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## Time Dilation Requires an Ether

### ***Abstract***

The phenomenon of time dilation demands the existence of a field that supports the propagation of photons. Historical references identify this field as the luminiferous ether. I will call it the ***temporal-inertial field (TI field)***, because I may attribute properties to this field not obtained by classical versions of the luminiferous ether. Time dilation occurs when an ongoing process moves relative to space, relative to this ether, relative to this TI field. The greater the velocity of the process relative to space the greater is the time dilation experienced by that process. The rate at which a process is slowed ***or accelerated*** is intrinsic, absolute and depends solely on the velocity of the process relative to space. If space has no properties other than dimensionality, motion relative to that space is undefined and meaningless and can have no influence on any ongoing process. Accordingly I assert the existence of the so-called TI field that supports the propagation of photons and occupies and permeates all of space, including the space of atoms. The entire thrust of this paper is that geometry does not govern the physics of time dilation; motion relative to the TI field of space does.

### **A Tale of Two Paradigms**

Two paradigms are considered that may underlie time dilation: the geometry of empty space and a space permeated with a particle field that supports the propagation of force and messenger articles such as the photon. The properties of these two 'spaces' are summarized as follows:

#### ***The geometry of empty space:***

- Space is truly empty, devoid of substance and has only the property of dimensionality.
- There is no absolute reference frame in which to judge the motion of photons and other force and messenger particles.
- Motion cannot be reckoned relative to this empty space.

- Motion through a propertyless space is measured relative to an arbitrary system of coordinates.
- Behaviors are inferred to evolve from the motion of frames of reference relative to each other.

***The Temporal-Inertial Field:***

- A field of particles termed the TI field permeates space.
- The TI field provides a frame of reference for the motion of photons and other force and messenger particles.
- The TI field supports the propagation of photons and other force particles (except gravitons).
- Motion can be reckoned relative to the particles of the TI field.
- Behaviors are inferred to evolve from the motion of entities relative to the TI field.

***The Paradigm of the Geometry of Empty Space***

***Or The Geometry of Empty Space Governs Physical Relationships***

Einstein was so wedded to the concept of geometric relationships underlying the forces of nature that he attributed gravity to the curvature of space. What can be curved in an empty space? The expression of curvature must imply a gradient of some quantity from one point in space to another. Webster [\[1\]](#) defines gradient: (1): “change in the value of a quantity (as temperature, pressure, or concentration) with change in a given variable and especially per unit distance in a specified direction”, and (2): “the vector sum of the partial derivatives with respect to the three coordinate variables x, y and z of a scalar quantity whose value varies from point to point.” What is the value or scalar quantity that can vary from point to point in empty space? By definition there is none. Ah, perhaps it’s some flux of particles that transits space. A perfect example would be gravitons emanating from a gravitational body and flowing through space and creating a gravitational field. Does that negate Einstein’s concept of emptiness? Space itself is empty, but ‘stuff’ flows through it? In the example of a gravitational field, can the varying flux of gravitons in the space surrounding a gravitational body be interpreted as the curvature of space? What does all this have to do with time dilation? Let’s see.

Einstein acknowledged the vagueness of a space without properties: “...we entirely shun the vague word ‘space,’ of which, we must honestly acknowledge, we cannot form the slightest conception, and we replace it by ‘motion relative to a practically rigid body of reference’.” [\[2\]](#) Einstein then replaces the rigid body with a system of coordinates by which to measure motion. There can be no other means by which to reckon motion in a space without properties.

A space without properties is by definition nothingness. Motion relative to a propertyless space is undefined and meaningless. The geometric analysis of two frames of reference moving relative to each other shows that time intervals measured in the two frames differ from each other. The difference in time interval between the two frames is a function of the difference in velocity between the two frames of reference.

This geometric analysis yields a paradox: From the perspective of each frame of reference, the passage of time in the other frame appears to be slower. The measurements of the passage of time in each frame are symmetric with each other. There is no way in the geometric analysis to violate the symmetry. There is nothing in the analysis to contradict the paradox. If the measurement of time in each frame cannot be slower than the other, then neither can be slower than the other. Time dilation cannot result from a difference in the velocity between two reference frames no matter how compelling the math.

The conclusion that I reach in this inquiry is that the assumption of an empty space in the geometric analysis of time dilation is invalid and that geometry alone does not govern the physics of time dilation.

### ***The Paradigm of the Temporal-Inertial Field***

Empty space can have only two properties, dimensionality and volume. Empty space can provide no frame of reference for motion relative to that space.

The prime assertion of this conjecture is that motion in a space without properties can have no effect on whatever entity is moving in that space. Accordingly, the path of a force or messenger particle, such as a photon, relative to its emitter cannot be influenced by the motion of the emitter through a space without properties. The exchange of force particles determines the fundamental timing of all physical processes.

Space is not empty; it is permeated by particle fields: dark energy, dark matter, virtual particles, the Higgs field and, perhaps, many more. I assert the existence of a field that supports the propagation of the particles that mediate three of the four fundamental forces of nature, the strong force, the weak force and the electromagnetic force. I term this field the ***temporal-inertial field*** and assert further that the motion of any process relative to this field causes the process to slow down relative to the time the process takes when stationary relative to this field. [3] In the past, a field termed the ether or luminiferous aether was invoked to support the propagation of photons and other phenomena: "...every theory of local action assumes continuous fields, and thus also the existence of an 'aether'." [4]

We couldn't articulate it more clearly than Professor Hawley [5]: "...it is clear that at a very basic level, time is tied into measurements of space.' And again: "...we define our concepts of space and time intervals in comparison with standard physical processes."

"The rate at which physical processes occur gives us our measure of time, and if all those rates changed together, an observer could not notice it. Try to imagine measuring time that does not involve some periodic physical process!"

"Modern physics has shown that physical processes depend on the interaction of fundamental forces at a very basic level." And lastly, "For physical processes, the exchange of the particles that produce forces has ultimate importance. Moreover, the crucial distinguishing factor of special relativity is not so much the speed of light, as it is the existence of a finite speed of propagation of forces."

The particle exchanges that underlie all processes, atomic, chemical and biological, determine the measures of time taken by such processes. These exchanges take longer when the entity encompassing the exchange is moving relative to the TI field of space. [6] Accordingly, processes moving relative to this space take longer than do stationary processes. Unlike a space devoid of properties, the TI field provides a frame of reference for the motion of force particles like the photon. It is the velocity of photons and other force particles relative to the TI particle field that determines the rates at which the fundamental clocks of nature tick.

The exemplar for the variation of time with velocity chosen in this paper is an idealized, transverse photon clock.

## Time Dilation

Time dilation has been defined as the decrease in the rate of flow of time in a frame moving with respect to an outside observer. Time dilation in the frame moving relative to an outside observer is given by Kutner [7]:

$$t_m / t_s = 1 / (1 - v^2 / c^2)^{1/2} \quad (1)$$

where

$t_m / t_s$  is the ratio of time interval  $t_m$  measured by the moving clock with respect to the time interval  $t_s$  measured by the clock of the outside observer.

$v$  is the velocity of the moving clock relative to that of the outside observer.

Let me restrict the validity of Eq (1) by requiring the clock of the outside observer, measuring the value of  $t_s$ , to be stationary relative to space.

I contest in this paper the validity of this explanation of time dilation. The geometric view expresses time dilation as a function of the difference in velocity between two frames, in a space without properties, moving relative to one another. I contend that time dilation is a function of the velocity of an entity relative to the TI field, not a function of the velocity of the entity relative to an arbitrary frame of reference in a space without properties.

The geometric view does not address the physics of time dilation. The physics of time dilation are not governed by geometry, but are more fundamental. The physics of time dilation occur at the subatomic level and affect all processes that move relative to the TI field. [6]

## The Two Clock Experiment

The following discussion was first presented in reference [3]. Imagine two spaceships, A and B, located in space far away from any gravitational masses. The two ships each contain an accurate clock. Ship B moves at speed  $v$  away from ship A **which is stationary with respect to the TI field**. Onboard ship B, clock B runs more slowly than its counterpart on ship A in accordance with Eq (1). Ship B cruises along for a while and

its clock continues to run more slowly than clock A. Ship B then begins to slow down. As it slows down, its clock tick rate speeds up until, when ship B's velocity with respect to ship A is zero, clock B ticks at the same rate as clock A. This observation is valid and is in accord with Eq (1).

Now, reverse the process and send ship B back toward ship A. As ship B's velocity increases, the tick rate of its clock again slows down. Approaching ship A, ship B decelerates and as it does, its clock rate again speeds up until as ship B comes to a stop next to ship A its clock is again running at the same rate as clock A.

Measurements confirm that clock B, having lost considerable time with respect to clock A in ship A, is now running at the same rate as clock A.

At no time during the test did clock A influence the rate of clock B. Had clock A not been a part of the test, the variation in clock B's rate would have changed as described. Clock A provided only a means of comparison and measurement of the time 'lost' by clock B. Accordingly, the variation of clock B's rate was determined solely by its motion with respect to the TI field itself. Clock B's ***tick rate decreased as its velocity increased*** relative to the TI field. Clock B's ***tick rate increased as its velocity decreased*** relative to the TI field. We can conclude from this thought experiment and Eq (1) that clock B's tick rate would be at its maximum when the clock is stationary relative to the TI field.

It's a logical conclusion from the thought experiment that any motion with respect to the TI field causes time dilation. ***Accordingly, velocity with respect to the TI field, not velocity relative to another frame of reference, must be the active factor in evaluating the time dilation of a moving object.***

To support the assertion of the highlighted sentence above, continue our thought experiment, but ignore the caveat that ship A is stationary with respect to space. Let ship A move with velocity  $v_1$  with respect to the TI field. Let spaceship B move at velocity  $v_2$  with respect to space. For simplicity, assume that  $v_2$  is in the same direction as  $v_1$ . Both clocks will now experience time dilation in accordance with Eqs (2) and (3).

$$t_1 / t_0 = 1 / (1 - v_1^2 / c^2)^{1/2} \quad (2)$$

$$t_2 / t_0 = 1 / (1 - v_2^2 / c^2)^{1/2} \quad (3)$$

where

$v_1$  is the velocity of clock A with respect to the TI field.

$v_2$  is the velocity of clock B with respect to the TI field.

$t_1 / t_0$  is the ratio of period  $t_1$  measured by clock A with respect to the period  $t_0$  that would be measured by an identical clock that is stationary relative to the TI field.

$t_2 / t_0$  is the ratio of period  $t_2$  measured by clock B with respect to the period  $t_0$  measured by the stationary clock

The ratio of the periods measured by the two clocks is obtained by dividing Eq (3) by Eq (2):

$$t_2 / t_1 = (1 - v_1^2 / c^2)^{1/2} / (1 - v_2^2 / c^2)^{1/2} \quad (4)$$

Equation (4) represents the time dilation between two clocks moving at velocities of  $v_1$  and  $v_2$  relative to the TI field. The expression for the time dilation between two clocks derived from the geometrical relation of two frames moving at a velocity of  $v$  relative to each other ignores their motions relative to the TI field. This derivation would yield Equation (1) where now  $v = v_2 - v_1$ .

Compare the result of Eq (4) with that of Eq (1) repeated below as Eq (5) with changed subscripts:

$$t_2 / t_1 = 1 / (1 - v^2 / c^2)^{1/2} \quad (5)$$

These two expressions equate only if  $v_1$  in Eq (4) is zero, that is, only if the clock measuring  $t_1$  is stationary relative to the TI field.

Let me summarize the meaning of the foregoing arguments:

1. The TI field is the absolute reference frame for motion of particles or objects in the field.
2. Time dilation of an object moving in space is a function of its velocity relative to the TI field. The faster a clock moves relative to the TI field, the greater is its period and the slower its clock ticks.
3. Comparison of the time dilation between two clocks moving in space must be based on each clock's velocity relative to the TI field as expressed in Eq (4), not on the difference of their velocities relative to each other.
4. The contention that any calculation of time dilation of a moving object depends solely on its velocity with respect to space is supported.

## The Reciprocity Paradox

“When two observers are in relative uniform motion and uninfluenced by any gravitational mass, the point of view of each will be that the other's (moving) clock is ticking at a slower rate than the local clock. The faster the relative velocity, the greater the magnitude of time dilation. This case is sometimes called special relativistic time dilation.” [8]

Had the crew members in ship B of our thought experiment been able to see the clock in ship A, while they were speeding away from ship A, they would have seen clock A running more slowly than their own. From the perspective of each ship, the clock in the other ship appeared to run more slowly than the clock in the ‘home’ ship. This phenomenon is the so-called reciprocity paradox and is a paradox of appearance only. Analysts of the reciprocity paradox ask which clock is really running slowly and how the paradox can be resolved. According to the geometric theory, the resolution lies in identifying which clock accelerated during the experiment or comparing the clocks when

they are brought together. However, this comparison would not succeed in an empty space without properties, but would work in the real world because in the real world the TI field exists. The paradox results from the geometric analysis of the problem. The paradox does not arise if the analysis addresses the root cause of time dilation and that cause is motion relative to the TI field of space not the relative motion between two clocks in a space without properties. This, in turn, begs another question: How do you determine the velocity relative to the TI field of space? I refer the reader to reference [3] for an extensive discussion of this subject.

### ***Compare Two Clocks Moving Without the Temporal-Inertial Field***

To pound this point home yet again, consider two spaceships that contain identical, accurate, sensitive clocks. This experiment is conducted in a space that is free of properties other than dimensionality. There is no ether, there is no field that supports the propagation of photons, there is no TI field. The experiment begins with the ships in proximity, stationary relative to each other and with their clocks in synchrony with each other. One ship then accelerates and achieves relativistic velocity  $v$ . From the perspective of each ship the other ship is moving away at velocity  $v$ . From the perspective of each ship the clock in the other is ticking slower than its own clock. This, again, is the reciprocity paradox. How can both clocks be judged to run slower than the other? The obvious answer is that this cannot occur. However, from the perspective of each ship, the clock in the other ship really does appear to tick more slowly. The mathematics of the geometrical analysis is indisputable. The perspective of each ship relative to the other is symmetric. There is nothing to violate this symmetry. If only one of the clocks can tick more slowly than the other, then in this symmetrical situation, neither clock can tick more slowly than the other. Neither clock experiences time dilation. The paradox is not real; it is an illusion.

Two ships pass each other at velocity  $v$ . Without a medium to support the propagation of photons, without an ether, without the TI field, there is nothing to violate the symmetry of the two ships passing each other. Each moves at velocity  $v$  relative to the other. The history of which ship accelerated is irrelevant and meaningless. There is nothing in either the geometry or the physics of the situation to distinguish how the ships got there and at what velocity.

So what contributes to the illusion? Referring to Figure 1, photons of the 'other guy's' clock appear to trace a sawtooth pattern through space as they reflect between the two mirrors of the clock. The judgement in the geometric analysis is that the velocity of the photon along the diagonals of the path is  $c$ . My assertion is that in a space without properties, the vertical component of the photon velocity is  $c$  and remains unchanged by the velocity of the ship. The vertical component of the photon's apparent sawtooth path is  $c$  and the horizontal component is the difference in velocity  $v$  between the two ships. The apparent velocity of the photons is greater than  $c$ , but this is an illusion. The period of each clock remains equal to twice the vertical separation  $d$  of the two mirrors divided by the vertical component of the photon velocity  $c$ . The period of each clock is thus  $2d/c$ , the same value as though the clocks were stationary relative to each other. There is no time dilation. There is no paradox.

I make these assertions because ***the geometric analysis does not represent the physics of time dilation***. As I argued in the section *The Two Clock Experiment*, velocity relative to the TI field is the root cause of time dilation.

### ***Compare Two Clocks Moving Within the Temporal-Inertial Field***

This experiment is conducted in a space permeated with the particles of the TI field. This field supports the propagation of photons. The experiment begins with the ships in proximity, stationary relative to each other, stationary relative to the TI field and with their clocks in synchrony with each other. Ship A remains stationary relative to the TI field. Ship B accelerates and achieves relativistic velocity. The velocity of Ship B and its clock relative to both Ship A and the TI field is then  $v$ . From the perspective of either ship the clock in the other is ticking slower than its own clock. This, again, is the reciprocity paradox.

Even though the relationship between the two clocks in this experiment appears symmetric it is not. Geometrically the relationship is symmetric, but the physics that determine the timekeeping of the two clocks is not symmetric. What violates the symmetry in this experiment that does not operate in the experiment with two clocks moving without a TI field? It is motion relative to the TI field. Unlike the comparison of the two clocks moving without the TI field, one of the clocks in this experiment really does tick more slowly than the other. From the perspective of ship B, the clock in ship A is ticking more slowly. Ship A appears to be moving away from ship B with velocity  $v$ . As 'seen' from ship B, the photon path of the clock in ship A traces a sawtooth pattern as the photons appear to move diagonally between the lower and upper mirrors of the clock. Again, refer to Figure 1 for a graphical representation of the clock.

The simple assumption is that the photons of the clock in ship A move at the velocity  $c$  along the diagonals of the sawtooth pattern. This is not true. The photons of the clock in ship A actually move vertically with velocity  $c$  and appear to move horizontally with the apparent velocity  $v$  of ship A. The apparent total velocity of the photons is greater than  $c$ , but this is an illusion. The period of the clock is twice the vertical separation  $d$  of the mirrors divided by the vertical velocity  $c$  of the photons. The period of the clock is  $2d/c$ , the same as the period of the clock measured when both ships and clocks were stationary relative to each other and relative to the TI field. This occurs because ship A is stationary relative to the TI field. On the other hand, ship B is moving at the velocity  $v$  relative to the TI field. The photons of the clock in ship B really do propagate at velocity  $c$  along the diagonal of their sawtooth pattern and thus the period of the clock is decreased by the Lorentz factor  $\gamma = 1 / (1 - v^2 / c^2)^{1/2}$  as given by Eq (1) and time dilation occurs. This happens because the clock in ship B is moving at the velocity  $v$  relative to the TI field. When we consider only the factor that determines the period of the moving clock, namely the velocity of the clock relative to the TI field, time dilation occurs and the so-called reciprocity paradox disappears. There is no paradox.

## Motion Through Space is the Root Cause of Time Dilation

We have seen in the thought experiments that any motion with respect to space causes time dilation, an effect that can increase or decrease the measure of time in a moving process. We used clocks in our thought experiment, but the effect of time dilation applies to any process. [6] When I refer to space, I do not refer to an empty, featureless, space without properties other than dimensionality. I refer to a space permeated with a particle field I call the **TI field**. The TI field supports the propagation of photons. ***The absence of a field to support the propagation of photons negates the phenomenon of time dilation. Alternatively, the presence of a field to support the propagation of photons enables time dilation.***

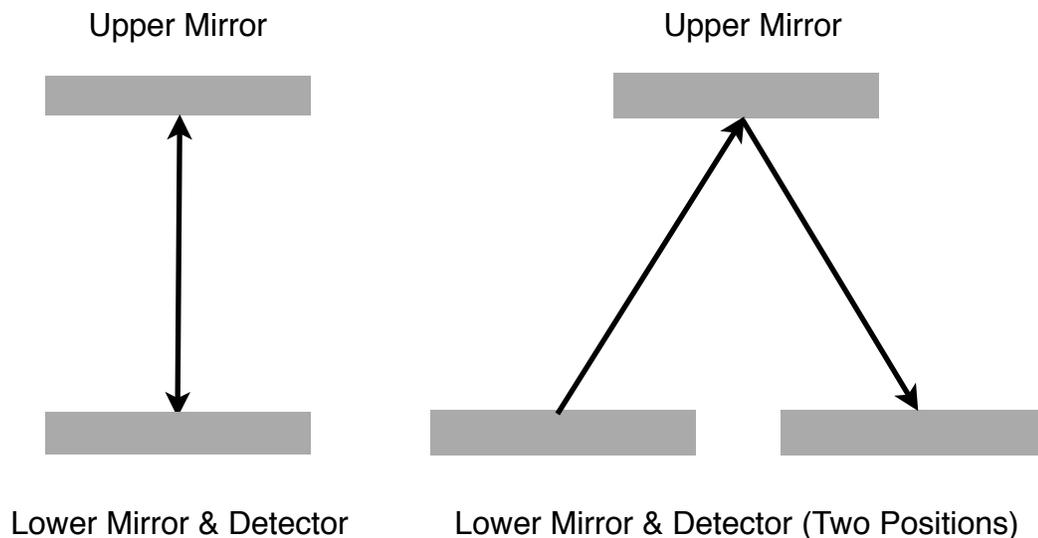


Figure 1. Two Views of the Transverse Clock. Left View is Stationary, Right View is Moving to the Right at a Velocity of  $v$  Relative to the TI Field (Upper and Lower Mirrors are Separated by the Vertical Distance  $d$ )

## The Aberration of Starlight

It takes only one contradictory, ugly fact to negate an otherwise beautiful theory. The ugly fact that negates all ether theories (to date) is the aberration of starlight. The aberration of starlight has been advanced [9] to refute the existence of an ether (the TI field in this study) that supports the propagation of light. I am so committed to the existence of the TI field, because it answers so many questions [3], [6], [10] that I urge that we ignore the ugly fact of the aberration of starlight until it too can be explained by the action of the TI field.

## Conclusions

1. The TI field provides an absolute reference frame for motion of particles or objects in space.
2. Time dilation of an object moving in space is a function of its velocity relative to the TI field. The faster a clock moves relative to the TI field, the greater is its period and the slower its clock ticks.
3. Comparison of the time dilation between two clocks moving in space must be based on each clock's velocity relative to the TI field as expressed in Eq (4), not on the difference of their velocities relative to each other.
4. There is no time dilation without a field (of particles) that supports the propagation of photons. This field is termed the Temporal-Inertial field in this conjecture.
5. The presence of a field to support the propagation of photons enables time dilation.
6. Geometry does not govern the physics of time dilation; motion relative to the TI field does.
7. The path of photons is unaffected by motion of the photon source through a space devoid of properties other than dimensionality.
8. The reciprocity paradox of time dilation cannot be resolved by a geometric analysis.
9. The reciprocity paradox does not arise if the analysis of time dilation is confined to the root cause of time dilation, velocity relative to the TI field.
10. The contention that any calculation of time dilation of a moving object depends solely on its velocity with respect to the TI field of space is supported.

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