The Law of Universal Specificity
&
The Theory of Everything That is Light

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***Abstract*—The causal discovery presented in this paper is that special and general relativity time dilation are both caused by specific work—changes in specific energy—as apposed to being caused by two very different unrelated phenomena, as previously understood. This is a newly induced generalization, and a significant portion of this paper is a study of this new generalization's implications. The implications studied includes: the mass-energy equation, the photon momentum equation, the mass of photons, red/blue shifts in photon frequency. It turns out, $E = mc^2$ is a special case of the total relativistic energy equation, which is derived in this paper. The total relativistic energy equation is such that $E \leq mc^2$. This change from the mass-energy equation to the total relativistic energy equation has many implications. Firstly, it implies that mass and energy are not the same things, as previously understood. Energy remains an inseparable aspect of an object with mass, as it did under Newtonian Physics, which in turn implies photons have mass. Secondly, it implies a change is required in the photon's momentum equation, because that equation was derived from $E = mc^2$. The last covered implication is that a simple experiment, leveraging a photon's red/blue shifts, can test for, and measure, a photon's mass. Finally, the paper indulges in some speculation where the implication study was unable to prove an implication. This speculation posits a potential path towards integrating quantum mechanics and relativity, and that perhaps only three fundamental forces exist, where the other supposed forces are only a special combination of one of the three. These three forces are electric forces, magnetic forces, and gravitational forces, and a photon is responsible for these forces and are coupled together under electromagneticgravitatism, where each force operates orthogonality, one force in each spacial dimension.**

TABLE OF CONTENTS

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1. INTRODUCTION

The main content within this paper is an adjustment of the legacy model of relativity to a more consistent causal model, to include any implications of this shift. The legacy model is a mix of descriptive models and causal models. The power in transforming to a more consistently causal model is the ability to determine when legacy descriptions will succeed, when legacy descriptions will fail, and a new ability to discover new casual relationships that would be impossible otherwise.

A Historical View Point

This would not be the first time in history that these powerful effects manifested when transferring from a legacy model to a more consistently causal model. Perhaps the greatest contrast in history is the earth centered descriptive model vs the sun centered causal model—or Ptolemy's vs Kepler's model of our solar system.

It was this transformation to Kepler's model that made Newton's Universal Law of Gravitation possible, which made general relativity possible. Further differences between Ptolemy's and Kepler's model are discussed in Appendix A to draw out more important differences between descriptive and causal models.

These transformations never mean observations are going to change all of a sudden. It only ever means that our understanding of observations become richer, we become more effective at prediction—the source of our cognitive power—and more capable at discovering deeper truths.

The critical historical point is this: like Ptolemy's model, if relativity contains elements of a descriptive model, then these elements are likely to stall scientific progress until a more consistent causal model is offered and accepted. This paper attempts to make such an offer.

Causal Proofs

Causality is a law of nature. It is the law of identity applied to action. This causal law states that a thing must act, or change, in accordance with its nature, and it cannot act, or change, contrary to its nature. Because of this, causal relationships always involve some change or action. In addition, causal proofs always involve observing and demonstrating what drive these changes. The only known methods to prove a causal relationship are Mill's Methods.

In contrast, much of science today involves finding models that accurately describe observation, and to use these models to make predictions. This is a focus on *what* happens, rather than on *why* it happens.

Causal proofs, on the other hand, go beyond deriving math models that describe *what* observations were, and they explain *why* an observation is necessary *because* of the nature of the entities involved. The difference between a descriptive vs causal model is the difference between: (1) not being able to distinguish between coincidental observations and necessary observation, and (2) being able to distinguish between them.

Certain things are outside the domain of causality because they are always invariant. For example, the limit of speed, which is commonly referred to as *the speed of light*, is an invariant outside causal consideration. These invariant things, whatever they are, do no change; therefore, they cannot cause change in something else. In a sense, invariant things of this kind are more fundamental than causality, because no causal relationships can contradict them; and all casual relationships must remain consistent with them.

For deeper discussion on why the claims in this subsection are the case, see *The Nature of Causality* in Appendix B.

Importance of Standards of Measurements to Experiments

Experiments that employ Mill's Methods assume standards of measurements are invariant—meaning you do not switch back and forth between different units of measurement without a conversion of equivalence. Invariant standards are critical to making causal discoveries and deriving their mathematical relationship.

Relativity shows us that our standards for measuring time and measuring distance, and all other measurements that make use of those, changes depending on the reference frame they are employed—the units of measurement change in an undetectable manner. This posses problems when considering relativistic thought experiments, and it leads to paradoxes.

In order to resolve the paradoxes, first a conversion of equivalence must be found and used. Such a conversion is made possible by a more consistent causal model of relativity as will be shown in later sections.

Other Key Concepts

In order to keep the main discussions in this paper concise, it had to be assumed that the reader was sufficiently familiar with certain key concepts. If this turns out not to be the case, then something termed *cognitive blindness* is induced, where the discussions in this paper are unable to help the reader become aware of some key fact, or unable to help them make sense of some key point. This is because a key concept was assumed to be commonly understood (between reader and writer) in sufficient manner, when in fact there was a significant difference. Appendix B further discusses many of these key concepts to help gain a better common understanding when necessary or desired.

Paper Organization

This paper is organized in the following sections: [TBD]

2. The Legacy Relativity Model

In this section, the legacy relativity model is discussed, focusing on special relativity because this is where we make the transformation to a more consistent causal model begins.

An important emergent property of special relativity is kinetic time differential—AKA time dilation.[2] Further discussion on how time differentials are conceptualized in this paper, see *Time Differential* in Appendix B. Review Appendix C for a legacy derivation of kinetic time differential.

In the legacy model, changes in time differentials are due to velocity, which is mathematically modeled in Equation (1).

$$\frac{dt}{dt'} = \sqrt{1 - \frac{v^2}{c^2}} \tag{1}$$

Where :

dt' is the time derivative of the stationary observer
dt is the time derivative for the moving observer
v is the relative velocity of the moving observer
c is the limit of the speed of light

This model describes what each observer sees, and helps predict future observations, but it also leads to many problems to include: a lack of measurement standards, a lack of universal simultaneity, mathematical complexities akin to the complexity found in Ptolemy's planetary model, and paradoxical contradictions.

Lacks Instrumental Grounding

The legacy relativity model lacks instrumental grounding. We learn from the legacy model that length contracts and time dilates, which are used to estimate velocity, forces, energy, and many more physical things. They are all relative depending on the reference from of the observer. It is believed that no standards can exist, and all is equally valid because they are equally relative.

Lacks a concept of Simultaneity of Events

Since all reference frames are relative, no one can determine if two unrelated events at two locations are simultaneous, or even which one came first. This is a limit on the legacy model's ability to conclusively decide what happens when and where because of the shifting standards of measurement are not able to be converted to an invariant equivalent under this model.

Obviously something cannot happen both before and after another event, but we can lack an ability to discern which is true without the right tools. This is a limitation of the legacy model than some contradictory property of reality, which is known cannot be contradictory.

Parallel to Ptolemy's Model

General relativity, which are based on the foundation of special relativity, is very complex mathematically, and very

[2] The term, *time differential*, is preferred over the term, *time dilation*, because *dilation* implies something gets bigger, like when pupils dilate. Differential, on the other hand, is a more general term because it only acknowledges there *might* be a difference in size, and it does not indicate whether the size difference is bigger or smaller.

difficult to comprehend, and yet, still great at predicting future observations. Not unlike Ptolemy's descriptive model.

The causal model derived in this paper simplifies the constructs immensely, like Kepler's three laws simplified the planetary model.

Paradoxical Contradictions

The legacy model for kinetic time differential leads to many paradoxes such as the twins paradox, the ladder paradox, Ehrenfest's paradox, et. al.

Appendix D explains what the twins paradox is and why the twins paradox is an accepted contradiction. Contradictions cannot exist in reality, and arriving at a contradiction indicates an error in thought has occurred, and thus, this puts special relativity on unsound footing. The nature of contradictions, and why it indicates an error, are further discussed in *Contradictions* in Appendix B.

The next section covers what legacy attempts were made to resolve the twins paradox.

3. Legacy Approaches to Paradoxes

When it comes to the twins paradox, one must be able to determine which twin, or both, experiences time dilation before the twins meet up to determine the truth. Is there a method to determine a priori, before comparing watches, which twin ages? Certain attempts were made in the past to do this, for which I will list two distinct approaches: one focusing on acceleration as the cause over velocity, and the other accepting velocity as the cause and using the Lorentz transformation.

Acceleration Matters

This "acceleration is the cause" approach seems plausible since we "know" one twin accelerated and the other did not—it seems to be the difference that makes the difference. They are on the right path, but this argument ignores the fact that acceleration is also relative, and for the same reason velocity is relative.

For example, when referencing the twins paradox in Appendix D, the twin traveling to Alpha Centauri can measure a relative acceleration of the other twin—meaning he can measure the acceleration of the twin on earth if he assumes himself to be stationary. The fact the traveling twin feels a force can be explained as a temporary normal force to counter act a gravitational force—the net for is still zero.

This acceleration explanation is missing something critical as we shall soon see in the next section.

Lorentz Transforms

The problem with Lorentz Transformation being the resolution of the twins paradox, is that one must somehow know which twin to apply the transformation to first. Suppose all data on acceleration were lost (not even navigational reference to stars), all you have are relative velocities, and changes to relative velocities. Which twin should this transformation be anchored on? No one can tell, and any guess is subject to random error.

From this modified thought experiment, one quickly realizes that this Lorentz transformation argument is basically the same argument as the acceleration argument, without acknowledging the use of acceleration information. The reason the transformation was claimed to "resolve" the twins paradox, was because they implicitly took for granted it had something to do with which twin accelerated. So if the acceleration argument is not complete, then this only hides this fact behind an implicit, unacknowledged assumption.

The next section covers what is missing from the acceleration argument, and begins the transformation from the legacy reltivity model to a more consitent causal model.

4. Universal Inertial Measurement Unit

The problems induced by relativity stem from a lack of invariant standards. In order to establish a universal standard, we need to update our understanding of what an inertial reference frame is. In general relativity, a body in gravitational free fall is said to not be accelerating—the equivalency principle. The equivalency principle is rejected, and claims that a free falling state is accelerating since the net forces are not zero, even if not felt. Section 6 discusses how a force is applied imperceptible to any accelerometer.

An inertial reference frame is one in which net forces are zero, which means the reference frame is not accelerating. The kinetic forces can be measured using an accelerometer and gyroscope, and the gravitational forces can be measured using extremely accurate clocks able to measure time differential gradients. Section 6 derives how gravitational forces can measured by from measuring time differential gradients.

From these three instruments, a universal inertial measurement unit (UIMU) can be constructed to determine the net sum of forces, and any resulting accelerations. An inertial frame is one in which the net forces from the UIMU is zero.

5. Changes in Time Dilation Due to Changes In Specific Kinetic Energy

In how most "resolve" the twins paradox to date, it seems universally agreed upon, whether acknowledged or not, that velocity does not cause time differentials to be different than one. Fortunately, velocity is not the only antecedent factor that might have caused the changes in time differentials between the twins. Something else occurred, which was not common to both twins, and that factor was the twin traveling to Alpha Centauri had work done to himself—we know this with certainty because of the UIMU used by both twins.

Work has a well known relationship to a change in kinetic energy, as defined in Equation (2). Equation (2c) is the relationship between specific work (left side) and change is specific energy (right side).

$$W = \Delta E_K \tag{2a}$$

$$\int F(s)ds = \frac{1}{2}m(\Delta v)^2 \tag{2b}$$

$$\int a(s)ds = \frac{1}{2}m(\Delta v)^2 \tag{2c}$$

We do not yet have enough information to determine the

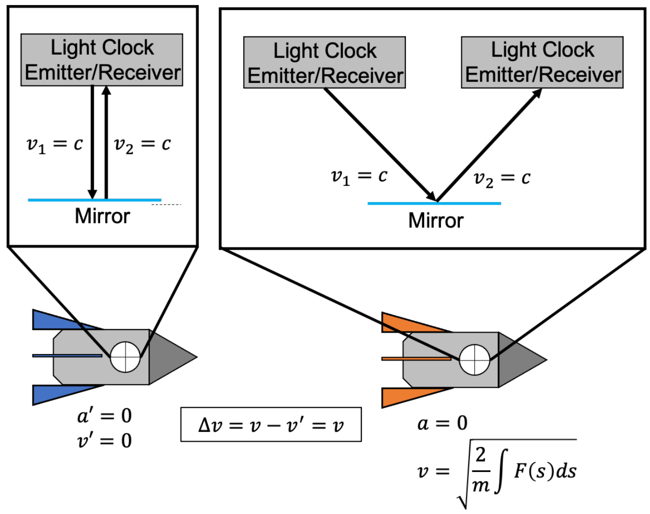

Figure 1. **Reframing the problem with what we know.**

cause of time dilation. One more consideration is required. Does the same work applied to two different objects with two different masses experience the same time dilation; or does it have more to do with specific work applied?

Two simple thought experiments tells us that a change in specific work is the cause.

Proof:

First, let us evaluate changes in kinetic energy.

Case 1: Consider a planet that barley moves when some work is done to it versus the same work done to a tiny marble, which causes that marble zoom to a much higher velocity. Observing both of their light clocks reveals that the marble experiences more time dilation than the planet; therefore, invoking the method of difference, where each object experienced a different effect than the other, while having the same change in kinetic energy, proves that change in kinetic energy cannot be the cause of time dilation.

Now, let us evaluate changes in specific kinetic energy.

Case 2: Consider the same two objects as before, but now they have the same change in specific energy applied to them. By definition, their light clocks show the same time dilation; therefore, invoking the method of agreement, where each object experienced the same effect, while having the same change in specific kinetic energy, proves that change in specific kinetic energy is the cause of time dilation ■.

We now know that a non-zero net force, detected by our UIMU, causes time dilation, and it also causes the change in relative velocity between the initial inertial frame and the traveling twin, in the twins paradox. It explains why the Lorentz transformation approach to resolving the twins paradox works, and why the acceleration explanation was a good start, but incomplete.

Knowing what we now know, we can reframe the problem from scratch in terms of a causal solution.

A Causal Derivation

A UIMU can be used to determine if a net force is being applied over some distance. Kinetic time differential can now be derived in causal terms using geometry. Figure 1 sets up the problem pictorially, and the time derivative relationship between the two frames is shown in Figure 2.

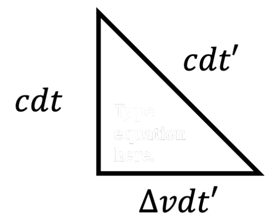

Figure 2. **Updated Pythagorean relationship for distance traveled.**

Using geometric and energy laws we get Equation (3):

$$(cdt)^2 + (\Delta v dt')^2 = (cdt')^2 \tag{3a}$$

$$dt^2 + \frac{\Delta v^2 dt'^2}{c^2} = dt'^2 \tag{3b}$$

$$\frac{dt^2}{dt'^2} + \frac{\frac{1}{2}\Delta v^2}{\frac{1}{2}c^2} = 1 \tag{3c}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_K}{e_{K,\max}}}\ ■ \tag{3d}$$

Or if you wanted this in terms of specific work and acceleration you get Equation (4).

$$\frac{dt}{dt'} = \sqrt{1 - \frac{w}{e_{K,\max}}} \tag{4a}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\int a(s)ds}{e_{K,\max}}} \tag{4b}$$

We now have an equation of time dilation in terms of the causal factor, change in specific kinetic energy. We can see that the Pythagorean relationship between the speed of light and the change in velocity was truly the relationship between max kinetic specific energy and change in specific kinetic energy.

It is important to note some differences between the meaning of Equation (1) and Equation (3). In Equation (1), v causes the time differential for as long as there is a velocity difference—it applies time differential over time. Equation (3), on the other hand, creates a time differential between the two reference frames up front during acceleration over some distance, and once the acceleration is complete, then the differential remains the same until the object is acted upon by non-zero net force.

Applying Equation (3) to The Twins Paradox example resolves the paradox partially, and studying time differential effects on units of length explains (termed here *space differential*) the rest, as shown in *The Causal Solution* in Appendix D.

To sum up what has been proven thus far, now it ought to be well established that a change is specific kinetic energy causes time dilation and apparent space differential. In addition, changes in specific kinetic energy also causes a change in velocity, making velocity necessarily correlated to time dilation, but not its cause, which is why both twins observe the same thing, but time dilation only affects one twin.

With our improved causal understanding of the cause of kinetic time differential, we now turn gravitational forces to study its relationship to time dilation.

6. Changes In Specific Energy Due to Time Differential Gradient

A significant difference between the causal model and the legacy model stems from the causal model's rejection of the equivalency principle, when defining an inertial reference using net zero forces detected by an UIMU. A force felt on earth countering the gravitational forces is not equivalent to a net force of the same magnitude in space, even if our perception (pressures felt) confuses the two different situations—we lack the ability to measure time differential gradients. What we lack in our perception can be overcome by well crafted instruments, such as an UIMU.

Since the concept of space-time, and its curvature, stems from assuming that the equivalency principle is valid, and since this principle is rejected in the causal model, a new accounting is needed. From the causal solution in the twins paradox, found in Appendix D, space dilation is an illusion created by time dilation. Space, therefore, no longer needs curvature to explain observations as will become plain in this accounting of gravitational forces.

The force of gravity is actually caused by a time differential gradient. The relationship between energy and time dilation is interchangeable. Changes in specific energy causes time dilation, and changes in time dilation (or a time dilation gradient) causes changes in specific energy. This is consistent with legacy understanding, but needs refinement given our better understand for the cause of kinematic time dilation.

Given the relationship between changes in time dilation and changes in energy, one can define what a time dilation gradient is, one can see what its relationship to acceleration would be, and it matches observation. This relationship is derived in Equation (5).

$$\nabla dt = \frac{dt - dt'}{dr'} \tag{5a}$$

$$\nabla dt = \frac{dt'\frac{1}{\gamma} - dt'}{dr'} \tag{5b}$$

$$\frac{1}{\gamma} = \nabla dt \frac{dr'}{dt'} + 1 \tag{5c}$$

$$\sqrt{1 - \frac{\Delta SE_K}{SE_{K,\max}}} = \nabla dt \frac{dr'}{dt'} + 1 \tag{5d}$$

$$\Delta SE_K = SE_{K,\max}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{5e}$$

$$g(r)dr' = \frac{1}{2}c^2(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{5f}$$

$$g(r) = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \blacksquare \tag{5g}$$

Where :

∇dt is time time dilation gradient

dt' is time derivative further away from gravitational source

dt is time derivative closer to gravitational source

dr is distance between time derivatives

g is gravitational acceleration at location of gradient, which is also the geometric mean of accelerations at the dt and dt$'$ locations

g is measuring a difference in unit specific energy per unit length (or Joule per meter per kilogram). This difference is caused by a time dilation gradient, which induces a force we call gravity. This is also why everything falls at the same rate, because forces scale with mass.

Given that a time dilation gradient induces a change in energy, an object existing in this gradient is said to have specific potential energy—a potential to achieve some specific kinetic energy state caused by this gradient. Deriving a measure for this potential energy was completed a long time ago using Newtonian physics, which is $g(r) = \frac{GM}{r^2}$.

Gravitational time dilation between two objects influenced by a gravitational field is derived by using Equation (3) to determine how much change in energy exists between the two objects caused by the time differential gradient. Essentially however much total work is required to get from one stationary point in the gradient to another is related to their relative time dilation via Equation (3).

For example, if the initial location is the center of mass of a hollow gravitational source, then the time dilation at the center vs some distance away is equal to time dilation created by a change in specific kinetic energy necessary for the apex of the trajectory to reach said distance, as show in Figure 3. This is because this is how much work is done by gravity between the points.

As another example, if the initial location is at some altitude away from the gravitational source, and the new location is infinitely far away, then the time dilation at that altitude is

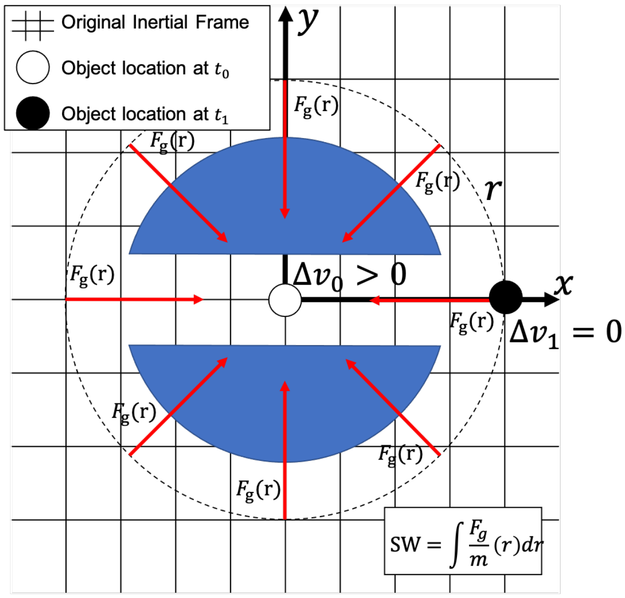

Figure 3. Time dilation at center relative to some point distance r away.

equal to time dilation created by a change in specific kinetic energy required to achieve escape velocity, because this is how much work is done by gravity by the time the object is infinitely far away as given by Equation (6):

$$\frac{dt}{dt'} = \sqrt{1 - \frac{2GM}{rc^2}} \tag{6a}$$

Where :

dt' is time derivative for object infinitely far
dt is time derivative for object r distance away
G is the gravitational constant
M is the mass of the gravitational source
r is the distance to center of gravitational source
c is the speed of light

Adjusting Equation (4) to be in terms of potential energy gives us Equation (7):

$$\frac{dt}{dt'} = \sqrt{1 - \frac{w}{e_{K,\max}}} \tag{7a}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_P}{e_{P,\max}}} \blacksquare \tag{7b}$$

Where :

dt' is time derivative before time dilation
dt is time derivative after time dilation
e_P is specific potential energy

Integrating the relationship between changes in specific kinetic energy and the presence of a time dilation gradient, gives us a new perspective on the total energy equation, as we will see in the next section.

7. Changes in Total Energy Causes Changes in Time Differential

It is no coincidence that time differential is in terms of fractions of the limit of achievable energy for both specific potential and specific kinetic energy. Before we consider changes in specific total energy, let us first consider changes between specific potential and specific kinetic energy does to time dilation, when total specific energy remains the same.

Changes in Potential or Kinetic Energy is Not the Cause

In reviewing Equation (3) and Equation (7), simple analysis reveals that transferring some amount of specific kinetic energy to some amount of specific potential energy (or vice versa) would cause the same time dilation with respect to some initial inertial reference frame. Time dilation is conserved, and so is energy.

For this proof, we are an outside observer in our own inertial reference frame observing an object that starts with some amount of positive specific potential energy, who then transfers all of it to kinetic energy.

Proof :

Let $\mathrm{SE_P} > 0$.

$$\text{Let } \frac{1}{\gamma} = \frac{\Delta t}{\Delta t'} \tag{8a}$$

$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta SE_P}{SE_{P,\max}} \tag{8b}$$

$$1 - \frac{1}{\gamma_P^2} = \frac{\Delta SE_P}{SE_{P,\max}} \tag{8c}$$

$$\left(1 - \frac{1}{\gamma_P^2}\right) SE_{P,\max} = \Delta SE_P = \Delta SE_K \tag{8d}$$

$$\left(1 - \frac{1}{\gamma_P^2}\right) SE_{K,\max} = \Delta SE_K \tag{8e}$$

$$1 - \frac{1}{\gamma_P^2} = \frac{\Delta SE_K}{SE_{K,\max}} \tag{8f}$$

$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta SE_K}{SE_{K,\max}} \tag{8g}$$

$$\frac{1}{\gamma_P^2} = \frac{1}{\gamma_K^2} \blacksquare \tag{8h}$$

Invoking the method of agreement: observing that changes in specific potential energy and changes in specific kinetic energy induced no changes in time dilation, proves that they do not causes time dilation. The same change in total specific energy caused the same change in time dilation proves that changes in time dilation are caused by a change in total specific energy.

Let us now relate total specific energy to time dilation.

Deriving Total Specific Energy Equation

This derivation begins by taking specific potential energy and specific kinetic energy's relationship to γ^2 and solving for change in total specific energy, ΔSE_T.

$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta SE_P}{SE_{P,\max}} \tag{9a}$$
$$\Delta SE_P = \left(1 - \frac{1}{\gamma_P^2}\right) SE_{P,\max} \tag{9b}$$
$$\text{Let } \tau_{\mathrm{P}}^2 = 1 - \frac{1}{\gamma_P^2}$$
$$\Delta SE_P = \tau_P^2 \frac{1}{2} c^2 \tag{9c}$$

$$\frac{1}{\gamma_K^2} = 1 - \frac{\Delta SE_K}{SE_{K,\max}} \tag{10a}$$
$$\Delta SE_K = \left(1 - \frac{1}{\gamma_K^2}\right) SE_{K,\max} \tag{10b}$$
$$\text{Let } \tau_{\mathrm{K}}^2 = 1 - \frac{1}{\gamma_K^2}$$
$$\Delta SE_K = \tau_K^2 \frac{1}{2} c^2 \tag{10c}$$

$$\Delta SE_T = \Delta SE_P + \Delta SE_K \tag{11a}$$
$$\Delta SE_T = \tau_P^2 \frac{1}{2} c^2 + \tau_K^2 \frac{1}{2} c^2 \tag{11b}$$
$$\Delta SE_T = (\tau_P^2 + \tau_K^2) \frac{1}{2} c^2 \ \blacksquare \tag{11c}$$

Qualities of τ ranges from $[0, 1]$ for both specific potential and kinetic energy contributions to time dilation. If either are 1, then that form of specific energy is contributing the maximum amount it can to time dilation—it has reached its limit. For example, when $\tau_K = 1$ it is because $ax = \frac{1}{2}c^2$; or, when $\tau_P = 1$ it is because $gr = \frac{1}{2}c^2$. It is apparent from Equation (11c) that $E_T \leq mc^2$. Equally apparent, when both τ_P and τ_K are less than unity, then Equation (11c) simplifies to the very familiar Equation (12).

$$E_T = E_P + E_K = mgr + \tfrac{1}{2}mv^2 \tag{12}$$

This implies that energy is not some separate entity from mass, but rather energy is an inseparable aspect of an object, which has mass. Therefore, mass cannot be converted into energy, as theorized before, in the sense that mass disappears and pure energy without mass appears.

Lets consider a case involving a photon, a particle commonly believed to have no mass. Let's assume that a non-accelerating object with some mass, m, is not in vicinity of any gravity potential. If this object were to disintegrate into nothing but photons, What would the total energy be of all the released photons (considered in the reference from from which the object started)? If we assume that mass is conserved, then the total mass of the photons is m, and its speed is c by definition. Therefore, $\tau_P^2 = 0$ and $\tau_K^2 = 1$ and plugging these values into the total relativistic energy equation we get: $E_T = \frac{1}{2}mc^2$.

Now, if instead this same object started near a gravity potential, such that $\tau_P^2 = 1$, then the total energy of all the disintegrated photons would be $E = mc^2$ instead because in addition of the specific kinetic energy there is also the specific potential energy. Figure 4 helps visualize this situation.

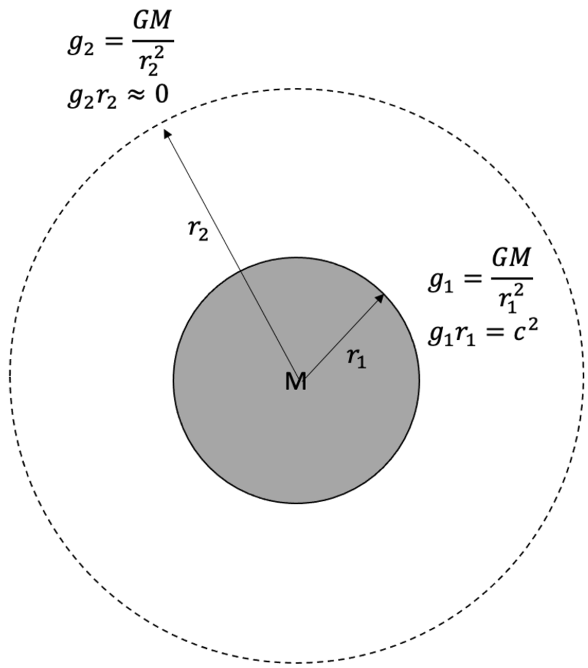

Figure 4. Comparing $\tau_P^2 = 1$ to $\tau_P^2 = 0$.

If a photon is not massless, like many formerly supposed, then what is its mass? We now have the tools to measure this.

Reinterpreting Red/Blue Shift Reveals Photon Mass

We know from electromagnetism that the energy of a photon particle is defined by Equation (13).

$$E = \frac{hc}{\lambda} = hf \tag{13}$$

Now that we have the total relativistic specific energy equation from Equation (11c), we can use that with Equation (13) to estimate the mass of a photon using red/blue-shift measurements as proven below:

Proof :

$$\Delta E = \frac{hc}{\Delta\lambda} = h\Delta f = (\Delta\tau_P^2 + \Delta\tau_K^2)\frac{1}{2}mc^2 \tag{14a}$$
$$\frac{hc}{\Delta\lambda} = (\Delta\tau_P^2 + 0)\frac{1}{2}mc^2 \tag{14b}$$
$$m = \frac{2h}{\Delta\tau_P^2 \Delta\lambda c} = \frac{2h\Delta f}{\Delta\tau_P^2 c^2} \tag{14c}$$

Therefore, measuring the change in specific potential energy and the measured shift in wavelength (or frequency) can yield the mass of a photon. This seems like a relatively (pun intended) easy experiment to set up. What is required most likely already exists. With an emitter at a location on earth, with a known gravity potential, emitting light at a known wavelength (can be constant emission), and with a receiver in orbit, with a known gravity potential, you can collect all the required measurements to estimate the mass of a photon.

I would not assume that the photons at various wavelengths to have the same mass. In fact, it stands to reason, that they would not have the same mass given certain other observations.

Reinterpreting Photon Momentum

Because it was formerly assumed that $E = mc^2$, it was also assumed that the momentum of a photon was defined as Equation (15) below:

$$p = \frac{E}{c} \tag{15}$$

But with our new understanding of total relativistic specific energy we get Equation (16) below instead:

$$p = \frac{2E}{(\tau_P^2 + \tau_K^2)c} \tag{16}$$

This suggests that momentum changes as total specific energy changes—this much makes sense. But, since changes in specific energy induce a color shift, then it seems there is a relationship between a photon's mass and its wavelength (and frequency), assuming constant velocity. I am uncertain how to reconcile this implication with conservation of mass, because the same photon might shift its color and these relationships suggests that its mass also changes. Experimental evidence shows that a photon's momentum is a function of its wavelength, and its energy is also a function of its wavelength. If the masses are different for photons of different wavelength, then we need to revisit what mass means. I speculate in the next section that the measurement of matter (quantity of particles) is subject to dilation too.

Solving for a photon's mass as a function of wavelength or frequency yields:

$$m = \frac{2h}{(\tau_P^2 + \tau_K^2)\lambda c} \tag{17a}$$

$$m = \frac{2hf}{(\tau_P^2 + \tau_K^2)c^2} \tag{17b}$$

This reconciliation will have to wait on future work and additional experimental evidence making use of the progress contained in this work. I will now indulge in speculation in what this reconciliation may be, and therefore, what it might mean; and take the implications of this speculation much farther.

8. Speculations

It is important to delineate what scientific work is based on causal proofs and what is speculation. Unfortunately today, this delineation is obscured far too often largely due to a general ignorance on a valid method of induction. I do not like the popular approach of picking an arbitrary hypothesis and treating as if it were true until proven otherwise—it is a regression to a prescience era in my opinion.

Do not misunderstand me, I am no Einstein; if I were ignorant of the valid method of induction, this paper would likely not exist. If this work has merit, it is only because I know what contradictions mean when I see them, I know how to conduct the causal discovery process[3], and I know how to integrate and find implications of newly discovered generalizations to material I am familiar with [3][4][5]—anyone could have done what I did using those same powerful cognitive tools and methods.

The causal discovery in this paper was that special and general relativity time dilation are both caused by the same phenomena—changes in specific energy—as apposed to being caused by two very different unrelated phenomena, as previously understood. This is a newly induced generalization, and the rest of the paper, up to this point, has been a study of the implications via deductive reasoning. I have taken the deductions as far as I can, and now I a will begin to speculate.

Theory of How Photons Create Gravity and Gravitational Relativity

I acknowledge up front that there is a possible issue with conservation of mass if the mass of a photon were related to its wavelength, because its mass could change simply because its color shifts. A photon would weigh more inside a gravity well. I do not think the amount of matter (measured as mass) is actually changing, but our measure for it might change depending on our reference frame. We understand that our measure for time, and space change in relativistic sense termed dilation. Is it so unrealistic to assume that our measure for the amount of matter might change as well, that it too might be susceptible to dilation?

Why might our measure for the amount of matter change? What could cause this to happen? One plausible reason is that photons with the same intensity (amplitude), but different frequency, interacts with different amounts of space over the same time period, as shown in Figure 5. This gives the appearance, in how its modeled anyway, that one frequency is "more dense" than the other.

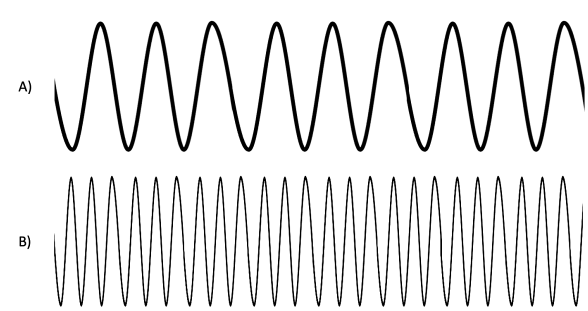

Figure 5. (A) being a smaller frequency seems "less dense" than (B).

[3] And that this process is the only known valid method of induction.

This concept—increasing frequency increases the photon's "density"—is consistent with what is found in Equation (17b), $m \propto \frac{f}{(\tau_P^2+\tau_K^2)}$, but I acknowledge that it could be a coincidence.

What could this mean if it were the true reason? Perhaps every photon is exactly the same frequency, and the only difference that gives the appearance of a frequency change is difference in time dilation causing a shrinking of the space between wave peaks.

What if they do not all go the same speed? Maybe each photon goes so fast, a limit approaching c, that they only appear to all go the same speed. Perhaps changes in specific energy causes imperceptible difference in speed, which then causes their frequency to shift, and therefore, the space between peaks of the wave would shrink or grow accordingly.

I am not sure of the exact reason and I cannot prove these speculations, but perhaps how me measure mass has to do with the space between peaks, so how we measure their mass changes —the existing standards of measurement dilates— as the frequency changes; however, the quantity of matter remains unchanged.

If distance between peaks affects how we measure mass, then perhaps it also affects what we perceive as gravity. Maybe what we are observing with differences in frequency are differences in space-time density. Reconciling this issue satisfactorily might lead to the integration between quantum mechanics and gravity.

Some experimental observations lending to the plausibility of this theory include, refraction observations, and the energy of a photon is known to be related to its frequency and if its speed is the same, then how we measure mass might dilate (or perhaps its speed changes imperceptibly). Also, it is well established that blue light refracts more than red when changing mediums (e.g., light travels in from a vacuum and passes through something more dense like earth's atmosphere). If blue photons have a greater gravitational force, but they have the same amount of matter as red photons, it might explain why blue bends more than red.

Theory of Electromagneticgravitism

If photons are responsible for gravity, then photons are responsible for three forces: electrical forces, magnetic forces, and gravitational forces. Electromagnetism would be a special case of *electromagneticgravitism*, where each force operates orthogonality to the others, and gravitational force operates longitudinally (along the light path) as a function of the frequency of electromagnetism, which makes gravity's coupling with electromagnetism fundamentally different from the electromagnetic coupling.

It would be an interesting coincidence if photons were responsible for three forces, one force in each spatial dimension. Maybe those are the only three forces because there are only three dimensions, and the nuclear forces are actually a special case of *electromagneticgravitism*—each being a different combination of two of the three fundamental forces. These combinations are most likely electrogravitism and magneticgravitism since electromagnetism is well understood.

Matter is Comprised of Photons

If atomic particles (electron, neutron, photon, positron, etc.) were simply many structured photons then the total relativistic energy of all the photons might be $E = mc^2$. This would occur if the structure of the photons were so tightly packed that the distance between photons caused $\tau_P^2 = 1$ (we already know $\tau_K^2 = 1$ for photons).

There is compelling evidence that conventional matter (found on the periodic table) are nothing but light: every massed object emits and absorbs photon radiation constantly, and split atoms releases a significant amount of photons. It might explain why Planck's Law operates as it does, since higher energy implies higher temperature, which implies more kinetic energy for the atomic particles and more kinetic energy is related to blue shifts in photons.

If this were the case, it might lead to the discovery of certain photon structures that combine electromagnetic waves in such a manner that it causes charged patterns or magnetic patters. For example, the structure of photons comprising an electron, could be a photon structure that causes a net negative electric charge while the magnetic part cancels out completely in destructive interference. A difference structure of the same photons might create a positron, which has a positive electric charge, and no magnetic field. As another example, a certain structure of structures (structure of photons, neutrons and electrons) might disrupt the destructive interference of the magnetic part of a photon such that a magnetic field is created. Or when you consider the dynamics of electric or magnetic particles as simply moving light structures, then this might explain how electricity generates magnetism and vice versa.

Perhaps all there is is light in the universe, and the seeming variety of matter found in the periodic table of elements, and their various states, are each simply a unique structure of photons. If so, then the energy of all the photons comprising traditional matter could be $E = mc^2$. However, the released energy can only be $E = \frac{1}{2}mc^2$ because the released photons are no longer in close proximity to each other, and $\tau_P = 0$. The original object still lost mc^2 energy, because that much mass dissipated as released photons, so where did half the energy go? Half the energy was used to achieve escape velocity—i.e., to escape from neighboring photons.

If structured photons comprise matter, there may be a sense in which gravity my be caused by length contraction. First observe that change in specific kinetic energy, which causes a blue shift when moving towards something and red when moving away. A change in potential kinetic energy, which causes a blue shift when moving towards something and red when moving away. This may not be a coincidence.

Perhaps gravity is what we experience with length contraction when a photon experiences changes in its kinetic energy. If this be the case, then perhaps structured photons are constant changing direction, which by definition has to occur since the massed objects move slower than, c; otherwise, the photons would escape, and some do. Perhaps like changes in electrical flux causes a magnetic field and changes in magnetic flux causes an electrical field, the perhaps changes in electromagnetic flux causes a gravitation field via length contraction. If the center of mass had the most length contraction and it reduced as $\frac{1}{r^2}$, then this could explain what causes gravity—length contraction. Since length contraction occurred for changes in kinetic energy, then is it so hard to believe it also occurs for changes in potential energy.

Ether It Is or It Isn't

Perhaps the only states in terms of motion is a non-accelerating and an accelerating state. Perhaps velocity only serves to measure the different between the states of motion. As in, what we call velocity is only a relational measurement between two states, which is useful because it tells us how much acceleration is required to transition from on state to another.

9. Conclusion

In conclusion, it was proved that the common cause uniting all known forms of time dilation is changes in specific energy: specific potential energy for general relativity and specific kinetic energy for special relativity. This had significant implications causing us to update our understanding of the mass-energy equation, photon momentum, and photon mass. In addition, speculations about the nature of a photon's mass lead to a concept of mass dilation, a potential path towards integrating quantum physics and relativity, and finally to the coupling of electromagnetism with gravity, termed *electromagneticgravatism*.

Appendices

Using Figure 3, consider an object at the center of a massive, but hollow, gravitational source. At t_1, the object has some initial positive velocity, v', to the right. Once the object leaves the center, it experiences a gravitational force the the left. Then at $t2$ the object reaches its apex and is to the left of the original inertial frame. The work is calculated, and it creates overall negative work (or potential) because of the negative force applied over positive distance. Negative work can be plugged into Equation (4), and you get Equation (7).

The reason $SE_{K,\max}$ is used, instead of an equivalent specific potential energy, is because this is the maximum kinetic energy possible at t_1.

One can also derive gravitational time dilation starting from a different inertial reference frame, which is an infinite distance away from a gravitational source. This is the common way to define potential energy. The gravitational force would be extremely small, approaching zero, but not zero. Assuming no other influences, and given enough time, an object starting at that reference frame with zero velocity relative to it, would accelerate towards the gravitational source and achieve some velocity relative to that initial frame, which is not accelerating. Then if that object decelerated to a stop relative to the initial frame, and applied equal counter force to the gravitational force, then that object would stop accelerating relative to the initial reference frame too, but it would be experiencing time dilation. If you accounted for the total work done, applied it to Equation (3), you would find that the object's gravitational time dilation (relative to the initial frame) is a function of GM/r, which is the specific potential energy at its current location. This result matches the common form for gravitation time dilation shown in Equation (6, because the common form for for this equation assumes the initial reference frame is infinitely far away from the gravitational source. Now we have a form applicable to any reference frame contained in Equation (7).

A. Ptolemy vs Kepler

Ptolemy's model predicted heavenly events quite well, and when it failed, more mathematical apparatus was added to account for the new anomaly. It was continually being updated, and becoming more complex in the process.

Then Kepler came along with a causal model and found only three, relatively simple, laws were necessary to describe planetary motion more accurately than Ptolemy's model could, and it explained when Ptolemy's model would work and when it would not.

Their respective simplicity and complexity can be compared in Figures 6 and 7

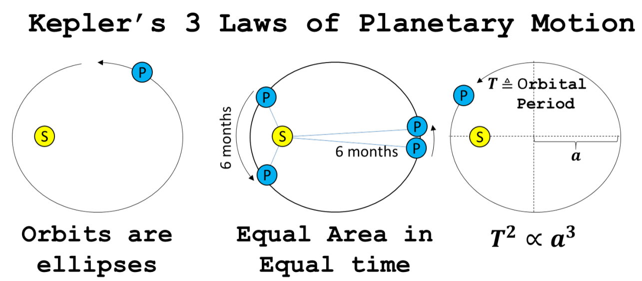

Figure 6. **Kepler's causal planetary model.**

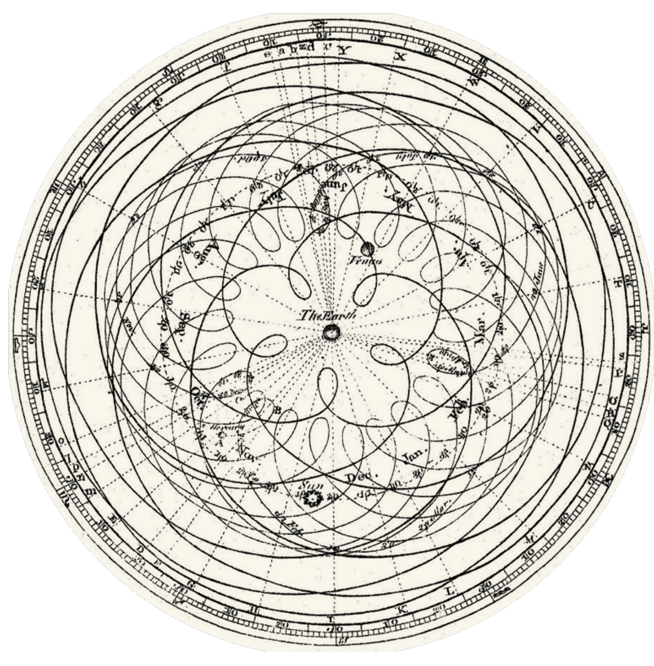

Figure 7. **Ptolemy's descriptive planetary model.**

B. Discussion of Key Concept

Axioms

Identity, contradiction, causality

Causality

Induction Vs Deduction

Scientific Method

Time Differential

As an analogy for interpreting what changes in time differential does, imagine a system of cogs turned by a hand crank attached to the time differential cog, which drives the others. For this analogy, the original inertial reference frame time drives that hand crank at the same revolutions per minute (RPM) regardless of time dilation. When time dilation occurs, then that original time dilation cog is swapped out for a smaller cog. From then on the hand crank spins the system of cogs at a slower RPM than before time dilation, and will continue to do so until that cog is swapped out again (by another change in specific kinetic energy). Figure 8 illustrates this analogy.

C. Legacy Derivation of Special Relativity Time Dilation

The cause of time dilation, in special relativity, has been attributed to relative velocity. As we shall soon see, relative velocity is correlated to time dilation, but it is not the cause of time dilation. The reason relative velocity has been attributed as the cause of time dilation is derived from geometric laws when you assume the speed of light is constant. The original idea of the speed of light being constant stems from Maxwell's wave equations. In addition, the speed of light has been empirically measured to be constant from Michelson's experiments, who was actually attempting to prove it was not constant [2].

A simple thought experiment sets up the problem to derive time dilation given constant speed of light. First imagine a light clock on a stationary ship that emits light from a known location, the light travels some distance, Δy, strikes a mirror and returns the same distance back to the clock's receiver, as shown in Figure 9.

Now imagine that the ship instead has some positive and constant velocity, v, then the light clock can be observed to emit light at the source, bounce off the mirror and return to the receiver but the overall path was different. The light traveled the same vertical distance as before, but this time the light is traveling some non-zero horizontal distance, as show in Figure 10.

Traditional Newtonian physics would have v_1 and $v2$ be greater than c since the motion of the ship would contribute to the total velocity of the light. However, since the speed of light is constant in all references frames, then $v1$ and $v2$ remain c—the same speed the light was traveling when the ship was at rest.

Following geometric laws gives us a relationship between time experienced on the moving ship, Δt, and time experienced on the stationary ship, $\Delta t'$. A *differential* exists between how time passes between the two reference frames. Pythagorean's theorem may be leveraged compare how much distance is covered by the light of the two clocks, as shown in Figure, to derive time dilation.

Using geometric laws we get:

$$(cdt)^2 + (vdt')^2 = (cdt')^2 \tag{18a}$$

$$dt^2 + \frac{v^2 dt'^2}{c^2} = dt'^2 \tag{18b}$$

$$\frac{dt^2}{dt'^2} + \frac{v^2}{c^2} = 1 \tag{18c}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{v^2}{c^2}} \ \blacksquare \tag{18d}$$

From equation (18) it seems reasonable to conclude v caused the time dilation because the speed of light is constant and the only variable is v_{ship}. As will be shown, via the method of difference and agreement, velocity cannot be the cause. Velocity is actually correlated to time dilation because velocity is an effect to the real cause of time dilation.

D. Twins Paradox

The Legacy Setup

Assuming that velocity is the cause of special relativity, then time dilation leads to what is termed *The Twins Paradox*, and the events of this paradox are illustrated in Figure 12. In this paradox, a twin takes off in a ship at some velocity towards Alpha Centauri, arrives, stops, turns around and upon returning home discovers that his twin aged more than himself.[4] This is a paradox because, according to special relativity's account for time dilation each twin fully expected that the other would have aged less. Why? Because on the flight out and back, each twin perceived that the other was moving, so the other's light clock would have looked like Figure 10. Both twins in fact observed the other's light clock looking like Figure 10.

Both clocks appeared to look like Figure 10, but only one aged. This tells us something very important because it reveals a contradiction in our assumptions. It was assumed that perceived velocity causes time dilation, because it creates a time clock that looks like Figure 10, which means time dilation occurs. And yet for one twin, time dilation did not occur. Invoking the method of difference, where each twin experienced a different effect than the other, while having the same relative velocity, proves that velocity cannot be the cause of time dilation. Then what is?

The Causal Resolution

Applying Equation 4 to the four events as shown in Figure 12, and assuming the same magnitude of acceleration was applied over the same magnitude of distance, gives us Equation (19):

[4] Just to clarify, it is assumed the stationary twin is in uniform space, i.e., not in the vicinity of any source of gravity; that the distance being accelerated is so small of fraction of the total distance covered it can be ignored; and the relative velocity between the stationary twin and Alpha Centauri is zero.

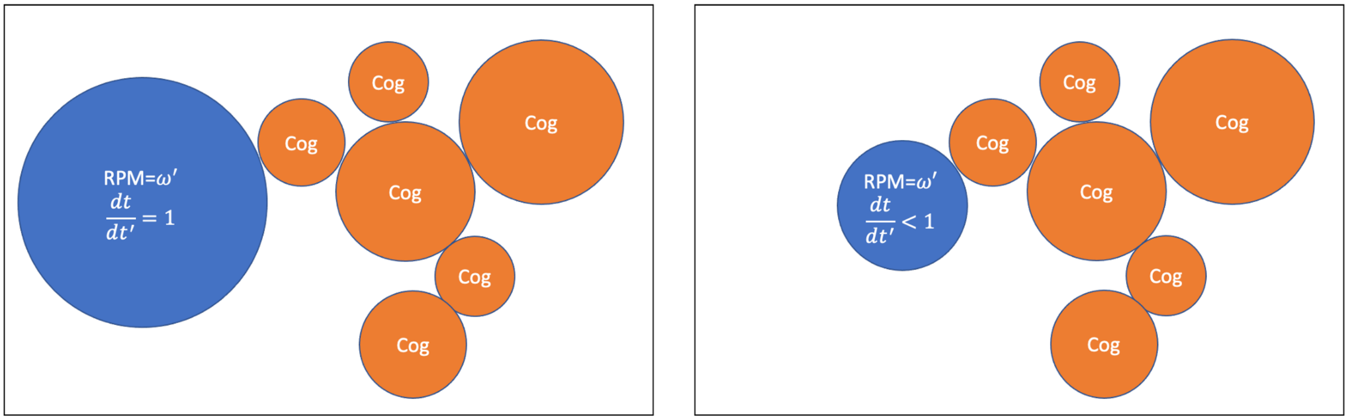

Figure 8. **Left: system of cogs without time dilation. Right: system of cogs with time dilation.**

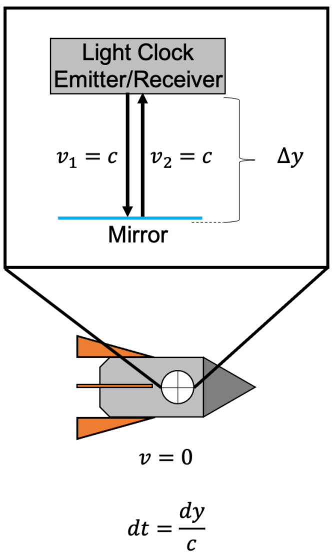

Figure 9. **Light Clock At Rest.**

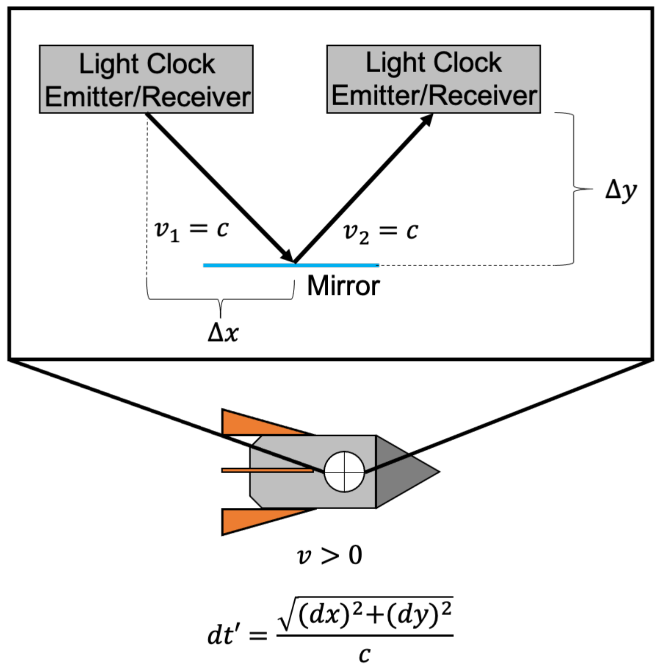

Figure 10. **Light Clock In Motion.**

Event 1 :

$$\frac{dt_1}{dt'} = \sqrt{1 - \frac{ax_a}{SK_{E,max}}} \tag{19a}$$

Event 2 :

$$\frac{dt_2}{dt'} = \sqrt{1 - \frac{ax_a + (-a)x_a}{SK_{E,max}}} = 1 \tag{19b}$$

Event 3 :

$$\frac{dt_3}{dt'} = \sqrt{1 - \frac{ax_a + (-a)x_a + (-a)(-x_a)}{SK_{E,max}}} \tag{19c}$$

Event 4 :

$$0 = ax_a + (-a)x_a + (-a)(-x_a) + (a)(-x) \tag{19d}$$

$$\frac{dt_4}{dt'} = \sqrt{1 - \frac{(0)}{SK_{E,max}}} = 1 \tag{19e}$$

Where :

dt' is the time derivative before time dilation

dt_1 is the time derivative for the accelerating twin after event 1

dt_2 is the time derivative for the accelerating twin after event 2

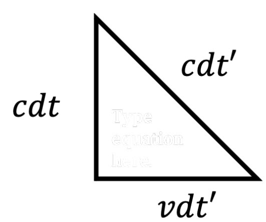

Figure 11. **Pythagorean relationship for distance traveled.**

As might be expected, time differential is unity after event 2 and event 4.

Although the cause for why the accelerated twin was the twin that experienced time dilation, one last question remains to be answer before the paradox is resolved. Why would both twins perceive the other twin's light clocks behaving exactly the same way? In short, it an optical illusion caused by a space

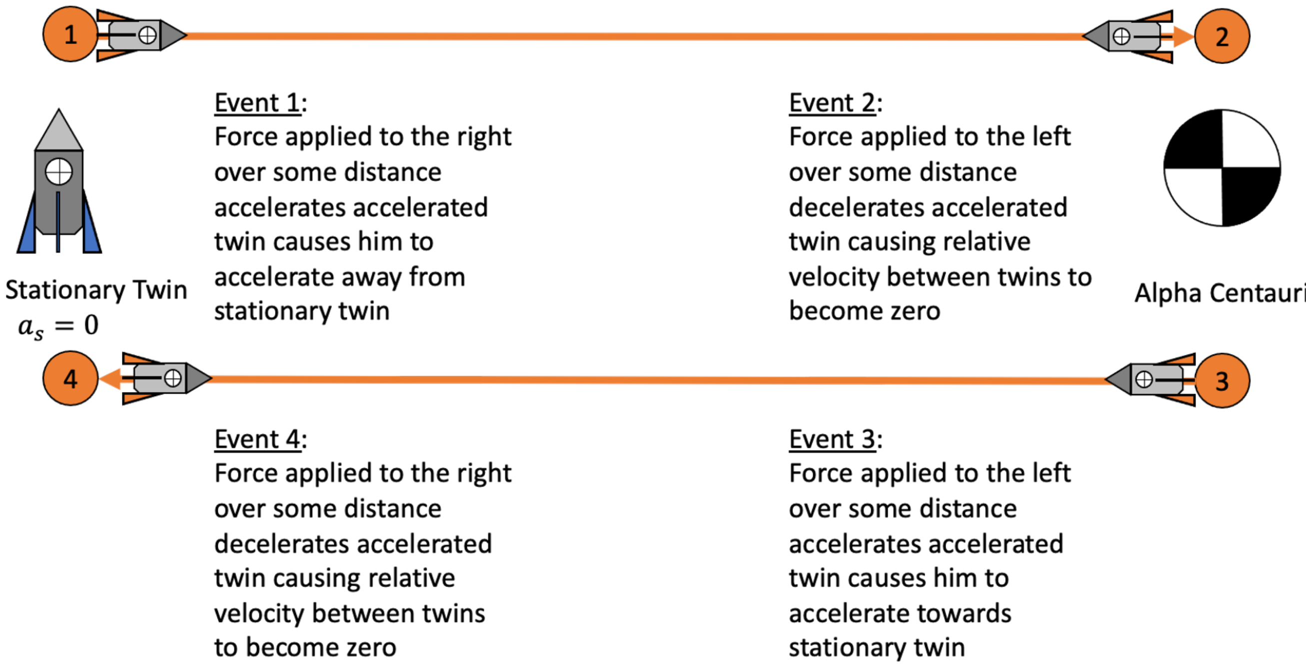

Figure 12. Events Leading to The Twins Paradox.

differential—AKA length contraction—which is defined by Equation (20).

$$\frac{dx}{dx'} = \sqrt{1 - \frac{\Delta e_K}{e_{K,max}}} \tag{20}$$

Where :

dx' is the space derivative before time dilation
dx is the space derivative after time dilation

Two steps are taken to prove length contraction only affects the accelerated twin, as proved by Equation (21), which causes both clocks to look the same regardless of perspective.

Proof :

$$v' = v \tag{21a}$$

$$\frac{dx'}{dt'} = \frac{dx}{dt} \tag{21b}$$

$$\frac{dx'}{dt'} = \frac{dx}{dt'\sqrt{1 - \frac{\Delta SK_E}{SK_{E,max}}}} \tag{21c}$$

$$\frac{dx}{dx'} = \sqrt{1 - \frac{\Delta SK_E}{SK_{E,max}}} \blacksquare \tag{21d}$$

(21e)

Where :

v' is relative velocity before time dilation
v is relative velocity after time dilation
dx' is space derivative before time dilation
dx is space derivative after time dilation
dt' is time derivative before time dilation
dt is time derivative after time dilation
a' is the accelerated twin's acceleration in initial inertial frame
x' is the accelerated twin's distance accelerated in initial inertial frame

An interpretation of Equation (21) is considered in the following thought experiment, which is aided by Figure 13. Consider an accelerated twin headed towards some destination at velocity, v'. Suppose the effect of time dilation is that the time differential cog makes the system of cogs under time dilation rotate at half their original RPM. This means the accelerated twin arrived at their destination wither their cogs at half RPM compared to the stationary twin measured. When your measurement of time is halved it only makes your distance appear halved.

Wrapping up The Twins Paradox, The accelerated twin experiences time dilation and apparent length contraction, which are effects that cancel out when the accelerated twin is observing the velocity of the light in the stationary twin's time clock—and this cancellation creates the mirage. As we can see from this, the twins paradox is resolved.

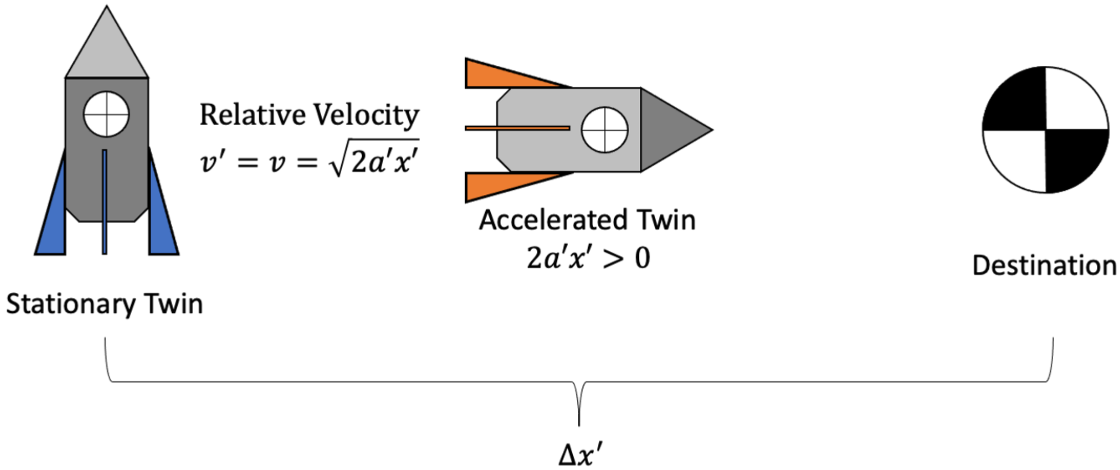

Figure 13. **Example Used In Proof for Cause of Length Contraction Optical Illusion.**

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