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

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***Abstract*—The Law of Universal Specificity quantifies the causal relationship between changes in total specific energy and time dilation. This law was the result of a path taken to induce the cause of kinetic time dilation and relate this cause to gravitational time dilation. These two sources of time dilation, previously understood to arise from two unrelated phenomena, are proved in this paper to be causally related. It is demonstrated that changes in specific energy cause changes in time dilation, and changes in time dilation, from what is termed a time derivative gradient, causes changes in specific energy. In other words, kinetic time dilation and gravitational time dilation are causal reciprocals of each other—the former caused by acceleration and the latter causing acceleration. This discovery required a new causal framework to induce a causal model of relativity, which meant foregoing previously accepted assumptions (which were used as a basis to build the legacy models), and instead follow the chain of available evidence via inductive proofs without accepting non-validated assumptions. It was discovered that the resulting conclusions are on significantly firmer footing, having a validated basis from which to draw conclusions and construct this relativistic causal model, which the legacy models lacked. This is not to say the legacy models are false, in the sense that they fail at predictions (not any more than Ptolemy's models are for planetary motion); however, that is to say they lacked a consistent integrated causal footing, relatively speaking, as is demonstrated. Certain deduced implications of this discovery were investigated, which included implications creating a need to revisit: the Schwarzschild metric, $E = mc^2$, mass-energy relationship, a photon's mass, and a photon's momentum. Lastly, Certain speculative implications were pursued as plausible leads to unite relativity and quantum physics, via providing a quantum explanation for gravity; and a possible lead to a theory of everything that is light was also pursued.**

TABLE OF CONTENTS

1. INTRODUCTION

The Law of Universal Specificity quantifies the causal relationship between changes in total specific energy and time dilation. In one sense, it revolutionizes how we think of relativity, in another it is only an adjustment of relativity's legacy model to a more consistently causal model. The legacy model is primarily a descriptive model, in that it makes certain assumptions and deduces a model consistent with observations. The power in transforming to a more consistently causal model is the ability to avoid making non-validated assumptions; therefore, one gains the ability to determine when legacy predictions will succeed, when legacy predictions will fail, and it creates a new ability to discover new casual relationships that would be impossible otherwise.

The main difference in derivation between Einstein's method and the method contained in this paper is a difference between deductive proof and inductive proof, respectively. Einstein used a deductive process, which required making assumptions to serve as premises from which a conclusion can be deduced. Some of these assumptions were not validated beforehand; and others required a revisit after conclusions were deduced—this never happened. For special relativity, Einstein assumed light speed is constant, velocity is relative (impossible to tell who is moving), and all non-accelerating reference frames are as good as any other. For general relativity, Einstein made an additional non-validated equivalence principle assumption: that an $9.81[m/s]$ accelerating reference frame on a rocket is equivalent to a reference frame on earth experiences the same acceleration produced by the normal force countering the gravitational force. This effectively got rid of gravity as a force causing motion, since this acceleration is considered, via the equivalence principle, as inertial (or non-accelerating). So long as the legacy descriptive model, and its assumptions, continues to be consistent with observation, it continues to be accepted.

In contrast, inductive proofs do not need to make use of non-validated assumptions, so this paper does not make use of them in its proofs, and it revisits other assumptions that seemed valid until relativistic conclusions were drawn. Controlled thought experiments are leveraged to reveal which factors are the cause to an effect, and which are not. Then once a cause-effect relationship is discovered, it is used to deduce implications and to induce deeper causal relationships.

Learning from History: A Historical View Point

This would not be the first time in history that a well predicting descriptive model was replaced by a more consistently causal model to great effect and advancement. Nor will it be the last. There seems to be a great need to start somewhere, and a descriptive model is a great place to start, supposing insufficient evidence is available to induce a causal model. Perhaps the greatest contrast in history, between a legacy and a causal model, is the earth centered descriptive planetary model vs the sun centered causal planetary model—i.e., Ptolemy's vs Kepler's planetary model.

Ptolemy assumed earth was fixed, a good starting place since it appears that way. Then he deduced that the Planets must revolved around the earth. An additional assumption was made: planets move in circles, which it certainly appears that way when tracking them across the night sky over time. With these assumptions, Ptolemy deduced the math required to describe observations with a veneer of a casual explanation—e.g., planets move in circles around earth *because* the earth is fixed, which then causes what we observe. Ptolemy also updated his assumptions, and model, to account for new observations that did not quite match the prior version of the model. In the end, he was able to predict planetary circular motion about an empty point in space, and this space's circular motion about another empty point near earth, and this second empty point circling around earth. Thus, his assumptions and descriptive model were able to remain consistent with observation. With a detailed table, people were able (still are if the know how) to use his model to make amazing predictions, which only served to entrenched his descriptive model for over a millennium. The domain of astronomy stagnated for just as long because they lacked a causal understanding for their observations, and they did not know they lacked it—after all the assumptions remain consistent with observations. This is where the deductive approach to science necessarily stalls.

As Kepler came into the scene, his first task aimed to perfect Ptolemy's model with data made available by Brahe (the required evidence to induce a causal model). Once he did this, he found the same eccentricity in the Sun's and all the known planets' epicycles—i.e., their path around their respective empty points in space shared the same parameter. Why? This can only be explained by a motion common to all those body's—namely (and he did not know yet) the motion of the earth around the sun. This drove him to run analysis on the available data to see what possible cause integrates and explains this common motion, and he found that the Sun being the center of a planetary model was the only possible uniting cause—the one remaining factor that causally connects all planetary motions into three, relatively simple, laws.[2]

It was this transformation to Kepler's causal model that made Newton's causal derivation of his Universal Law of Gravitation possible, which made the achievements of Einstein descriptive general relativity model possible. These transformations to a causal model never mean legacy descriptive model's predictions are necessarily invalid. It only ever means that our understanding of observations become richer, explanations become simpler, we become more effective at prediction—the source of our cognitive power—and we become more equipped to discover deeper causal truths impossible to discover otherwise.

As an analogy, the relationship of a descriptive model to a causal model might be thought of as manipulating a causal equation until the causes involved are no longer recognizable. At least this is the way it appears in hindsight, since Kepler's model can form Ptolemy's if you make the proper transformations of Kepler's model to match Ptolemy's assumptions, and yet planetary motion about nothing but empty space makes no causal sense. For a simpler more tractable example, however, consider what happens when this happens to the conservation of momentum equation, which states that for a closed system the total momentum before an interaction is the same as the total momentum after an interaction. Observe the result after mild manipulation, as shown in Equation (1) for two bodies before and after a collusion.

$$p_1 + p_2 = p_3 + p_4 \tag{1a}$$
$$m_1 v_1 + m_2 v_2 = m_1 v_3 + m_2 v_4 \tag{1b}$$
$$m_1 \frac{\Delta x_1}{\Delta t} + m_2 \frac{\Delta x_2}{\Delta t} = m_1 \frac{\Delta x_3}{\Delta t} + m_2 \frac{\Delta x_4}{\Delta t} \tag{1c}$$
$$m_1 \Delta x_1 + m_2 \Delta x_2 = m_1 \Delta x_3 + m_2 \Delta x_4 \tag{1d}$$
$$m_1(\Delta x_1 - \Delta x_3) = m_2(\Delta x_4 - \Delta x_2) \tag{1e}$$
$$\frac{m_1}{m_2} = \frac{\Delta x_4 - \Delta x_2}{\Delta x_1 - \Delta x_3} \tag{1f}$$
$$\frac{m_1 g h}{m_2 g h} = \frac{(\Delta x_4 - \Delta x_2)}{(\Delta x_1 - \Delta x_3)} \tag{1g}$$
$$\frac{E_{P1}}{E_{P2}} = \frac{(\Delta x_4 - \Delta x_2)}{(\Delta x_1 - \Delta x_3)} \tag{1h}$$

Where :

E_{Pi} is the i^{TH} object's potential energy
Δx_1 is the distance covered in some time interval for object 1 before collusion
Δx_2 is the distance covered in some time interval for object 1 after collusion
Δx_3 is the distance covered in some time interval for object 2 before collusion
Δx_4 is the distance covered in some time interval for object 2 after collusion
p is momentum
m is mass
v is velocity
Δt is some time interval

In this form, Equation (1h) out of context loses all meaning. After all, what does a potential energy ratio between two objects have to do with distances covered, in some time interval, before and after a collision? But if you measure and input the right variables, this meaningless descriptive model will be an impeccable predictor. Suppose you discovered this

[2]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.

descriptive model isolated from any concept of conservation of momentum, then what could possibly be the next step?

The critical historical point is this: like Ptolemy's model, relativity's legacy models contains elements of a descriptive model, and these elements, in effect, have stalled scientific progress in this domain. This domain will continue to stall, like Ptolemy's model caused its domain stall, until a Kepler-like causal model is offered and accepted. This paper attempts to make such an offer.

Key Concepts

Lastly, in order to keep the main discussions in this paper concise, it had to be assumed that the reader possessed an understanding of certain key concepts sufficiently in common with the author. If this turns out not to be the case, Appendix B further discusses many of these key concepts to help gain a better common understanding when necessary or desired. Sections that have references in this appendix are indicated as necessary.

Paper Organization

This paper is organized in the following sections: Section 2 quickly breaks down what induction is, how it compares to deduction, and why it is required; Section 3 presents the legacy special relativity model and its issues; Section 4 presents legacy attempts to resolve the twins paradox; Section 5 presents a required novelty needed for any relativity inductive proofs; Section 6 presents the inductive proof for what causes kinetic time dilation; Section 7 defines and derives the effect of a time derivative gradient; Section 8 inductively proves that change in total specific energy causes time dilation and completes the Law of Universal Specificity; Section 9 presents implications that can be deduced; Section 10 pursues interesting speculative implications; and finally, Section 11 wraps up with a conclusion. Appendices contain richer content to provide more color to the material when desired.

2. Inductive vs Deductive Proofs

Between the two proofs, inductive proofs are the lesser well known. They are causal proofs, and it requires: observation of the causal relationship, application of the law of identity to observed actions, and standardized measurements to quantify the causal relationship.

Deductive proofs, on the other hand, start with premises and then conclusions are deduced from them—think formal deductive logic. The problem with deduction is the problem of induction. Premises always include at least one generalization—e.g., all men are mortal—which can only be verified inductively. Therefore, one cannot verify a deductive conclusion before one has verified all the inductive conclusions that serve as the premises.

This relationship between induction and deduction means that when discovering something new, like a scientific discovery, induction is always required. Only after achieving verified inductive conclusions, can one deduce its implications. More on induction vs deduction is covered in *Induction Vs Deduction* in Appendix B.

Causal Proofs

Causality is a law of nature. It is the law of identity applied to action. The law of identity states a thing is what it is, implying it cannot be what it is not. The law of causality, likewise, states that a thing must act, or change, in accordance with its nature, implying 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 through controlled experiments. The only known methods to prove a causal relationship through controlled experiments are Mill's Methods of induction—it cannot be done by making non-validated assumptions and deducing implications consistent with observations.

In contrast, much of scientific activity today involves making non-validated assumptions and finding models that accurately describe observation, and using these models to make predictions until observations fail, which drives an assumption update and model revision—the exact same method employed by Ptolemy, and by most in my profession, Artificial Intelligence.[3] This is a method that focuses on *what* happens, and making assumptions as to *why* it happens, rather than proving *why* it must happen.

Causal proofs, on the other hand, demonstrate *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. The indistinguishably from (1) stems from making a non-validated assumption, leading to the unanswerable question: is the assumption right, or is it wrong? No body knows, or can know, for sure until a causal relationship is inductively proven. Being continually consistent with observation will never prove the validity of an assumption, one way or the other.

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 relationships.

Legacy relativity models show us that our standards for measuring time and measuring distance, and many more measurements that depend on those, change depending on the reference frame they are employed—i.e., the units of measurement change in a manner needing a conversion. This posses problems when considering relativistic thought experiments, and it leads to paradoxes (unresolved contradictions).

In order to resolve the paradoxes, first a conversion of equivalence must be found and used, and it must be knowable when to use it. The legacy model for relativity uses Lorentz transforms to do this conversion, but they make an implicit assumption as to when to use it, as we shall see in Section 4. Knowing explicitly when to use this conversion is made possible by a more consistent causal model of relativity as will be shown in Section 6.

Causality Has Limits

The last point made here on causality is that certain things are outside the domain of causality, and causal proofs, because

[3] Thus the reason for my title to distinguish myself from those that use this method: Causal AI Architect.

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 all casual relationships must remain consistent with them.

For deeper discussion on causality, see *The Nature of Causality* in Appendix B.

3. The Legacy Relativity Model

In this section, the legacy relativity model is discussed, focusing primarily on special relativity because this is where the transformation to a more consistent causal model begins. The complexities of general relativity's model is also presented.

An important emergent property of special relativity is kinetic time differential—AKA time dilation.[4] Further discussion on how time differentials are conceptualized in this paper, see *Time Differential* in Appendix B. Also, review Appendix C for a legacy derivation of the kinetic time differential.

In the legacy model, changes in time differentials are due to velocity, which is mathematically modeled in Equation (2).

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

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 of the observer. It is assumed that all inertial references frames are equally valid; therefore, it is believed that no standards can exist. Indeed, commonly held view is that two or more observers can all disagree in measurements and all are correct.

Lacks a concept of Simultaneity of Events

Since it is assumed that all inertial references frames are equally valid, no one can determine if two unrelated events at two different locations occur simultaneously, or even which one came first. This is a limit on the legacy model's ability to conclusively decide when something happens and where it happens, 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 rather than some contradictory property of reality, since reality cannot contradict itself.

Parallel to Ptolemy's Model

General relativity, which are based on the foundation of special relativity with an additional equivalency principle assumption. This lead to replacing gravitational forces with the curving of what is termed *space-time*. In order to reconcile this equivalence principle, very complex math was required to integrate this assumption with observation. First, geodesic math tensors had to be introduced to replace gravitation force, because gravity used to be thought as causing an acceleration which caused the motion we see of falling objects and orbiting objects. Now that gravity is no longer considered a force under the legacy model, space-time curvature now makes it appear as though something is accelerating, when it is actually traveling in a straight line (e.g., think straight great circles around the globe projected on a flat map appear curved). Then since the curvature changes depending on the strength of gravity, which fallows the inverse square law, metric tensors were required to capture this change in the form 40 *Christoffel Symbols*. All of this is defined over 4 dimensions in the *Riemann Curvature Tensor*, which is a $4 \times 4 \times 4 \times 4$ tensor (totaling 256 elements). Given certain permutations of the values in this Riemann Tensor, you can derive a smaller *Ricci Tensor* and *Ricci Scalar*. Then finally the parameters of curved space can be equated to an Energy Tensor in *Einstein's Equation*, which is acknowledged to be unproven, but matches known observation so far. All said and done there are (5) Tensors and (1) scalar, which informs an unproven equation, which is practically impossible to solve without making simplifying assumptions and using a computer to numerically solve. Also, when it comes to light they have to make special substitutions to make it all work out.

To sum up, general relativity makes one more assumption than special relativity (the equivalence principle), is very complex mathematically, and very difficult to comprehend; yet, this legacy model is still great at predicting known (and previously unknown) observations. Additionally, it is viewed that gravitational time dilation and kinetic time dilation are seemingly unrelated things driven by unrelated phenomena.

This is not unlike Ptolemy's descriptive model, which made a somewhat similar assumption to the equivalence principle—e.g., instead of assuming space is curving around earth, Ptolemy assumed celestial motion moved around earth—and Ptolemy derived an extremely complex math model from this assumption, it was impossible to comprehend planetary motion around nothing, and yet, it was excellent at making predictions.

The causal relativity model derived and offered in this paper eliminates the un-validated assumptions, simplifies the mathematical apparatus immensely, makes solving relativistic problems simpler, unites seemingly different phenomena under a common cause, and makes observations sensible; very much like what Kepler's model did for planetary motion.

[4] 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.

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 in more detail what the twins paradox is and why the twins paradox is really an accepted contradiction when unresolved. In short, one twin travels (to and from Alpha Centauri) at relativistic speed, and ages less than the other twin. The paradox comes in when both twins predict the other ages less, because each observes the same things, they both think they are the stationary twin, and both apply the time differential equation, which causes both to predict the other twin is younger.

Arriving at a contradiction ought to stop one in one's tracks for it means an error in thought has been made because contradictions cannot exist in reality.[5] This puts special relativity on unsound footing until this paradox is sufficiently resolved. To date, despite claims from others, the twins paradox not been sufficiently resolved. This paper, in Section 6, will use this paradox to induce the cause of time dilation, which is not velocity. But, before that, we cover two legacy attempts that were made to resolve the twins paradox in the next section.

4. Legacy Approaches to Twins Paradoxes

When it comes to the twins paradox, a resolution requires that one is able to determine (with certainty) which twin experiences slower time before clocks can be compared. In other words, one must know the cause, and its effect, before the effect reveals itself. Is there a method to determine a priori, before comparing watches, which twin ages less and which ages more? Certain attempts were made in the past to figure this out, for which I will list two distinct approaches: the first approach assumes time dilation (slower aging) occurred during acceleration, and the other rejects this approach and uses a transformation to determine which twin ages less.

Acceleration Matters

This perspective seems plausible since we "know" one twin accelerated and the other did not, and the "accelerated" twin does age less—it seems to be the difference that makes the difference. This approach is certainly on the right path, but all variations of this approach ignore one key fact, and the worst variation ignores two facts:

1. Slower aging is proven not to occur during acceleration because the same acceleration can lead to different amounts of aging, and acceleration can be eliminated from the equation.
2. Acceleration is also relative, and for the same reason velocity is relative.

An example of fact (1): if the twin traveled twice as far given the same acceleration profile, that twin will be that much younger. Also, if you eliminate acceleration all together, you still have the traveling clock tick slower. Say two ships are used to travel, one from earth towards Alpha Centauri, and one from Alpha Centauri towards earth. Then, once the ships reach top speed (i.e., stop accelerating) you send a start time to the moving ship from earth and that ship's light-clock maintains time. At a rendezvous point somewhere in the middle, the clock information transfers to the returning ship and its light-clock maintains time from there; this is all accomplished without acceleration. Finally, when the return ship reaches earth, the clock information transfers to earth to report the final time. The light-clocks maintained time all during moments of non-acceleration. The result? The moving clock ticked at a slower pace, proving via method of agreement that dilation occurred during motion.

As an example of fact (2): 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 that the traveling twin feels a force could be explained as a temporary normal force to counter act a gravitational force—the net force is still zero. If this were the case, the other twin would have aged less. The feeling of acceleration, via an accelerometer registering some force, is not sufficient to determine which twin ages less.

This acceleration explanation, is on the right path, but it is missing something critical as we shall soon see in the next section.

Lorentz Transformation Reveals the Truth

This claimed resolution assumes that acceleration is not relevant, and only relative velocity causes time dilation. It uses the Lorentz Transform to switch back and forth between reference frames and will work *if* you know which twin serves as the reference point that experiences no time dilation, which is the fatal flaw with this approach. Which twin is considered stationary, and which is moving?

If you apply the transformation to the wrong twin first, then you get an answer that does not align with reality. If acceleration is not relevant to time dilation, then lets get rid of that information. All that remains, in terms of "relevant" information is relative velocities over the trip. Which twin caused the relative velocity? No one can tell, and any guess is subject to random error. A concrete example is provided in Appendix E.

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. It relies on acceleration to compute time dilation accurately, while at the same time denying acceleration's involvement in time dilation—this contradiction is obviously self refuting.

The reason the transformation was claimed to "resolve" the twins paradox, was because they implicitly took for granted that changes in time differentials had something to do with acceleration. Therefore, if the acceleration argument is not complete, then the Lorentz Transformation 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 relativity model to a more consistent causal model.

[5] The nature of contradictions, and why it indicates an error, are further discussed in *Contradictions* in Appendix B.

5. Universal Inertial Measurement Unit

The problems that plague relativity's legacy model stem from a lack of invariant measurement standards. In order to establish a universal standard, we need to update our understanding of what an inertial reference frame is. In the legacy model, a body in gravitational free fall is assumed to not be accelerating—derived from the assumed equivalence principle.

No only is a causal relatively model explicitly avoiding non-validated assumptions, in this case, this equivalence principle is completely rejected because it is provably not equivalent. Gravity is a force, even if we do not possess a means to measure it among our five senses—that would be like saying most of the light spectrum does not exist because we cannot tell with our own eyes that it does exist. The point here is this: free falling is not equivalent to floating in empty space, and being on earth is not equivalent to accelerating in empty space. The reason they are not equivalent is simple: the time derivative gradient (TDG) is zero in empty space and non-zero in free fall and on earth.[6] This difference in gradients breaks any equivalence that may have been previously assumed.

We maintain that a free falling state is accelerating since the net forces are not zero, even if not felt by our senses; and being stationary on earth's surface is non-accelerating since the net force is zero even it it feels unbalanced by our senses. In short, we resurrect the Newtonian notion that gravity is a force, thus getting rid for any need for curved space. As we will see, this will make the math so much simpler.

An inertial reference frame is one in which net forces are zero, which means the reference frame is not accelerating—as will be shown in Section 7, this means an inertial frame is one in which its time differential is not changing.[7] 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 TDGs.

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 an UIMU is zero. Using an UIMU, a twin can tell if they are not accelerating on earth, or accelerating in a ship in deep space. This UIMU instrument, along with the new conception of inertial reference frame, was the missing link in the legacy attempts to resolve the twins paradox.

6. 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, changes in time differentials is not primarily driven from relative velocity. However, the true cause has remained unproven deductively because it cannot be discovered deductively. Induction is required to test antecedent factors to determine which one drives the effect.

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 and our updated conception of an inertial reference frame.

Work, a force applied over some distance, has a well known relationship to a change in kinetic energy, as defined in Equation (3). Equation (3d) is the relationship between specific work and change is specific energy.

$$W = \Delta E_K \tag{3a}$$

$$\int F(s)ds = \frac{1}{2}m\Delta v^2 \tag{3b}$$

$$\int a(s)ds = \frac{1}{2}\Delta v^2 \tag{3c}$$

$$w = \Delta e_K \tag{3d}$$

We do not yet have enough information to determine what precisely causes changes in time differential. 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—i.e., work is inversely proportional to mass?

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 to zoom to a much higher velocity. Observing both of their light clocks reveals that the marble experiences smaller time differential (slower clock) 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 changes in time differential.
>
> 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 change in their time differential; 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 changes in time differential ■.

We now know that an object undergoing a non-zero net force, detected by our UIMU and scaled by inverse mass, applied over some distance causes its time differential to change; and it also causes a change in its relative velocity to the initial

[6] Section 7 derives how gravitational forces can measured by from measuring TDGs.

[7] It can be different from another frame, but its not becoming more or less different.

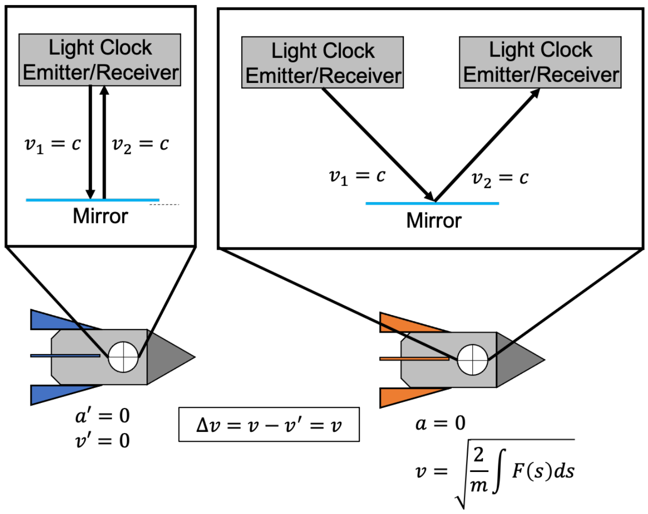

Figure 1. Reframing the problem with what we know.

inertial frame. It explains why the legacy 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

An UIMU can be used to determine if a net force is being applied over some distance. Kinetic time differential can now be derived using geometry—similar to the legacy derivation in Appendix C, but this time we use causal terms instead of correlated terms. Figure 1 sets up the problem pictorially, and the time derivative relationship between the two frames is shown in Figure 2.

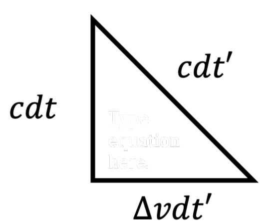

Figure 2. Updated Pythagorean relationship for distance traveled.

Using geometric and energy laws we get Equation (4):

$$(cdt)^2 + (\Delta v dt')^2 = (cdt')^2 \tag{4a}$$

$$dt^2 + \frac{\Delta v^2 dt'^2}{c^2} = dt'^2 \tag{4b}$$

$$\frac{dt^2}{dt'^2} + \frac{\frac{1}{2}\Delta v^2}{\frac{1}{2}c^2} = 1 \tag{4c}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_K}{e_{K,\max}}} \blacksquare \tag{4d}$$

Or if you wanted this in terms of specific work and acceleration you get Equation (5).

$$\frac{dt}{dt'} = \sqrt{1 - \frac{w}{e_{K,\max}}} \tag{5a}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\int a(s)ds}{e_{K,\max}}} \tag{5b}$$

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 of velocity squared ratios (change in velocity over the speed of light squared) was truly the relationship of specific energy ratios (achieved change in specific kinetic energy over max achievable kinetic specific energy).

It is important to note some differences between the meaning of Equation (2) and Equation (4). In Equation (2), v causes the time differential for as long as there is a velocity difference—it applies time differential over time. Equation (4), 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.[8] For example, the moving twin continues to age less until his energy state changes to match the stationary twin.

Applying Equation (4) to The Twins Paradox example resolves the paradox—we know which twin ages less. Special relativity legacy model assumes time dilation also induces something termed a *space differential*—AKA length contraction. This stems from an assumption that both observers measure the same relative velocity. If the measured relative velocity for the traveling twin is the same as (or less than) that measured by the stationary twin, then the space differential must also affected.

Given that time dilation is now a known causal effect, and was derived without making the "relative velocity is measured the same for both observers" assumption needed to be checked and verified—without further evidence why can it not be greater than, the same as, or less than the relative velocity measured by the stationary observer.

Appendix D proves why measured relative velocity for the moving observer is always as what is measured by the stationary observer—i.e., pair-wise relative velocities are always

[8] See *Time Differential* in Appendix B for a more detailed illustration of time differential inertia.

measured the same for each pair of observers. The resulting space differential is shown in Equation (6).

$$\frac{dx}{dx'} = \frac{1}{\gamma} = \sqrt{1 - \frac{\Delta SK_E}{SK_{E,max}}} \tag{6}$$

The correct interpretation of (6), as is demonstrated in Appendix D, is that the units of measurement for length for the moving observer has changed. A yard stick no longer measures a yard, it measures something greater than a yard—e.g., $\Delta x' = \gamma\Delta x \implies \Delta x' > \Delta x$. Thus, the appearance of length contraction is only an optical illusion, like refraction, which is created because of time dilation.

It is now well established that a change is specific kinetic energy causes time dilation and space differential. In addition, changes in specific kinetic energy also causes a change in relative 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.

7. Changes In Specific Energy Due to Time Derivative Gradient

A significant difference between the causal model and the legacy model stems from the causal model's rejection of the equivalence 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. Our inability to discriminate between the two should not be surprising, since we lack an innate ability to measure TDGs. What we lack in natural 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 equivalence principle is valid. And since this principle was demonstrated to be false and has been rejected by the causal model, a new accounting for gravity is required. From the causal solution in the twins paradox, found in Appendix D, space dilation is an optical illusion created by time dilation, in the sense that the moving observer's instruments measuring length have shifted units. Space, therefore, no longer needs curvature to explain observations as will become plain in this causal accounting of gravitational forces.

The force of gravity is actually caused by a TDG. The relationship between energy and time differentials are reciprocal. It has been proven inductively that changes in specific energy causes changes in time differentials, and it stands to reason that induced changes in time differential (like a TDG) would cause changes in specific energy. We know that a TDG exists radiating outward from massed bodies—it has been measured and used for GPS systems to function. But this reciprocal relationship, where TDG causes changes in kinetic energy, needs derivation given our better understand for the cause of kinematic time dilation.

Given the relationship between changes in time differentials and changes in specific energy, as seen in Equation (4), one can define what a time dilation gradient is (based on observation) and derive its relationship to acceleration, as shown in Equation (7).

$$\nabla dt \triangleq \frac{dt - dt'}{dr'} \tag{7a}$$

$$\nabla dt = \frac{dt'\frac{1}{\gamma} - dt'}{dr'} \tag{7b}$$

$$\frac{1}{\gamma} = \nabla dt \frac{dr'}{dt'} + 1 \tag{7c}$$

$$\sqrt{1 - \frac{\Delta SE_K}{SE_{K,\max}}} = \nabla dt \frac{dr'}{dt'} + 1 \tag{7d}$$

$$\Delta SE_K = SE_{K,\max}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7e}$$

$$\bar{g} dr' = \frac{1}{2} c^2 (1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7f}$$

$$\lim_{r_1 \to r_2} \frac{\int_{r_1}^{r_2} g(r') dr'}{\int_{r_1}^{r_2} dr'} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7g}$$

$$GM \lim_{r_1 \to r_2} \frac{\int_{r_1}^{r_2} \frac{1}{r'^2} dr'}{r_2 - r_1} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7h}$$

$$GM \lim_{r_1 \to r_2} \frac{\frac{1}{r_1} - \frac{1}{r_2}}{r_2 - r_1} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7i}$$

$$GM \lim_{r_1 \to r_2} \frac{\frac{r_2 - r_1}{r_1 r_2}}{r_2 - r_1} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7j}$$

$$\lim_{r_1 \to r_2} \frac{GM}{r_1 r_2} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7k}$$

$$\lim_{r_1 \to r_2} \sqrt{g(r_1) g(r_2)} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{7l}$$

$$g(r') = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \blacksquare \tag{7m}$$

Where :
- ∇dt is time time derivative 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 (e.g., 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, and this is why gravity is indeed a TDG force. Concrete examples using this equation are given in Appendix G.

Given that a time dilation gradient induces a change in energy (proportional to inverse mass), 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 (4) to determine how much change in energy exists between the two objects caused by the TDG. 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 (4).

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 the gravitational force between the two points.

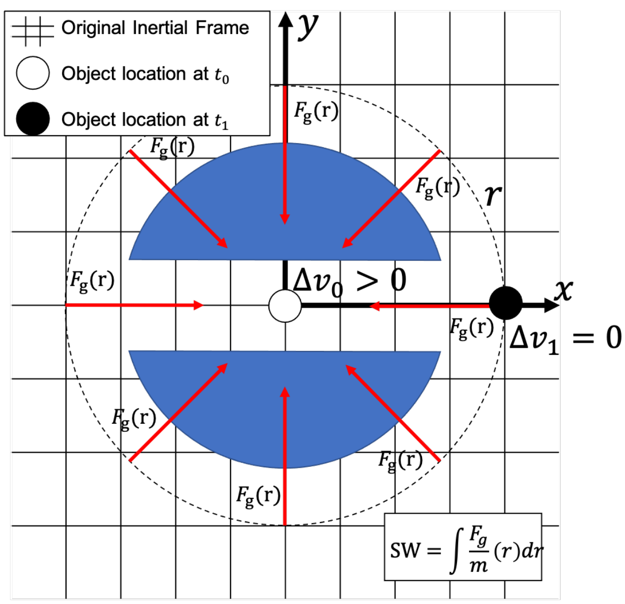

Figure 3. Time dilation at center relative to some point distance r away.

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 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 the gravitational force by the time the object is infinitely far away as given by Equation (8):

$$\frac{dt}{dt'} = \sqrt{1 - \frac{2GM}{rc^2}} \tag{8a}$$

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 (5) to be in terms of potential energy gives us Equation (9):

$$\frac{dt}{dt'} = \sqrt{1 - \frac{w}{e_{K,\max}}} \tag{9a}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_P}{e_{P,\max}}} \blacksquare \tag{9b}$$

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 TDG, gives us a new perspective on the total energy equation, as we will see in the next section.

8. Changes in Total Energy Causes Changes in Time Differential

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

Changes in Potential or Kinetic Energy is Not the Cause

We just proved that change in specific kinetic and potential energy are related to changes in time differentials, but as we shall soon this is only have the picture because we implicitly assume all else remained equal. Now we test what if all else does not remain equal to discover a more fundamental cause to changes in time differentials.

In reviewing Equation (4) and Equation (9), 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 specific energy.

For this proof, we are an outside observer in our own inertial reference frame observing an object that starts with some amount of specific potential energy, who then transfers all of it to kinetic energy (no longer in a gravity potential somehow).

$$\text{Proof :}$$
$$\text{Let } \mathrm{SE_P} > 0.$$
$$\text{Let } \frac{1}{\gamma} = \frac{\Delta t}{\Delta t'} \tag{10a}$$
$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta e_P}{e_{P,\max}} \tag{10b}$$
$$1 - \frac{1}{\gamma_P^2} = \frac{\Delta e_P}{e_{P,\max}} \tag{10c}$$
$$\left(1 - \frac{1}{\gamma_P^2}\right) e_{P,\max} = \Delta e_P = \Delta e_K \tag{10d}$$
$$\left(1 - \frac{1}{\gamma_P^2}\right) e_{K,\max} = \Delta e_K \tag{10e}$$
$$1 - \frac{1}{\gamma_P^2} = \frac{\Delta e_K}{e_{K,\max}} \tag{10f}$$
$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta e_K}{e_{K,\max}} \tag{10g}$$
$$\frac{1}{\gamma_P^2} = \frac{1}{\gamma_K^2} \blacksquare \tag{10h}$$

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 are not the fundamental causes to changes in time differentials—they each play half a role.

The same change in total specific energy caused the same change in time differentials proves, via method of agreement, 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 Relativistic Total Specific Energy Equation

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

$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta e_P}{e_{P,\max}} \tag{11a}$$
$$\Delta e_P = \left(1 - \frac{1}{\gamma_P^2}\right) e_{P,\max} \tag{11b}$$
$$\text{Let } \tau_{\mathrm{P}}^2 = 1 - \frac{1}{\gamma_P^2}$$
$$\Delta e_P = \tau_P^2 \frac{1}{2} c^2 \tag{11c}$$

$$\frac{1}{\gamma_K^2} = 1 - \frac{\Delta e_K}{e_{K,\max}} \tag{12a}$$
$$\Delta e_K = \left(1 - \frac{1}{\gamma_K^2}\right) e_{K,\max} \tag{12b}$$
$$\text{Let } \tau_{\mathrm{K}}^2 = 1 - \frac{1}{\gamma_K^2}$$
$$\Delta e_K = \tau_K^2 \frac{1}{2} c^2 \tag{12c}$$

$$\Delta e_T = \Delta e_P + \Delta e_K \tag{13a}$$
$$\Delta e_T = \tau_P^2 \frac{1}{2} c^2 + \tau_K^2 \frac{1}{2} c^2 \tag{13b}$$
$$\Delta e_T = (\tau_P^2 + \tau_K^2) \frac{1}{2} c^2 \blacksquare \tag{13c}$$

Values 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 differential—it has reached its limit of change in specific energy. For example, when $\tau_K = 1$ it is because $ax = \frac{1}{2}c^2$; or, when $\tau_P = 1$ it is because $gr = \frac{1}{2}c^2$.

Scaling Equation (13c) by mass gives us a relativistic total energy equation, shown in Equation (14).

$$m \Delta e_T = \Delta E_T = (\tau_P^2 + \tau_K^2) \frac{1}{2} mc^2 \tag{14}$$

When both τ_P and τ_K are less than unity, then Equation (14) simplifies to the very familiar Equation (15).

$$E_T = mgh + \tfrac{1}{2} mv^2 \tag{15}$$

Solving for time differential as a function of change in total specific energy gives us Equation (16d):

$$\Delta e_T = (\tau_P^2 + \tau_K^2) \frac{1}{2} c^2 \tag{16a}$$
$$\Delta e_T = \tau_T^2 e_{\max} \tag{16b}$$
$$\frac{\Delta e_T}{e_{\max}} = 1 - \frac{1}{\gamma_T^2} \tag{16c}$$
$$\frac{1}{\gamma_T} = \frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_T}{e_{\max}}} \tag{16d}$$

This now gives us changes in time differential as a function of its cause, change in total specific energy. This completes the inductive proof of the Law of Universal Specificity, which unites all forms of changes to time differentials to changes in total specific energy. We now turn to its implications.

9. Deduced Implications

Many implications result from this new causal discovery, even more than what is contained in this paper. A few implications are covered here to include implications creating a need to revisit: the Schwarzschild metric, $E = mc^2$, mass-energy relationship, a photon's mass, and a photon's momentum.

Revisiting The Schwarzschild Metric

In my research I stumbled up an example here [6]. Basically, the example answers the question: given measurements from an observer really far away from a planet's gravitational field, what is the time differential between two objects on the planet's surface (some distance r from its center), when one object is stationary and the other is falling with observed (from the distant observer) velocity, v?

Appendix H contains the detailed calculations, but the results derived using the legacy model and the Schwarzschild Metric is shown in Equation (17).

$$\frac{dt_f}{dt_s} = \sqrt{1 - \frac{\gamma_P^4 v'^2}{c^2}} \tag{17}$$

Where :

dt_f is the falling object′s time derivative

dt_s is the stationary object′s time derivative

γ_P is γ only considering specific potential energy

v' is velocity of the falling object as measured by distant observer

Appendix H contains the detailed calculations, but the results derived using the Law of Universal Specificity causal model is shown in Equation (18).

$$\frac{dt_f}{dt_s} = \sqrt{1 - \frac{\gamma_P^2 v'^2}{c^2}} \tag{18}$$

Where :

γ_P is γ only considering specific potential energy

Appendix H has the detailed argument, but the conclusion is this: both models agree that the falling object's velocity measured on the surface is greater than when it is measured by the distant observer. The legacy model gets the additional γ^2 factor by assuming space-time curves and the speed of light (measured by a distant observer) is constant in a gravity potential, which is proven to not match observations when refracting light through higher gravity potential mediums, as is discussed in the next subsection.

Revisiting $E = mc^2$

Looking at Equation (14), it is apparent that $E_T \leq mc^2$. Additionally, light is also assumed to be eternal, because of conservation of mass and energy; therefore, for light, $\tau_P^2 + \tau_K^2 \geq 1$.

If an object were, with respect to an inertial UIMU described in Section 5, accelerated to c, and close to a gravity potential such that $\tau_P^2 = 1$, then this would result in that objects total energy being $E_T = mc^2$. This does not seem possible given that, according to Equation (16d), the time differential would become imaginary—a clear contradiction.

It seems more reasonable to conclude that the max energy for any object is always limited by $\frac{1}{2}mc^2$, as Equation (16d) suggests, in order to avoid imaginary time differentials. In which case, everything is limited by: $\tau_P^2 + \tau_K^2 \leq 1$. Combining this inequality with the inequality at the beginning of this section, gives us $\tau_P^2 + \tau_K^2 = 1$ for light.

Two pieces of evidence strongly suggest that light travels less than c when in vicinity of a gravitational time differential and other contexts. This evidence is found in the domain of refraction, where light is known to travel less than c, and in a thought experiment involving a light clock that operates parallel to the velocity vector. The thought experiment is discussed in Appendix F, while refraction is discussed here.

Taking a fresh look at refraction with this possibility in mind, what would this mean? It means the index of refraction, n, is related to gravitational time differential. In fact, when one attempts to relate n in terms of gravitational time differential, then the result is Equation (19).

$$n = \frac{c}{v} \tag{19a}$$

$$\frac{1}{n} = \frac{c - \Delta v}{c} \tag{19b}$$

$$\frac{1}{n} = 1 - \frac{\Delta v}{c} \tag{19c}$$

$$\frac{\Delta v}{c} = 1 - \frac{1}{n} \tag{19d}$$

$$\frac{dt}{dt'} = \sqrt{1 - \left(1 - \frac{1}{n}\right)^2} \tag{19e}$$

$$\frac{1}{\gamma_P^2} = 1 - \left(1 - \frac{1}{n}\right)^2 \tag{19f}$$

$$\left(1 - \frac{1}{n}\right)^2 = 1 - \frac{1}{\gamma_P^2} = \tau_P^2 \tag{19g}$$

$$\frac{1}{n} = 1 - \tau_P \tag{19h}$$

$$n = \frac{1}{1 - \tau_P} \ \blacksquare \tag{19i}$$

Where :

dt' is time derivative outside refracting object

dt is time derivative inside refracting object

n is the index of refraction

v is the velocity of light inside refracting object

Δv is light′s change in velocity

This would explain a few things, like

1. Why light curves under the influence of gravity is related to refraction.
2. Why light changes direction once during refraction.
3. Why the light's wavelength gets smaller.
4. Why increased density is correlated to increased refraction angle and slower light speeds.
5. Why it requires something like refraction to observe light slowing down.

It explains why light curves under the influence of gravity is related to refraction, because gravity is a form of refraction. The cause is the same in both cases, a TDG. Snell's law can now be employed to predict the curvature of a light path due to gravity.

It explains why light changes direction once, because the the TDG exists only at the entry point and the exit point of the refracting material, and it is flat everywhere else.

It explains why the wavelength gets smaller, because of the conservation of energy where $\gamma_P^2 + \gamma_K^2 = 1$ for light, more of its energy is now accounted for in the γ_P^2 term. Thus, it's frequency, as measure of its energy, remains unchanged while its wavelength gets smaller. Also, from the light's perspective, which would measure its speed as c, it blue shifted—just as light blue shifts when light descends into greater gravitational potential anywhere else.

It explains why increased density is correlated to increased refraction and the slowing down of light. The distance between gravity sources, within the material, decreases, which increasing the gravitational potential and time differential. The angle is more severe with higher density because the forces induced at the TDGs located at the entry and exit points are stronger.

It explains why refraction allows us to see light slowing down, because space does not bend as it is assumed to in the legacy model. Observing light slow down during refraction is an outside view looking into a domain with slower time without bending space. This is why Schwarzschild Metric example in Appendix H is in error.

Given this new understanding of the available evidence, it is reasonable to adjust prior assumptions about light speed and the total energy of massed objects. It is now reasonable to split the concept previously under *constant speed of light* into two concepts: (1) the speed light is traveling, and (2) the upper speed limit anything can travel. Additionally, it is now reasonable to conclude that the total energy of massed objects is $\frac{1}{2}mc^2$ and not mc^2.

What about the prior assumption that mass and energy are interchangeable? This concept too must be revisited.

Revisiting Mass-Energy Relationship

Nothing from the relativistic total specific energy equations gives rise to the notion that mass and energy are interchangeable—that mass can be converted into energy or vice versa. Given relativity's more consistent causal model's new foundation, we must dismiss this notion as arbitrary, lacking any evidence. Energy remains an inseparable aspect of an object having some relationship to the object's mass—as it did in Newtonian physics. Therefore, mass cannot be converted into energy, as theorized before, in the sense that mass disappears and pure energy without mass appears. The energy that appears, in say splitting the atom, is a bunch of fast moving massed objects that are extremely tiny—the same amount of mass lost by the original object.

Lets consider a case involving a massed object comprised of many entangled photons, a particle the legacy model assumed to have no mass. Let's also consider that this object is inertial according to an UIMU, and has some mass m. If this object were to disintegrate into nothing, but free moving photons, What would the total energy be of all the released photons? If we assume that mass is conserved, then the total mass of all the photons is m, and their speed would c by definition—not being influenced by their neighbors gravitational time differential any longer. Therefore, $\tau_P^2 = 0$ and $\tau_K^2 = 1$ and plugging these values into the total relativistic energy equation we get: $E_T = \frac{1}{2}mc^2$.

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

Revisiting a Photon's Mass

Integrating the photon energy equation, in Equation (20), with the relativistic total energy equation, in Equation (14), and with light being eternal, gives us the relationship between the mass of a photon and its frequency[9] as shown in Equation (21).

$$E(\nu) = h\nu \tag{20}$$

$$E(\nu) = h\nu = (\tau_P^2 + \tau_K^2)\frac{1}{2}mc^2 \tag{21a}$$

$$m(\nu) = \frac{h\nu}{\lambda(\tau_P^2 + \tau_K^2)e_{\max}} = \frac{h\nu}{e_{\max}} = \frac{2h\nu}{\lambda c^2} \tag{21b}$$

Where :

E is the total energy of a photon.

h is Planck's constant.

ν is the photon's frequency.

The mass of a photon is a function of its frequency. It stands to reason, given certain other observations about a photon's momentum.

Revisiting a Photon's Momentum

Because it was formerly assumed that $E = mc^2$, it was also assumed that the momentum of a photon was defined as Equation (22) below:

$$p = mc = \frac{E}{c} \tag{22}$$

But with our new understanding of relativistic total energy we get Equation (23) below instead:

$$p = mc = \frac{2E}{c} \tag{23}$$

Experimental evidence shows that a photon's momentum is a function of its frequency, and its energy is also a function of its frequency. This much does not contradict observation,

[9] We know from refraction that wavelength does not do a good job relating to its total specific energy. Thus frequency is best used to satisfy conservation of mass in cases of refraction.

but it suggests something very peculiar. If photon undergoes a color shifts—red-to-blue or blue-to-red—then its mass changes. If the masses are different for the same photons of different frequency, then we need to revisit what mass means. I am not entirely certain how to reconcile this, but I speculate in the next section, that while the quantity of matter is not subject to change, that its measurement may be subject to measurement differentials, just like time and space.

The complete reconciliation, of a photon's mass and frequency, will have to wait on future work and additional experimental evidence making use of the progress achieved by this work. I will, however, indulge in speculation in what this reconciliation may be, and therefore, what it might mean for a theory of everything that is light.

In Summary

In summary, we revisited and made corrections to the following topics: the Schwarzschild metric, $E = mc^2$, mass-energy relationship, a photon's mass, and a photon's momentum. We now move onto implications that are suggested, but could not be deductively proven.

10. Speculative Implications

It is important to delineate what scientific work is based on causal or deductive proofs and what is speculation. Unfortunately today, this delineation is obscured far too much largely due to common practice of accepting non-validated assumptions to deduce descriptive models.

Do not misunderstand me, I am no Einstein. The only significant thing that separates me from others in this field is the cognitive method I employ—the inductive scientific method. Which means, I do not accept non-validated assumptions, I know how to clearly detect and root cause contradictions, I know what they mean when I see them, I know how to conduct the causal discovery process[10], 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 the same with those same powerful cognitive methods.

The causal discovery in this paper was that kinetic and gravitational time differentials are both part of the same phenomena, as apposed to being caused by two very different unrelated phenomena, as previously understood—contained in the Law of Universal Specificity. This is a newly induced generalization, and up to this point, the paper has presented an inductive proof of this law, and a study of its 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

I acknowledge up front that there is a possible issue with conservation of mass and a photon mass being related to its frequency, because its mass could change simply because its color shifts. A photon would weigh more inside a gravity well. I do not think the quantity 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 a relativistic sense. 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 a measurement differential (a changing of units)?

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 4. This gives the appearance, in how its modeled anyway, that one frequency is "more dense" than the other.

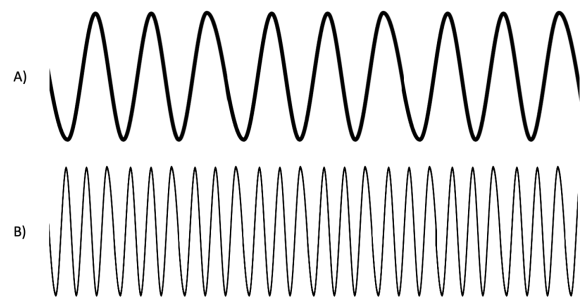

Figure 4. (A) being a smaller frequency seems "less dense" than (B).

This concept—increasing frequency increases the photon's "density"—is consistent with what is found in Equation (21), $m \propto \nu$, but I acknowledge that it could be a coincidence—i.e., a description of *what* is rather than *why* it is.

What could this mean if it were the true reason? If distance between peaks affects how we measure mass, then perhaps it also affects gravity—i.e., the strength of TDGs. If blue photons have a greater TDGs, but they have the same quantity of matter (not to be confused with mass) as red photons, it might explain why blue light bends more than red during refraction.

Theory of Electromagneticgravitism

If photons are responsible for gravity, then photons are responsible for three known forces: electrical forces, magnetic forces, and gravitational forces. Electromagnetism would actually be a special case of *electromagneticgravitism*. Interestingly, 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 would make 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 light interacts with, and the nuclear forces are really just a special case of *electromagneticgravitism*—each being a different combination of two of the three fundamental forces. These combinations would most likely be electrogravitism and magneticgravitism since electromagnetism is well understood. This would explain why only five forces had been claimed to be discovered to date.

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

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

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.

11. 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 (5), and you get Equation (9).

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 (4), 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 (8, 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 (9).

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 5 and 6

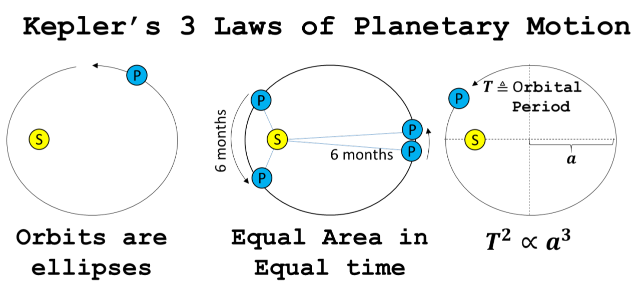

Figure 5. Kepler's causal planetary model.

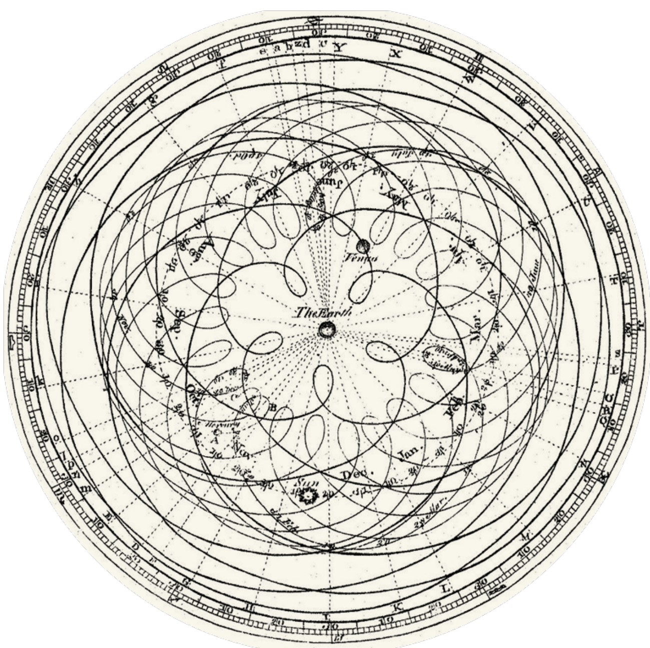

Figure 6. Ptolemy's descriptive planetary model.

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 7 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 8.

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 9.

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:

$$(cdt)^2 + (vdt')^2 = (cdt')^2 \tag{24a}$$

$$dt^2 + \frac{v^2 dt'^2}{c^2} = dt'^2 \tag{24b}$$

$$\frac{dt^2}{dt'^2} + \frac{v^2}{c^2} = 1 \tag{24c}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{v^2}{c^2}} \blacksquare \tag{24d}$$

From equation (24) it seems reasonable to conclude v caused

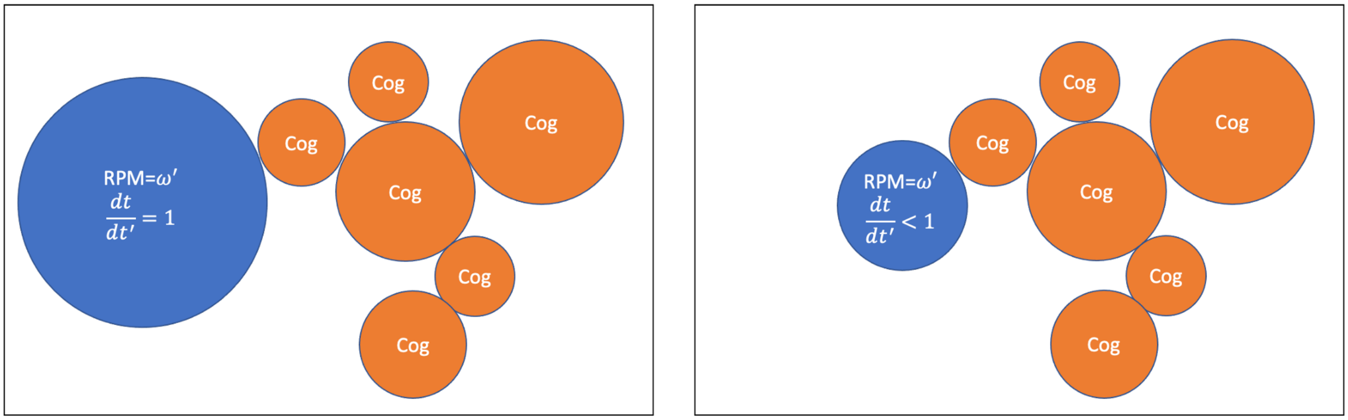

Figure 7. **Left: system of cogs without time dilation. Right: system of cogs with time dilation.**

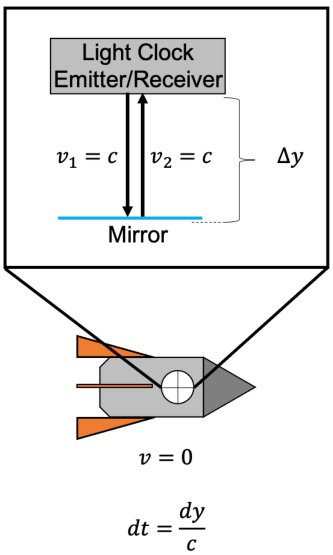

Figure 8. **Light Clock At Rest.**

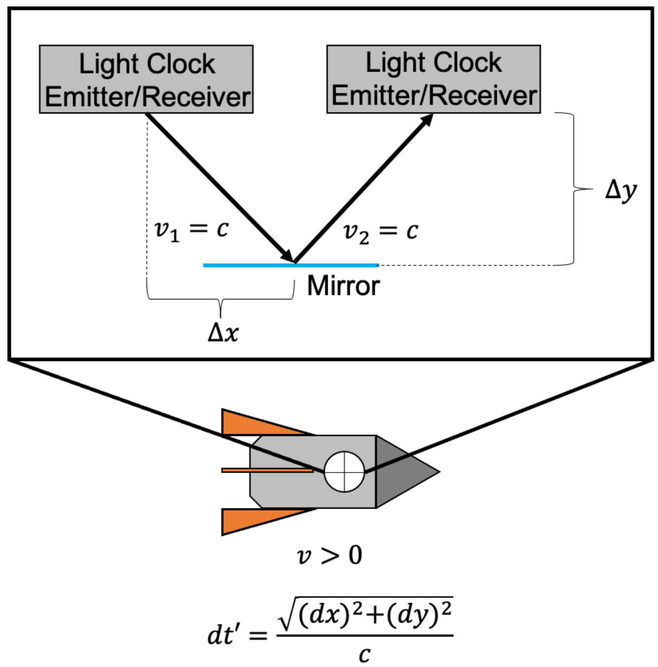

Figure 9. **Light Clock In Motion.**

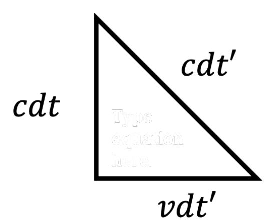

Figure 10. **Pythagorean relationship for distance traveled.**

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 11. 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.[11] 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 9. Both twins in fact observed the other's light clock looking like Figure 9.

Both clocks appeared to look like Figure 9, 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

[11]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.

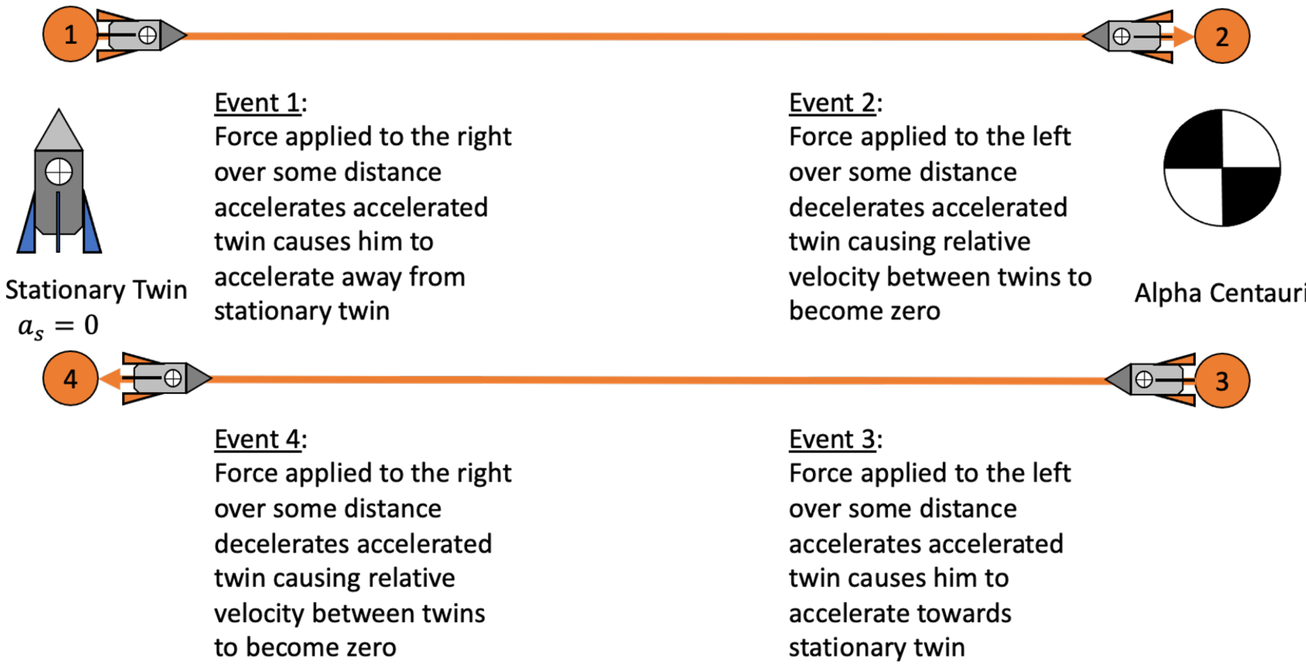

Figure 11. **Events Leading to The Twins Paradox.**

a time clock that looks like Figure 9, 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 5 to the four events as shown in Figure 11, and assuming the same magnitude of acceleration was applied over the same magnitude of distance, gives us Equation (25) (next page):

Event 1 :

$$\frac{dt_1}{dt'} = \sqrt{1 - \frac{ax_a}{SK_{E,max}}} \tag{25a}$$

Event 2 :

$$\frac{dt_2}{dt'} = \sqrt{1 - \frac{ax_a + (-a)x_a}{SK_{E,max}}} = 1 \tag{25b}$$

Event 3 :

$$\frac{dt_3}{dt'} = \sqrt{1 - \frac{ax_a + (-a)x_a + (-a)(-x_a)}{SK_{E,max}}} \tag{25c}$$

Event 4 :

$$0 = ax_a + (-a)x_a + (-a)(-x_a) + (a)(-x) \tag{25d}$$

$$\frac{dt_4}{dt'} = \sqrt{1 - \frac{(0)}{SK_{E,max}}} = 1 \tag{25e}$$

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
dt_3 is the time derivative for the accelerating twin after event 3
dt_4 is the time derivative for the accelerating twin after event 4

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

Relative Velocity and the Space Differential

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 is no longer certain that they would see the same thing, given this new causal understanding. The relative velocity measured by the moving observer can be faster, slower, or the same. We test each and determine that we can prove it cannot be faster or slower, which only leaves that the relative velocity must be measured the same for both observers.

We start with assumption that both twins measure the same relative velocity, and its consequence to space differential—AKA length contraction—is shown in Equation (26).

$$\text{Proof :}$$

$$v' = v \tag{26a}$$

$$\frac{dx'}{dt'} = \frac{dx}{dt} \tag{26b}$$

$$\frac{dx'}{dt'} = \frac{dx}{dt'\sqrt{1-\frac{\Delta SK_E}{SK_{E,max}}}} \tag{26c}$$

$$\frac{dx}{dx'} = \sqrt{1-\frac{\Delta SK_E}{SK_{E,max}}} = \frac{1}{\gamma}\ \blacksquare \tag{26d}$$

$$\begin{aligned}\text{Where :}&\\ v' &\text{ is measured velocity from inertial frame}\\ v &\text{ is measured velocity from moving frame}\\ dx' &\text{ is space derivative before time dilation}\\ dx &\text{ is space derivative after time dilation}\\ dt' &\text{ is time derivative before time dilation}\\ dt &\text{ is time derivative after time dilation}\end{aligned}$$

The effect is that both clocks to appear to behave the same regardless of observer.

If we assume that both clocks did not appear the same because relative velocity appears faster for the moving twin, then we get Equation (28) instead:

$$\frac{dx}{dx'} > \frac{1}{\gamma} \tag{28}$$

The effect is that both clocks to appear different depending on observer.

If we assume instead assume relative velocity appears slower for the moving twin, then we get Equation (29):

$$\frac{dx}{dx'} < \frac{1}{\gamma} \tag{29}$$

Only Equation (26) avoids any contradictions, making it the only remaining option. Observe each equations effects on relative velocity measured by the moving observer, as shown by the y-axes in Figure 12. We can see in the top plot of the figure, that if the moving observer were to see a velocity less than that of the stationary observer, you get the interesting contradiction where added velocity reduces velocity; therefore, we can eliminate that option. We can see in the bottom plot of the figure, that if the moving observer were to see a velocity greater than that of the stationary observer, you get the contradiction where measured velocity exceeds the speed of light; therefore, we can eliminate that option. Therefore, the only remaining option is that pair-wise measured relative velocities must remain equal for both pair-wise observers.

An interpretation of Equation (26) is that the units of measurement for length for the moving observer has changed. A yard stick no longer measures a yard, it measures something greater than a yard—e.g., $\Delta x' = \gamma \Delta x \implies \Delta x' > \Delta x$. This is only an optical illusion, like refraction, as illustrated by the following example.

Consider an accelerated observer headed towards some destination at velocity, v'. Suppose the time differential is affected such that it is halved. Then when the measurement of time is halved it also makes distance traveled appear halved—e.g., instead of Alpha Centauri being about four light years away, the trip was made as if it were two light years. The true distance of things did not change in reality, but because time was affected, it appeared closer, which is the meaning of Equation (26).

Wrapping up The Twins Paradox, The accelerated twin experiences less than unity time differential and a space differential to match. As this appendix shows, the twins paradox is resolved when the causal model is applied.

E. Twins Age On a Continuum

This is a concrete example for not having acceleration information and predicting which twin ages. As a concrete example suppose the relative velocity between twins starts off as zero, then there is a relative velocity of v_s causing twins to separate, then there is a relative velocity of v_c causing twins to converge back together until finally they are together and their relative velocity is zero again. Which twin ages less? There are indeed an infinite set of possibilities resulting in a continuum of possibilities.

Below includes specific numbers, with just the relative velocity information, and results presented shortly after. Assuming you do not predict the result beforehand, it will prove the point.

1. Relative velocity, as seen by twins, is 0. This is the start of the twins common reference frame.
2. Then instantly the relative velocity, as seen by twins, becomes $0.2c$, causing them to move apart. One twin can be said to be moving left, the other right. This continues for $3.5\ [sec]$, as measured from the right twin that sees the other moving right to converge.
3. Then instantly the relative velocity, as seen by twins, becomes $0.2c$, causing them to move converge. This continues for $3.8\ [sec]$, as measured from the right twin again—the time it takes for the twins to rendezvous.
4. Experiment ends after rendezvous. Twins instantly decel-

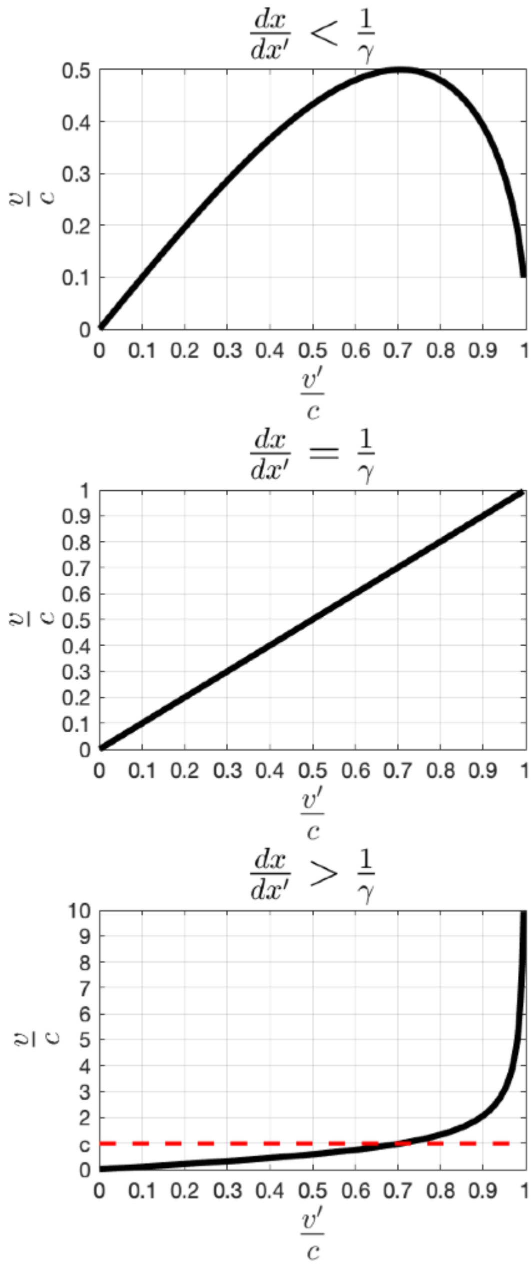

Figure 12. Top: relative velocity is slower for moving observer. Middle: relative velocity is the same for both observers. Bottom: relative velocity is faster for moving observer.

erate to 0. Clocks are compared.

Make a prediction, for which twin ages less, then see these results: Total scenario time for primary reference frame is 10.4 $[sec]$. The left "moving" twin ages 9.2 $[sec]$, and the right twin ages 7.4 $[sec]$, according to their respective clocks.

Why? Here is the remaining relevant information:

1. Both twins instantly accelerate to $0.2c$ to the right, with respect to primary inertial reference frame. Relative velocity, as seen by twins, is 0. This is the start of the twins common reference frame.
2. "Moving" twin instantly accelerates to $0.2c$ left, with respect to primary inertial reference frame—essentially stopping. Relative velocity, as seen by twins, is $0.2c$. This continues for 5 $[sec]$, as measured from primary inertial reference frame's clock.
3. "Moving" twin instantly accelerates $0.38c$ to the right, with respect to primary inertial reference frame. Relative velocity, as seen by twins, is $0.2c$.[12] This goes on for 5.4 $[sec]$, as measured from primary inertial reference frame's clock—the time it takes for the twins to rendezvous.
4. Experiment ends after rendezvous. Twins instantly decelerate to 0. Clocks are compared.

This is a case where if you starting initial inertial reference frame from when both twins accelerated together, you might expect the left accelerating twin to age less, but he ages more. This suggests that it might be possible for there to be a universal origin where all clocks tick fastest, or that accelerating away from earth may have different effects depending on the direction you go—towards this possible origin might age you faster, and going away might age you slower.

F. Parallel Time Clock

In this example using a light clock, the light clock will be parallel to the velocity vector, as shown in Figure 13 and Figure 14.

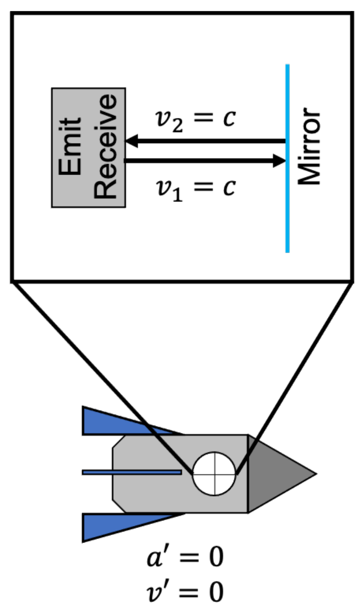

Figure 13. Stationary parallel light clock.

This example is interesting because if light travels at the same speed, then the time differential seems to be different depending on direction—e.g., coming from left has a larger time differential than coming from right—which does not make sense. From the stationary ship's perspective, observing the moving orange ship in Figure 14, light takes longer to travel from the emitter to the mirror than it does from the

[12]The relative velocity is found using the velocity addition equation in relativity, see Equation 30 in Appendix F.

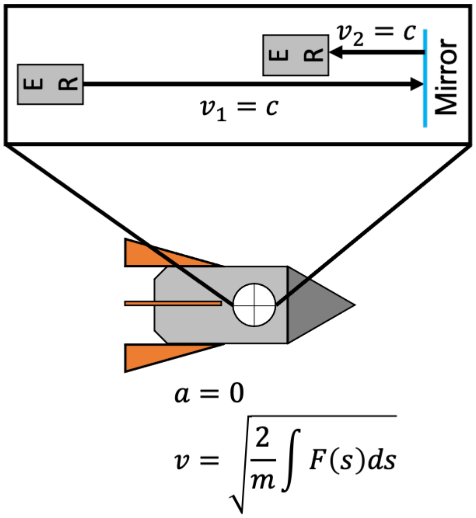

Figure 14. **Moving parallel light clock.**

mirror to the receiver. While from the perspective of the person in the ship, as seen in Figure 13, the time it takes to go to the mirror is the same time it takes for the light to go back to the receiver.

How is this reconciled given that light is constant? I fail to find any reconciliation without rejecting the assumption that light travels at different speeds, albeit imperceptibly different. If we treat light as a third traveling object with its own speed subject to change, then it is not surprising why both appear to see the light traveling at the same speed when it is imperceptibly different.

Consider a case where two objects travel in opposite directions at half the speed of light. Do they see eachother as traveling, $c = 0.5c + 0.5c$=c? No, you need to employ the relativity velocity addition formula shown in Equation (30), which tells you that the ships traveling at $0.5c$ in opposite directions will measure their relative velocity as $0.8c$.

$$v_{12} = \frac{v_{01} + v_{02}}{1 + \frac{v_{01}v_{02}}{c^2}} \tag{30}$$

Where :

v_{12} is the velocity of the moving objects seen by the other moving object

v_{01} is the velocity of the first moving object seen by the inertial frame

v_{02} is the velocity of the second moving object seen by the inertial frame

Taking Equation (30) to the extreme, where the speeds are close to c, one's ability to distinguish between changes in velocity becomes vanishingly small, as shown in Figure 15.

While distinct observers might agree to each other's perceived relative velocity, they will necessarily disagree what they perceive a third object's relative velocity will be, except for objects traveling near c. Those extremely fast objects, like light, might appear to have the same relative velocity for all observers, when really it is imperceptibly different. In this case, with the parallel light clock, the person viewing the moving light clock is observing imperceptibly faster light from emitter to mirror (compared to the return trip from mirror to receiver). The person moving with the clock would experience no difference in the light's speed during its trip to and from the mirror.

G. Time Derivative Gradient Examples

Two examples are provided to show how the TDG relates to gravitational acceleration. The first example involves the earth's TDG and its respective gravitational acceleration; and the second example involves the Sun's TDG and its respective gravitational acceleration.

The Earth's TDG Example

In this example, we form a TDG estimate between a location, r_1, on the earth's surface and another location, r_2, 1000 meters above r_1. Assuming that our base time derivative is dt_2, then we get the time differential from Equation (31):

$$\text{Let : r}_1 = 6371000\ [m]$$
$$\text{Let : G} = 6.6744 \times 10^{-11}\ [m^3 kg^{-1} s^{-1}]$$
$$\text{Let : M} = 5.97219 \times 10^{24}\ [kg]$$
$$\frac{dt_1}{dt_2} = \sqrt{1 - \frac{\Delta e_P}{e_{\max}}} = \sqrt{1 - \frac{\int_{r_1}^{r_2} \frac{GM}{r^2} dr}{e_{\max}}} \tag{31a}$$
$$\frac{dt_1}{dt_2} = \sqrt{1 - \frac{9.81 \times 10^3}{e_{\max}}} = 1 - 1.0925 \times 10^{-13} \tag{31b}$$

The resulting TDG is given in Equation (32).

$$\text{Let : dt}_2 = 1 \implies dt_1 = 1 - 1.0925 \times 10^{-13}$$
$$\nabla dt \triangleq \frac{dt_1 - dt_2}{dr'} \tag{32a}$$
$$\nabla dt \triangleq \frac{-1.0925 \times 10^{-13}}{1000} = -1.0925 \times 10^{-16} \tag{32b}$$

Using Equation (7), we can find the resulting acceleration as show in Equation (33):

$$\sqrt{g(r_1)g(r_2)} = \bar{g} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{33a}$$
$$\bar{g} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{33b}$$
$$\bar{g} = 9.8185[{}^{m}/{}_{s}] \tag{33c}$$

Comparing results from Equation (33) to what we would get with the geometric mean of known gravitational acceleration values, using Newton's Law of Universal Gravitation, is shown in Equation (34). It shows that errors are within limits of precision of the machine used to do the calculation (percent error is 0.0036% or 36 in million):

$$\sqrt{g(r_1)g(r_2)} = 9.8185 \tag{34a}$$
$$\sqrt{(9.8204)(9.8174)} = 9.8185 \tag{34b}$$
$$9.8189 \approx 9.8185 \blacksquare \tag{34c}$$

The Sun's TDG Example

What about when the distances are really far apart when measuring the TDG? In this example we form a TDG estimate between a location, r_1, a distance from the sun that is earth's mean orbital radius, and another location, r_2, a half light second further away. Assuming that our base time derivative is dt_2, then we get the time differential from Equation (35):

$$\text{Let}: \mathrm{r}_1 = 1.5203 \times 10^{11}\ [m]$$
$$\text{Let}: \mathrm{G} = 6.6744 \times 10^{-11}\ [m^3 kg^{-1} s^{-1}]$$
$$\text{Let}: \mathrm{M} = 1.9887 \times 10^{30}\ [kg]$$
$$\frac{dt_1}{dt_2} = \sqrt{1 - \frac{\Delta e_P}{e_{\max}}} = \sqrt{1 - \frac{\int_{r_1}^{r_2} \frac{GM}{r^2} dr}{e_{\max}}} \tag{35a}$$
$$\frac{dt_1}{dt_2} = \sqrt{1 - \frac{8.7352 \times 10^8}{e_{\max}}} = 1 - 9.7192 \times 10^{-9} \tag{35b}$$

The resulting TDG is given in Equation (36).

$$\text{Let}: \mathrm{dt}_2 = 1 \implies dt_1 = 1 - 9.7192 \times 10^{-9}$$
$$\nabla dt \triangleq \frac{dt_1 - dt_2}{dr'} \tag{36a}$$
$$\nabla dt \triangleq \frac{-9.7192 \times 10^{-9}}{\frac{c}{2}} = -2.1628 \times 10^{-25} \tag{36b}$$

Using Equation (7), we can find the resulting acceleration as show in Equation (37):

$$\sqrt{g(r_1)g(r_2)} = \bar{g} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{37a}$$
$$\bar{g} = \frac{c^2}{2dr'}(1 - (\nabla dt \frac{dr'}{dt'} + 1)^2) \tag{37b}$$
$$\bar{g} = 1.9438 \times 10^{-8} [{}^m\!/\!{}_s] \tag{37c}$$

Comparing results from Equation (37) to what we would get with the geometric mean of known gravitational acceleration values, using Newton's Law of Universal Gravitation, is shown in Equation (38). It shows that errors are within limits of precision of the machine used to do the calculation (percent error is 0.049% or 490 in million):

$$\sqrt{g(r_1)g(r_2)} = 1.9438 \times 10^{-8} \tag{38a}$$
$$\sqrt{(0.0057)(6.573 \times 10^{-14})} = 1.9438 \times 10^{-8} \tag{38b}$$
$$1.9429 \times 10^{-8} \approx 1.9438 \times 10^{-8} \blacksquare \tag{38c}$$

TDG Examples Takeaway

The key takeaway with these two examples, with both near and far estimates of TDG, is that observations match within errors of precision. The TDG model, relating the TDG to acceleration, is a causal model that matches observation.

H. Law of Universal Specificity vs Schwarzschild Metric

This appendix contains the details on an example that answers the question: given measurements from an observer really far away from a planet's gravitational field, what is the time differential between two objects on the planet's surface (some distance r' from its center), when one object is stationary and the other is falling with observed (from the distant observer) velocity, v'?

This example is worked out using the Law of Universal Specificity and the Schwarzschild metric in order to form a comparison between the legacy model and the causal model for relativity.

The Schwarzschild Metric Solution

This solution was originally derived from here [6]. It is assumed that the person at that reference solved it correctly, as we spotted no errors. The Schwarzschild metric produces Equation (39) to compare time derivatives from the distant observer to the objects on the ground of the planet.

$$c^2dt = (1 - \frac{r_s}{r'})c^2dt' - \frac{dr'^2}{1 - \frac{r_s}{r'}} - r'^2d\theta'^2$$
$$- r'^2sin^2\theta' d\phi'^2 \tag{39a}$$
$$r_s = \frac{2GM}{c^2} \tag{39b}$$

Where :

dt' is time derivative for distant observer
dt is time derivative for objects from planet center
dr' is the radial derivative for objects as measured by distant observer
$d\theta'$ is the azimuth derivative for objects as measured by distant observer
$d\phi'$ is the elevation derivative for objects as measured by distant observer
G is the gravitational constant
M is the mass of the gravitational source
r_s is the Schwarzschild radius
r' is the distance, measured by distant observer, of objects to center of gravitational source
c is the speed of light

It is assumed that the planet is not rotating, and the distant observer is directly above the objects being measured. This way Equation (39) can simplify to Equation (40):

$$c^2dt = (1 - \frac{r_s}{r'})c^2dt' - \frac{dr'^2}{1 - \frac{r_s}{r'}} \tag{40}$$

For the falling object $dr' = v'dt'$ and substituting this in gives us Equation (41):

$$c^2dt_f = (1 - \frac{r_s}{r'})c^2dt' - \frac{(v'dt')^2}{1 - \frac{r_s}{r'}} \tag{41a}$$
$$\frac{dt_f}{dt'} = \sqrt{1 - \frac{r_s}{r'}}\sqrt{1 - \frac{v'^2/\left(1 - \frac{r_s}{r'}\right)^2}{c^2}} \tag{41b}$$

For the stationary object $dr' = 0$ and substituting this in gives us Equation (42):

$$c^2dt_s = (1 - \frac{r_s}{r'})c^2dt' - \frac{0}{1 - \frac{r_s}{r'}} \tag{42a}$$
$$\frac{dt_s}{dt'} = \sqrt{1 - \frac{r_s}{r'}} \tag{42b}$$

Relating Equation (41) and Equation (42) gives us Equation (43), which is the Schwarzschild metric solution to this problem:

$$\frac{dt_f}{dt_s} = \frac{\frac{dt_f}{dt'}}{\frac{dt'}{dt_s}} = \sqrt{1 - \frac{v'^2/\left(1 - \frac{r_s}{r'}\right)^2}{c^2}} \tag{43a}$$
$$\frac{dt_f}{dt_s} = \sqrt{1 - \frac{\gamma_P^4 v'^2}{c^2}} \tag{43b}$$

The Law of Universal Specificity Solution

To solve this problem using The Law of Universal Specificity, we need to measure the difference in total specific energy between the distant observer and the objects, and relate this value to the resulting time differential.

For the falling object this relationship becomes Equation (44):

$$\frac{dt_f}{dt'} = \sqrt{1 - \frac{\Delta e_T}{e_{\max}}} \tag{44a}$$
$$\frac{dt_f}{dt'} = \sqrt{1 - \frac{\Delta e_P + \Delta e_K}{e_{\max}}} \tag{44b}$$
$$\frac{dt_f}{dt'} = \sqrt{1 - \frac{\frac{1}{r'}GM + \frac{1}{2}v'^2}{e_{\max}}} \tag{44c}$$

For the stationary object this relationship becomes Equation (45):

$$\frac{dt_s}{dt'} = \sqrt{1 - \frac{\Delta e_T}{e_{\max}}} \tag{45a}$$
$$\frac{dt_s}{dt'} = \sqrt{1 - \frac{\Delta e_P + \Delta e_K}{e_{\max}}} \tag{45b}$$
$$\frac{dt_s}{dt'} = \sqrt{1 - \frac{\frac{1}{r'}GM + 0}{e_{\max}}} \tag{45c}$$
$$\frac{dt_s}{dt'} = \sqrt{1 - \frac{\frac{1}{r'}GM}{e_{\max}}} \tag{45d}$$

Relating Equation (44) and Equation (45) gives us Equation (46), which is the Law of Universal Specificity solution to this problem:

$$\frac{dt_f}{dt_s} = \frac{\frac{dt_f}{dt'}}{\frac{dt'}{dt_s}} = \sqrt{1 - \frac{\frac{1}{2}v'^2/\left(1 - \frac{\frac{1}{r'}GM}{e_{\max}}\right)}{e_{\max}}} \tag{46a}$$
$$\frac{dt_f}{dt_s} = \sqrt{1 - \frac{\gamma_P^2 v'^2}{c^2}} \tag{46b}$$

Comparing The Law of Universal Specificity and The Schwarzschild Metric Solutions

The interesting part about this problem is that if we just had relative velocity, v, as measured by the objects themselves then we could simply use the specific kinetic energy side of special relativity time differential equation. The reason you need to use the total specific energy, or the Schwarzschild metric, is because measurements are made from a distant observer and this distant observer is trying to relate the objects' time derivatives.

Comparing Equation (43b) and Equation (46b), one observes a single difference—a factor scaling v' by γ_P to some power, where γ_P is just the gravity potential contribution to the time differential conversion, $\frac{dt'}{dt}$. The factor is γ_P^4 for the Schwarzschild metric solution, and it is γ_P^2 for the Law of Universal Specificity solution. Each are scaling v' in order to convert v' to v, which then becomes the special relativity time differential equation.

Which is right, both cannot be. Does $v = \gamma_P v'$ or does $v = \gamma_P^2 v'$? The answer is the former (explained shortly); however, when γ_P is very close to one, like on earth, then $\gamma_P \approx \gamma_P^2$ to the point where I doubt instruments are sensitive enough to tell the difference. This explains why observation has not contradicted predictions so far,e.g., consider GPS—or at these minute differences, if they were detectable, they could have easily been attributed to precision error in measurements.

Before answering why $v = \gamma_P v'$, let us first consider why, in special relativity, $v = v' \neq \gamma_K v'$. In special relativity, $v = v'$ because $\frac{dx}{dx'} = \frac{dt}{dt'}$ which implies $\frac{dx}{dt} = \frac{dx'}{dt'}$, or $v = v'$. This causes two different observers, one moving and one stationary, to report that the other's velocity are v (the same for both observers).

Getting back to our example with a gravity potential, the reported velocities for two observers (e.g., on on a planet's surface and one really far away) are no longer consistent. Why? Because $\frac{dx}{dx'} \neq \frac{dt}{dt'}$ given gravitational caused time differentials. This much is agreed upon between the Schwarzschild metric solution and the Law of Universal Specificity solution—they only disagree as to the degree of the difference.

Converting $\frac{dr'}{dt'}$ to v we get:

$$\frac{dr}{dt} = \frac{dr'}{dt'}\frac{dt'}{dt}\frac{dr}{dr'} \tag{47a}$$

$$= \frac{dr'}{dt'}\gamma_P\frac{dr}{dr'} \tag{47b}$$

The extra γ^2 term found using the Schwarzschild Metric is from the additional assumption of space-time curvature replacing the force of gravity. The causal model making no such non-validated assumption does not have this term. This is the main difference between the models.

Since light is known to take longer to travel through a gravity potential than it would if that space were empty, it is assumed by the legacy model that the space inside the gravity potential gets longer; therefore, it takes longer for light to travel through. This is the reason behind a need for space-time curvature, because light is assumed to travel at c inside a gravity potential as measured by the distant observer, thus explaining why it takes longer and travels at c.

The Law of Universal Specificity causal model, however, does not assume the speed of light remains the same. Gravitational time dilation can slow the speed of light down when measured by an outside observer, as proven by refraction discussed in Section 9.

To sum up, both models agree that the falling object's velocity measured on the surface is greater than when it is measured by the distant observer. The legacy model gets the additional γ^2 factor by assuming space-time curves and the speed of light (measured by a distant observer) is constant in a gravity potential, which is proven to not match observations when refracting light through higher gravity potential mediums.

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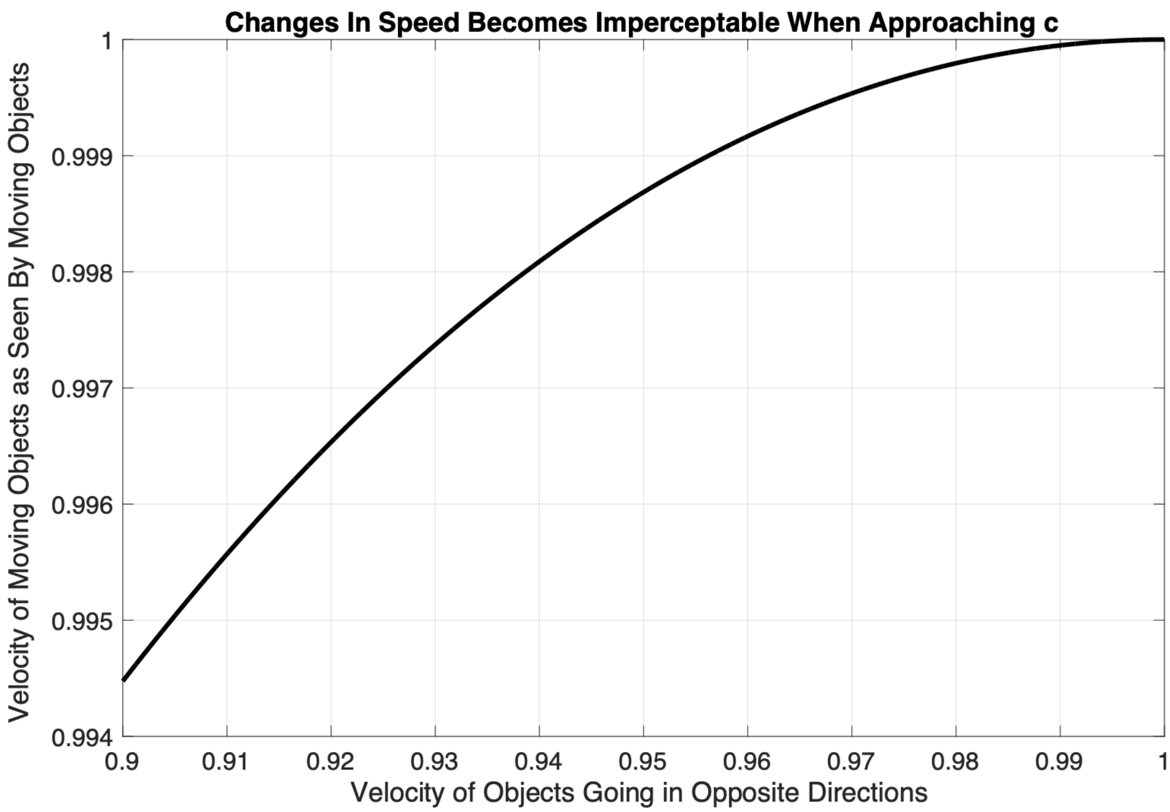

Figure 15. **Changes in speed becomes increasingly indistinguishable the closer to light.**