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The Argument for an Ether Revisited

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 Historical references identify this field as the luminiferous ether.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 moving through that space. 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.

Part I

This paper is an extended version of the companion paper *Time Dilation Requires an Ether* [1]. The first nine pages of this paper comprise Part I and are identical with only minor revisions to those of the first reference. [1] Part II of this paper provides additional examples and derivations of the different values of time dilation based on the two paradigms introduced in Part I: *The Geometry of Empty Space* and *The Temporal-Inertial Field.*

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 or frame.
- 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 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. A space without properties can have no effect on an entity moving through it, whether the entity moves at constant velocity or accelerates. However, 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]

I 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 the next section of 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]:

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

where

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

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

Let me restrict the validity of Eq (1) by requiring the clock in the frame of the outside observer, measuring the value of t_1, to be stationary relative to a space containing the TI field.

I contest in this paper the validity of this definition 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 contain accurate, identical clocks. 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 tick rate of clock B. Had clock A not been a part of the test, the variation in clock B's tick 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 tick 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 that determines 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).

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

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

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):

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

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:

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

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 appears 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, or do you even have to? 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 each clock be judged to tick 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 both clocks can't tick more slowly than their counterparts, 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 motion of the ship. Again, the vertical component of the photon's apparent sawtooth path is c. 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.

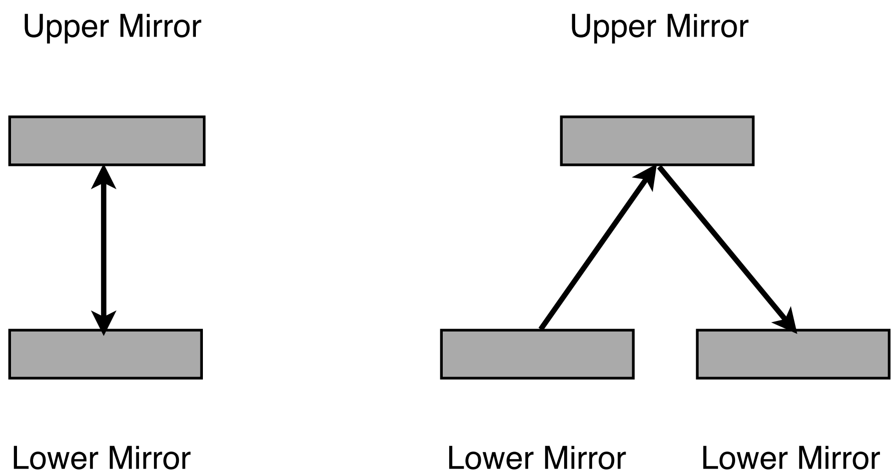

Figure 1. a b c d Two Views of the Transverse Clock. Left View is Stationary, Right View is Moving to the Right at a Velocity of v Relative to the TI Field (Upper and Lower Mirrors are Separated by the Vertical Distance d)

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 is it that 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 clock A 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 clock A 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 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.***

Part II

The Photon Clocks

We continue the examination of the behavior of two photon clocks aboard a spaceship moving at relativistic speed relative to their identical counterparts at a point in space that we can consider the reference point for motion of the spaceship. The clocks comprise two mirrors, a laser and a photon detector. One of the moving clocks is the transverse clock and it is oriented so its photons move transversely, but not exactly perpendicularly, to the velocity vector of the spaceship carrying the clock. The other clock is the longitudinal clock and it is oriented so that its photons move longitudinally and parallel with the velocity vector of the ship.

We examine the behavior of the two clocks in two spaces, one without the presence of the TI field and one within the TI field. We examine these behaviors from the perspective of a moving ship, designated ship B, and from the perspective of the 'stationary' reference frame of a second ship, designated ship A.

Assumptions of this Study

- The fundamental assumption of this study is that a field of particles, that I label the TI field, supports the propagation of photons and other force particles.
- The TI field provides a frame of reference for the motion of photons and other force particles.
- ***A space without properties can have no effect on an entity moving through it, whether the entity moves at constant velocity or accelerates. This point will be expanded in a subsequent section.***
- In a space without the TI field, photons move in ballistic trajectories unrestrained by the propagating medium of the TI field.
- In a space without the TI field, photon velocity appears to be the vector sum of c plus the velocity of the ship carrying the photon emitter, but this is an illusion seen from a perspective external to the ship and not moving with the ship.
- In this paper I set aside the contradiction with my conjecture that requires the TI field to support the propagation of photons and other force particles. I assume that photons move at the velocity c without a TI field despite the assertion of the conjecture that the motion of photons without the support of the TI field has no counterpart in reality.
- The following analyses of photons moving without the support of an ether (TI field) are straw men based on geometry only. These analyses satisfy the geometry of the situations, but, according to this conjecture, geometry does not govern the physics of time dilation.

Operation of the Transverse Clocks With No Temporal-Inertial Field

This part of the experiment is conducted in a space devoid of properties other than dimensionality. There is no TI field to support the propagation of the photons, but we'll assume that they move at a velocity of c. The photons move in ballistic paths unaffected by the space they traverse. At the start of our experiment ship B is stationary relative to ship A.

Refer to Figure 1 and examine the operation of the transverse clocks aboard the spaceships. Each simplified clock comprises two mirrors, a laser and a photon detector. The laser of clock B is aimed straight up toward the upper mirror. The laser emits short pulses of photons toward the upper mirror in the figure, the photons reflect off the mirror and are detected at the second mirror. The mirrors are a vertical distance d apart. When clock B aboard ship B is stationary relative to the reference clock in ship A, the period of clock B is 2d/c. This period is the time it takes a pulse of photons to traverse the distance between the mirrors twice. Aboard ship A is an identical reference clock and its period is also 2d/c.

As ship B speeds up, the photon path, when considered by a preferred observer (one who can see such photons) in ship A assumes a sawtooth pattern reflecting from each mirror in turn. Viewed from inside ship B the photon path is still straight up and down. The vertical component of the photon velocity is still c, their launch velocity if you will, from the laser. The apparent horizontal velocity of the photons is the velocity v of ship B. The total velocity of the photons appears to exceed the velocity c of light, but this is an illusion as 'seen' from the perspective of the reference clock. Photons of the transverse clock traverse the vertical distance between the two mirrors in a period of 2d/c. Time dilation does not occur.

To repeat: The period of the clock remains unchanged at 2d/c. There is no increase in the period of the clock even as the ship acquires relativistic speed. Time dilation does not occur.

The reciprocal view from ship B to ship A also perceives a sawtooth pattern of the laser beam of clock A. This too is an illusion. In both cases, the laser beam moves vertically at velocity c between the two mirrors separated by the distance d and their periods are both 2d/c.

Summary of the Operation of the Transverse Photon Clock With No TI Field

1. Photons follow ballistic trajectories. Their velocity is not constrained by their propagation in the medium of the TI field because there is no TI field. There is no counterpart to this behavior in reality.
2. When the ship is stationary, the laser is directed vertically and the photons move up and down reflecting between the two mirrors.
3. When the ship is moving the laser is directed vertically and the photons move up and down with their emission velocity c and horizontally with the velocity of the ship (and the laser). The photons are emitted from the laser with the same vertical velocity as when the ship was stationary but with the apparent vector addition of the longitudinal velocity of the ship. This summation is an illusion.

4. The period of the clock remains the same as when the ship was stationary because the vertical speed of the photons is unchanged. The apparent longitudinal velocity is caused by the longitudinal velocity of the ship. There is no time dilation.

Operation of the Longitudinal Clocks With No TI Field

The following analysis satisfies the geometry of the longitudinal clock in ship B moving relative to the 'stationary' reference frame of the clock in ship A, but we've argued in the section *The Two Clock Experiment* that it is motion relative to space itself that causes time dilation not motion relative to some arbitrary reference frame. The space that provides a reference for motion is a space populated with particles of the TI field. An empty space cannot provide a reference frame for motion at all, and motion relative to an arbitrary reference frame in empty space will exhibit time dilation relative to the frame but the time dilation is neither intrinsic nor absolute.

The reciprocal view from the moving frame of the clock in ship B to the stationary frame of the clock in ship A would show that clock A in the stationary frame runs more slowly than clock B in the moving frame and by the same ratio. Neither value of time dilation is real.

This behavior, again, comprises the reciprocity paradox. Behavior of the two clocks is symmetric. The symmetry cannot be violated in a propertyless space. Neither the 'moving' clock nor the 'stationary' clock can tick more slowly than the other, so neither can tick more slowly than the other. The symmetry can be violated and the paradox resolved only if the clocks move in a field that supports the propagation of photons, the TI field.

Motion Through a Space Without Properties is Undefined

In our thought experiments, two ships are in motion relative to each other. Their motion relative to the empty space they are in is undefined. We can consider ship A to be stationary relative to space and ship B to be moving or vice versa. The two situations are entirely equivalent. Each ship's motion relative to the other is symmetric. Relative to the clock in either ship, the clock in the other ship appears to tick more slowly. This reciprocity paradox is unresolvable in this geometric analysis. The history of which ship accelerated to produce their velocity difference is irrelevant and offers no solution to the paradox. If the two ships are brought together, motionless relative to each other, their clocks will tick at the same rate and neither clock will have lost time relative to the other. The symmetry of their motion relative to each other is inviolable. Both clocks cannot tick more slowly than their counterparts. Therefore, neither clock can tick more slowly than the other. The reciprocity paradox is an illusion.

The motion between two reference frames in a space without properties that yields the inviolable symmetry of the reciprocity paradox tells us that geometric relationships cannot govern the physics of time dilation. The motion that violates this symmetry must be motion relative to a space with properties. This space must contain something that can be used to reckon motion. The thesis of this paper is that this something is the TI field, the field that supports the propagation of photons and other force particles.

The Earth Occupies a Privileged, But Not a Unique Place in the Universe

Operation of the Global Positioning System (GPS) confirms that time dilation occurs as predicted by Einstein's Theory of Special Relativity. [9] This statement appears to contradict the foregoing arguments that claim:

- There is no time dilation between two frames of reference moving relative to each other in a space without properties.
- Time dilation is a function of the velocity of an entity relative to the TI field.

Reference [3] summarizes the characteristics and behavior of the TI field:

- Motion of an object with respect to the TI field causes time dilation. When comparing the time dilation of one object with respect to another the motion of each object with respect to the TI field must be considered. If only their velocity relative to each other is considered in measuring the time dilation between the two, the calculation will be in error unless one of the objects is stationary with respect to the TI field.
- The Global Positioning System must compensate for time dilation of its satellite clocks that is caused by their orbital motion and by gravity. These calculations do not account for the Earth's motion through space and yet the GPS works flawlessly. One of the fundamental conclusions of this conjecture is that the TI field moves in orbit around the Sun just as the Earth. In addition, the TI field orbits the Milky Way Galaxy just as the Sun and moves with the galaxy as well. Accordingly, there is no relative motion between the Earth and the TI field.
- To account for its orbital motion about the Sun, the TI field must be subject to the force of gravity. In a well ordered system as the solar system, the TI field will orbit the Sun in the same profile (orbital velocity vs distance from the Sun) as the planets. Earth should not be a special case, so this behavior should prevail at each planet.

In brief:

- Proper operation of the Global Positioning System (GPS) indicates that the Earth does not move with respect to the TI field.
- Particles of the TI field must therefore be subject to gravity and orbit the Sun just as the Earth does.
- Earth occupies a privileged, but not a unique place in the universe.
- The privileged position of Earth is one at rest relative to the TI field.[3]

Geometric Analysis of the Longitudinal Photon Clock With No TI Field

This treatment is included to show that the geometric analysis of the photon clock yields the same result mathematically as the analysis of the action of the TI field. However, it is the assertion of this paper that geometry does not govern the physics of time dilation; motion relative to the TI field does.

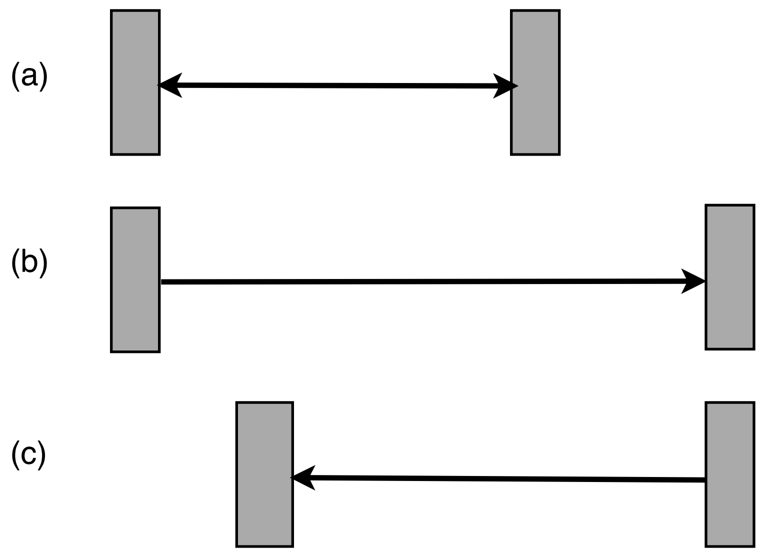

Figure 2. ^ Operation of the Longitudinal Clock. In Upper Figure (a), the Clock is Stationary. In Figures (b) and (c), the Clock Moves to the Right With Velocity v. The Stationary Horizontal Separation of the Mirrors is d.

In the longitudinal clock, portrayed in Figure 2, photons move longitudinally across the distance d between two mirrors. The photons move from the rear mirror to the forward mirror and back again to the rear mirror. Figure 2a depicts the stationary clock. When the ship and clock are moving without the TI field, photons are unaffected by the velocity of the ship and clock. Considering only the geometry of the situation in Figure 2b, photons emitted by the laser at the rear of the clock transit the distance d between the mirrors plus the distance moved by the forward mirror during the transit. The transit time is given by Eq (6).

$$t_1 = (d + v\, t_1) / c \tag{6}$$

Rearrange Eq (6):

$$t_1 = d / (c\,(1 - v / c)) \tag{7}$$

The photon transit time t_2 when moving from the forward mirror to the rear mirror and detector, as shown in Figure 2c, is given by the distance d between mirrors minus the distance travelled by the advancing rear mirror all divided by c.

$$t_2 = (d - v\, t_2) / c \qquad (8)$$

Rearrange Eq (8):

$$t_2 = d / (c\,(1 + v / c)) \qquad (9)$$

Combining Eqs (7) and (9) and rearranging terms gives the period of the moving longitudinal clock.

$$t_m = t_1 + t_2 = 2d / (c\,(1 - v^2 / c^2)) \qquad (10)$$

Recall that the period t_s of the stationary longitudinal clock is 2d/c. The ratio of the periods of the moving clock and stationary clock (uncorrected for length contraction) [10] is then given by

$$(t_m / t_s)_{uncorrected} = 1 / (1 - v^2 / c^2) \qquad (11)$$

Recall that the Lorentz factor $\gamma = (1 - v^2 / c^2)^{1/2}$. The period of the longitudinal clock would appear to be slowed by the square of the Lorentz factor γ, but for the contraction of the distance between the mirrors by the same factor γ. If the distance between mirrors of the longitudinal clock is decreased by γ, the period of the clock is decreased accordingly. The period is thus slowed by the Lorentz factor γ, not γ squared.

$$t_m / t_s = 1 / (1 - v^2 / c^2)^{1/2} \qquad (12)$$

This geometric analysis yields the correct result for the time dilation of the longitudinal clock B relative to the reference clock A, but this conjecture asserts that while the math fits the geometry, there is no counterpart in the physical world. The time period measured for the longitudinal clock satisfies the geometry of the moving clock, but does not actually occur. The apparent time dilation of clock B is an illusion. Motion of the clock through a space without properties can have no effect on the tick rate of the clock. While ship B and its clock appear to move relative to the reference frame of ship A and its clock, ship B does not move relative to the propertyless space. Accordingly, the photon path of the longitudinal clock is unchanged and the period of the clock is the same as when ship B was stationary relative to ship A.

The reciprocal view from the moving frame of ship B to the stationary frame of ship A would show that clock A in the stationary frame runs more slowly than clock B in the moving frame and by the same ratio. This too is an illusion. Neither value of time dilation is real.

Consider the operation (or non-operation) of the longitudinal clock from the perspective of the moving clock itself.

Behavior of the Longitudinal Clock from the Perspective of the Moving Ship

The velocity of photons is c relative to the ship and the clock. In the longitudinal clock, photons move longitudinally across the distance d between two mirrors. The photons move from the rear mirror to the forward mirror and back again to the rear mirror. From the perspective of the ship and clock, space is moving passed the ship from the front to the rear. But what is moving? A space without properties is nothingness itself. There is nothing in this space by which to reckon its motion. Motion relative to this space is undefined. The velocity of the photons of the clock is unaffected by the motion of the clock through a space without properties. The photon transit time t_m of photons moving through the distance between mirrors is twice their separation divided by the velocity of light c.

$$t_m = 2d / c \tag{13}$$

This is the same value as that of the stationary clock. There is no time dilation. Tables 1 and 2 summarize the behavior of the transverse and longitudinal clocks operating without a TI field.

Table 1. Behavior of the Onboard Clocks With Two Different Orientations Without a TI Field (Perspective: Ship)

Photons of the transverse clock move vertically or perpendicular to the motion of the ship.	Photons of the longitudinal clock move parallel to the motion of the ship.
Space is without properties except for dimensionality.	Space is without properties except for dimensionality.
Motion of the ship relative to a space without properties is undefined.	Motion of the ship relative to a space without properties is undefined.
Photons move vertically at a velocity of c across the distance d between two mirrors twice. The period of a photon moving between the two mirrors is 2d/c. There is no time dilation.	Photons move longitudinally at a velocity of c across the distance d between two mirrors twice. The period of a photon moving between the two mirrors is 2d/c. There is no time dilation.

Table 2. Behavior of the Transverse and Longitudinal Clocks Operating Without a TI Field (Perspective: External to Ship)

Photons of the transverse clock move vertically or perpendicular to the velocity of the ship.	Photons of the longitudinal clock move parallel to the velocity of the ship.
Photons move vertically across the distance d between two mirrors. The photons appear to move in a sawtooth path, reflecting between the two mirrors, as the spaceship moves by the stationary observer, but it's the motion of the spaceship that provides the horizontal velocity of the photons. The vertical velocity of the photons is unaffected by the horizontal motion of the ship and clock and is still c. The period of the photons moving between the two mirrors is 2d/c. There is no time dilation.	Photons move from the mirror at the rear of the ship toward a receding mirror at the front of the ship and back again toward the approaching mirror at the rear. The period of the moving clock appears to be longer than its counterpart in a stationary clock. The apparent time dilation is the square of the Lorentz factor γ. The apparent time dilation is an illusion just as the reciprocal view from the ship to the stationary reference clock. The moving clock satisfies the geometry of its configuration, but motion relative to a space without properties has no effect on the photon path. Hence there is no time dilation.
From the outside, the period of the moving clock appears longer than a stationary reference clock, but the appearance is an illusion just as the reciprocal view from the ship to the reference clock.	From the outside, the period of the moving clock appears longer than a stationary reference clock, but the appearance is an illusion just as the reciprocal view from the ship to the reference clock.

Operation of the Clocks Within a TI Field

This part of the experiment is conducted in a space permeated by the TI field, the field that supports the propagation of photons and the other force particles that mediate the forces between subatomic particles. These force particles move at a velocity of c relative to the TI field. At the start of our experiment ship B is stationary relative to ship A.

Again, refer to Figure 1 and examine the operation of the transverse clocks aboard the spaceships. As in the experiment in the space devoid of the TI field, each simplified clock comprises two mirrors, a laser and a photon detector. The laser emits short pulses of photons toward the upper mirror in the figure, the photons reflect off the mirror and are detected at the second mirror. The vertical separation of the mirrors is d. When clock B aboard ship B is stationary relative to the reference clock in ship A, the period of clock B is 2d/c. This period is the time it takes a pulse of photons to traverse the distance between the mirrors twice. Aboard ship A is an identical reference clock and its period is also 2d/c. So far, this duplicates the scenario of the experiment with no TI field. But as spaceship B moves away at high velocity from reference ship A, things change.

As ship B speeds up, the photon path, when considered by a preferred observer (one who can see such photons) in ship A assumes a sawtooth pattern reflecting from each mirror in turn. The vertical component of the photon velocity is no longer c. The velocity of the photons along the diagonal of the sawtooth pattern is c. The horizontal velocity of the photons is the velocity v of ship B. The sawtooth pattern of the laser beam ‘seen’ from the reference ship is the actual path of the photon beam. The vertical component of the photon velocity is obtained from the Pythagorean theorem in which, as just stated, the longitudinal velocity is v of the ship and the diagonal velocity (along the hypotenuse of the triangle of velocities) is c. The vertical component is thus given by

$$v_{vertical} = (c^2 - v^2)^{1/2} \qquad (14)$$

Rewrite Eq (10) as

$$v_{vertical} = c\ (1 - v^2 / c^2)^{1/2} \qquad (15)$$

The period of the transverse clock is increased by the decrease in the vertical component of the photon velocity when the ship and clock are moving. The period t_s of the stationary clock is

$$t_s = 2d / c \qquad (16)$$

The period t_m of the moving clock is

$$t_m = 2d / (c\ (1 - v^2 / c^2)^{1/2}) \qquad (17)$$

The period of the moving transverse clock relative to the reference clock is

$$t_m / t_s = 1 / (1 - v^2 / c^2)^{1/2} \qquad (18)$$

Letting $K = v^2 / c^2$, Eq (18) becomes

$$tm / ts = 1 / (1 - K^2)^{1/2} \qquad (19)$$

Equation (19) expresses the time dilation experienced by the transverse photon clock in the spaceship moving in the TI field. Equation (19) is the same as Eq (1) where in Eq (19), K = v/c.

The Transverse Clock from the Perspective of the Moving Ship

Consider the perspective of ship B moving in the TI field. The photon beam moves vertically when ship B is stationary relative to ship A. The beam reflects back and forth between the two mirrors that are a distance d apart. The period of clock B is 2d/c. When ship B is moving at a velocity v, one would expect space to move toward the rear of the ship with velocity v. From the perspective of the ship, particles of the TI field do just that. The TI field particles move like a tide with velocity v from the front of the ship to the rear. If the laser were directed straight up, the photon beam would be swept toward the rear of the spacecraft and miss the upper mirror as the photons propagate through the TI field. To reach the mirror mounted directly above the laser, but moving, the photon beam must be inclined toward the front of the ship through the angle θ relative to the vertical so that when the photons traverse the vertical distance to the mirror they arrive at the place the mirror will be when the photons get there.

$$\theta = \text{arcsine}\ (v / (\gamma\ c)) \tag{20}$$

where

$$\gamma = 1 / (1 - K^2)^{1/2} \tag{21}$$

so Eq (20) becomes

$$\theta = \text{arcsine}\ (K\ (1 - K^2)^{1/2}) \tag{22}$$

The Lorentz factor γ represents the length contraction [10] of the transverse photon clock parallel with the direction of the velocity of the ship.

The angle θ is plotted in Figure 3 vs K where K = v/c. At small values of v/c, the direction angle of the laser increases almost linearly with v/c, but as v approaches c, the Lorentz factor γ begins to dominate the angle at which the laser must be inclined. Physically, as the length contracts in the direction of the velocity of the spaceship, the rate of change of the inclination of the laser begins to decrease. When v/c reaches the value of $2^{1/2} / 2$, the inclination angle of the laser must be decreased until, when v approaches very close to c, the laser inclination must approach zero or nearly perpendicular to the velocity vector of the ship and laser clock. The maximum inclination angle of the laser is 30 deg when $K = 2^{1/2} / 2$.

This value is obtained by differentiating the value of the sine of the inclination angle of the laser, setting the differential to zero and solving for K where, again, K = v/c.

Recognize that the laser's inclination does not change because of changes in the velocity of the ship; it must *be changed* to guide the photon beam in the direction of the mirror.

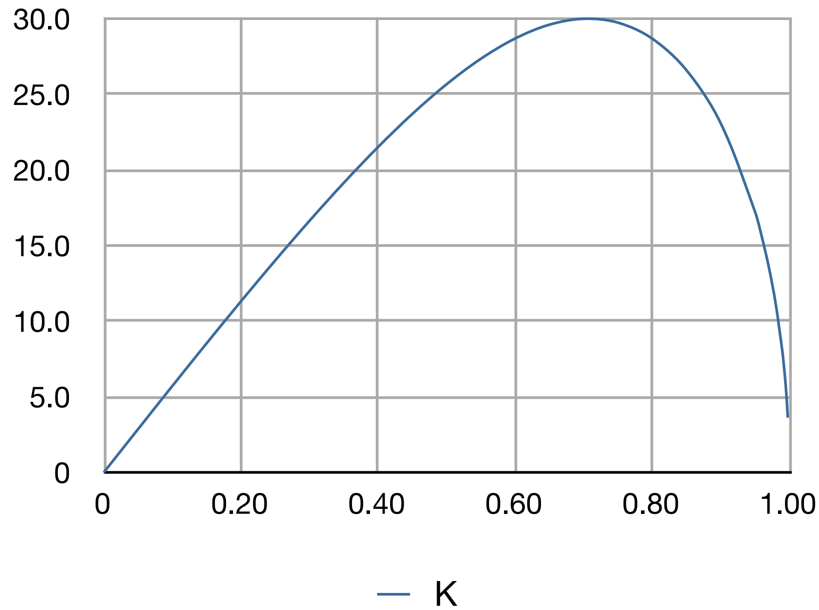

Figure 3. ^ The Direction Angle θ (in deg) of the Onboard Laser of the Transverse Clock Relative to the Vertical vs K (K = v/c)

Adjustment of the Period of the Transverse Clock

The inclination of the laser beam decreases the vertical velocity of the photons from the laser to the upper mirror and back down to the lower mirror. When the spaceship and clock velocity is zero, the photons move vertically between the mirrors with velocity c. When the spaceship velocity increases and the laser is inclined from the vertical through the angle θ, the vertical component of velocity of the photons is c cos θ. Accordingly, the period of the clock is increased by the factor of 1 / cos θ. The need to incline the laser against the flow of the TI field is a consequence of the interaction of photons with the field as the clock moves through it. The requirement to incline the laser into the 'wind' of the TI field is not predicted by the geometric analysis of the clock, because the geometric analysis does not contemplate the TI field.

I don't believe the increase in period of the transverse clock represents an increase in time dilation of the moving ship and clock; it is only an artifact of the geometry of the transverse clock.

The factor F_θ by which the period of the transverse clock is increased by the inclination angle θ is plotted vs K in Figure 4, where again, K = v/c. From Eq (22) the factor F_θ can be expressed as a function of K:

$$F_\theta = 1 / (\cos (\arcsin (K (1 - K^2)^{1/2})) \qquad (23)$$

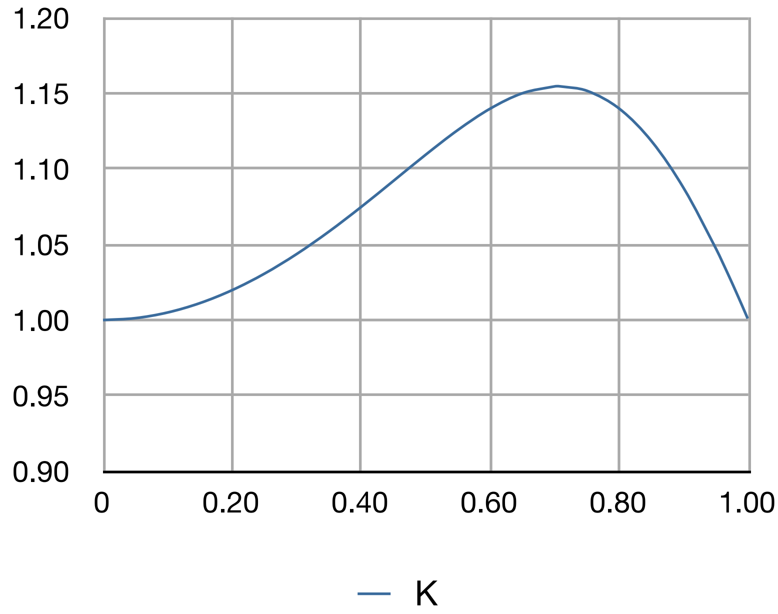

Figure 4. ^ Adjustment to the Period of the Transverse Clock by the Factor F_θ Plotted vs K, where K = v/c

Summary of the Operation of the Transverse Photon Clock in the TI Field:

1. When the ship is stationary, the laser is directed vertically and the photons propagate up and down at the speed of light c reflecting between the two mirrors. The clock period is 2d / c.
2. When the ship is moving, the laser and the photon trajectory must be inclined in the direction of the ship's velocity at an angle relative to the vertical of arcsin (v / (γ c)) where v is the ship's velocity relative to the TI field.
3. The photon velocity is c directed along the inclined trajectories between the two mirrors.
4. Time dilation occurs in accord with Eq (1) and Eq (19).
5. The factor F_θ is the ratio of the increase in the period of the transverse clock, but does not represent an increase in time dilation of the moving ship and clock. The increase is only an artifact of the geometry of the transverse clock.
6. If the laser were not directed toward the ship's velocity vector, as described in item 2, the photons would be swept toward the rear of the ship and miss the mirrors.
7. The argument could be made that if you tilted the laser forward for the clock operating without the TI field, the photons would move at the velocity c along the diagonals of the sawtooth pattern and thus increase the period of the clock. This

argument fails, because the clock doesn't really move relative to an empty space; the upper mirror remains directly above the laser and lower mirror. Photons from the tilted laser would miss the upper mirror.

Behavior of the Longitudinal Clock Within the TI Field

The velocity of photons is c relative to the TI field. In the longitudinal clock, photons move longitudinally across the distance d between two mirrors. The photons move from the rear mirror to the forward mirror and back again to the rear mirror. Forward moving photons are slowed by the flow of the TI field toward the rear of the ship. Rearward moving photons are sped up by the flow of the TI field toward the rear of the ship.

Calculate the photon transit time t_1 when the velocity of the photons, moving from the laser at the rear of the clock, is opposed by the velocity of the TI field moving from the front of the ship toward the rear.

$$t_1 = d / (c - v) \qquad (24)$$

Calculate the photon transit time t_2 when the velocity of the photons, moving from the forward mirror to the rear mirror (and detector), is enhanced by the velocity of the TI field moving from the front of the ship toward the rear.

$$t_2 = d / (c + v) \qquad (25)$$

Combining Eqs (24) and (25) and rearranging terms gives the period of the moving longitudinal clock.

$$t_m = 2d / (c\ (1 - v^2 / c^2)) \qquad (26)$$

Recall that the period t_s of the stationary longitudinal clock is 2d/c. The ratio of the periods of the moving clock and stationary clock (uncorrected for length contraction) is then given by

$$(t_m / t_s)_{uncorrected} = 1 / (1 - v^2 / c^2) \qquad (27)$$

Recall that the Lorentz factor $\gamma = (1 - v^2 / c^2)^{1/2}$. The period of the longitudinal clock would appear to be slowed by the square of the Lorentz factor γ, but for the contraction of the distance between the mirrors by the same factor γ. If the distance between mirrors of the longitudinal clock is decreased by γ, the period of the clock is decreased accordingly. The period is thus slowed by the Lorentz factor γ, not γ squared.

$$t_m / t_s = 1 / (1 - v^2 / c^2)^{1/2} \qquad (28)$$

Table 3 summarizes the behavior of the transverse and longitudinal clocks operating in the TI field.

Table 3. Behavior of the Transverse and Longitudinal Clocks Operating in the TI Field (Perspective: Ship)

Photons of the transverse clock move vertically or perpendicular to the motion of the ship.	Photons of the longitudinal clock move parallel to the motion of the ship.
The TI field permeates space	The TI field permeates space
Particles of the TI field stream past the ship at the velocity v.	Particles of the TI field stream past the ship at the velocity v.
Photons aimed vertically from the bottom mirror to the top mirror are swept to the rear of the spaceship in a sawtooth pattern. The velocity of the photons along the diagonals of the sawtooth is c. The source of the photons must be directed forward at an angle of arcsin (v/(γ c)) relative to the vertical for the photon path to be seen as vertical within the spaceship. The period of the clock seen onboard is 2d/c. The period of the clock is slowed by the Lorentz factor γ. This time dilation is undetectable by observers aboard the ship.	Photons move longitudinally across the distance d between two mirrors, one at the rear of the ship and one in the front. The photons move from the rear mirror to the forward mirror and back again to the rear mirror. Forward moving photons are slowed by the flow of the TI field toward the rear of the ship. Rearward moving photons are sped up by the flow of the TI field toward the rear of the ship. The period of the clock would be slowed by the square of the Lorentz factor γ, but for the contraction of the distance between the mirrors by the factor γ. The period is thus slowed by the Lorentz factor γ, not γ squared. This time dilation is undetectable by observers aboard the ship.

Table 4 summarizes the behavior of the transverse clock operating within and without the TI field.

Table 4. Photon Behavior in the Transverse Clock Within and Without the TI Field

TI Field	Ship and Laser	Behavior of the Clock
No	The ship is stationary. The laser is vertical. The mirrors are a distance d apart.	The photons move vertically between the two mirrors at velocity c. The period of the clock is 2d/c.
No	The ship moves horizontally at velocity v. The laser is vertical.	The vertical component of the photon velocity is c. The apparent horizontal component of the photon velocity is v. The period of the clock is 2d/c. There is no time dilation.
Yes	The ship is stationary. The laser is vertical. The mirrors are a distance d apart.	The photons move vertically between the two mirrors at velocity c. The period of the clock is 2d/c.
Yes	The ship moves horizontally at velocity v. The laser is pointed in the direction of the ship's motion at an angle of arcsine (v / (γ c)) from the vertical.	The photons move at velocity c and at an angle of arcsine (v / (γ c)) from the vertical. Time dilation occurs in accord with Eq (1).

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 [11] 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], [12] 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 temporal-inertial (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 TI 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 based on 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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