Three-Dimensional Time and Relativity

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Abstract.

In a previous paper, 'Concepts of Three-Dimensional Time in Electrodynamics', the concept of three-dimensional Vector Time is introduced along with its impact to electrodynamics. In that paper, the impact of 3D Time on the Lorentz Contraction Factor is shown. The result is that in order for the Lorentz Contraction Factor to remain real and positive, the speed of light in three-dimensional time always has to be more than the speed of light. The limit of the speed of light is still there, but the implication is that in three-dimensional time, it is not possible to slow down enough to reach the speed of light. In this paper, the derivation of the Lorentz Contraction Factor for 3D Time is detailed and the implications are discussed.

1.1 Introduction

The Lorentz Contraction Factor for Vector Space Scalar Time means that an object in a moving frame goes faster and faster relative to an observer, the length along the direction of travel gets smaller and smaller for the observer watching the object in that moving frame that goes by them. The observer also notices that time is slower for this moving frame. So, the relative experience of space and time is different depending on which frame of reference the observer is in. Since there are no absolute frames of reference, there is always a relativistic effect due to motion in space and time. The magnitude of the relativistic effects is zero for zero velocity and very large for velocities close to the speed of light in Vector Space Scalar Time.

When considering these relativistic effects for Vector time, a new Lorentz Contraction Factor needs to be calculated. This paper shows how this new Lorentz Contraction Factor is determined and the implications of this Lorentz Contraction Factor for Vector Time and Scalar Space.

Note: In this paper, instead of 4Space, Vector Space Scalar Time is used and instead of 4Time, Vector Time Scalar Space is used. This is done in this paper to highlight the vector and scalar properties of the space and time dimensions that are being discussed.

1.1.1 Impact of relativity on space and time

The epiphanies Einstein had in developing the relativity theories, Special Relativity and General Relativity, was that it was the speed of light is the same in all frames of reference and that it is possible to imagine a frame of reference in which gravity, or acceleration, could be ignored. By creating these frames of reference, two different observers would see, or experience, two different realities. Each observer's reality would be valid, but absolute measurements of space and time can no longer be counted on to express accurately to the other observer what they are witnessing. Since the speed of light is the same for both, there is a way to correlate what one observer experiences to what the other observer experiences. Let's look at a simple example of a ball bouncing up and down in a rocket, a rocket that is moving along imperceptibly to the person inside, that is, it is moving at constant velocity.

From the perspective of the person inside the rocket, there is no way to tell that the rocket is moving , or how fast it is moving, or even if it is moving at all, because there are no windows to look outside. The ball they are playing with is thrown from their hand to the floor and comes back to their hand. They see the ball moving up and down in the same axis relative to them.

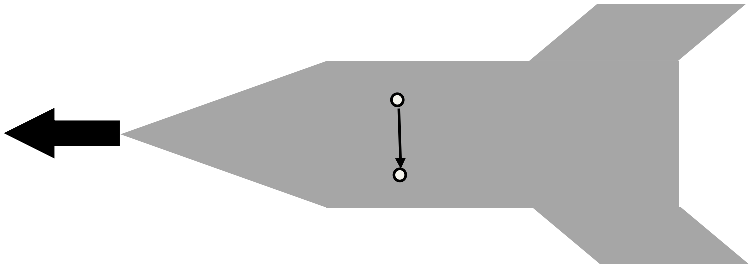


Figure 1 Reference frame inside the rocket.

Let’s make the rocket have one-way mirrored walls, so the person inside cannot see out, but the people, in this case astronauts outside this moving rocket can see in. For the astronaut on the outside, looking at the person inside the rocket going by and bouncing this ball, they would see the trajectory of the ball as shown below.

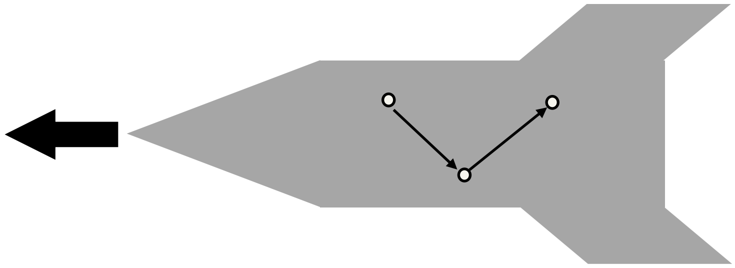


Figure 2 Reference frame outside the rocket

If either of these observers had to describe the path of the ball, and the distance it covered, they would give different results. So, we have an event in space and time that two people observe, but would describe differently. Who is right? The answer is that they are both right.

Einstein’s theory of relativity gives us a way to predict what changes will happen to space and time in a moving frame by someone outside that moving frame. The theory also states which variables do not change at all. The most well-known variable, the speed of light, is the same for everyone independent of your frame of reference. The other lesser known variables are the interval of spacetime and mass, both of which will be explored in this paper.

1.1.2 Time slowing down.

Now let’s change this example of a ball bouncing between the hand of the person on the rocket and the floor to that of a photon that bounces between two mirrors. Each round trip of the photon is used as a tick of a highly accurate clock for the person on the rocket. Now the astronaut outside, watching the rocket go by, also has their own photon clock, using the same mechanism of bouncing a photon between two mirrors. We have a photon clock for the astronaut inside the rocket and one for the astronaut outside the rocket.

The astronaut outside the rocket would say that the clock of the astronaut in the rocket is ticking more slowly, that is, the photon has to travel a longer distance for each round trip. This outside astronaut is convinced that their photon clock is the accurate one. Now the astronaut inside the rocket, who can now look out, would say exactly the same of the outside astronauts clock. Their clock is correct and the poor astronaut outside has a clock that is running slow. They cannot agree on how fast time is progressing.

We now understand how time is slowed down by a moving reference. Without going into the details, space is also changed by a moving frame. The length of an object moving relative to the observer will appear shorter in the direction of travel. This effect of space shortening does not apply to the dimensions of space perpendicular to the direction of motion. So, space compresses, and time expands when an observer tries to measure space and time in a moving frame.

Einstein realized that there is no absolute frame of reference, only a relative frame of reference which is based on how you define your place in space and time. But there is more. How do you tell which of you is moving? The person standing on the ground of planet earth would say they are the reference and everything that is moving relative to him. A person floating on a balloon in the air could say that they are still and that the person standing on the earth spinning around its axis, is the one who is really moving. Let's assume for this analogy the air the balloon is floating in has no density, so does not move the balloon along with the spinning earth. Both of these people would be right.

Who has not had the experience of being stopped at a light in a car and day dreaming. All of a sudden, you feel like your car is moving and you press harder on the brake pedal, only to realize that the bus or car next to you is moving slightly relative to you.

1.1.3 Frame of reference

Now, Einstein postulated that in order for the frame of reference to be valid, there has to be no way the observer in that reality can see which frame of reference they are in and how fast they are going. As long as frame of reference is moving at a constant velocity, there is no way for you to tell that you are moving. Currently, sitting still on the surface of planet earth, you are moving at roughly a thousand miles per hour when you are close to the equator, you are moving 67 thousand miles an hour due to the earth moving around the sun, and let's include the half a million miles an hour due to the rotation of our solar system around the milky way axis. So, we are moving incredibly fast, but we feel like it is stationary. It is only motion relative to these planetary motions, that is a difference in velocity or acceleration, that we perceive as motion at all. It is only when the plane you are seated on changes to a faster velocity, on take-off, or slower when coming into land that you are sensitive to its motion. During the flight, given no turbulence, you cannot tell you are moving.

Another frame of reference is one where there is no gravity, or stated better, where the effects of gravity are undetectable. If you are in a free-falling elevator, everything in the elevator is falling at the same rate, so it appears as if there is no gravity. For those outside the elevator, their frame of reference is that it is gravity that is the cause of the weightlessness that those in the elevator are experiencing. For a person born in a frame of reference like the inside of the free-falling elevator and with no way to see outside the elevator, assuming the elevator is huge in comparison to their world, they have no way of knowing that it is the very force of gravity that makes everything appear to be free of the influence of a force like gravity. So, Einstein understood, that the frame of reference is crucial to understanding your perspective of the world around you. Now in order for relativity to apply, it is important to get a unique frame of reference. These frames of reference might be small, like a tiny rocket, or large, like a solar system.

1.2 Relativity in Vector Space Scalar Time [4Space]

So, space and time are not absolute. What besides the speed of light can be used to help correlate the experience of one observer to another? Like the speed of light, these variables must not change with differences in the relative speed between the two frames of reference. These variables are called invariant.

One of these variables that was derived from the Theory of Special Relativity is the Interval of Spacetime. What Einstein determined is that even though the separation in space or the separation in time are different, the separation of events in the combination of both, *spacetime,* is the same for both. What this means it that there is a way that the observations of both astronauts, one inside the rocket and another outside the rocket, can be reconciled. Remember, they observe their clock to run at different rates. The relationship that Einstein defined is as follows,

$$[\text{Interval in spacetime}]^2 = [\text{speed of light x separation in time}]^2 - [\text{separation in space}]^2 \qquad (1)$$

Now the reason for the speed of light in the separation of time term is that in order to subtract these terms, they must be in the same units. The separation in time is converted to distance by multiplying it by the speed of light, that is, change or separation in space / change or separation in time x separation in time = change or separation in space. Representing time as a distance is not that foreign. It is common for us to speak of a journey in either time or distance. It is actually more common to speak of it in terms of time, so we might say a journey will take us an hour in time, but the journey could be 35 miles or 65 miles, depending on what roads we take, that is what speed we are moving at. We use our average speed to convert time to distance, just like the speed of light is used in the equation above. If our average speed was 40 mph, and we drove for half an hour, then instead of saying our journey took half an hour in time, we say it was 20 miles in space.

Let's examine the photon clock example. The photon from the astronauts' frame of reference inside the rocket starts and end at the same place, the exact same spot on the floor of the rocket. So, the separation in space is 0 feet. If the distance between mirrors is 3 feet, then the separation in time is 2 x 3 = 6 feet. So, for this astronaut, the spacetime interval is

$$\text{Interval in spacetime} = \text{square root } (6^2 - 0^2) = 6 \text{ feet.} \qquad (2)$$

Let's assume that the rocket moved 8 feet in the time it took for the photon to bounce up and back down.

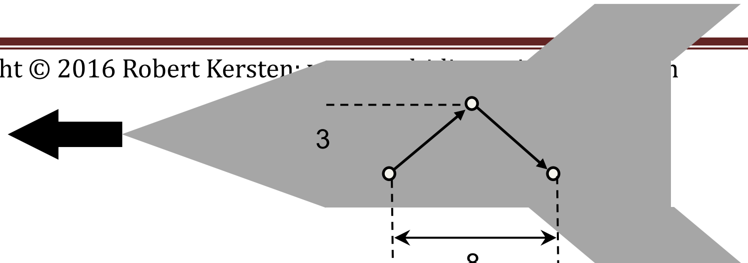


Figure 3 Photon clock in moving rocket

The total distance in time travel for this photon as witnessed outside the rocket is now the longer arrows to the up position and then back down again. Each of these arrows is 5 feet, so a total of ten feet is travel by the photon versus the 6 feet based on the inside frame of reference. For the astronaut outside the rocket, they will calculate a spacetime interval of

Interval in spacetime = square root $(10^2 - 8^2)$ = square root $(100 - 64)$ = 6 feet. (3)

The same. So even though the space and time are not the same, the interval in spacetime is the same for both astronauts, so this variable can be added to the speed of light at being the same for both astronauts.

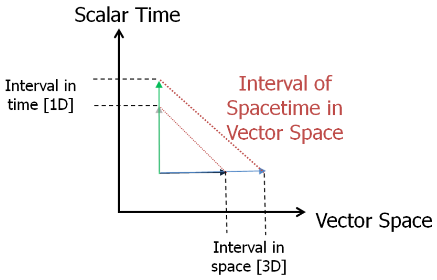


Figure 4 Motion in Vector Space Scalar Time

In Figure 4, Scalar Time is c*t, which converts time in seconds to feet or meters, so that the Invariance of Spacetime in Vector Space is all in terms of distance.

1.2.1 **Speed of motion in Vector Space Scalar Time [4Space].**

As shown in the previous section, in relativity the interval in spacetime, is the same for both observers. One observer will measure space as x and time as t, the other will measure space as x' and time as t'. Since the interval in spacetime is the same for both, these two sets of space and time variables can be equated, as shown below.

$$(t')^2 - x'^2 = (t)^2 - x^2 \qquad (4)$$

Note that time in this equation is already assumed to be in meters, that is, c*t.

In the above equation, t' and x' are time and space for the moving frame of reference and t and x are time and space for the frame of reference outside of the moving frame of reference. In this example, the event happens in the same location, so x' = 0. This corresponds to the ball bouncing on the same spot of the rocket floor. The equation now becomes,

$$(ct')^2 = ((ct)^2 - \mathbf{x}^2) \tag{5}$$

where in Vector Space

$$\mathbf{x} = \mathbf{v}\, t \tag{6}$$

Putting the latter into the previous equation, the interval is,

$$t' = t\, (1 - v^2 / c^2)^{1/2} \tag{7}$$

$$t = \gamma_s\, t' \tag{8}$$

$$\text{where } \gamma_s = 1/ (1 - v^2 / c^2)^{1/2} \tag{9}$$

For $v << c$, the v^2 / c^2 term is close to zero, so γ_s equals one and so space and time in both frames are measured as the same. As v approaches c for the moving frame, the v^2 / c^2 term approaches one, making γ_s larger and larger. This means that the observer viewing the moving frame of reference measures the time it takes for the photon to go up and back down to take longer and longer. This can be easily visualized since the increased velocity adds more distance in the direction of motion in Figure 3. The impact is that time for the moving frame is seen as going slower and slower. There is a limit and this is reached at the singularity when v equal c. If $v > c$, then the v^2 / c^2 term is above one, and the result is the square root of a negative number, which is not considered a real solution for t'.

For the space component along the direction of travel, the equation with the Lorentz contraction factor γ_s is

$$x' = x / \gamma_s \tag{10}$$

In this case, for velocity v approaching zero, γ_s is one so there is no difference between x' in the moving frame and x. But when v approaches c, γ_s gets larger and larger, making the length for the moving frame appears smaller and smaller.

1.2.2 Worldline in Vector Space Scalar Time [4Space]

In relativity, it is common to plot events in Vector Space Scalar Time as points in a Worldline plot. In this plot, time is plotted on the y axis and one component, for clarity reasons, is plotted on the x axis. Now as a reminder, time is not plotted in seconds, but in terms of meters, so the separation in time is the speed of light times time.

Now if you are staying in the same place, say x = 5 miles, space is static, that is the interval of space is always zero, but time can never stop, so the interval of time continues on, one second at a time. If a person does not move from this 5 mile spot, the worldline is a straight line parallel to the time axis at x = 5 miles. If you move from one spot to another, the graph will change the space locations as time progresses up the time axis with each tick of the clock.

Now there are limits to where you can move in this Worldline plot. The limit is that the interval of space divided by the interval of time can never exceed the speed of light. These lines, drawn at a 45 degree angle to the space and time axis, are the limits [represented by the plum color in Figure 5]. So, any place inside these plum lines, along the time axis, is allowable. Any spacetime event that is outside these lines is a speed faster than the speed of light and is not allowable.

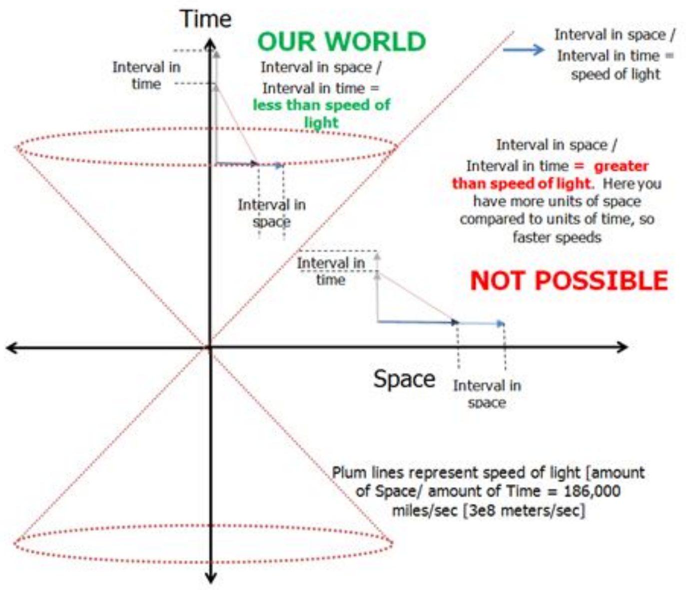


Figure 5 Worldline diagram for Vector Space Scalar Time

1.2.3 Timelike, Spacelike and Lightlike

One of the interesting definitions that come out of framing space and time in this Worldline format are three terms, Timelike, Spacelike and Lightlike.

Let's tackle the Lightlike term first. When velocity equals the speed of *light* as shown by the plum lines at 45 degree angle to the Space and Time axis in Figure 5, then this is considered a Lightlike event.

If the separation in time is larger than the separation in space, this event is called Timelike. The most obvious example is if the person or object is not moving in space, so the separation in space between two events is zero. Since the time between these two events is always different due to the progression of time, this makes the separation in time dominant. Any event where the separation in time is dominant is called a Timelike event.

Based on the Timelike definition, it is easy to see that an event is defined as Spacelike if the event is along the Space axis, that is, if the separation of space is larger than the separation of time. The separation of time is zero when the measurement of the two events is taken at the same time, that is, simultaneously, but there is a distance between the two events in space that is larger than that of the separation in time.

1.3 Relativity in Vector Time Scalar Space [4Time]

Now in Vector Time Scalar Space, the dimensional properties of space and time are reversed. Time is now a vector field and space is a scalar field. For convenience, I have continued to plot space along the x axis and time along the y axis. In Vector Time, a person can move from one location in time to another, but space progresses ever onward in the same manner that time does in Vector Space. In this plot, all motion is in terms of time, so Scalar Space must be divided by c to turn space into units of time.

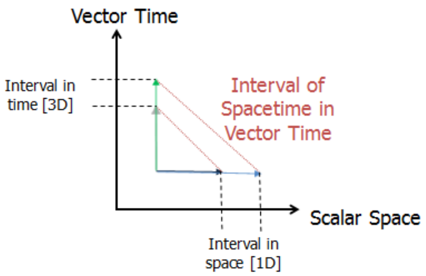


Figure 6 Motion in Vector Time Scalar Space[4Time]

An object that stays stationary in a location in Vector Time has a worldline that would be a straight line parallel to the Scalar Space axis. In the Vector Time Scalar Space, velocity is change in time divided by change in space, the reciprocal of velocity in Vector Space Scalar Time. In Vector Time Scalar Space, the interval of vector time divided by the interval of Scalar Space must always exceed the speed of light. If it does not, then it is no longer in Vector Time Scalar Space [v > c], but now in Vector Space and Scalar Time [v < c].

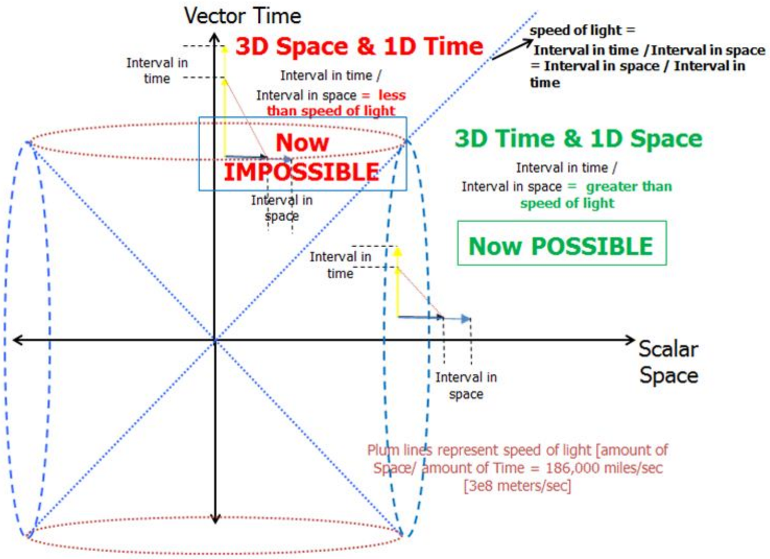


Figure 7 World Line for Vector Time Scalar Space [4Time]

Notice that the 45 degree lines which represent the speed of light can be reached in two ways. One is in Vector Space Scalar Time when the interval of vector space divided by the interval of Scalar Time equals the speed of light. The other way is in Vector Time Scalar Space when the interval vector time divided by the interval of Scalar Space also equals the speed of light.

1.3.1 Speed of motion in Vector Time Scalar Space [4Time]

In the previous section, the Lorentz contraction factor, γ_s, was determined to be $1/ (1 - v^2 / c^2)^{1/2}$. For low velocities, γ_s is one so there is no contraction in the vector field. As v approaches c, γs gets smaller and smaller. For the space vector field, the moving length is reduced by γ_s and the Scalar Time field is expanded by it. If the velocity is greater than c, then γ_s is negative and therefore not a real velocity so not allowable.

But it cannot be assumed that γ_s is correct for Vector Time Scalar Space [Appendix A]. In fact, as shown in Appendix B, the value of the Lorentz contraction factor for Vector Time Scalar Space is different. I will call it γ_t. The Lorentz contraction factor, γ_t, for Vector Time Scalar Space is

$$\gamma_t = 1 / (1 - c^2 / v^2)^{1/2}. \qquad (11)$$

In this case, if $v < c$ then γ_t is an imaginary number and is not a real velocity, therefore not allowable.

But, when v is just above c, then γ_t is a very large value. As v approaches infinity, then γ_t approaches one. In fact, v only has to equal 3c and the value for γ_t is already 1.06, so approximately one. On either side of $v = c$, the values for γ_s and γ_t are very large and these values for γ_s and γ_t approach one as the velocity moves away from $v = c$. This value of one for the gamma happens in Vector Space as the velocity approaches zero and for Vector Time as the velocity approaches infinity.

Now when the Lorentz contraction factor is applied to the vector field of time, which is derived in Appendix B, the result is

$$t' = \gamma_t\, t \qquad (12)$$

so the component of the vector field in the direction of motion in Vector Time is very large when velocity is very close to the speed of light [c] and the same as velocity approaches infinity.

For the Scalar Space field, which is the Vector Time clock, the equation is,

$$x' = x / \gamma_t \qquad (13)$$

The scalar field is very small when velocity is close to c, but the same when v approaches infinity.

To summarize the effects on space and time in Vector Time Scalar Space. In 4Time, velocity is always faster than the speed of light. It can never be slower than the speed of light. In 4Time, Scalar Space, which is the agent of change in 4Time, will expand just like Scalar Time, the agent of change in 4Space, expands with motion. In 4Space, the slower the relative motion between two frames of reference, the more the measurement of space and time between these two frames of reference are the same. In 4Time, this happens when the relative motion between the frames of reference is the most extreme, that is much faster than the speed of light, and the effects on time and space between two frames of reference in 4Time gets more and more dissimilar as the motion between them slows down and the relative motion approaches the speed of light.

In both 4Space and 4Time, the largest relative difference between the measurement and experience of space and time happens as the relative motion is close to the speed of light, but from opposite sides.

1.4 Combining both Worldlines

The commonality between the Vector Space Scalar Time and Vector Time Scalar Space is that in both the Vector fields shrink in length along the direction of motion and the Scalar fields expand as velocity gets closer to the speed of light.

I wanted to combine both Vector Space Scalar Time and Vector Time Scalar Space into one world diagram. The choice is to keep the axis as Time and Space for both or keep one axis as the scalar field and the other the single component of the vector field. I chose to keep the Time and Space axis consistent. I made the green colors for Vector Space Scalar Time and the blue colors for Vector Time Scalar Space. With this diagram, events are now possible in all parts of the diagram, not just to one side or the other side of the speed of light [blue dotted lines].

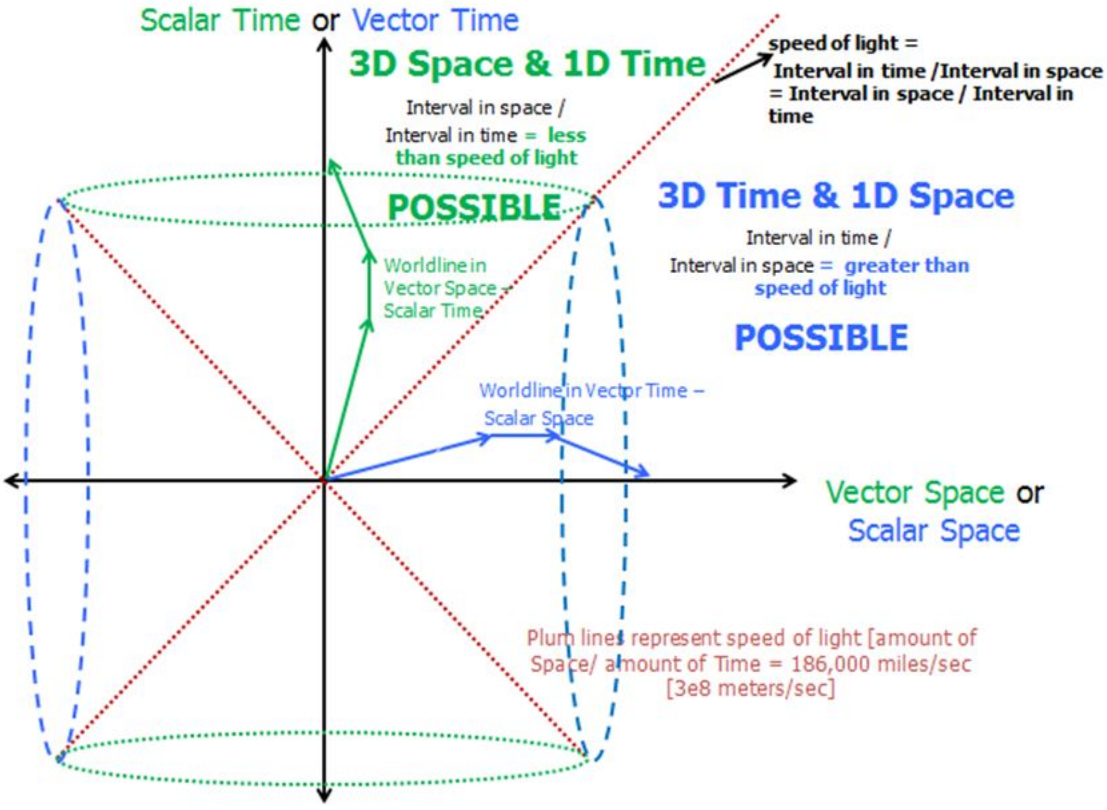


Figure 8 World diagram for both Vector Space-Scalar Time and Vector Time - Scalar Space

1.4.1 Reciprocal relation between these two spacetime realities

In this section, I will describe how the Reciprocal System Theory [RST] describes matter moving between these two spacetime realities. To review, the motion in these two realities as defined in the RST are reciprocal of each other. In Vector Space Scalar Time it is a vector space field divided by scalar time field. In Vector Time Scalar Space it is Vector Time field divided by Scalar Space field, that is, 1 / velocity of Vector Space Scalar Time. The other factor to come out of this relationship with space and time is that from the frame of reference of motion, space is equivalent to 1/ time and time is equivalent to 1/space. The effect on motion is the same if space is increased, or time is reduced since space is equivalent 1/time. In both cases, motion increases. So space and time are reciprocal of each other.

The impact of this reciprocal relationship is that if matter in 3D Space is moving away from all other matter, that is, the fabric of this universe is expanding carrying matter embedded in space further from each other. While this expansion is going on in 3D space, in 3D Time matter, the fabric of Vector Time is moving closer together since 1 / increasing space = contracting time. So all the matter in time is moving closer together, a manifestation of what is defined as gravity. So the total energy expended on expansion and contraction, in both these spacetime realities, is conserved at all times.

In 3D space, as the space term in the velocity term we are familiar with, that is d**s**/dt, goes from zero to infinity, velocity in 3D Time goes from infinity to zero. This is because the time term in that velocity term, dt/ds, goes from infinity [time = 1/(space = 0)] to zero [time = 1/(space = ∞)] given this reciprocal relationship.

In a situation, like that seen in astronomy, the Reciprocal System Theory states that if matter is compressed enough so that the kinetic energy, due to extremely high temperature, is in excess of what can be released as radiation energy, the star will explode. For all particles exploding with a kinetic energy that results in a speed less than the speed of light, the particles expand in Vector Space. These particles will lower the density of the star.

For particles exploding with a kinetic energy that is just above the speed of light, these particles are no longer detectable in Vector Space, therefore disappearing from our reference frame. These particles, moving at faster than the speed of light, expand in Vector Time. Now expansion in Vector Time to infinity, from the reference frame of Vector Space [our only reference frame], is one divided by infinity. From the Vector Space reference frame, this expansion in Vector Time is a compression to zero in the Vector Space reference frame. These particles will increase the density of the star.

The Reciprocal System Theory defines allowable states for Vector Space Scalar Time. The energy of motion in that matter results in a particular form of matter that we define as atomic particles, atoms, etc. Energy that is not used to bind matter results in kinetic energy, the energy of motion we can measure in Vector Space. When an event, as described above, results in matter with excess kinetic energy, that is motion faster than the speed of light, the matter is now in Vector Time and it reconfigures to the laws of energy of motion in Vector Time. Remember, this motion is based on the same motion in Vector Space, but it is the reciprocal of Vector Space. Any excess energy that is left over after this new reconfiguration results in motion in Vector Time.

What is described here is a very simplified process of how matter behaves in Vector Space and Vector Time. There are much more details given in the Reciprocal System Theory about astronomical and atomic processes that the reader might find interesting. [ref 3]

The total amount of time and space, with one expanding while the other one is contracting, is conserved in totality between Vector Space and Vector Time. If space and time are conserved, then velocity is also conserved.

1.5 Energy, Momentum and Mass

The unification of Vector Space and Scalar Time through the invariant variable of interval of spacetime was shown in the previous sections. Vector Space and Scalar Time are clearly different, but they can be combined and these equations help to correlate the behavior of space and time in different frames of references. Now in this section, Vector Momentum and Scalar Energy will be unified in a similar manner where Mass is the invariant property that links the two together.

Of the three properties, Energy, Momentum and Mass, mass is the easiest of the terms to relate to since it is tangible. We can see and touch mass, but this is not true for the other two. We can experience the effects of the other two. With regards to momentum, every time we slow down or accelerate, we feel momentum as the resistance to change from the velocity and direction we were on. Newton called momentum a ‘quantity of motion’. Energy is more difficult to define. Einstein has shown that energy can show up as mass, and from physics it is known that it can show up as kinetic energy, potential energy, thermal energy, electromagnetic energy, atomic energy as well as all the forms of chemical energy.

All three of these properties, Energy, Momentum and Mass are conserved, but they are not all invariant. Mass is the only property that is conserved *and* is invariant [unchanging] in all frames of reference.

1.5.1 Momenergy in Vector Space Scalar Time

Energy and momentum have different units, so as they are defined in Newtonian physics, they cannot be combined. But if velocity is defined as a fraction of the speed of light, that is $\text{velocity}_{\text{relative}}$ [v_r] instead of the conventional way with units of distance / time, then both Kinetic Energy [K] and momentum [p] have units of mass. That is,

$$p = m\, v_r = m * (\text{unitless fraction}) = m \qquad (14)$$

and

$$K = \tfrac{1}{2}\, m\, v_r^2 = m * (\text{unitless fraction})^2 = m \qquad (15)$$

So now both momentum and kinetic energy have the same units, that of mass with the relative expression for velocity. These equations are good for slow speed, but do not work for relativistic speeds.

In the relativistic equations for energy and momentum, the proper time is used, where the relationship between proper time [T] and the familiar time [t] is

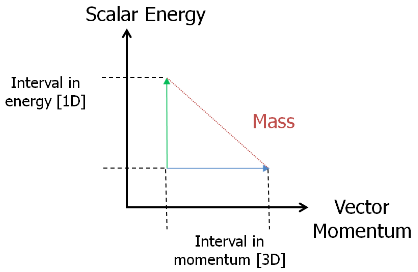
$$dT = dt/\,\gamma_s\text{, that is } \gamma_s = dt/dT \qquad (16)$$

The proper time [dT] is often called the wristwatch time, since it is closely correlated to the time the user has on his wrist in their own frame of reference. The other time is what is said to be happening to *time in the moving frame*. As described before, the faster you go, the more this time slows down relative to the proper time. The definitions of one component of the Vector Momentum [p_x] and Scalar Energy, using proper time are;

$p_x = m\ dx/dT = m\ dx/dt\ dt/dT = m\ v_r\ \gamma_s$ (17)

$E = m\ dt/dT = m\ \gamma_s$ (18)

Here momentum is the space part and energy is the time part. Velocity, which is change in space / change in time so Vs = p(x) / E



Here mass^2 = energy^2 - momentum(x)^2. The space part is Momentum(x) and the time part is Energy. All three variables are conserved. Scalar energy, momentum(x) and scalar mass. As stated before, mass is both conserved and invariant. [ref 2].

Velocity is then defined as,

$v_{relative}$ (space) = p(x) / E in 1D or p(x,y,z) / E in 3D (19)

When velocity is zero, that means the mass is at rest, and $\gamma_s = 1$.

This means that $E_{rest} = m$ (20)

E_{newton} is correlated to Newtonian energy with the following equation,

$E_{newton} = E * c^2$ (21)

Now the energy of mass at rest, using equation 21 is

$E = m\ c^2$ (22)

The units for energy and mass are equal in Newtonian physics.

1.5.2 Momenergy for Vector Time Scalar Space

In Vector Time Scalar Space, Energy is the vector and we graph only one component of the energy vector and momentum is scalar. Here we represent Vector Energy as having three components, t_1, t_2, and t_3. [ref 1]

In this case, energy is still the time part and momemtum is still the space part. What changes is the conversion of $\text{velocity}_{\text{conventional}}$ to $\text{velocity}_{\text{relative}}$ in time. The relationship between Vector Space Scalar Time and Vector Time Scalar Space velocities are reciprocal. In Vector Space Scalar time it is change in Vector Space / change in Scalar Time. In Vector Time Scalar Space it is change in Vector Time / change in Scalar Space. So,

$$\text{Velocity}_{\text{conventional}}(\text{Vector Time Scalar Space}) = 1 / \text{Velocity}_{\text{conventional}}(\text{Vector Space Scalar Time}) \tag{23}$$

From now on, $\text{Velocity}_{\text{conventional}}(\text{Vector Time Scalar Space})$ will be shown as $v_{\text{t-conventional}}$ or $v_{\text{t-relative}}$ and $\text{Velocity}_{\text{conventional}}(\text{Vector Space Scalar Time})$ as $v_{\text{t-conventional}}$ or $v_{\text{t-relative}}$.

$$V_{\text{t-relative}} = c / v_{\text{t-conventional}} = 1 / V_{\text{s-relative}} \tag{24}$$

Also, in a previous section, γ_t was derived in equation 11. Using these relations, the equations for scalar momentum and Vector Energy are

$$E(t_1) = m\,\gamma_t \tag{25}$$

$$P = m\,\gamma_t\,V_{\text{t-relative}} \tag{26}$$

Solving both equations 25 and 26 for mass and then equating them gives the equation for $V_{\text{t-relative}}$,

$$V_{\text{t-relative}} = p / E(t_1) \ \text{ in 1D} \qquad \text{or} \qquad p / E(t_1,t_2,t_3) \text{ in 3D} \tag{27}$$

This is the opposite of the relationship for $V_{\text{s-relative}}$ because equation 24 states the reciprocal relation between these two velocities, so vector energy and Scalar Momentum from the perspective of Vector Space Scalar Time, that is $V_{\text{s-relative}}$, would be

$$V_{\text{s-relative}} = E(t_1,t_2,t_3) / p \tag{28}$$

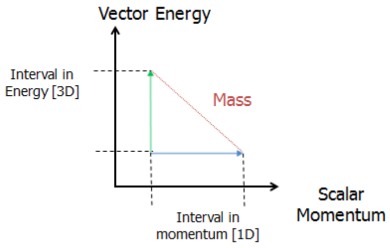


Figure 9 Momenergy in Vector Time Scalar Space

The relationship of Vector Energy to Scalar Momentum in Vector Time Scalar Space is the same,

$\text{mass}^2 = \text{energy}(t_1)^2 - \text{momentum}^2$.

Since mass is invariant in both Vector Time Scalar Space and Vector Space Scalar Time,

$$(\text{energy}(t_1 \text{ in Vector Time}))^2 - \text{momentum in time}^2 = \text{energy in space}^2 - \text{momentum}((x_1 \text{ in Vector space}))^2 \quad (29)$$

1.6 Multidimensional Causality and Time Travel

The behavior of γ_t is similar to that of the hypothetical Tachyons. As Tachyons lose energy, their speed increases, so that at the lowest energy state, they are traveling at infinite speed. As energy is added to the Tachyon, it slows down and approaches the speed of light. At the lowest energy state, that is where γ_t is one, velocity in Vector Time Scalar Space is infinite. This effect of adding energy to slow a particle in Vector Time Scalar Space is counterintuitive to our experience of energy and velocity in Vector Space Scalar Time. The speed of light is a barrier that prevents Tachyons from transitioning to speeds less than the speed of light. As shown above, γ_t is negative for these less than c velocities.

The lowest energy of Vector Time Scalar Space is the reciprocal of the lowest energy state of Vector Space Scalar Time where velocity equals zero. So in Vector Time Scalar Space, the lowest energy state is 1/ (lowest energy state of Vector Space Scalar Time), which is $V_t = 1 / V_s\,(0)$ results in a V_t that equals infinity. Now for both γ_t and γ_s, these values increase as the velocity in Vector Space Scalar Time increases to the speed of light and in Vector Time Scalar Space, the speed of light decreases to the speed of light. Very close to the speed of light, both γ_t and γ_s reach their maximum value.

In Vector Space, the arrow of Scalar Time is from the past, into the present and on into the future. The present is carried away by photons at the speed of light and in doing so, becomes the past. In Vector Space Scalar Time, if you can move faster than the speed of light, you can witness all the events that happened in the past. I purposely stated witness, not interact with.

In Vector Time, events that happen in time are locations in this vector field. One way to imagine this is to assign one of the three axes of Vector Time to the progression we are familiar with, that is time progressing from the past, in the present and then into the future. So t_1 could be time from some starting point billions of years ago, to the present and a time billions of years into the future. For each point on the t_1 axis, there is a plane represent by perpendicular axes t_2 and t_3. In this plane are all the possible outcomes of events influenced by the past and present, and an amplitude of probability is associated with each of these possible outcomes in this Vector Time field. These events include cosmic scale events such as the evolution of galaxies to the atomic scale events such as the fastest transition of energies of a particular atomic particle.

So as time progresses along the t_1 axis, all the spacetime events behind the present are actualized possibilities of events and in front of the present are the ever-changing amplitudes of probabilities for each possible spacetime event. All this is being recorded in the Vector Time field. Move around from location to location in this Vector Time field and you can *visit* any spacetime event at that particular time in all of spacetime. Since velocity is always faster than the speed of light in this Vector Time field and without any additional energy, is infinite, all events in time, from deep into the past to far into the future can theoretically be *visited* easily and rapidly. The challenge is slowing down enough to focus on a specific event that is very close to the present, that is, the speed of light. From the frame of reference of Vector Time Scalar Space, visiting the exact present is not achievable since it would take infinite energy to slow down enough to be in the exact present, the moment of now. From the frame of reference of Vector Space Scalar Time, visiting the exact present is not achievable since it would take infinite energy to go fast enough to be in the exact present, this same moment of now.

The question now is if a future possible event is now visited in Vector Time, and it is witnessed during that visit that the probability of one particular outcome is more than that of the probability of a second outcome (the more desirable outcome) is it possible to augment the amplitude of probability for the second outcome while visiting this future possible event. Since there is no limitation in the direction of time in Vector Time, the energies of this action on the possible second outcome could travel back in time to the present and affect the current possibility of this second outcome before the present, changing the potential outcome in the next moment of now.

In the model that I present, Vector Time Scalar Space holds the probabilities of possibilities of future events in Vector Space Scalar Time. Quantum Physics deals with this well by using statistics for a ensemble of particles to predict the outcome of an atomic event. What Quantum Physics cannot do is predict the outcome of a specific particle. Would this model of spacetime, which includes Vector Time and Scalar Space allow physics to do that, I am not sure. The interface that defines how changes in spacelike events that are associated with Vector Time Scalar Space and faster than the speed of light affect changes in the timelike events associated with Vector Space Scalar Time is through changes in the ratio of space TO time, or speed. This is a scalar relationship and does not include any transformations of direction of Vector Space to Vector Time. But what this model with the additional dimensions of Vector Time and Scalar Space can do right now is present a new way to view matter, and possibly ourselves, in a more encompassing spacetime reality. What I do propose in my first paper, Concepts of Three-Dimensional Time in Electrodynamics [ref 1], is to use the gradient operation to expand, or generate vector directions from the equations of Scalar Time to Vector Time [and Scalar Time to Vector Time. In the other direction, I propose to use the divergent operation to compress the directional properties of Vector Time to generate Scalar Time and Vector Space to generate Scalar Space.

One of the favorite topics of the possibility of faster than light motion is time travel. In an analogy, I describe what including Vector Time and Scalar Space to spacetime might be. We start by imaging a technology that allows a person to view, or experience, Vector Space Scalar Time and Vector Time Scalar Space. With this technology, the totality of time and space could be viewed, but from different frames of references. From the frame of reference of Vector Space Scalar Time, the totality of all future probabilities of events could be viewed in Vector Time Scalar Space. The probability of highest future outcome could be more accurately determined based on current events in Vector Space Scalar Time. I would imagine that *all* the inputs that add to the probability of a particular outcome, as well as the accurate *correlation* of the past to this future outcome, could be seen in Vector Time Scalar Space. In many instances, our theories are limited because we either do not know all the inputs, or do not understand all the correlations of present actions to the future outcome well enough to make an accurate prediction. Also, it might be possible that the energies of some future probability in Vector Time Scalar Space might be amplified in some manner, or created as a brand-new event.

This would be similar to the action where a person decides what event they are interested in having happen in their future. They might describe in detail what this future event would look like and then go evaluate the present, as well as review the past, and decide what actions in the past and present are not in alignment to create this future outcome. They then realign current actions and thoughts to be in alignment with this future event, or objective. Future oriented people are constantly traveling in their mind to the future to set goals and adjusting the behavior in the present to meet these objectives.

From the frame of reference of Vector Space Scalar Time, it takes effort to travel the distances between locations in space, especially those distances in the cosmos. Matter is separated out in this Vector Space field yet linked to the same moments that are part of the Scalar Time field. In one location in Vector Space, there can be multiple layers of time. For example, on the surface of the earth in one location in Vector Space are rocks that are billions of years old, biological life that might only be minutes old and other forms of life and matter in between these two extremes. So a very large span of time collapses into one location in space.

In Vector Time Scalar Space, it takes effort to travel in time to different locations in the Vector Time field. So, the ancient rocks and the brand new biological life are in very different time locations in this Vector Time landscape. To witness this same event, the ancient rocks and new biological life, simultaneously in Vector Time might not be possible. Matter is now separated out by time in Vector Time field while at the same time being part of the same Scalar Space field. So, in one location in Vector Space, it might be possible to witness all the matter that was in existence at a moment in Vector Time irrespective of separation in time. Likewise, a very large span of distances in Vector Space collapses into one location in time.

Assuming it is possible to travel in all these dimensions of spacetime realities by using some to be discovered technology that can convert the matter of a spacetime ship from Vector Space Scalar Time paradigm to Vector Time Scalar Space paradigm, I could imagine that depending where you wanted to travel, it might be better to travel in Vector Time Scalar Space than in Vector Space Scalar Time. For example, if you wanted to go to a location in the cosmos that is extremely large in terms of distance in Vector Space Scalar Time, it is likely better to travel in Vector Time Scalar Space where the distance in time might be very close. Once at that Vector Time Scalar Space location, you could use this technology to convert the matter of the spacetime ship back to the Vector Space Scalar Time paradigm, which is now in a location extremely far from where you started in Vector Space Scalar Time.

1.7 Conclusion

The focus of this paper has been to evaluate the impact on the foundations of Relativity when considering the extra spacetime dimensions of Vector Time Scalar Space. The impact of the constancy of the speed of light and the effect of motion between two frames of reference on the measurement of space and time radically changed how space and time was viewed. No longer could an absolute measurement be agreed upon when observers in frames moving relative to each other at very fast motion. Two different measurements of space and time are made and both are right. The theories of relativity are necessary to correlate these two measurements.

The frames of references, and how they impact of measurement of space and time are a very good model to better understand the extra dimensions of Vector Time Scalar Space. To begin this understanding, I chose to evaluate and compare the Lorentz Contraction Factor for Vector Space Scalar Time to a new Lorentz Contraction Factor calculated for Vector Time Scalar Space.

The changes in space and time in Vector Space and Scalar Time are captured in the Lorentz Contraction Factor γ_s, which is equal to $1 / (1 - v^2 / c^2)^{1/2}$. This paper introduces a new Lorentz Contraction Factor, γ_t , for Vector Time Scalar Space which is shown to be $1 / (1 - c^2 / v^2)^{1/2}$.

In Vector Space Scalar Time, the Lorentz Contraction Factor γ_s is one for slow velocities, but it becomes very large for velocities approaching the speed of light. The effect is that length in vector space compresses in the direction of motion and scalar time expands.

For Vector Time Scalar Space, the Lorentz Contraction Factor γ_t is one for extreme velocities, but it becomes very large for velocities approaching the speed of light. The effect is that length in vector time compresses in the direction of motion and scalar space expands.

The correlation between Vector Space Scalar Time and Vector Time Scalar Space is that the effects due to relativity are the same for the Vector Fields and Scalar Fields. In both realities, the Vector Fields shrink along the axis of motion and the Scalar Fields expand. The interesting part is that in both 4Space and 4Time, the largest relative difference between the measurement of space and time happens close to the speed of light, but from opposite sides. As the motion changes from close to the speed of light, slower in 4Space and faster in 4Time, the more space and time are the same for the two observers in different frames of reference.

With the additional dimensions of Vector Time and Scalar Space, causality as we currently define and understand it is challenged. I expect this understanding to be a work in progress for some time as the understanding of the relationships between Vector Space Scalar Time and Vector Time Scalar Space becomes clearer

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1. *Concept of Three-Dimensional Time in Electrodynamics*, Robert Kersten, www.multidimensionaltime.com, Paper 1.
2. *Spacetime Physics* , Edwin Talyor and John Archibald Wheeler, W.H. Freeman and Company, New York, 1992, p195-203.
3. *Nothing But Motion*, Dewey Larson, North Pacific Publishers, 1979.

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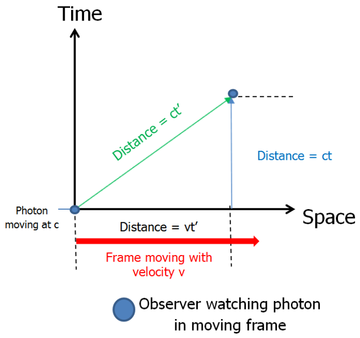
1.8 Appendices

1.8.1 Appendix A: Calculation of γ_s for Vector Space Vector Time

First, let's use the technique to calculate γ_s. Set a frame for the moving particle moving up and down in the same location inside a moving frame and one for an observer watching the particle outside the moving frame, where the frame is moving at velocity v. In the particle frame, the particle would move up and down in the same location, moving along the time axis for a distance ct . The observer sees the particle move along the green line, for a distance ct'. The frame moves a distance vt' in this time.

Laying out the geometry, we can determine how much change in space, or time, there needs to be made to make the motion the same for both frames. This results in γ_s for Vector Space Scalar Time.



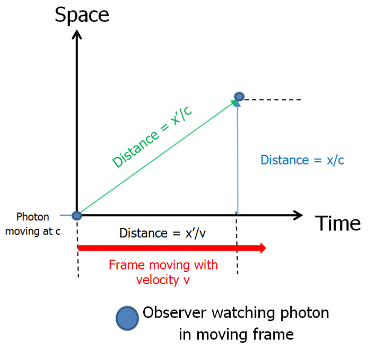
Velocity = dx/dt

Time in terms of meters is t * dx/dt or ct.

$(ct')^2 = (vt')^2 + (ct)^2$
$c^2 t^2 = t'^2 (c^2 - v^2)$
$t = t' (1 - v^2/c^2)^{1/2}$
$t' = 1/(1 - v^2/c^2)^{1/2} t$

$t' = \gamma_s t$
where $\gamma_s = 1/(1 - v^2/c^2)^{1/2}$

1.8.2 Appendix B: Calculation of γ_t for Vector Time Vector Space



Velocity = dt/dx
Space in terms of seconds is x / dt/dx or x/c.

$(x'/c)^2 = (x/c)^2 + (x'/v)^2$
$x^2/ c^2 = x'^2 (1/c^2 - 1/v^2)$
$x = x'(1- c^2/v^2)^{1/2}$
$x' = 1/(1- c^2/v^2)^{1/2} x$

$x' = \gamma_t x$
where $\gamma_t = 1/(1- c^2/v^2)^{1/2}$

1.8.3 Appendix C: Calculation of Lorentz contraction factor for Vector Time Scalar Space

Now in Vector Time, Time is the length of the Vector Field and Space is the progression of the Scalar Field.

$t_0 = t_2 - t_1$
$t' = t'_2 - t'_1$
$t = \gamma_t (t' - x/v')$

put t_0 and t into the equation with γ_t above and subtracting them gives,

$t_2 - t_1 = \gamma_t ((t'_2 - x'_2/v) - (t'_1 - x'_1/v))$

now $x'_1 = x'_2$ because this happens at the same location in the moving frame. These terms cancel.

$t_2 - t_1 = \gamma_t (t'_2 - t'_1)$

or

$t' = t_0 / \gamma_t$

This correlates well with the form of the Vector Space field under motion, where,

$L = L_0 / \gamma_s$

The behavior of γ_t and γ_s make the behavior different, but the form is the same.

The form for the behavior of the scalar field is also the same. For the Scalar Time field, it is

$t' = \gamma_s t_0$

and for the Scalar Space field associated with the Vector Time field, it is,

$x' = \gamma_t x_0$