be, if we are to have power to go where we choose. Generations of waves will thus follow one another in time, but may miss of indiscriminately in space.

I imagine an immense sphere surrounded by an exceedingly shallow ocean of varying depths. In the future, as here, life is of two parts, the instinctive, and the intellectual. The depth of the water represents the former, the height of the wave the latter. It is this latter alone which is distinctive, the former is common to all. For the lower organisms the water is shallow, for man & the brutes it is deep. For the lower organisms the waves are infinitesimal, for the brutes somewhat larger, and for man larger still. There is a limiting height however which these waves can never pass, unless the water also grows deeper. Probably we are still far from such a limit. When a creature is created a disturbance is produced in the water; when the disturbance ceases i.e. death comes, a wave is

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formed. This disturbance is produced by the action of Ether + Energy on the mind in the form of sensation. The longer one lives the greater the disturbance produced + the higher the wave. If the mind is weakened by old age, or disease the wave loses nothing, but every effect remains, whether it is forgotten in the present life or not. In the case of a child, a savage, or an animal, the wave is not so high + never can be. The higher the wave the more happiness it may contain, but if a small wave is as full as it will hold, what more could be desired? "Intellect" as here used does not mean science, or law, or any particular branch, but the whole mind. Criminals are men whose minds are dwarfed in some particular, and their waves are smaller (perhaps shorter), allying them more to the savage. It may be to a certain extent their misfortune + not their fault, as in the case of children that die young, but the result is just the same. There is no need to state the inflexibility of nature's laws. The criminal may regret it but the child can not.

Without ether or energy they may be unable to originate ideas themselves, further than what they already have,

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but perhaps by means of our brains, and the effect they may exert on us, new ideas occur to both them and us. Similar minds associate together, & if any remain criminal, they would likewise associate till they acquire wisdom from one another or mankind and improve. The ocean itself of course represent a far higher intellect than any of the waves upon it, and is very far from being instinctive except in as far as it concerns the waves. Instinct in the waves is original thought in the ocean.

As to Christ I would rank him with Zoroaster, Buddah, Confucius and Mohammed, as the founder of one of the great religions of the earth. Most Free-thinkers, Liberals, Radicals, Infidels, etc. are not really Christians, though they may call themselves so. The name implys a partial worship of Christ. The afore mentioned individuals follow all five of the great ~~the~~ teachers more or less. Atheism implys crude and imperfect thought or an abnormal mind. The miracles of Christ are inexplicable except as inventions of the early teachers, (Paul's conversion was as implied a thunder-stroke), but even then it is almost as wonderful that they should have obtained such universal credence. The New Testament does not lay especial

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emphasis on truth and it is likely that the parables were misunderstood by many & taken perhaps for true stories. The imagination of that race seems to be very fertile in the east. Many of the miracles are clear impossibilities, even in the present state of science, such as Joshua commanding the sun & moon to stand still, Christ turning water to wine, & feeding 5000. These transgress the very simplest chemical & physical laws. As science advances we may be able to demonstrate the impossibility of the others also. Eating animal & vegetable food.

Jan. 20, '80. The end to be attained in this life is the highest happiness. This happiness should come largely from what you give as well as from what you receive. It should come from the thought of the good you are doing the world and not merely from the money you are to receive for it, or the pleasures to be attained by you — travel, etc. for instance.

Apr. 12, '80 The end to be attained is not the Highest Happiness but the Good of Mankind. This however will produce in one the Highest Happiness.

It would be an excellent to plan to construct a Holy Book by making the best selections from the Bible, Koran, Vedas, etc. And have them all printed in one

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good sized volume, for the use of those in sickness + affliction. We should thus get the advantage of all instead of that of a single book. Perhaps a still smaller collection of the very best parts, might also be published. It is said the books of Buddhism are particularly comforting to those in affliction.

Jan. 23, '81. If the laws of Nature necessarily follow on the constitution of matter (if light is necessarily propagated with just such a velocity, + if 2 + 2 necessarily make 4), there is no need of a God, save to create the original ether. In this case it is easier to understand an original "Ether" than an original "God". On the other hand, if the laws of Nature do not necessarily follow, if gravity might have increased ~~inversely~~ as the cube of the distance, + if 2 + 2 might have made 5, or 5.001; and if the world in that case would have been a very inferior affair, then an excellent selection was made. I say excellent because the world is evidently a success, there is more happiness than unhappiness among its organized inhabitants. If the wisest possible selection was made, when an inferior one was quite as likely, then there was probably a powerful Mind to make that selection. Hence a proof of some value of the existence of a God might be obtained by showing

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that things are not necessarily as they are.

But if the existance of a God were proved, it would not necessarily follow that he cared particularly for us, or ~~paged~~ paid any attention to us whatsoever, or cared for our worship or prayers. Indeed prayers for physical objects, such as that a vessel may not strike on such a reef, or that a sick person may recover, by supernaturally added strength or extermination of multiplied germs are necessarily useless. For instance the "Hospital Expt." suggested by Tyndall could have had but one result. On the other hand prayers that another person's consciousness may be influenced one way or another might be attended to. At least we have no proof to the contrary. But the influence in any case would not be very strong perhaps about 2 or 3% & without doubt in an expt. like Tyndall's would result in failure. Hence we may conclude that prayer is practically useless save in strengthening the superstitious mind.

Jan. 28, 82. The case of Garfield's death is a striking instance in point, where probably 100 000 000 persons wished he might recover & perhaps 30 000 000 at one time or another prayed for him. Moreover his life hung so long in the balance, that it seems as if the 30 000 000 & of

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prayer might have overbalanced the few ounces of pus. ~~But perhaps it was the prayer that so prolonged his suffering life and ~~that~~ increased his sufferings.~~

Jan. 23, '81. (continued). It might seem as if man were from mental causes more unhappy than the lower animals, as judged by suicides, as well as otherwise; and that intelligent dogs are sometimes more unhappy than lower consciousnesses. Perhaps then beings having higher aspirations than ourselves would be still more unhappy. If so, then are our aspirations too high? Should we not merely try to increase our present happiness by civilization etc. and not ~~try~~ aspire to future consciousness?

Jan. 29, '82. In the above article and elsewhere I ~~say if they~~ speak as if doubting the existence of a God. By this I really mean an active all-ruling Mind. Without doubt matter + energy have existed from the beginning of time, which may mean infinity. If one defines God as the Universe, including everything, & everybody, and every mind in it, as some do, why of course there is a God. My position at present is unchanged since May 25, 1880, but being now perhaps a little firmer in belief. I admit that I know absolutely nothing as to whether there is a God and a Future Consciousness, or not. Knowing nothing about them, I am ~~absolu~~ wholly

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undecided on these questions, but hope that both may be answered in the affirmative.

Feb. 27, '81. It seems to me that Atheism Agnosticism and Theism may well be compared to the case of a man holding out his two hands and saying he has a coin in one of them, and telling you to guess. One man may be sure it is in the right, and another that it is in the left, but the wise man will say that he does not know.

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Spirits Feb. 10, 1880. Mediums.

Aunt S. had heard very curious statements from a medium, Mrs. White. Aunt C. & S. and Mother had heard curious things from other mediums so I determined to investigate the matter.

I got Shurtleff to go last week to make an engagement for himself, which he did with a man at Mrs. White's. He asked if his initials were required but he was told no. Saturday night he saw me and told me to go today (Tues) at 10 A.M. He waited at corners two or three times on his way home, but felt sure that no one followed him.

I made out the following list of questions & remarks.

4 Theories or explanations. (1) Spies. (2) The person is mesmerized & thinks he hears & is so deceived. (3) Real mind reading or clair-voyancy. (4) Spiritual communication. To test these I on the visit note everything, but answer only yes and no. The theory of spies would be settled by Shurtleff's going. I think I should know if I were mesmerized. So that it lies between Clairvoyancy & Spirits if she tells me more than others could.

To test the spirit theory. Ask about friends in the spirit world & meanwhile think of persons here whom I know only by sight - a grey-haired man auburn haired woman & little child.

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Ask for messages from Blanch Charles. I had previously made up ~~three~~ two, one of which I repeated aloud in my room, & wrote down; another which I only thought of and wrote the initials of the words. The year 581 B.C. is put down in his book. I did not read what was said, but when I get to the medium ask for the statement of the event. Ask the name of Lizzie's half-sister who died, also description, age, etc. I don't know these myself. Ask about my ancestors. Ask in what does future happiness consist, their occupations, is there music, how soon do they rise from the dead? is immersion necessary? Ask about truth of miracles of Christ & Joshua. Ask about rappings.

Tests for clairvoyancy, (think meanwhile of politics, selling cotton, etc.) What causes high temperature of sun (think of burning coals) what is ~~t~~ temperature? What is on other side of moon (think of air & water being absorbed. This same medium had previously told Mr. George Clark that the air & water were over there.) Tell the date of a coin held in my hand, (think meanwhile that it is 1860. I had been previously told that it was not). Tell the date of another coin. This date I know it was a ~~Moroccan~~ Morocco coin dated 1272 from Mahomet. See B. 65.

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Interview.

Called at the house at 10.00 Girl came to door said Mrs White ~~she was~~ busy with visitors & showed me into Parlor. There was an old lady waiting there who afterwards proved to be an acquaintance, I suppose a former patient. My hour was put down in a book with something looking like S S before it. Waited in parlor till 10.20 old lady went out & returned. Mrs White came in, age about 30 to 35, quite pretty. Showed me into room & I waited 5 minutes. Then she came in sat down opposite me & remarked it was a cold day and opened conversation.

M. I think you are rather mediumistic, that you can see things very clearly, or will be able to in the future.

There she twitched in her chair once or twice turned over an hour glass and apparently went to sleep, first placing her hand on mine. Pretty soon she began to speak in a chilly voice & very fast. ~~I~~ M ~~What~~ Charl Charl (this perhaps was a guess at my name) M Elderly lady not very wrinkled quite pretty had large eyes. You didn't expect grandma? She wants to see others, she was very sweet. Here's grandpa he was breathy not slow. What is initial of your name? ~~M~~

W. A.

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M Willie?
W Yes.
M Grandpa want to see Willie, while Willie quite a surprise didn't expect it. Others hadn't come pleased that you had.
M Another gentleman, your father?
W Perhaps.
M Yes. Noble forehead, fine face, commanding respect, honored for his integrity, ~~the~~ great honesty his peculiarity; as he grew old he grew thin, and weak, but not sick. Died suddenly. (There she let go my hand. I took out my note book immediately she began to go to sleep. It was hidden from her behind the table which was between us.)
M He didn't want to go he was just getting ready to have a nice time. But now he wouldn't exchange places on any account.
W. What was his name?
M. Will Will the old William?
W. No. M John? There is a John I think.
M. What was his initial?
W. E.
M. Oh yes Edward wasn't it?
W. Yes.
M There are two of you because he speaks of his boys.
W Yes.
M. What is the other's initial?

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W. E.
M Yes. He is Edward too. Have you a sister?
W No.
M I mean in the spirit land.
W Oh yes.
M Then there's little Mary.
W No.
M Well there's John.
W No unless you mean one of my ancestors who died before I did.
M Well perhaps. Your sister was a beatiful girl with thoughtful head & large brown eyes like yours but larger handsomer than you. Not so big as you with lighter fluffy hair. She says tell your Mother she's very happy.
W. There's another gentleman I'd like to hear from.
M. There's Charly,-
W. Yes he's the one I want to hear from.
M. Why you said you didn't know him before.
W. Well I didn't think of him by that name. (I did not say I did not know him I merely made no answer when she spoke of him).
M Well he's a man now. You used to call him Mr. Well Willie says he the folks have forgotten me, but I'm glad to see you at last. He was strong minded ~~looking~~ or rather strong minded. His death

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was sudden. He was quite witty.
W What was his last name?
M What was first letter?
W P.
M. It was something like Peter Perkins no I can't tell. He wanted to do what he started on but it came to someone else to finish. He wants you to struggle on & educate yourself in the path you have intended ~~for that~~ you are capable & by faithful application you will do something ~~the~~ which will be a great improvement to the world. He will help & assist you.
W. Well there was a particular message he was to send me.
M Yes there was something I can't make it out.
W Something about an old state he was interested in, way back.
M Oh yes about some peculiar number.
W About 581 B.C.
M Yes he wants you to find that out, & finish the work, yes that it you're to finish the work & you will have the success & glory he would have attained. He started to write about the egyptians and you're to finish the manuscript.
W Well my sister-in-law had a sister who died can you tell me about her?
M Her name was Nelly.

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W. No. (I said this at a guess though I thought it was Mary)
M What is your sister's initial?
W L.
M. Oh yes Lizzie. Her sister has not gone long let me see her name was Mary wasn't it.
W Geo (At a guess it proved afterwards to be Maria).
M She came here a little time ago, & wants to see Lizzie. Lizzie is not very well, far from well, tired, etc. Wants Lizzie to come here. Eddy is very nice he's not like you. You are more of a dictionary man that he is, he is more hammer & tongs, he likes work. You work with brain, he with his hands, that is merchant work you know. He'll get along very well. You needn't worry about him.

She then gave a lot more rubbish of which I place below merely the notes

Great grandpapa, english race, peculiar grandmother beautiful fine eyes Spanish He was minister, no doctor, professional I mean like squire. Looked up to. first society. family gone down a little since now rising again. Came from New Hampshire. northern part of Mass, Lexington or round there. Then followed a lot of the same stuff about other members. The coin trick she said was not in her line. Finally

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I asked about the heat of the sun. She said it was caused by friction & electricity. She wound up by saying the miracles of Christ ~~were~~ were true but were merely natural phenomena, but in the case of Joshua it was a misprint & should be sun not sun. She didn't say how they should spell moon.

It was a clear fraud from begining to end and yet this medium is considered perhaps the first in Boston. Her hours are all taken up a week in advance, & her prices are $2. instead of $1, which the others charge. Most remarkable stories are told of her. To first I, she named all ~~the~~ those who had gone in the family, mentioned me particularly, spoke of my tastes, described the different members of the family accurately, besides doing numerous other wonderful things. To Mr. George Clark she spoke of the telescopes in his yard, & that the center of gravity of the moon was on the other side, together with the water & air. Her method is merely to get as much out of you as she can by questions, & then tell quantities of facts mostly of a generalized character and then trusting to your forgetting the mistakes & remembering the rest, a thing which I found I was very likely to do even though guard [ing against it.

Completed Feb. 19 at 4 o'clock.

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A Theory of Gravitation.

Feb. 23, 1880. Imagine a large hot body A placed near a small cold one B, fig. 1. The molecules of A are vibrating rapidly and cause the ether particles in their vicinity to do the same. These strike the mols. of B as shown in Fig 2. The lines through them merely show the direction of their vibrations. The molecules are represented as rings. The mols vib. more rapidly & in their turn cause the e. part. to vib. both within & without. When the e are struck & caused to vib. they react trying to stop the mols, but as long as the supply is kept up from A they cannot. The e within B vibs with the same force (in ~~shorter~~ paths (?)) as that outside so that (A out of the way) no pressure is felt on B. The pressures about B are represented in Fig. 3. If one of the outside arrows were removed B would go in that direction.

Fig. 1.

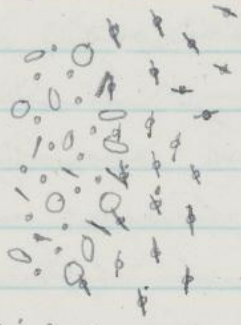

Fig. 2.

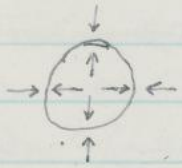

Fig. 3.

Except in the presence of matter e is uniformly distributed throughout space and is at 0 pressure. The part. do not travel about, but each has its mean place & moves backwards & forwards through it continually. Nothing can possibly raise the pressure except electricity or matter (the former being probably caused by the approach of the latter) & the particles move away from their places only on its (i.e. elect.) account or on the approach of matter. In these respects it differs from gas. It might resemble gas at 0 pressure. When an e vibs. it tends to set all the ~~el~~ in its neighborhood in parallel vibs. (polarized light).

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A mol. does not. The pressure of gas on a body is shown in Fig. 4. It is therefore compressed. The pressure of a short column of mols. Fig. 5 is equal to that of a long one because the mols moving in all directions soon neutralize each others effect so that only those very near exert any pressure on the body. If one column were made exceedingly short in rarefied gas probably a pressure would be exerted. In either the case is different, the e. part. vibrate parallel to those in their immediate vicinity, and transmit their force through them even from an infinite distance; so that a long column always exerts a greater pressure than a short one. Although the column is infin. long the pressure is perfectly finite, varying inversely as the sq. of the dist. [The pressure of this infinite column would be tremendous & may be calculated I think from the case of the earth] The force of the longer column depends on its greater mass.

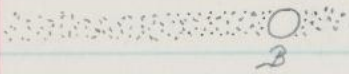

Fig. 4.

Fig. 5.

Fig. 6.

Suppose now that the longer column is cut by the insertion of another body C. The force will be transmitted through C just the same. For suppose the e. bet. C & B move ~~towards B striking it as blows~~ so as to strike a blow towards the right then C will move towards B with all the mols. beyond it. But the e within C does not press on B because its included mols are moving in all

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directions together with the included e & the latter is devoting all its energy to holding them apart & has none left with which to hammer B. Consequently there is less pressure on the side of C & B is forced in that direction by the portion of the infin. column reaching to the right which corresponds in atomic bulk & position with C.

The above theory must I think necessarily follow if the following hypothesis be admitted.

All matter is composed of finite molecules.

Besides matter there exists an all pervading ether composed of still finer finite particles.

The transverse vibrations of this ether produce heat.

The continuation of this theory is found ~~in an inseparable form~~ on Pages 53 – 56 ~~and is then continued on Page 56~~

Thea. Mar. 2, 1880. I find (1) that bodies of high & equal temperature can in no case attract unless almost in contact. (2) The larger the bodies the more readily they attract.

The case of Biela's Comet which split in two, the two parts gradually moving further & further from ~~each~~ one another is nicely explained by my theory. It would be interesting to calculate & see what results gravitation alone would lead to in this particular case. See B. 149.

Mar. 12, '80. What mass must the e particles have, given its veloc. to produce gravitation. Nature Vol 21 page 369.7 + 369.9+

The ether particles being fixed explains their transverse vibrations.

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Calculate size of molecules from force of cohesion. For small distances gravitation does not vary inversely as the square of the dist. on account of the size of the mols. Mar. 20, '80.

Obtain formulae of attraction for large masses at high & equal temperatures, & find limiting dist. of attraction. Mar. 20, '80. The molecules may get so near together that the e. particles cannot get in between them or cannot vibrate & in that case there is the whole force of the ether ocean to hold them together. This is the case with cohesion. It is similar to the case of leaden plates held together by the pressure of the air.

Nov. 1, '83. The two stars in 61 Cygni do not attract one another. Newcomb 476.9 also see Castor 477.5

Nov. 1, '83. Given average size of double stars. Knowing mag. we can find dist. On double stars this gives dist. bet. them & ∴ mass of the two. Now prove that spec. grav. is exceedingly small when stars are distant, & it indicates that hot bodies are repelled. Work out mass of Sirius (see Pop Sci XII p.47) as explained in Newcomb & Holden.

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Dimensions of the Universe. Jan. 25, '80. ~~approx.~~

Quantity	Dimensions in meters
Diameter H. Molecule	·00000 00005-8
Mean Path H. Mol.	·00000 00965-
Gold Leaf	·00000 0139*
Min. Wave length of Spect.	·00000 0309
D Wave length " "	·00000 059
Max Wave length " "	·00000 14
Iron Leaf	·00005 2*
Nobert 19th band	·00000 022
Min. Wave length of Sound	·0066
Mid. C " " " "	1·3
Max. " " " "	20·6
Velocity of Sound in Air	330·
Velocity of H Molecule	1860·
Diameter of Earth	13 000 000·
Velocity of light	300 000 000·
Distance of Moon	382 000 000·
Diameter of Sun	1 380 000 000·
Distance of Sun	148 000 000 000·
" " Neptune	4 430 000 000 000·
" " α Centauri	30000 000 000 000 000·
" " 0th Mag. Star.	200 000 000 000 000 000·
" " 15th Mag. "	200 000 000 000 000 000·

A vibration refers ~~in all cases~~ to a whole wave length in the case of sound and light. In the case of the molecule it refers to the number of collisions per second.

Obtain the probable error of the Diam. H Molecule.

Mean Path of H Molecule is at 0°C 760 mm.

Min. Wave length of Spectrum is according to Egselbach

* Dictionary Science 432

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The Unit employed is the Meter.

Dimensions	Vibrations per second	Meas	Remarks
5.8×10^{-11}		$1 \times 10^{-19} = .00000\ 000000\ 000000\ 01$ gm	
965×10^{-10}	$1775.0\ 000\ 000. = 1775 \times 10^{7}$		
309×10^{-9}	$1\ 000\ 000\ 000\ 000\ 000. = 1 \times 10^{15}$		
5.9×10^{-8}	$500\ 000\ 000\ 000\ 000. = 5 \times 10^{14}$		
14×10^{-7}	$210\ 000\ 000\ 000\ 000. = 21 \times 10^{13}$		
22×10^{-8}			
66×10^{-4}	$5.0000. = 5 \times 10^{4}$		
13×10^{-1}	$25.6. = 25.6 \times 10^{0}$		
206×10^{-1}	$16. = 16 \times 10^{0}$		
33×10^{1}			
186×10^{1}			
13×10^{6}	Time required by light	$6\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 6 \times 10^{24}$ gms	
3×10^{8}	1 sec		
382×10^{6}	1 sec	$1\ 960\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 1.96 \times 10^{30}$ gms	
138×10^{7}	4 sec		
148×10^{9}	493 sec = 8 min 13 sec		Parallax 8.8"
443×10^{10}	4 hours		
3×10^{16}	3 years		" 1."
2×10^{17}	20 "		" .15"
2×10^{20}	20000 "		

Max Wave length is according to Capt. Abney.

Roberts 19th band is the finest collection of lines yet counted by the microscope. He has ruled some ~~stay~~ half the distance apart of these. This line should be the ~~third~~ fourth instead of the ~~sixth~~ eighth.

Min. Wave length of sound was determined by Dr. C. J. Blake in a lady with a perforated

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tympanum. It is generally given at 40 000 for extraordinary but perfect ears.

Mid. c wave length ~~this~~ is here taken at the physicist pitch. The French pitch is 261 double vibrations.

Velocity of Sound in air is at 0° C.

Velocity of Light ~~given~~ is for a vacuum and is probably correct to six places of figures.

Distance of 0th Mag. Star is one of about the brightness of Arcturus or Capella; ~~But~~ of course does not necessarily give the distance of these particular stars. The parallax which is only approximate at the best, was obtained from an examination of the parallaxes of a number of bright stars and a mean value taken. These ~~parallax is merely~~ numbers are only introduced to give a rough idea of the distance.

Dist. of 15th Mag. Star is probably about the greatest distance ever penetrated by telescopes. In particular cases the distance is, of course greater than the mean but the coefficient is so uncertain that this is not allowed for.

The scale of magnitudes adopted is that proposed by Pogson and seems to be in many respects the best. In order that one star may exceed another by a ~~one~~ magnitude, the logarithm of its brilliancy ~~must~~ exceed must exceed that of the other by .4. Hence a star of the 0th magnitude as compared with one of the 5th is 100 times as brilliant and 1/10 ~~than~~ the distance.

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mag	log bril	bril
0	2.0	100
1	1.6	40
2	1.2	16
3	.8	6.3
4	.4	2.5
5	.0	1.

The enclosed table illustrates the Rule of magnitudes taking a star of the 5th as a standard.

The mean between the diameters of the H molecule and the Sun is .084. The diameter of the human brain is .10 to .12 it therefore comes very near to the mean position, which is rather singular when we recollect we are dealing with quantities separated from one another by 10^{18}. The diameter of the H molecule is so uncertain however that the difference may be much greater or much less. To determine the mass of the H Molecule we have Mean Path 965×10^{-10} meters $= 965 \times 10^{-9}$ decimeters $= 9.65 \times 10^{-7}$ deci. Taking recip we have $.104 \times 10^{7} = 1.04 \times 10^{6}$ mols in 1 deci. Cubing give 1.12×10^{18} mols in 1 litre. Wt 1 litre H = .089 gms = 89×10^{-3} gms $\frac{89 \times 10^{-3}}{1.12 \times 10^{18}} = 80 \times 10^{-21} = 8 \times 10^{-20}$ = Wt. H. Molecule.

I find however that the weight is given somewhere at 46×10^{-25} gms although the other figs. agree with mine. Unfortunately I did not copy the reference.

The mean path in H is 166 times the diam. In CO_2 it is 41 times. On the next page are given the molecular magnitudes at 0°C + 760 mm ranked according to our present knowledge.

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Objections to the Metric System.

March, 14, 1880.

There are two great objections to the Metric System; first the names, & second the numbers. And the only thing left of it then is the unit employed; and this is incorrect. In making a choice of units, some invariable quantity should be taken, which could be measured with as great accuracy as it was possible to employ in constructing the measure. This however was not done. If the wave length of line D were chosen as a unit would it [illegible] required acc[illegible] selected and [illegible] must acc[illegible] numbers [illegible] was fo[illegible] rejection gen[illegible] nothing fo[illegible] diately to [illegible]

Long Measure		Square Measure	
100 hairs make	1 nail	100 sq. meters make	1 ~~sq~~ are
100 nails "	1 meter (or yard)	100 ares "	1 hectare
1000 meters "	1 kile	100 hectares "	1 sq. kile

Cubic Measure		Weight	
10 gills make	1 quart	100 grains make	1 bit (?)
10 quarts "	1 peck	100 bits "	1 kilo
10 pecks "	1 barrel	1000 kilos "	1 ton.
10 barrels "	1 stere		

In cubic measure the word "new" would have to be prefixed for a few years to the denominations.

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There are two great objections to the Metric System; first the names, + second the numbers. And the only thing left of it then is the unit employed; and this is incorrect. In making a choice of units, some invariable quantity should be taken, which could be measured with as great accuracy as it was possible to employ in constructing the measure. This however was not done. If the wave length of line D were chosen as a unit would it be possible to measure it with the required accuracy? However since the meter has been selected and adopted, it is too late to change, and we must accept it as a unit. The names and numbers however we need not adopt. This was pointed out + excellent reasons for their rejection given by Mr. Samuel Barnett in Pop. Sci. Monthly for May 1878. I will therefore proceed immediately to the nomenclature I would suggest.

Long Measure			Square Measure		
100 hairs make	1	nail	100 sq. meters make	1	are
100 nails "	1	meter (or yard)	100 ares "	1	hectare
1000 meters "	1	file	100 hectares "	1	sq. kile

Cubic Measure			Weight		
10 gills make	1	quart	100 grains make	1	bit (?)
10 quarts "	1	peck	100 bits "	1	kilo
10 pecks "	1	barrel	1000 kilos "	1	ton.
10 barrels "	1	stere			

In cubic measure the word "new" would have to be prefixed for a few years to the denominations.

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Total Solar Eclipse. July 29, 1878.

Selenite-Polariscope. Corona polarized radially rather faintly. Zenart Polariscope similar.

O O

Sky unpolarized at zenith apparently but elsewhere polarized as usual radially from the sun.

Polarimeter (Savart). (1) 10° right of sun -7 (2) 10° below sun -1 faintest, - line did not wholly disappear Polarimeter held with index to the right - to right of upper O + to left of it -

Corona towards end as I remember it

I was struck with the ghostly appearance of the light. Night Hawks came out just before totality + went in soon after. Was struck with the small size of the Corona. At end of totality observed wavy bands lying in the direction of the course of the moon, about 3 ft broad, + vibrating about one single vibration per. sec. They were about 6 ft apart and were very conspicuous lasting nearly a minute. These estimates were made after the bands had disappeared + I therefore do not put so much faith in them.

I wrote an article containing all my observations which was published in the ~~Proceedings~~ Monthly Notices of the R. A. Society for Dec. 1878. I was never able to obtain a copy however.

The following list I made out before the eclipse of things I wished to observe.

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Study to tell at a glance the plane of polarization.

Look for polarization of sky before, during, & after totality. Look at moon.

Look for intermercurial planet. Notice cold.

Watch for shadow of moon.

Notice size, striation, and how many rays in corona.

The following is a list of things I wish I had observed.

The shape & extent of the Corona through my field glass.

The Protuberances.

The Plane of polarization of the sky immediately around the Corona & also of the Moon.

The stars visible.

The limit of polarization of the Corona.

The shadow of the Moon & the vibrating shadows following it with more care.

Another Time observe also the Height of the Corona see P 148.

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Molecular Motions.

Apr. 15, (?) 1877.

Made some measurements of the molecular motions so called of fine particles suspended in water. The substance selected was gamboage. A high magnifying power (1/5" obj. and 1/10" (?) obj) was employed & the following measurements made.

Spec. Grav 1.05 Diam .0025 to .0012 mm ~~in diam.~~

Length expansion .0006 to .0008 mm. Wt .00 000 00025 mgms.

Energy .00000 000 000 000 16 mgm mm Vib per sec. 5.

Mar. 16, 80. To compare these quantities more readily with molecular measurements let us suppose them ~~alt~~ linear ones multiplied by 10^7 and the cubical by 10^{21} we shall then have:—

Diam H mol. .58 cms	Mean Path H mol. 96.5 cms
" Particle 2500 to 1200 cms	Path Particle 800 to 600 cms
Wt H mol 80 gms	Veloc. H. mol per sec 18600 000000 *
" Particle 2500 000 000 gms	" Particle " " 30 to 40 m.

$$E = MV^2 = M_1V_1^2 \therefore \frac{M}{M_1} = \frac{V_1^2}{V^2} \qquad \cancel{(186\times10^8)^2 \times 80} \qquad \cancel{M = \frac{M_1V_1^2}{V^2}}$$

$$\cancel{M = \frac{80\times(186\times10^8)^2}{}} \qquad M = \frac{M_1V_1^2}{V^2} = \frac{25\times10^8\times1600}{(186\times10^8)^2} = \frac{100\times10^{10}\times16}{4\times346\times10^{18}}$$

$$\frac{4}{346\times10^6} = \frac{1}{86\times10^6} = \frac{1}{8.6\times10^7} = .116\times10^{-7} = 116.\times10^{-10} = .00000000116 \text{ gms}$$

$$\frac{80}{116.\times10^{-10}} = \frac{8\times10^{11}}{116} = 7000\ 000000$$

If the above calculations are correct a particle weighing $\frac{1}{7000\ 000000}$ th part of a molecule would be able under the circumstances to produce the observed molecular motions. But then its in water & not H. gas.

It would be interesting to make observations in

* ~~Multiplied by 10^8~~ * This equals 11 600000 miles.

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alcohol and glycerine as to the motion of the particles. By permitting the steam from boiling water to pass in front of the objective of a microscope the little bubbles of which it is composed may be clearly seen. These might be studied to advantage.

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Density of the Corona or a Comet's Tail.

Apr. 3, '79.

Measure the light of the corona & then supposing all of it to be reflected obtain the maximum & probable mass. Allow it an albedo equal to mercury & then equal to that of meteorites. Do the same for a comet's tail & the Zodiacal Light.

For a photometer one might use a star out of focus as Edmond does for Neb. or a gas flame shining through a minute hole, then through blue glass, and striking on a piece of white paper held so as partly to cover the Corona or Tail.

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Variable Stars & Clusters

Aug. 24, '79.

The star is surrounded by vapor through which its light is faintly seen. This envellope contracts, heat devellopes & it is changed to gas, and the star shines forth with its added brilliancy. When it cools the vapor reforms. Variables occupy a place intermediate between the Sun & Jupiter and hence are always faint. See Newcomb p 457.2 + 457.7.

Star clusters are formed from nebulae & the stars have not yet separated. Pleiades have separated a good deal & the stars in the Dipper still more, Sirius the Sun & the brighter stars have separated almost entirely. The Sun is moving towards a point lying between Vega, Arcturus, & Antares, & moderately near α Cygnus. We find that Vega Arcturus & α Cygnus are approaching us. Comets may separate the same way. Nebulae occur where clusters are fewest. See # 131.

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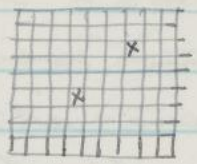
Parallax of the Sun & Stars.

Jan. 26, 1880.



The object is to avoid the jumping of the stars due to any irregularities in the motion of the telescope. A piece of glass is ruled in fine squares and inserted at the focus of the telescope. This is viewed by two eye-pieces by two observers at the same instant. Each observer noting only his own star. A bell is struck every 10 seconds & at the stroke of the bell each notes his star. It is necessary that they should have the same personal equation. A bright star may be rendered faint by increasing the illumination of the field of its eyepiece.

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Temperature of Jupiter, Saturn, etc.

Apr. 15, '80.

Supposing Jupiter to be at a high temperature, if its spectrum were compared with that of Venus it would be found to differ from it probably only in the rays of low refrangibility while it would coincide for the violet & ultra violet. A terrestrial body could then be placed in the sunlight & heated till its spectrum coincided with that of Jupiter & its temperature determined. It would be interesting to see if the material of which the body was compared had any effect on the spectrum. The spectra could probably best be compared by the aid of photography. Perhaps photography might be successfully employed in other photometric researches.

See C. 167.

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Theory of Life.

May 25, '80.

Written up Nov. 11, 1880

The Molecules as we know have a tendency to arrange themselves in certain regular groups called crystals. In a solution of chromic acid for example the crystals will visably grow larger, when material ready prepared is furnished to them.

Carbonate of Calcium sometimes crystalizes in spherical forms. Hypothesis. This salt crystalized in the Ocean in former times when the chemical constitution of the latter was unknown as also its temperature + pressure. As the crystals came down they took in other substances with them as hydrogen which might have been dissolved in the water. These crystals gradually came to have a definite composition (the one which was found most enduring) and took up the hydrogen calcium etc. in the proper proportions. Particles were all the time wearing off and fresh ones had to be supplied. But beyond a certain size they would sink + could not be carried around so easily by the water. When they did get too large they would therefore separate into two. In the mean time they were constantly eliminating the ~~to~~ calcium and heavier materials and absorbing more water until they reached the state of the amoeba ~~&~~ monads + other low forms. Thus Life dawned upon the world. It is not

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necessary that the Ocean should have a definite composition. Perhaps fungi would originate in hyposulphite of soda solutions or plain ~~salt~~ NaCl solutions preferred they were impure & contained carbon & hydrogen. Since there are fungi adapted to these solutions it seems as if they might readily originate in them and it might be a promising chance for experiment.

Once the separate cells thoroughly formed they would begin to collect in masses like the sponges each cell doing all the work for itself. Gradually a division of labor would be found desireable the outside cells collecting & the inner ones digesting the food. A system of intercommunication would thus become necessary, which would involve a third set of cells. Although now constituting a single animal (so called) each cell would have nevertheless a separate and distinct existance the same as before, — some dying and new ones being created. Up to the present time the creature has no nervous system and no consciousness. As different foreign substances come in contact with the outer cells they become more sensitive to touch & finally nerves appear.[x] Some of the epithelial cells thicken & fill with water forming rudimentary eyes. These are found to be an advantage & are continued &

[x] See Nature Vol XX

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improved. A nervous center is formed near them owing to this greater activity thus forming the rudimentary brain. Various exterior appendages appear, the Sense of Hearing devellopes, & the three Touch Senses are improved. Comparisons are now made between the sensations produced by various foreign objects and fear and finally Consciousness appear. The animal rises from the water ~~and~~ devellopes to Man.

A Man may then be compared to a vast city containing numerous living organisms besides much "non-living" matter. Some of the citizens are constantly dying & others being produced (generally by budding) until at last as they degenerate some epidemic seizes the citizens in a vital part and they die too fast and then Death ensues.

In generation two suitable living citizens (which are no more living than any two others) come in contact, and when suitable material is placed at hand, other cells rapidly crystalize round them, and the whole creation of the animal which formerly took centuries, is now under favoring circumstances ~~produced~~ accomplished in a few months.

A man is thus constantly dying, and the whole population is said to change once in about seven years.

To the Brain Cells belongs Consciousness not individually but collectively, each one contribu-

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ting it quite, and when one dies a somewhat similar one takes his place. But during these citizens lives they are not always producing consciousness, for one third of the time they are absolutely inactive, and the same thing occurs when a man faints. At these times all consciousness absolutely ceases. What we want in a Future State is not a future Life (or if we do we can't have it) but a Future Consciousness. Life and Death belong to Matter only. The question then is can Consciousness (which may cease for the time, even when the Brain Cells are all right), possibly exist in any form when ~~their~~ Brain Cells have been utterly destroyed? Are they for instance by their action on Earth now, laying up a Charge of Consciousness as it were, in Heaven, which is to endure for all time? I think it will be clear that Life without Consciousness in a Future State, would be useless to us; it is not the Life, but only the Consciousness that we want.

The human Family may be compared to the branch of a tree ~~upon~~ which the leaves are constantly dropping, but of which some ~~of the citizens~~ always live through; some of the citizens ~~lives~~ at different times forming part of two separate individuals. It is the human family, the human germ, that lives, the specialized individuals dropping off

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one after another. And the human family is after all but the small topmost branch of the great tree of organic life. Life is therefore eternal after all — that is within limits.

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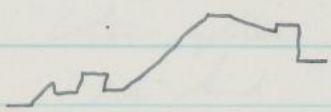
Theory of Happiness.

Jan. 29, '82.

Happiness is of at least three kinds. (1) That caused by sensual enjoyment, as eating a good dinner to a hungry man, or a walk in clear bracing air, on a sunny morning, also the effects produced by any stimulant. There is this difference between them however, that the former has no reaction while the latter has. The contrary effect produced by ~~at~~ feeling unwell (i.e. physical suffering), or general despondancy without any special cause, ~~also~~ comes under this heading. This heading includes in general all physical pleasures and pains.

(2) Mental pleasures. For these there must necessarily be a change of condition. For instance a poor man while becoming a rich man feels he is rising to a higher plane ~~of~~ and feels happy but when he ~~becom~~ gets there and becomes rich his happiness ceases.



Happiness of the second kind may be represented by a curve. Here a sharp rise would give ~~greater~~ pleasure of greater intensity but of shorter duration than ~~of~~ a long one. Engagements, marriages, and deaths come under this heading. This kind of happiness can be brought forward in time by anticipation. In building "Castles in the Air" it is brought forward very far, so much so that the reality may never happen. In ~~this~~ case as you forget it slowly there is generally no corresponding disappointment and you get so much extra happiness

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free gratis. If the reality does happen, you probably do not enjoy quite so much, by the amount received from the anticipation. This kind of happiness may have a reaction or not, as the case may be.

(3) Moral pleasures. These include the pleasure brought on by seeing others enjoy themselves, and also the peculiar species of mental exhaltation produced by religion in superstitious minds. These pleasures do not generally have a reaction but they may produce unhappiness as is plainly shown when combined with a weak mind as in Cowper's case. Repentance for crime is a prominent illustration of the reverse under this kind of happiness, whereas dread of the punishment comes under the second kind.

Engagement and Marriage the ~~highest~~ causes of the greatest happiness men can have in life, each include all three kinds.

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To obtain the greatest amt. of Happiness.

It is evident that one should be engaged and married (well), but at what age depends on circumstances. Happiness of the 1st kind does not require change, therefore one should surround oneself with objects ~~of~~ which please the eye paintings, sculpture, interior decorations, etc. Cheerful sounds such as the singing of birds, and music should be frequent. ~~Sea~~ Rippling shimmers give some people very little pleasure (at least so I feel), and they may interfere with ones health, which is ~~the~~ by far the most important source of happiness of this kind, therefore they are to be avoided. Health being overwhelmingly more important than all the rest put together, should be preserved at all hazards, and a sunny climate with cool invigorating atmosphere is desireable. An early morning walk, having an object, ~~after breakfast~~ should be taken after breakfast.

2d kind. One should acquire enough money to give one every thing they can desire. [~~One~~ I should like to leave so much, that when invested in government bonds, requiring no attention, my income would ~~well~~ just fairly cover my expenses. This would throw the pleasures and nearly counterbalancing troubles of money getting entirely out of my sphere.] One should have some employment which should not be monotonous and in which one should be constantly doing something new so as to keep on a rising curve.

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Health of ourselves and friends is evidently an important condition of this 2d kind also. The pleasures of imagination produced by planning and by reading should be cultivated.
3d kind Self sacrifice and a general following of the Golden Rule cover this case. Exhaltation of a far grander & less selfish (although with most people less intense) kind, than the religious enthusiasm, is produced by the thought of the advance of the race, and the contemplation of the vast, sublime, and beautiful in the universe. I do not think the two can exist together in full perfection, and I think the latter is the preferable one.

There is one subject which requires some thought. Some people like to go to the theater and see tragic plays, in order to cry; they like to listen to sad music, and to think of dead friends. They also like to think of their misfortunes, and of disagreeable things said to them, to imagine the latter repeated, & to think what replys they would make to them, and to get indignant thereby making themselves very unhappy. This latter is certainly foolishness. Shakespeares tragedies are so unlike the occurences of modern days, that I think they do not make one unhappy as a general thing. Modern tragic plays like the "Exiles" "Two Orphans" etc. are different, and the question is should they be

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patronized, and do we get our money's worth of pleasure from seeing them? In music why do we like to hear "Home Sweet Home" & "Last Rose of Summer"? After a death is it best to try to forget our misfortunes as quickly as possible & by devoting our attentions to other topics?

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On Morality.

Jan. 29, '82.

Morality should not only be separated ~~Instinct~~ from theology, but I think it belongs to a wholly different sphere; and if there is a God, and a Future & Consciousness, morality has no connection with them. ~~Sin~~ Murder, for instance, is a perfectly natural attribute of the organic world, and occurs from the lowest to the highest forms, both of killing ones own kind, & killing other kinds of animals. In fact it is an absolute necessity, (wise dispensation of Providence). For a private individual to kill another man, under certain conditions ~~however~~, is accounted a Sin. For him to kill him under certain other conditions, is not a Sin. These conditions are defined by human law, for the good of humanity, & they are defined nowhere else. Hence when murder is a Sin it is a Sin against humanity. A man may think that "what is sin, is defined in his own heart"; (a fine-sounding theological expression). But after all, that merely means that he decides in his own mind, whether it is proper to kill the man or not; i.e. makes a law for his own conduct. That law will probably be no better than those made by other men, and will be a law for ~~humanity~~ the good of humanity, if the man means to do right, and does not kill from a sinful motive. [cont. on p. 167.

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Posterity
Jan. 29, '82.

If a God put us here, he intended that we should be happy, & that the principle of the Survival of the Fittest should work well carried out by the frequent murders, and warfare of former times, when all the weaker men were killed off. Nowadays the same object is accomplished by disease and suicide. As disease diminishes, suicides increase. These causes together with the smaller percentage of children born, as men become more civilized, will prevent a too rapid increase of humanity. As the Sun fades out in future ages men will deteriorate as they naturally would, from constant intermarriages so that our descendants after reaching a maximum of development, probably much higher than we have reached, will gradually retrograde back to the savage state, and perhaps down to their extinction.

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Morality cont. from p. 165.

The complicated business morality of the present day is clearly entirely a human affair, and so is our application of the Golden Rule. If there is a God ~~the~~ it is very certain we can do nothing immediately for him or in opposition to him. The idea that he would care, if we should swear at him is simply absurd. If now we take the morality from religion, and reduce its theology to a blank, it seems as if there would be very little left of it.

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Lines in Stellar Spectra.

Dec. 13, '05.

1	α	C	6562	5460	1102	
2	β	F	4861	4515	346	
3	γ		4340	4200	140	
4	δ	h	4101	4042	59	
5	ε	H	3968	3948	20	
6	ζ		3887	3885	2	
7	η		3840	3840	0	
8	θ		3799	3806	-7	
9	ι		3773	3780	-7	
				3754		0
10	κ		3754	3757	-5	
				3739		-3
11	λ		3736	3742	-6	
				3726		-4
12	μ		3722	3728	-6	
				3714		-2
13	ν		3712	3715	-3	
				3705	0	0
14	ξ		3705	3705	0	

	Recip.	1-recip.	(6562 - ction. wl.)*	(ction. wl.)	Diff
1	1.000		~~6562~~ 000	6562	0
			1701		
2	500	500	~~4861~~	4861	0
3	333	667	2268	4294	46
4	250	750	2551	4011	90
5	200	800	2722	3840	128
6	167	833	2835	3727	160
7	143	857	2915	3647	193
8	125	875	2977	3585	214
9	111	889	3024	3538	235
10	100	900	3062	3500	254
11	90	910	3096	3466	270
12	83	917	3120	3442	280
13	77	923	3140	3422	290
14	71	929	3160	3402	303

$$a = \frac{p_1\lambda_1 - p_2\lambda_2}{p_1 - p_2}$$

$a = 3570$

$c = (\lambda - a)\,p$

$c = (3799 - 3570) \times 8$ (for θ) $= 269 \times 8 = 2152$

$\lambda - a = \frac{c}{p} \therefore \lambda = \frac{c}{p} + a$

$c = (3705 - 3570) \times 14 = 135 \times 14 = 1890$

$\lambda - a = \frac{c}{p} \therefore \lambda = \frac{c}{p} + a$

$$\begin{array}{r} 135 \\ 14 \\ \hline 540 \\ 135 \\ \hline 1890 \end{array}$$

$p_1 = 14 \quad \lambda_1 = 3705$

$p_2 = 10 \quad \lambda_2 = 3754$

$$a = \frac{14 \times 3705 - 10 \times 3754}{4}$$

$= 3582$

$c = (\lambda - a)\,p = (3705 - 3582) \times 14 = 123 \times 14 = 1722$

no: $\lambda = \frac{c}{p} + a$

* Obtained from curve.

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Final Approximation.

$y = mx + c \qquad y = \frac{5}{1701}x - .93 = \frac{x}{3402} - .93$

$3402(y + .93) = x = 3402\left(\frac{1}{n} + .93\right) = \text{w. l.} = 3164 + \frac{3402}{n}$

x	y		$\lg x$	$\lg y$	y	$\lg y$
1			0.000		6562	3.81704
2	0		0.301	$-\infty$	4861	3.68673
3	46	46 2	.477	1.663	4340	3.63749
4	90	44 6	.602	1.954	4101	3.61289
5	128	38 6	.699	2.107	3968	3.59857
6	160	32 3	.778	2.204	3887	3.58962
7	189	29 4	.845	2.286	3840	3.58433
8	214	25 4	.903	2.330	3799	3.57967
9	235	21 2	.954	2.371	3773	3.57669
10	254	19 3	1.000	2.405	3754	3.57449
11	270	16 6	1.041	2.431	3736	3.57241
12	280	10 0	1.079	2.447	3722	3.57078
13	290	10 3	1.114	2.462	3712	3.56961
14	303	13	1.146	2.481	3705	3.56879

x	y	$\lg x$	$\lg y$
0	3817	$-\infty$	0.5827
.30	3.667	9.477	.5666
.48	3.637	9.681	.5607
.70	3.599	9.845	.5562
.90	3.580	9.954	.5539
1.15	3.569	0.061	.5525

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$y = mx + c \qquad y = \frac{.929}{2857}x - 1.13 = \frac{.103}{317}x - 1.13$

$c = y - mx$

$c = 0 - \frac{.929}{2857}\,3490.$

3490
.929
31410
698
3141
2857) 41533.10

3141.0
698
3141
2857) 3242.210 (1.13 = c
2857
3852
2857
995-1

$c = 0 - \frac{.8}{2500}\,3490.$

8
2500) 27920 (1.12
250
292
250
420

$y = \frac{.8}{2500}x - 1.12 =$

$y = \frac{3.2}{10000}x - 1.12 =$

First Approximation $y = .00032x - 1.12$

x	Recip	1-recip	(6562-then. w.l)	(then w.l)	Diff
1	1.000	.000	.000	6562	0
2	.500	.500	1.562	5000	139
3	.333	.667	2.062	4500	160
4	.250	.750	2.343	4279	118
5	.200	.800	2.500	4062	94
6	.167	.833	2.604	3958	71
7		.857	2.678	3884	44
8		.875	2.734	3828	29
9		.889	2.777	3785	12
10		.900	2.812	3750	-4
11		.910	2.843	3719	-17
12		.917	2.864	3698	-24
13		.923	2.883	3.679	-33
14		.929	2.902	3.660	-45

$\frac{y + 1.12}{.00032} = x$

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Wave l. obs.		Intensity	ECP theory	Diff	Diff 3584+	W.H.P. theory
1 a 6562	3580+5	∞	∞	∞		
2 β 4861		5 1528	= 5108	247	251	
3 γ 4340		5 764	4344	4	+8	4348
4 δ 4101	Corrected	5 509	4089	−12	−8	4093
5 3968		10 382	3962	−6	−2	3966 66
6 3887	9	3 306	3886	−1	+3 +1	3890 87
7 3840	3815	3 254	3834	−6	−2 −15	3838 39
8 3799	02	1 218	3798	−1	+3 0	3802 99
9 3773		5 191	3771	−2	+2 +2	3775
10 3754	4	1 180	3750	−4	0	3754 50
11 3736		3 153	3733	−3	+1 +1	3737 38
12 3722	3.5	2 139	3719	−3	+1 +1	3723 21
13 3712	0.5	2 127	3707	−5	−1 +5	3711 11
14 3705 —	2	1 ~5 118	3698	−7	−3 0	3702

	Theory 3584.07+	Obs Diff	Diff Mag.	Mag Diff.	Obs Mag.	Diff	Mag.
ε	3966.5	66.5	0.	10	66.5	0.	5.
ζ	3890.5	89.	−1.5	4	87.	−3.5	2.
η	3838.5	38.5	0.	5	34.	−4.5	3
θ	3802.5	02.	−.5	2	99.	−3.5	2.
ι	3775.5	76.5	+1.	.5	72	−3.5	2 faint
κ	3754.5	54.	−.5	1.	50	−4.	2.
λ	3737.5	38.	+.5	4.	36	−1.5	3.
μ	3723.5	23.5	0.	2.	22	−1.5	3.
ν	3711.5	10.	−1.5	2.	09	−2.5	3.
ξ	3702.5	02.	−.5	.5	98	−4.5	3 faint

y = 5 δ = 5 Bet 3700 + 3900 there are 16 lines = 4 or over.

$$\lambda = 3581 + \frac{1528}{n-1}$$

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No.	Series	Star Cons.		Sun	Theory	Diff (Theory − Sun)	Star w.l.*	Diff (Theory − Star)	Diff (Sun − Star)
2	Fβ	.00		4861	5109.0	+248	This assumes dispersion & w.l. in prism at 4500		
3	α	2.93	Oxy. 43 49 Higgins p	4340	4345.0	+ 5			
4	hδ	4.78	01 02	4102.0	4090.3	− 11.7			
5	Hε	5.99	68 67	3968.8 62	3963.0 62	− 5.8	3963	0	−5
6	ζ	6.80	87 87	3886.6	3886.6	+ 0.0	3889	−2	+2
7	η	7.38	24 25	3834.5	3835.7	+ 1.2	3838	−3	+4
8	θ	7.84	95 96	3799.8	3799.3	− 0.5	3796	+3	−3
9	ι	8.13	68 73	3770.4 faint	3772.0	+ 1.6	3770	+2	−2
10	κ	8.38	45 50	3749.7	3750.8	+ 1.1	3748	+3	−2
11	λ	8.54	30 28	3732.4	3734.8	+ 2.4	3733	+1	−3
12	μ	8.70	17 28	3720.0	3720.0	+ 0.0	3719	0	−3
13	ν	8.82	08	3708.4	3708.3	− 1.0	3709	−2	0
14	ξ	8.93	99	3697.6	3698.6	+ 1.0	3697	+1	−1
15	ο	9.02		3688.4	3690.1	+ 2	3690	0	+2
16	π				3682.9				

* From curve

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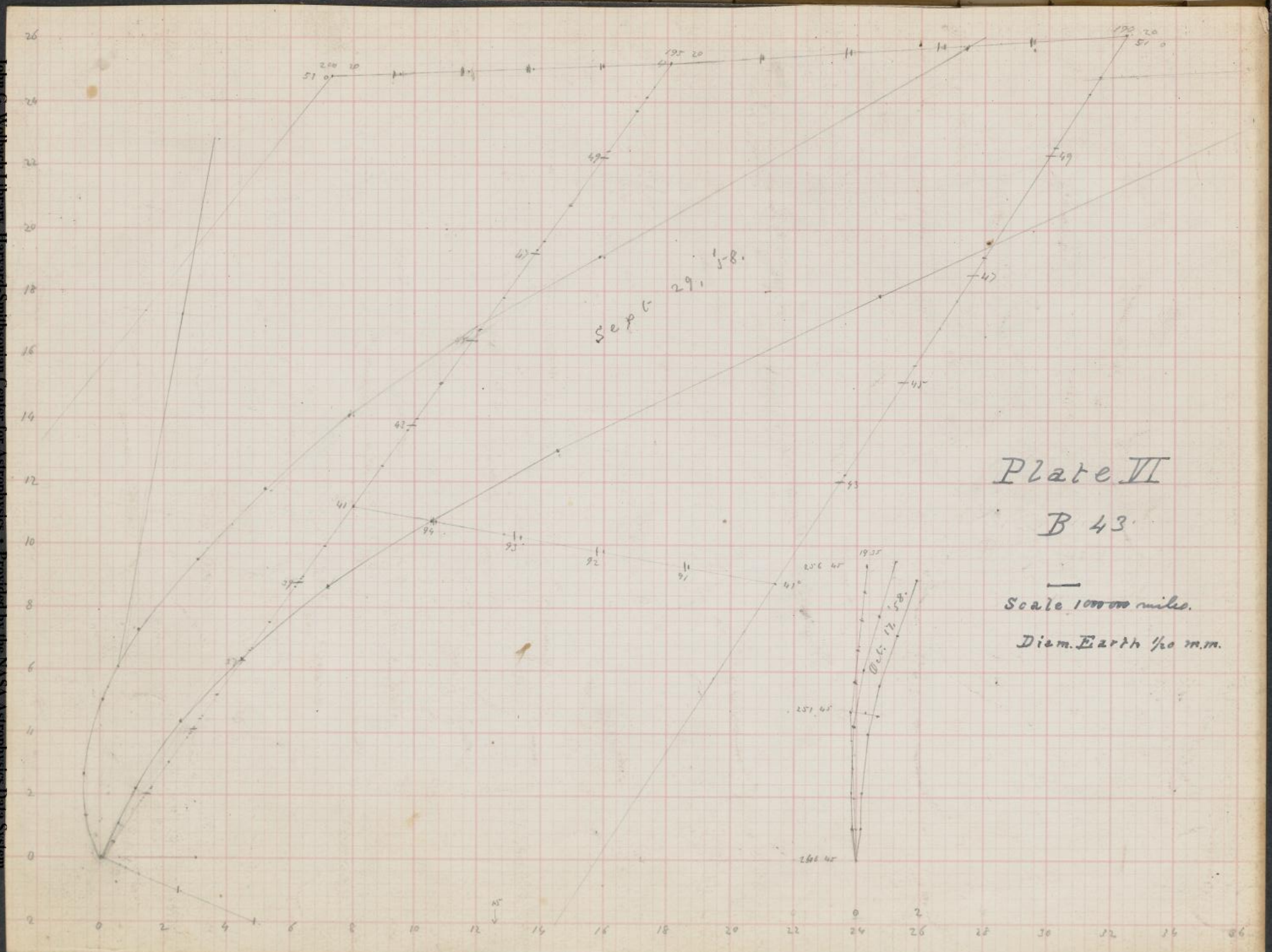

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