The Hypothesis of Perpendicular Time

Abstract

The entirety of this document assumes the existence of a maximum speed with which any entity in the universe can travel from a set of points in space to any other set of points in space. The consequences on the motion of the constituents of a typical system of particles, when the system is travelling at a speed which is close to the speed limit of the universe, are initially subjected to a qualitative analysis, the conclusions of which hint at a mechanical definition of time. A quantitative analysis of the same reveals the Lorentz Transformation Factor. The fact that the Lorentz transformation factor is derived on applying the definition of time, which was hinted from the qualitative analysis, supports that definition. The quantitative analysis, however, also revealed a different value (transformation factor*). Both the transformation factors are combined to form one transformation factor, which, given that n (the number of spatial dimensions in the universe through which any moving object traverses) is large enough, approximately equates to the Lorentz Transformation Factor. Thus, using the results derived here, the value of n might be revealed.

Distinctions of this document from Special Relativity:

- One of the postulates of special relativity is that the speed of light remains constant for any observer. This document, however, does not use that postulate, and thus, unlike special relativity, does not make direct use of any of the conclusions of the Michelson-Morley experiment.
- A definition of time is proposed, on the application of which, the transformation factors are obtained.
- Apart from the Lorentz Transformation Factor, a new transformation factor is obtained, which, on combining with the Lorentz Transformation Factor, yields a value which approximately equates to the Lorentz Transformation Factor, given that n (revealed later in the document) is large enough.

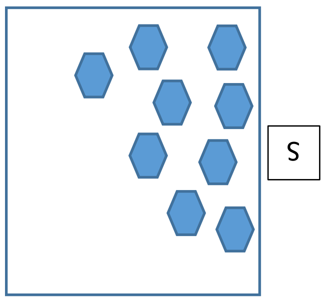
Notations and Terminologies:

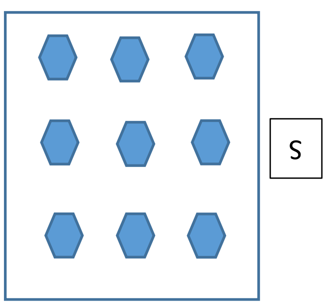
- **Transformation Factor*-** refers to the ratio of the velocity of the concerned particle relative to the concerned system, as measured by an observer moving relative to the system, **to** the velocity of the concerned particle relative to the concerned system, as measured by an observer, stationary relative to the system.
- **O -** the observer
- **S -** a system of particles
- $\boldsymbol{l}$ **-** the speed limit of the universe

1) Introduction

Considering a system of particles 'S', which, for the sake of simplicity, is isolated from its surroundings. Any change in the system must, therefore, occur exclusively because of internal processes, all of which must require some sort of motion, and the motion must be that of the system's constituents relative to one another.

Config. A





Config. B

The illustrations are of S in two different configurations, where A is its initial configuration, and B is its final configuration, which S attains from A after the rearrangement of the hexagons (its constituent particles). If referred to a clock placed outside of the system, a quantity 't' can be assigned to the time taken for the system to attain B from A.

Hypothetically, if a system S' is considered, which is identical to the system S in its initial configuration (A), such that it attains a final configuration (B), which is identical to that of S, but dampen the relative motion of the hexagons, right from its initial configuration, the time taken by S' to reach its final configuration from its initial configuration must be more than t.

If two identical clocks are taken and one of them is placed in S, and the other one is placed in S', but the relative motion of the constituents of the clock in S' are damped in a manner which is similar to that applied on the hexagons of S', then it must measure the time elapsed between the initial and final configurations of S' to be the same as that measured for S by the clock placed in S, because the functioning of the clock also depends on the relative motion of its constituent particles. (a more comprehensive explanation is provided later in this document)

A simultaneous observation of both the systems from the point of view of an observer situated outside of both the systems must reveal that 'time has slowed down' for S'. Naturally, this situation hints at a definition of time:

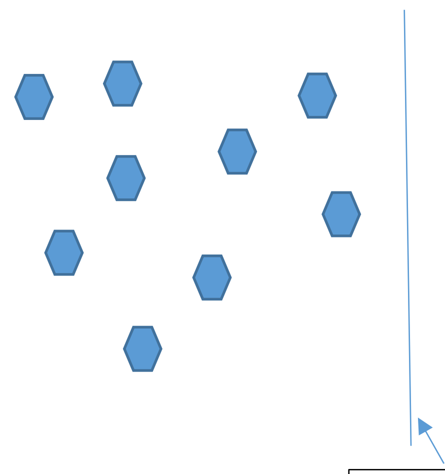
Time for a system is the motion of its constituents relative to one another.

Considering an observer 'O' observing the system of particles 'S' from outside of it: Owing to the existence of a universal speed limit l, anything moving *relative to O, as measured by O*, cannot exceed l in terms of its speed. Obviously, the same applies for the motion of S and its constituent particles. If S travels at a speed v_S *relative to O, as measured by O*, the speed of any of the hexagons *relative to S, but measured by O* must be such that they do not exceed l *relative to O, as measured by O*. Thus, *relative to O, as measured by O,* for v_S (the constant, non-zero velocity of S) being infinitesimally close to l, the velocities of the hexagons *relative to S, and measured by O*, must also be infinitesimally small such that they don't exceed l, *as measured by O*.

The concern is with the speed of the hexagons *relative to S, but measured by O*, because of the following reason- **Our perception of time:** Time is what a clock measures. As far as an ordinary clock is concerned, be it moving or stationary, our interpretation of time, based on our observation of the clock, depends on the motion of the 'hands' of the clock *relative to the frame of the clock, as measured by us.* In the instance of the simultaneous observation of the systems S and S' (as explained above), and the identical clocks placed inside of each of them, by an observer situated outside of both of those systems, the perception of the observer of the slowing down of time for S' is a result of the observer's measurement of the motion of the constituents of S' *relative to S', as measured by himself.* Therefore, as observed by O, the speeds of the hexagons *relative to S, but as measured by O* must be such that the speed limit l does not get violated *relative to him, as per his observation*. This would mean that O would observe the motion of the hexagons relative to S to be damped in contrast to the situation where S would have been stationary relative to him. Thus, to O, for S travelling at a speed which is close to l, 'time for S would seem to have slowed down.'

2) A quantitative analysis of the phenomenon characterized by the damped motion of the constituents of S:

So far, it is clear that the observation of the damped motion of the hexagons of a 'speedy' S is a consequence of the existence of a cosmic speed limit l, but the extent to which the motion gets damped is still not apparent. Acknowledging one of the possibilities, l might be compared to a 'concrete barrier' (as illustrated) which may be attained by any entity, but must be impossible to exceed.

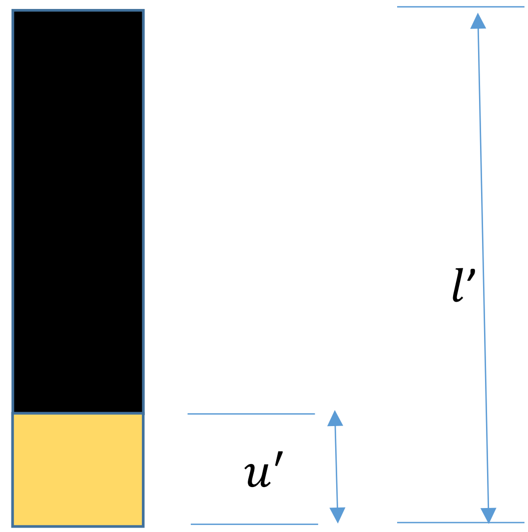


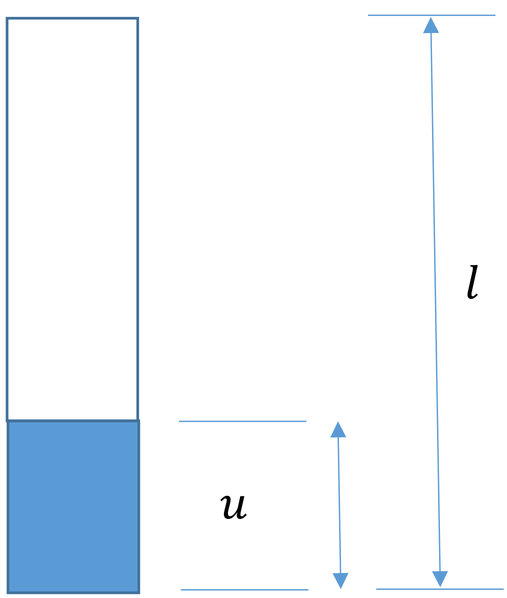
The barrier- It exists everywhere (its length being perpendicular to any hexagon's velocity vector) in space, and travels at a speed of l *relative to the concerned observer, such that no hexagon can exceed* l *relative to the observer.*

For instance, if the system S travels at a constant velocity v_S *relative to O, as measured by O,* and if the velocity vectors of all the hexagons point in the same direction as S's direction of motion, the maximum magnitude of velocity of any of the hexagons *relative to S, but as measured by O* must be $l - v_S$. In a situation, wherein the system starts accelerating such that v_S tends to l, and the minimum magnitude of velocity of any of the hexagons relative to S is v as measured by O, then for the instant where $v = l - v_S$, the magnitude of the velocities of all the hexagons must become precisely the same. This implies that at a certain value of v_S, the rate of all the processes of S must become equivalent to the rate of the slowest process inside of S. **This is absurd!** Thus, l cannot be compared to a concrete barrier. Let's examine the second possibility of the nature of the function which is responsible for the damped motion of a system's constituents when the system is travelling at high velocities. If the maximum attainable velocity in any given direction, as *measured by O but relative to S* is denoted by x; for S being stationary relative to O, $x = l$, but for S not being stationary relative to O, and moving at a constant, non-zero velocity relative to O, $x = l'$. (the values of l' have been obtained on the following page)

The speed reservoir- Considering an object p, initially at rest relative to O, which, when acted upon by an impulse j, attains a velocity u *relative to O, as measured by O*. Obviously, u remains constant for constant values of p and j. Thus, it is not wrong to assert that the ratio $\frac{u}{l}$ must also remain constant for those given values, where l is the speed limit of the universe.

If x is compared to a reservoir (as illustrated) such that any object p, when acted upon by an impulse j, always utilizes a constant fraction of that reservoir:

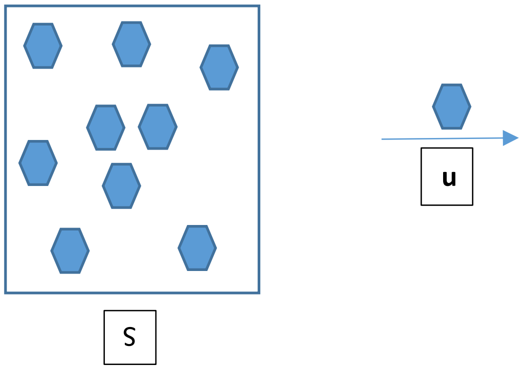




It follows that $\frac{u}{l} = \frac{u'}{l'}$

Where u' is the velocity of p, attained *relative to S, but measured by a non-stationary O*, initially moving at a constant velocity relative to p. Or, u' is the velocity of p upon being acted upon by j, when its initial velocity was constant and non-zero relative to O.

S: A system (S) of particles is considered, which, at random intervals of time, ejects constituent particles in random directions. The mass of the ejected particle is negligible as compared to the mass of the rest of the system. An essential property of the system is that the velocity of the ejected particle relative to the system, as measured by an observer on the system is always the same, regardless of the time and the direction of ejection.



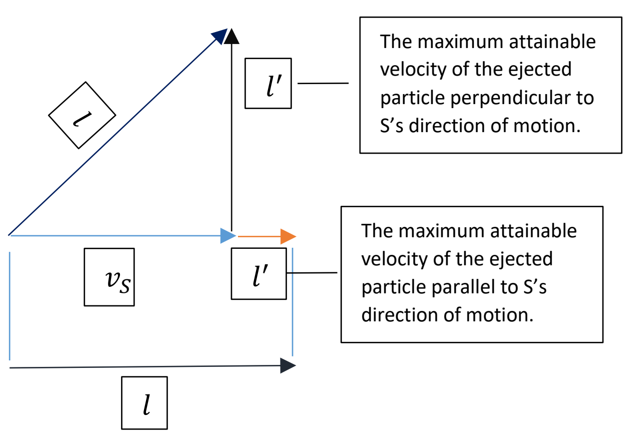
x, for a given direction, refers to the maximum attainable velocity of the particle p ejected by S, *relative to S, and measured by O.* In the situation when S is stationary relative to O, obviously, $x = l$, and in the situation when S is moving at a constant velocity v_S relative to O, $x = l'$. l' is distinct for different (parallel or perpendicular) directional components relative to S's direction of motion.

Parallel to S's direction of motion:

$$l' = l - v_S$$

Perpendicular to S's direction of motion:

$$l' = \sqrt{l^2 - v_S^2}$$



Since $$\frac{u}{l} = \frac{u'}{l'}$$

$$u' = \left(\frac{u}{l}\right) l'$$

Thus, for the directional component **perpendicular** to the system's direction of motion-

$$u' = \left(\frac{u}{l}\right)\sqrt{l^2 - v_S^2}$$

$$\frac{u}{u'} = \frac{u}{\frac{u}{l}\sqrt{l^2 - v_S^2}}$$

=) $$\frac{u}{u'} = \frac{1}{\sqrt{1 - \frac{v_S^2}{l^2}}} \qquad \textbf{(1)}$$

Note that this is the Lorentz Transformation factor.

And, for the directional component **parallel** to the system's direction of motion-

$$u' = \left(\frac{u}{l}\right)(l - v_S)$$

$$\frac{u}{u'} = \frac{u}{\left(\frac{u}{l}\right)(l - v_S)}$$

=) $$\frac{u}{u'} = \frac{l}{l - v_S} \qquad \textbf{(2)}$$

It is important to note that all the observations except that of l are made *relative to S, but are measured by O.* l as a measurement is defined *relative to O, as perceived by O*. Also, u and u' are the final velocities attained by p, which is ejected by S, on being acted upon by the same mechanism, and therefore, the **same amount of impulse.**

The situation wherein O observes S travelling at a constant velocity v_S relative to himself, he measures the velocity u' of the ejected particle relative to S, which turns out to be slower than it would have been in the situation where S were stationary relative to him. Since, time for a system is the motion of its constituent particles relative to one another, the observation of S made by O should reveal that the passage of time has slowed down for the inertial frame of

S, and that the ratio of the speed of the ejected particle *relative to S, but measured by O* when S is moving at a constant non-zero velocity v_S relative to him, **to** the speed of the ejected particle *relative to S, but measured by O*, when S is stationary relative to him, must act as a viable measurement of the ratio of the passage of time in both inertial frames. Therefore, it is unsurprising that (1) turned out to be 'precisely' the Lorentz transformation factor.

Since u and u' are the final velocities of the same particle being acted upon by the same amount of impulse-

$$mu = m'u'$$

=) $$m' = m(\frac{u}{u'}) \qquad \textbf{(3)}$$

Where m is the mass of the particle when it is stationary and m' is its mass when it is not stationary. This implies that the mass of a particle *transforms* as a function of its motion in accordance with (1) and (2).

3) An analysis of the movement of S and its constituents in n dimensions.

Considering the motion of S and its constituents with reference to a two-dimensional coordinate system, it can be easily deduced that the velocity of the ejected particle can be resolved into two components- one of them parallel to S's direction of motion, and the other component perpendicular to S's direction of motion.

With reference to a three-dimensional coordinate system, the velocity of the ejected particle can be resolved into three components- one of them parallel to S's direction of motion, and the other two components perpendicular to S's direction of motion.

Generalizing this distribution of velocity components with reference to an n-dimensional coordinate system, the velocity of the ejected particle can be resolved into n components- one of them parallel to S's direction of motion and $n-1$ components perpendicular to S's direction of motion.

Therefore, if $n \gg 1$, the number of perpendicular components will be far greater than the number of parallel components, in which case, the effects of (2) can be neglected, and only (1) might be accounted for, which, given the correctness of Einstein's Theory of Special Relativity, seems to be the case. However, using Special Relativity, given that the experimental value of the Lorentz transformation factor for any given velocity of a moving inertial frame is determined within a reasonable range of accuracy allowed by the apparatus and the relevant surrounding conditions, a small discrepancy between that value, and its theoretical value might hint at the number of dimensions that any moving object in our universe traverses through.

Combining expressions (1) and (2), and obtaining an equivalent transformation factor for n dimensions, which, on inputting the value of n must approximately yield the Lorentz Transformation Factor-

A system of particles is considered, which shall not be depicted. The system, at any instant of time, ejects n constituent particles in each of the n mutually perpendicular directions, such that all those particles have the same magnitude of velocity k when observed by an observer stationary relative to the system which they were ejected from and one of those ejections is in the same direction as the system's direction of motion (if it is moving relative to the observer) (The motion must not be accelerated.)

n is the number of dimensions in the universe, which any moving object traverses through.

Let k' be the speed of the ejected particle across any of the n perpendiculars, as measured by an observer moving at a constant, non-zero velocity v_S relative to the system.

Then for the ejection that is in the system's direction of motion, using (2):

$$k' = (\frac{k}{l})(l - v_S)$$

And, for any of the $n-1$ ejections that are perpendicular to the system's direction of motion, using (1):

$$k' = (\frac{k}{l})\sqrt{l^2 - v_S^2}$$

For the observation of the ejections by a stationary observer, the magnitude of the vector sum of the velocities of all the ejected particles-

$$m = \sqrt{n}k$$

Similarly, in the case of a non-stationary observation, when the observer is moving at a velocity v_S relative to the system, and because, relative to the direction of v_S, there is 1 parallel ejection and $n-1$ perpendicular ejections, the magnitude of the sum of the velocities of all the ejected particles-

$$m' = \sqrt{\left(\frac{k}{l}\right)^2 \{(l - v_S)^2 + (n-1)^2(l^2 - v_S^2)\}}$$

$$=)\ \frac{m}{m'} = k\sqrt{\frac{n}{\left(\frac{k}{l}\right)^2\{(l-v_S)^2+(n-1)^2(l^2-v_S^2)\}}}$$

$$\gamma' = \sqrt{\frac{n}{\left[\left(1-\frac{v_S}{l}\right)^2+(n-1)\left\{1-\left(\frac{v_S}{l}\right)^2\right\}\right]}} \qquad \textbf{(4)}$$

$(\frac{m}{m'} = \gamma')$

which is the required expression (Transformation Factor).

If γ' is the experimental value of the Lorentz transformation factor, and γ is the theoretical value of the Lorentz transformation factor for a given velocity v_S of the concerned moving inertial frame of reference, and -

$$a = \frac{\gamma'}{\gamma}$$

Then,

$$a\gamma = \sqrt{\frac{n}{\left[\left(1-\frac{v_S}{l}\right)^2 + \frac{(n-1)1}{\gamma^2}\right]}}$$

Where $\quad \frac{1}{\gamma^2} = 1 - \left(\frac{v_S}{l}\right)^2$

$$=)\ a^2\gamma^2 = \frac{n}{\left[\left(1-\frac{v_S}{l}\right)^2 + \frac{(n-1)1}{\gamma^2}\right]}$$

$$=)\ n = \left(\frac{a^2}{1-a^2}\right)\left[\gamma^2\left\{1-\left(\frac{v_S}{l}\right)\right\}^2 - 1\right] \qquad \textbf{(5)}$$

n is the number of dimensions in the universe through which any moving object traverses.

4) Conclusion

All the expressions derived in this paper are based on the definition of time proposed earlier in the paper, which might have other applications that have not been demonstrated in this paper. **(1)** is the Lorentz Transformation Factor, which is essentially a measure of the dampness of the motion of the constituents of any system, in perpendicular directions of the direction of motion of the system travelling at a given constant velocity relative to the observer in context. Since, with reference to any n-dimensional coordinate system, for any moving system, the number of parallel components of the constituents' velocities equals only one, and the rest of the components are perpendicular, given that the number of dimensions are high enough, **(4)** must approximately equate to the Lorentz Transformation Factor.

5) References

No references