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A New Dimension to Time Dilation

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Abstract:- In this theoretical paper hypothetical situations and instruments were used to form, analyse and derieve an expression with the objective of filling loopholes in einstein's theory of time dilation [1,2,3,4,10,12].

Time dilation as presented by *albert einstein* in 1905 is one of the most experimented and reviewed topic. time dilation states that time slows down in a moving object which is given by.

$$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1-\frac{v^2}{c^2}}}$$

Where: $^{\delta}t'$=dilated time elapsed | v = speed of moving object

$^{\delta}t$ = actual time elapsed | c = speed of light in vacuum

The explanation and expression of time dilation works only when vacuum is the medium of object propagation. but, when a medium other than vacuum is present, then this equation falls short of an important factor that is, optical density[8,9].

My research paper here, presents an expression to measure time dilation considering this missing factor.

***light beam clocks*[5,6,7] and the concept of closed and bounded systems have been used as a link connecting optical density to the original theory of time dilation. the new derivation has a potential to reduce errors in measurements in calculations which use the formula for time dilation.**

I. INTRODUCTION/BACKGROUND

In 1905 the great physicist albert eintstein[10] published his theory of general relativity[11,13,14,18] followed by his theory of time dilation which changed our perception of time and matter. the theory of relativity particularly time dilation has by far been proved by many experiments but with errors.

The formula given by albert einstein is valid only when the medium considered has very low resistance to the flow of light i.e preferably vacuum. we know that absolute vacuum is not possible. however empty a given system is, virtual particles and charges always appear and disappear even in a closed system ! hence the vacuum or the ideal medium that einstein reffered to must be containing particles and depending on the size and nature of these particles, the speed and path of light will be affected.

Hence we need to consider the optical permittivity or the refractive index of the material or medium through which light is propagating. the medium which we are considering in this paper is thus only a possibility just like the light beam clocks used by albert einstein.

II. METHOD

A hypothetical instrument : the light beam clock

let there be two mirrors m1 and m2 such that their reflecting surfaces face each other. they are at separation of 'l' by means of a rod which has been omitted for the purpose of clarity (fig.3). let there be a pulse of light that moves to and fro after successive reflections.such a set up is known as a light beam clock using which albert einstein proved his theory of time dilation.even we will be using the same to derieve a new expression.

Equation for calculating speed of light in our hypothetical medium.

let there be a slab made up of a substance which is optically transparent such that considerable amounts of light passes through it.let it's physical density[15,16] be 'p_d' and it's optical density be 'o_d'.this slab acts as a container to a hypothetical medium with high refractive index.

We know that the optical density denoted by a numerical value known as the refractive index (r.i.) of the substance is given by.

(r.i.) of substance = $\frac{c}{v}$

c = speed of light[17] in vacuum ; v = speed of light in medium

hence, we get : v = $\frac{c}{(R.I)OF\ SUBSTANCE}$

therefore, velocity of light in medium (s_m) = $\frac{c}{O_D}$ ➔ $\boxed{S_M = \frac{C}{O_D}}$ .. …..(i)

Derieving the velocity of light in our hypothetical medium :

let us now consider a tank (or in other words , a system enclosed by a transparent medium with low r.i.). the tank is fully air tight and impervious external physical agents. the surrounding temperature and pressure are kept at a sturdy non-fluctuating level .

light is free to enter and leave the system because of the transparent medium binding the liquid in the confined space.

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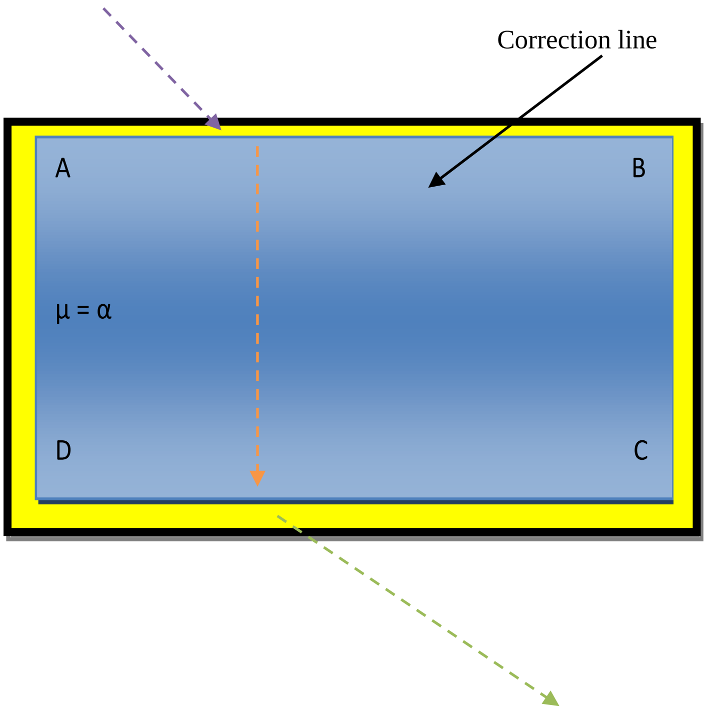
let the refractive index of this liquid medium be ‘α’ and it’s physical density be ‘$_\beta$’

The correction mark is the meeting place of the two media where the refraction of light takes place.

III. CONSIDER

A ray of light cd enters the setup , crosses the correction mark and continues on a straight path . it bends and again and then exits the setup.



Now we shall be confining our focus on the velocity of light within the bounded medium ‘abcd’

Now for the velocity of light in the medium : firstly from eq.(i) which we derieved earlier, we can clearly see that the speed of light in this given medium of refractive index = α will not be equal to ‘c’. hence we introduce c’ as the speed of light in the hypothetical medium which is given by :-

➔ $s_m = \frac{c}{O_D}$ .... (from eq.(i))

➔ $c' = \frac{c}{\alpha}$ . . . . (ii)

Clearly, c’ is going to be much more less than c for considerably large values of α. hence the speed of light in this medium is slower than the actual speed of light. we thus, move on to derieve a new expression for time dialation based on this concept of optical density.

IV. DERIEVING THE NEW FORMULA

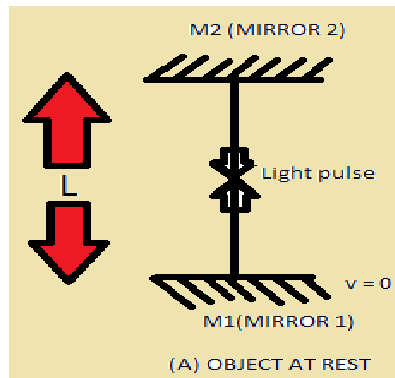
Time dilation – optical density relation.
case 1:

when light beam clock is at rest .

Clearly, the light pulse travels a distance of ‘2l’.

therefore, time taken = $^{\delta}t = \frac{2L}{v} = \frac{2L}{c'}$

or, ➔ $$^{\delta}t = \frac{2L\alpha}{c}$$ . . . .(iii)



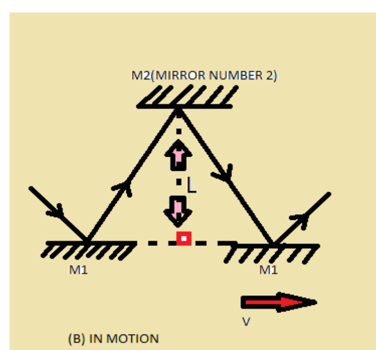
Note: The medium surrounding the light beam clock (the yellow background represents out hypothetical medium) is the reason why light in this case has slowed down.

Note: Here $^{\delta}t$ stands for the actual time elapsed

Case 2:

Clearly in the second case when the light beam clock is in motion we can see that.

Distance travelled = $$^{\delta}t' = 2\sqrt{L^2 + \left(\frac{v\,^{\delta}t'}{2}\right)^2}$$



{where $^{\delta}t$ is the dilated time elapsed}.........by pythagoras theorem hence the time between two successive reflections is :-

$$^{\delta}t' = \frac{2}{c'}\sqrt{L^2 \ldots}$$

………$time = \frac{distance}{speed}$

or,

$$\left(\frac{c\,^{\delta}t'}{2\alpha}\right)^2$$

…$c' = \frac{c}{\alpha}$….we get the required equation after transposition

or,

$$\left(\frac{\left(\frac{c}{\alpha}\right)^{\delta}t'}{2}\right)^2 = L^2 + \left(\frac{v\,^{\delta}t'}{2}\right)^2$$

.. ....by taking α to the numerator

or,

$$\left(\left(\frac{c}{\alpha}\right)^2 - v^2\right)\left(\frac{^{\delta}t'}{2}\right)^2 = L^2$$

…………taking $\left(\frac{^{\delta}t'}{2}\right)^2$ as common

or,

$$\left(\frac{^{\delta}t'}{2}\right)^2 = \frac{L^2}{\left(\frac{c}{\alpha}\right)^2 - v^2}$$

…………transposing $\left(\frac{c}{\alpha}\right)^2 - v^2$ to rhs

or,

$$(^{\delta}t')^2 = \frac{4L^2}{\left(\frac{c}{\alpha}\right)^2\left[1 - \frac{v^2}{\left(\frac{c}{\alpha}\right)^2}\right]} \rightarrow (^{\delta}t')^2 = \frac{\left\{\frac{4L^2}{\left(\frac{c}{\alpha}\right)^2}\right\}}{1 - \frac{v^2.\alpha^2}{c^2}}$$

or,

$$^{\delta}t' = \frac{\left\{\frac{2L}{\left(\frac{c}{\alpha}\right)}\right\}}{\sqrt{1 - \frac{v^2.\alpha^2}{c^2}}}$$

……………raising both sides to power ½ (sq. rt.)

or,

$$^{\delta}t' = \frac{\left(\frac{2L\alpha}{c}\right)}{\sqrt{1 - \frac{v^2.\alpha^2}{c^2}}} \rightarrow {}^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{v^2.\alpha^2}{c^2}}}$$

hence we derieve the expression:-

$$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{\alpha^2.v^2}{c^2}}}$$

V. RESULTS AND CONCLUSION

Let us now compare the equation that we have derieved to that given by albert einstein.

Einstein's equation	New equation
$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{v^2}{c^2}}}$	$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{\alpha^2.v^2}{c^2}}}$

Hence we can clearly see the similarity between the two equations.

On comparison of the two equations it is revealed that einstein neglected the property of optical density of substances in his ideal medium which itself had particles in it. due to this we can also explain the slight inaccuracies which have taken place in practically conducted experiments. experiments by scientists and analysts using atomic clocks revealed minute inaccuracies which are justified as follows.

VI. DISCUSSION

To verify our theory let us take an example in which we take into consideration: two atomic clocks[19,20]: one on the ground and the other on an aeroplane (an experiment that has been conducted quite a few times before).

let the aeroplane be travelling with a velocity ‘v_a’

(we know according to the theory of time dilation that the time which passes for the atomic clock on the aeroplane will be slower when compared to the time which passes for a similar clock on the ground.we check the magnitude of this dilated time from both the equations and compare them.)

Note : In the given example the medium of propagation is air .

Case1 (einstein’s theory)

According to the law given by albert einstein the dilated time elapsed should be given as follows.

$$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Hence by placing the value of v as v_a we get dilated time elapsed as.

$$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{v_A^2}{c^2}}}$$

Case2 (new theory)

According to the formula we derieved we have the values as : v = v_a and α = (r.i)of air = 1.000277

Hence dilated time elapsed is given by :

$$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{\alpha^2 . v^2}{c^2}}}$$

substituting given values, we get :

$$^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{(1.000277)^2 . v_A^2}{c^2}}} \rightarrow \ ^{\delta}t' = \frac{^{\delta}t}{\sqrt{1 - \frac{(1.0005540767) . v_A^2}{c^2}}}$$

Hence we can see that the negligible inaccuracy in the experiments were due to the absence of this small factor [$(1.000277)^2$ = 1.0005540767] from einstein’s equation. these were the causative agents of the small errors (of the order 10^{-7} – 10^{-9} second) . at higher speeds comparable to the speed of light the error due to the absence of refractive index from the formula can result in larger and more significant errors which cannot be neglected.

We have thus integrated the results given by albert einstein with the optical density of the medium.

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