Richard A. Peters

Affiliation: None

The Reciprocity Paradox

Abstract

The geometric interpretation of time dilation concludes that the geometric relation between moving objects is the cause of time dilation between the objects. The thesis of this paper is that the imposing edifice of the geometric interpretation rests on a flawed foundation. That foundation denies the existence of any fundamental (natural, physical, real) frame of reference for motion. Therefore the position, velocity and acceleration of an object may be reckoned to an arbitrary frame of reference. 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 propose a model in which a field of particles occupies and permeates all of space, including the space of atoms. In this model the phenomenon of time dilation demands the existence of a field that supports the propagation of photons. I label this field the ***temporal-inertial field (TI field).*** Time dilation occurs when an ongoing process moves relative to space, relative to this TI field. The greater the velocity of the process relative to the TI field 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 the TI field.

Table of Contents

^ Properties of the Temporal-Inertial (TI) Field Model

I define a field of space that I call the **Temporal-Inertial (TI)** field. Its relation to any of the Higgs fields that have been suggested to exist is undefined in this model. I may attribute properties to the TI field that do not obtain for the Higgs field or fields.

The name temporal-inertial is used because of the role of this field in the temporal and inertial interactions with particles of matter. The TI field supports the propagation of photons and other force-carrying particles and, hence, participates in the timing of the interactions among massive particles.

^ Time Dilation

Time dilation is defined as the decrease in the rate of flow of time in a frame moving relative to an outside observer. Time dilation in the frame moving relative to an outside observer is given by Cutner [1]:

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

where

t_2 / t_1 is the ratio of period t_2 measured by the moving clock with respect to the period t_1 measured by the clock of the outside observer.

v_2 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_1, to be stationary relative to space, or more specifically in this model, the TI field. In addition, the clock of the outside observer is outside the gravitational influence of any massive body.

I refer to the tick rate of a clock in this paper. The tick rate of a clock is the inverse of the period of the clock. If the period of a clock is 0.1 sec, its tick rate is 10 ticks / sec. The greater the period of a clock, the slower its tick rate and vice versa. It's more intuitive for me to think of the pace of a clock as its tick rate rather than its period.

^ The Geometric Interpretation of Time Dilation

The geometric interpretation of time dilation is so powerful, persuasive and accurate in describing the phenomenon that no rival modality has emerged to contradict it. The geometric interpretation concludes that the geometric relation between moving objects is the cause of time dilation between the objects. The thesis of this paper is that the imposing edifice of the geometric interpretation rests on a flawed foundation. That foundation denies the existence of any fundamental (natural, physical, real) frame of reference for motion. Therefore the position, velocity and acceleration of an object may be reckoned only to an arbitrary frame of reference.

Locate an object at the origin of this frame of reference. Identify the moving objects in this discussion as clocks, clocks that represent processes that take place over time. According to the geometric interpretation of time dilation, a second clock moving relative to the first clock appears to tick more slowly than the first clock. Conversely, from the perspective of the second clock, the first clock moves away from the second clock and it appears to tick more slowly than the second. The situation of the two clocks in an empty space is completely symmetrical. The apparent paradox of each clock ticking more slowly than the other is a phenomenon of perspective.

^ The Reciprocity Paradox Occurs Only in an Empty Space

In an empty space, the motions of the two clocks can be defined relative only to each other and are thus reciprocal. Clock B moves at a velocity v relative to Clock A and Clock A moves at a velocity v relative to Clock B, but in the opposite direction. The time dilation of each clock as seen from the perspective of the other is an illusion. This is the reciprocity paradox, an illusion of perspective. Neither clock ticks slower than the other. In an empty space, the reciprocity of the relative motion between two clocks (or two processes) ensures that neither clock experiences real time dilation. If the clocks are brought together at zero relative speed the elapsed time on both clocks since the start of the test will be the same.

To grind home the point yet again, let Clock A be the ‘stationary’ clock. Clock B moves away from Clock A at high speed and from the perspective of Clock A Clock B appears to tick more slowly. From the perspective of Clock B Clock A appears to tick more slowly. Is the tick rate of Clock A affected by the speed of Clock B? Clearly the tick rate of Clock A cannot be dependent on the speed of Clock B. Again, the apparent slowing of the tick rate of each clock as ‘seen’ from the perspective of the other is illusory.

The geometric interpretation of time dilation, that underlies Special Relativity, reveals the reciprocity paradox, the symmetry in the relative motion between moving objects that cannot explain real time dilation. How is it possible, then, that tests involving objects moving at high speed, the Global Positioning System (GPS), the Large Hadron Collider (LHC), in the real world show that time dilation is real. It’s simple, really, these test are conducted in a world that does not exist in an empty space.

In an empty space we have no alternative to reckoning motion relative to an arbitrary frame of reference. Relating the motion between two objects (clocks) to each other reveals the reciprocity paradox, the symmetry in the relative motion between the two objects that stymies a valid accounting of time dilation.

Is there another modality that could break the symmetry of the relative motion of the two clocks in an empty space? The existence of a field of particles that permeates space could serve as a frame of reference for motion of the clocks.

Consider an experiment taking place in real space, not the idealized empty space of the geometric interpretation.

^ A Thought Experiment in Real Space

This thought experiment employs clocks as proxies for processes that evolve in time, whether atomic, chemical, biological or mechanical. No rocket ships need apply; this is a thought experiment after all. A more detailed description of this experiment is given in reference [2].

Start with two identical clocks that are stationary relative to the field of particles that I call the TI field. Clock A serves as our reference clock and it remains stationary relative to the TI field throughout the experiment. Clock B accelerates away from Clock A at high speed, coasts for a time, then slows until it is stationary relative to Clock A, but at a great distance. Clock B then returns at high speed toward Clock A, slows down and comes to a stop at Clock A. Comparison of the two clocks shows that the elapsed time on Clock B is less than that on Clock A.

This thought experiment can be divided into nine phases as described in Table 1. Examine what happens to the tick rate of Clock B as its velocity relative to the TI field changes during the experiment.

^ Table 1. Phases of the Thought Experiment

Phase	Description
1	Clocks A and B are stationary relative to the TI field and are synchronized to indicate the same time.
2	Clock B accelerates away from Clock A. As the velocity of Clock B relative to the TI field increases, its tick rate decreases. Its tick rate is unaffected by its acceleration [3] [4] [5].
3	Clock B coasts at constant speed relative to the TI field. The period of Clock B is greater than that of Clock A by the ratio given in Eq (1).
4	Clock B decelerates to a stop at the point most distant from Clock A. As the velocity of Clock B relative to the TI field decreases, its tick rate increases. Its tick rate is unaffected by its deceleration [3] [4] [5].
5	Clock B stops relative to the TI field and Clock A. Its tick rate is again the same as that of Clock A.
6	Clock B accelerates back toward Clock A. As its speed relative to the TI field increases, its tick rate again decreases. Its tick rate is unaffected by its acceleration [3] [4] [5].
7	Clock B coasts at constant speed relative to the TI field. The period of Clock B is greater than that of Clock A by the ratio given in Eq (1).
8	Clock B decelerates to a stop relative to the TI field and adjacent to Clock A. As the velocity of Clock B relative to the TI field decreases, its tick rate increases. Its tick rate is unaffected by its deceleration [3] [4] [5].
9	Clock B stops relative to the TI field and adjacent to Clock A. Its period and its tick rate are again the same as those of Clock A.

We can safely conclude the following:

1. When Clock B was stationary relative to Clock A and the TI field at the start of the experiment, at the middle of the experiment and at the end of the experiment, its period and its tick rate were the same as those of Clock A.
2. During its high speed runs, the tick rate of Clock B was slower than that of Clock A.
3. Therefore, when the velocity of Clock B relative to the TI field increased, its tick rate decreased.
4. Conversely, when the velocity of Clock B relative to the TI field decreased, its tick rate increased.

Note, in particular, that in phases 4 and 8 when the velocity of Clock B relative to the TI field decreases, its tick rate increases. This behavior is in full accord with Eq (1). Imagine that we initiated our thought experiment with both clocks moving at high speed relative to the TI field. We then accelerate Clock B in the direction to decrease its velocity relative to the TI field. Its tick rate would then ***increase***. This would be a real change in the tick rate of the clock. In an empty space from the perspective of Clock A the tick rate of Clock B would still decrease. The reciprocity paradox would be in full sway and the geometric interpretation of time dilation that denies the existence of a fundamental frame of reference for motion would again fail to account for the real change in the tick rate of Clock B in its motion away from reference Clock A.

In our thought experiments, what influenced the tick rate of Clock B? Some entity in the immediate vicinity of Clock B must be responsible for the change of the clock's tick rate with its change in motion relative to Clock A and the TI field.

^ What Modality Affects the Rate of Evolution of a Process, e.g. the Tick Rate of a Moving Clock?

According to our thought experiment the rate of evolution of a process, that we exemplify as the tick rate of a clock, is slowed by the velocity of the process (clock) relative to some as yet undefined frame of reference. The tick rate of a clock, then, is a function of its velocity relative to this frame of reference for motion.

What entity impels the clock to decrease its tick rate as its velocity increases? What entity impels the clock to increase its tick rate as its velocity decreases? Whatever affects the clock must be in its immediate vicinity. The only such entity is space itself, the space that permeates the atoms of the clock, the atoms whose inner dynamics determine the tick rate of the macro object they comprise [6]. This space is not empty, but is permeated with particles. These particles define a frame of reference in which motion of the clock can be reckoned.

Motion of the clocks relative to the field of particles is not symmetrical. Providing a frame of reference for motion is a necessary but insufficient role for this field. The field must also interact with matter particles in a fashion that affects their inner dynamics. A field that supports the propagation of the force particles that regulate the dynamics of fundamental particles would meet this requirement. References [2], [6] and [7] show that the TI field meets these requirements.

The exchange of force particles, photons and gluons, determines the cadence of all physical processes at the most fundamental level. I concluded in reference [6] that a process that moves relative to the TI field and is mediated by the exchange of force particles takes longer than that process at rest relative to the field that supports the propagation of those force particles.

The modality driving the tick rate of the clock is the velocity of the clock relative to the particles of the TI field. This modality determines the time dilation experienced by the clock in accord with Eq (1). The velocity v_2 in Eq (1) is the velocity of the clock relative to particles of the TI field. While I've stated that v_2 is the velocity of the moving clock relative to the reference clock, I stipulated that the reference clock is stationary relative to the TI field and far from the gravitational influence of any body. The velocity v_2 in Eq (1) is therefore the velocity of the clock relative to the TI field.

The reciprocity paradox vanishes when we accept the TI field as the fundamental frame of reference for motion. The velocity of the clocks relative to each other is still symmetrical, but their velocity relative to the TI field is not and it is the interaction between matter particles and the TI field that drives time dilation.

^ The State of Motion of the TI Field

Clearly, the TI field is a frame of reference for motion, but determining the motion of an object relative to that field may appear to be problematic. This is so because determining the motion of the TI field itself is problematic. While the state of motion of the TI field is not readily measured, it can be inferred from the interaction of the field with nearby gravitational bodies. The most relevant of these interactions is the field's response to gravity. In reference [7] I argue that the TI field is subject to gravity and make the bizarre assertion that the TI field orbits the Sun just as the planets do. Accordingly, Earth orbits the Sun in concert with the TI field ensuring that the velocity of Earth relative to the TI field is zero.

Superimposed on the orbital motion of the TI field is the infall velocity of the field toward the Earth's center. This infall velocity of the TI field accounts for gravitational time dilation, but that phenomenon need not concern us here. Experiments on Earth work just fine using earthbound clocks as their reference. The Global Positioning System and the Large Hadron Collider are examples of systems that must account correctly for time dilation. The reciprocity paradox is not in play in these systems because they operate in real space in the presence of the TI field.

^ Conclusions

1. The clocks identified in this paper are representative of any time consuming process, whether subatomic, atomic, chemical or biological.
2. In an empty space, the reciprocity of the relative motion between two clocks (exemplifying processes) ensures that neither clock experiences real time dilation.
3. The time dilation of each clock as seen from the perspective of the other is an illusion. This is the reciprocity paradox, an illusion of perspective.
4. The geometric interpretation of time dilation, that underlies Special Relativity, reveals the reciprocity paradox that cannot explain real time dilation.
5. The reciprocity paradox vanishes when we accept the TI field as the fundamental frame of reference for motion.
6. The TI field provides an absolute reference frame for motion.
7. Time dilation of a clock (exemplifying a process) moving in space is a function of its velocity relative to the TI field. The faster a clock moves relative to theTI field, the greater is its period and the slower is its tick rate.
8. Time dilation of a moving clock (process) is intrinsic, absolute and not dependent on the observation of an outside observer.
9. Lastly, the question must be asked: Are there other phenomena borne of the notion of an empty space that were derived in disregard of the reciprocity paradox?

^ References

1. ^ Cutner, M.L., *Astronomy, A Physical Perspective,* (Cambridge University Press, Cambridge, 2003), p 128.
2. ^ a b Peters, Richard A., *Time Dilation and the Twin Paradox Revisited,* http://viXra.org/abs/1407.0073.
3. ^ Bailey, J., K. Borer, et al., *Measurements of relativistic time dilatation for positive and negative muons in a circular orbit,* http://www.nature.com/nature/journal/v268/n5618/abs/268301a0.html, 28 July 1977.
4. ^ *Time dilation of moving particles,* http://en.wikipedia.org/wiki/Time_dilation_of_moving_particles#Clock_hypothesis.
5. ^ *Clock hypothesis,* http://en.wikipedia.org/wiki/Clock_hypothesis.
6. ^ a b c Peters, Richard A. and Walter A. Johnson, *Conjecture on the True Cause and Meaning of Time Dilation,* http://viXra.org/abs/1212.0115, December 19, 2012.
7. ^ a b Peters, Richard A., *Conjecture on Time Dilation, Gravity and Inertia, Ver 2,* http://viXra.org/abs/1205.0112.