

Space-Time

The title of this ~~the~~ talk ^{namely} space-time, provokes the question, why ^{should the title be} space-time? why ~~not~~ space and time? ~~Is there any thing~~ ^{are} ~~so~~ space and time so ^{intimately mangled up} ~~interconnected~~, a ^{to} ~~highly~~ ~~hyphen~~ ^{hyphen}? Even the professional physicist - who may grant ^{that} ~~the~~ ^{close intermingling} ~~of~~ space and time, may ask the further question "Is not the connection between the two, however intimate a purely formal, ^{a way to say} ~~merely~~ a way of speaking ^{that} ~~which~~, reminds one of the creation of Samuel Butler, who are said to have sacrificed common sense at the altar of logic? ~~He may~~ ^{He may} go further and ask is not the physicist's description of even space as such just as formal: otherwise what meaning can one attach to the ~~usual~~ ^{usual} ~~question~~ ^{question} raised whether ^{description of} ~~the~~ Universe is curved or flat? and if curved whether its ~~to~~ curvature is positive and or negative; ~~it~~ ^{it} will ~~be~~ ^{be} ~~also~~ ^{also} ~~close~~ ^{close} connected to the question whether our Universe

one, with
received
intending
rest one
to which
we are
led
of
mathematical
or logical
reasoning

bounded or unbounded,
is finite or infinite?

~~First I shall do just as I please of
the question ^{later}. In the background in
the mind of the questioner is the ~~feeling~~ ^{feeling} that
these ~~statements~~ ^{statements} ~~are~~ ^{are} all logical correct deductions,
that ~~they~~ ^{they} ~~must~~ ^{must} be true? ~~That such a feeling is not~~
~~correct.~~
I shall take up first the attitude
of mind~~

~~The distinction~~ ^{The distinction} between ~~the~~ ^{the} ~~scepticism~~ ^{scepticism}
^{in the question} implied towards logical reasoning and the vague
feeling that it ~~is~~ ^{is} ~~not~~ ^{not} ~~contradict~~ ^{contradict} common sense is not
justified. After all logic is merely ~~organized~~ ^{organized} ~~organized~~
or canalised common sense. The physicists of the earlier
centuries were very ambitious in their
programme. They were convinced that all events ^{in Nature}
are ~~connected~~ ^{are} ~~as~~ ^{are} ~~have~~ ^{have} a causal relationship, i.e.
are connected as cause and effect. There ^{is} ~~was~~ a cause
or a reason for every phenomenon ^{that occurred} ~~observed~~ in Nature,
and what more natural than to ask why does it
happen, and why in the particular manner? ^{the physicist will say} ~~we are today~~

In the mind
we are aware
we have
of things

much use. ^{It is} ~~We are~~ contact with ^{just} ~~detached~~
observation, and description of Nature, with ^{find} ~~find~~
out the ultimate pattern of things in the Universe,
that is consistent with all the observed facts. If
the pattern of ^{Nature as defined} ~~Nature~~ ^{is} ~~is~~ ^{conform to} ~~conform to~~ ^{some of our} ~~some of our cherished predictions
~~it is not the physicist's fault. That is how Nature~~
~~behaves, it could not be helped. The physicist must~~
^{is that of} ~~is that of~~ Sherlock Holmes, when he expounds ~~the~~
~~what he~~ ^{proposed} ~~proposed~~ ^{series} ~~series~~ "When you have
~~eliminated all the~~ ^{eliminated} ~~eliminated~~ ^{all the} ~~all the~~ ^{impossibles} ~~impossibles~~
what is left over, however improbable, ~~it must be~~
must be the truth." It is unfamiliarity ~~that~~
^{prevents} ~~prevents~~ ^{makes} ~~makes~~ ^{certain} ~~certain~~ ^{things} ~~things appear improbable. It is so with
some of our concepts of space ~~time~~ and of space-
time.~~~~

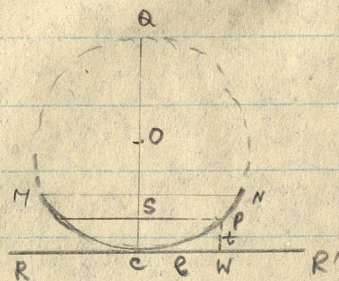
Let me take space first. you must all be
familiar with our good old Euclid. ~~His~~ ~~etc~~ have
heard of the classic book on geometry, ~~Euclid's~~ ~~Euclid's~~
elements. Starting with a few axioms, and ~~the~~
postulates, geometry he develops geometry as a
logical sequence of propositions, ~~each following from the preceding~~
~~one quite~~ They are so cogent, that when once you

167
444

4

Newton's rings.

Let MCN be a plano-convex lens placed on a glass plate.



The thickness of the film at c is zero but it gradually increases as we proceed from c on either side. The thickness of the film at P is t and let $cw = SP$ be R which is the radius of the Newton's ring.

On looking, we shall see rings, dark and light.

The condition for dark rings is

$$2\mu t \cos \theta = 2n\lambda \quad (\text{dark rings}) \quad \dots (1)$$

and the condition for bright rings is

$$2\mu t \cos \theta = (2n+1)\frac{\lambda}{2} \quad (\text{bright rings}).$$

Consider the figure,

Here $t = PW$

We can find the value of t.

We have, $SP^2 = CS \cdot SA$

I may illustrate by a few ^{to} typical examples. Whereas
 in ~~Euclid~~ the geometry of Euclid the three angles
 of a Δ ~~add up to~~ are together equal to
 $2 \text{ rt-}\angle$, ~~they in the one time they are either~~
~~greater or less than $2 \text{ rt-}\angle$ in it is not~~
 so in the other two geometries. In one of them
 the three angles are together ~~greater~~ ^{less} than $2 \text{ rt-}\angle$ and in
 the other greater. ~~The~~ If we draw 2 circles
 one with twice the radius of the other, the larger
 circle has 4 times the area of the smaller
 on Euclid's geometry. It is ~~more~~ ^{the part of the} than one - not -
 so in one the other is more ^{than} one and less
 in the other. Similarly if we take two spheres
~~one of $\frac{1}{2}$ the radius of the other~~ ^{one with $\frac{1}{2}$ the radius of the other}
 the larger sphere has a volume 8 times that
 of the smaller, on Euclid. ~~It is more~~ In the
 other two geometries it is more than 8 times in one
 and less than eight times in the other.

154

~~2/3~~
8/6

$$\text{or, } p^2 = t.(2R-t) \quad , \quad \text{where } R = \text{ca. } \text{oc} \text{ oc}$$

$$= 2Rt \quad - \quad \text{neglecting the 2nd factor.}$$

$$\text{it } = \frac{p^2}{2R}$$

Substituting this value in (i), we get.

$$2\mu \cdot \frac{p^2}{2R} \cdot \cos \theta = \frac{2n\lambda}{2}$$

$$\text{or, } p^2 = \frac{n\lambda R}{\mu \cos \theta}$$

$$\text{or } p_n^2 = \frac{n\lambda R}{\mu \cos \theta} \quad , \quad \text{where } n = 0, 1, 2, \dots \text{ etc. (ii)}$$

Thus the (ii) will give the radius of all dark rings.

The path difference in general is given by $(2\mu t \cos \theta + \frac{\lambda}{2})$

At C, t is 0

i.e. the path diff. at C = $\frac{\lambda}{2}$

Therefore the point C will be a dark pt.

~~It is the condition of reflection.~~

It is meaningless to ask

7

geometries is

Which of the three ~~results~~ true? ~~the~~
question has no meaning since ~~each result~~
is ~~based~~ ~~on~~ ~~assumptions~~ ~~relating~~ ~~to~~ ~~alternative~~ ~~particles~~
~~or~~ ~~particles~~ ~~particles~~. ~~and~~ ~~the~~ ~~three~~
3 ~~particles~~ between them exhaust the alternatives
all of which have the same status.

But it is quite another question to ask
to which of the three geometries does ~~the~~ ~~universe~~
conform ~~to~~ ~~or~~ ~~which~~ ~~of~~ ~~the~~ ~~three~~ ~~is~~ ~~the~~ ~~one~~
underlying ~~the~~ ~~physical~~ ~~universe~~ ~~or~~ ~~the~~ ~~universe~~;
expect a definite answer. The question is not
only a legitimate one, but one for which Nature
we may expect a definite answer. (obtained)

The answer may be elicited from Nature in the
following manner: As you must have ^{known} from the previous
broad ~~test~~ ^{work} by Professor C. V. Roman in this series on the
structure of the Universe, the milky way is only one
of the millions of galaxies, ~~is also~~ in the Universe
which each galaxy consists of ^{of the same} millions of stars is
made ~~up~~ ~~of~~ ~~stars~~ because of their great distances from us
look ~~like~~ ~~small~~ ~~nebulae~~ ~~and~~ ~~objects~~ ~~with~~ ~~the~~ ~~help~~ ~~of~~ ~~telescopes~~
at ~~many~~ ~~of~~ ~~the~~ ~~same~~ ~~distances~~ from us can be estimated, and their ~~number~~



130
946
=

In order to determine the refractive index of a liquid, we proceed as follows:-

We have

$$r_n^2 = \frac{n\lambda R}{\mu \cos \theta}$$

If $\mu = 1$ $\quad \theta = 0 \quad \therefore \cos \theta = 1$

then, $r_n^2 = n\lambda R$

$\therefore D_n^2 = 4n\lambda R$, where D is the diameter of the ring.

similarly the diameter for $(n+p)$ th rings can be given

as ~~D_n^2~~ $D_{n+p}^2 = 4(n+p)\lambda R$

$\therefore D_{n+p}^2 - D_n^2 = 4(n+p)\lambda R - 4n\lambda R$

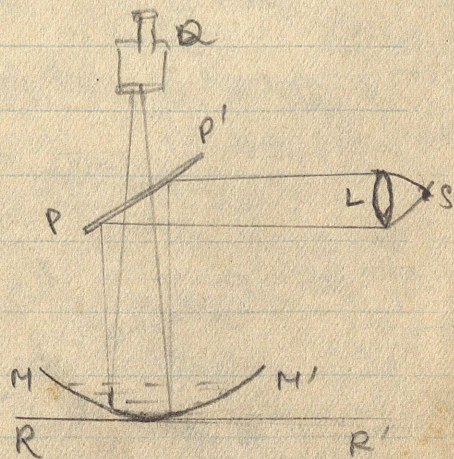
$= 4p\lambda R$. . . (iii)

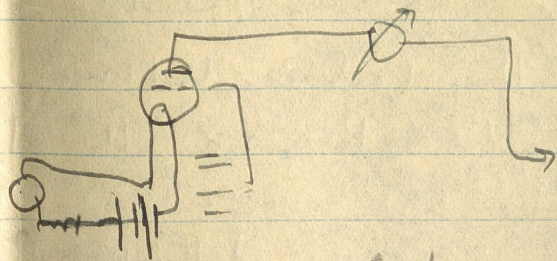
We shall utilise (iii) to find the refractive index of a liquid.

Let MM' be a convex lens placed on the plate RR' .

The radius of the curvature of the lens is R .

Let PP' be a plate





The galaxies are more or less alike, ~~as far as~~ ~~Because~~ as regards their size, luminosity, etc. ~~From their~~ ~~apparent luminosity~~ ~~in the~~ ~~direction~~ ~~of~~ ~~view~~ ~~from~~ ~~us~~ ~~they~~ ~~look~~ ~~as~~ ~~if~~ ~~they~~ ~~were~~ ~~near~~ ~~by~~ ~~because~~ of their large distances from us they ~~at~~ look ~~as~~ ~~if~~ ~~they~~ ~~were~~ ~~near~~ ~~by~~ when viewed through the telescope, like small nebulous objects, their apparent brightness giving us a measure of their distance from us. One may therefore study ~~the~~ ~~the~~ ~~distribution~~ ~~of~~ ~~these~~ ~~nebulae~~ both in depth and in direction. ~~For~~ ~~it~~ ~~is~~ ~~found~~ ~~that~~ ~~the~~ ~~distribution~~ ~~is~~ ~~all~~ ~~the~~ ~~same~~ ~~in~~ ~~all~~ ~~directions~~.

i.e. to say ~~any~~ every region of the sky, ~~provided~~ ~~it~~ ~~is~~ ~~not~~ ~~chosen~~ ~~too~~ ~~small~~, is like every other region of the same size, ~~regarding~~ the distribution of nebulae in it. ~~Any~~ ~~one~~ ~~of~~ ~~the~~ ~~regions~~ ~~can~~ ~~therefore~~ ~~be~~ ~~used~~ ~~as~~ ~~a~~ ~~sample~~ ~~region~~ ~~and~~ ~~if~~ ~~by~~ ~~selecting~~ ~~a~~ ~~few~~ ~~typical~~ ~~regions~~, will be

10
The distribution of nebulae in this space ~~is~~ ~~not~~ ~~uniform~~
uniform, i.e. to say their number in a given
large volume ~~is~~ the same, ~~as~~ ~~whatever~~ whether
we select the volume near us, or far in the

depths of space. Then we should find that
the ^{total} number of nebulae ^{which occur} within a selected distance

~~proportional~~ then ~~we should~~ ~~expect~~
the following result: ~~the~~ ~~number~~ of nebulae

within a given large distance from us, and the
number within half this distance, the latter
number should be just $\frac{1}{8}$ of the former.

~~In other words~~ the or more generally, the
total number of nebulae ~~is~~ occurring within any

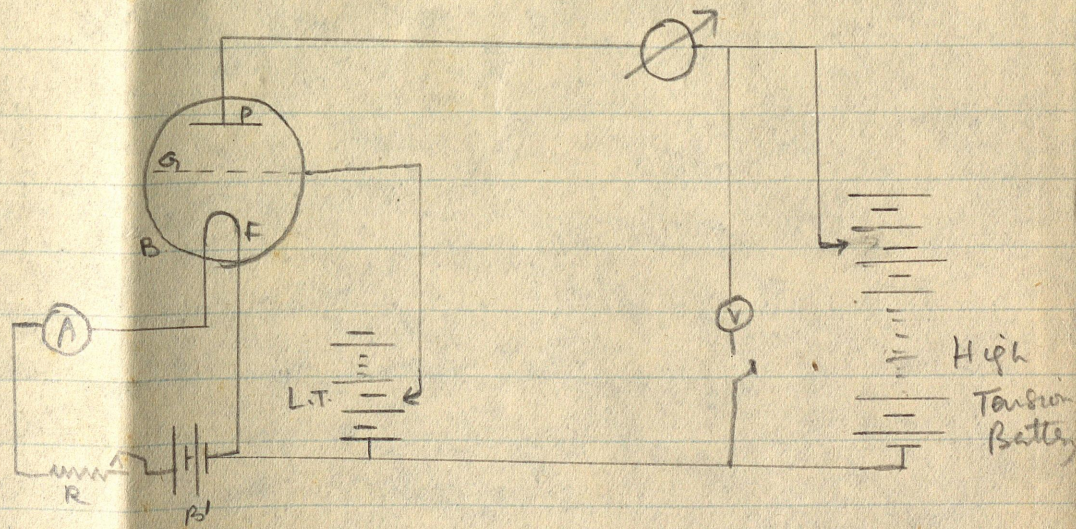
given distance from us should ~~increase~~ ~~as~~
vary as the cube of the distance, ~~just~~ ~~as~~

the volume of a sphere ~~is~~ ~~proportional~~ ~~to~~ ~~the~~ ~~cube~~ ~~of~~ ~~its~~ ~~radius~~.
Consequently ~~if~~ ~~we~~ ~~find~~ ~~such~~ ~~a~~ ~~distances~~

~~distribution~~ ~~variation~~ of the number of nebulae
if now the actual distribution of nebulae

VIII

Triode Valve



The triode bulb connections can be shown as above.

Here B is a bulb in which the filament is F. The plate ~~or~~ P is also an electrode. Between these two a grid G is ~~connected~~ placed.

The use of the ~~electro~~ triode valve is to amplify the current which is very small such as produced in photoelectric cells.

(as ~~found~~ ^{found} our survey) " ||
 does not conform to this prediction if we
 find the number of nebulae ~~enclosed~~ ^{occurring}
 within a given distance increases ^{at} ~~more~~
 rapidly or less rapidly than ~~the~~ ⁱⁿ proportion
 to the cube of the distance, then two conditions
 are open to us. ~~We may either~~ ^{we may} accept
 this. One of them is to take the geometry
 as Euclidean, and to accept the result
 that the distn of nebulae in space is not
 uniform, but varies with the distance from
 us. ~~We will then be in~~ ^{We then} from
 the centre of the Universe, in a unique
 way, a result which may be flattering
 to our vanity but certainly most embarrassing
 when we remember that our own galaxy is only
 one of the millions of galaxies that we see in
 the sky, ~~but~~ ^{and} in no way different ^{from them}. The ~~more~~ ^{more} ~~we~~ ^{we} ~~shall~~ ^{shall}
 prefer the alternative would be to ~~accept~~ ^{accept}
 the distn of nebulae as uniform, and ~~and~~ ^{and} ~~reject~~ ^{reject}

54)
$$\begin{array}{r} 18.5 \\ 1000 \\ \underline{54} \\ 460 \\ \underline{432} \\ 280 \end{array}$$

accept ^{a uniform} ~~the~~ distn of nebulae as uniform, and ~~and~~ ^{and} ~~reject~~ ^{reject}

anode potential, the grid is connected by ~~a~~ ^{the} sliding contact over low tension battery. This will give us grid potential. Now, we measure the current (anode) for different readings of grid potential. The grid potential can be varied by the help of the sliding contact as described before. Now, the grid contact is made over high tension battery and again different readings of anode current are obtained for diff. grid potentials.

Now the anode potential is varied, and ~~at~~ the same readings are again taken for grid potential and anode current.

Having determined these, we can plot them on a curve graph paper. The curves obtained are shown in the diagram

