A Model of Time

James A. Tassano

jimtassano.papers@gmail.com

ABSTRACT

In the first paper on hyperverse theory, the rate of radial expansion of the hyperverse was shown to be two times the speed of light, meaning every point in the universe is advancing into the fourth dimension at 2c. We experience this rapid radial expansion as time; it gives us the one-way arrow of time, the sense of the fleeting nature of a moment, and is universal throughout the cosmos. The vortices comprising the surface of the hyperverse, all of which have the same energy and tangential velocity, are the building blocks of both space and matter. Relative motion decreases centripetal velocity and consequently, perceived frequency. The difference between the observer's and the observed's apparent frequencies accounts for the difference in perceived clock tick rates. The time dilation function of special relativity is derived from the ratio of the centripetal velocities. Time is two part process, created by hyperverse radial expansion and the energy and spin characteristics of the quanta of space.

Subject headings: centripetal velocity; hyperverse; radial expansion; theory of time;

Introduction

"What is time?" is one of the most fundamental questions we have about existence, something nearly everyone must wonder about at some point in their lives. Time is so integral to existence that one cannot imagine life without it. The word 'time" is the most commonly used noun in the English language [1]; the second is 'year' and the fifth is 'day'. Despite our moment to moment living with time, no reasonable theory for what time is appears to exist, helping to explain a trend in physics claiming time in not real [2].

Time must have something to do with the expansion of space, as many cosmologists think that both space and time started with the Big Bang [3]. Besides wondering what time is, other questions can be asked.

Is time quantized, existing in discrete units?

Is there an 'arrow of time', as it is called, pointing one way? Many physicists try to explain time as a result of entropy, as it is basically the only quantity in physics requiring a one way direction for time [4]. The cosmological arrow of time is said to be the "direction towards which the universe becomes bigger" [5].

Relativity says time moves at different rates, depending on the relative velocity of the observer and observed. How can time move more slowly for one person than another?

Despite the dominance of time in our lives, time is a huge mystery, maybe the most perplexing of all aspects of our existence. Here, with a primary insight about the structure of the universe, we will present a model of time based on the expansion of space.

Tassano [6] presented a model of the universe as the 3D surface volume of a four dimensional sphere. When we calculate the radius of a 4D sphere with a volume equal to the observable universe, we find that the 4D sphere is expanding radially at twice the speed of light. Current data on the size of the observable universe allows us to calculate the rate of circumferential expansion of the hyperverse, and importantly, this number matches the Hubble constant. These calculations support the idea that the universe is the surface of an expanding four dimensional sphere. Additionally [6] indicates the Hubble constant is a measure of the increase in energy of the universe; space exists, the hyperverse has a surface, and it is energy.

In this paper we will start the discussion of the structure of the surface of the hypersphere and propose that it consists of a matrix of miniature 4-D hyperspheres, 4D vortices, similar to the whole, but much smaller. The spin of these vortices is what creates energy. The third paper in the series [7], discusses the nature of expansion and allows us to calculate the actual size and energies of the surface vortices. [8] will help make the connection between the quanta of space and the nature of matter. And [9], which gives a model of the structure of elementary particles, supports the concept that matter is composed of the quanta of space.

1. Frames and Cells

The 2c radial expansion gives a distinct and precise relationship between light speed and the radial expansion rate. It says that the speed of light is one-half the radial expansion speed. The hyperverse radius moves radially two units of distance for every one unit of distance light moves along the surface. This gives us two radial steps per each translational step for light. We can develop a model based on this observation, and we will refer to it as a 'frame and cell' model.

The units of space will be viewed here as 'cells'. From a 4D perspective, these cells are all the same distance from the hyperverse center. The cells will be shown to be quanta in [3], but it is sufficient here to refer to them as cells. It is hypothesized that the cells are, like the hyperverse itself, hollow, four dimensional, spinning vortices, but much smaller, as they comprise the surface of the hyperverse.

The radial expansion is viewed as occurring in steps, called frame advances. The idea is similar to motion picture frames, still shots, which, when run together produces motion. In this model, no motion is allowed between frame advances. The frame advance is the radial advance of a cell. The frame advances can be compared to the tick of the hyperverse clock, with one tick per frame advance.

The radial velocity is $2c$, and using the frame-cell model, we can conclude that light advances radially two frames while moving laterally, within the surface volume, one cell. This is a clean and logical way of modeling light speed and time.

2. Some Energy Aspects of a Cell

We will claim that energy is derived from spin, and that every cell has the same energy value. As supported below, the sum of the potential energy (PE) and linear kinetic energy (KE_{Linear}) of a cell equals mc^2, where m is the mass of the cell:

$$KE_{Linear} + PE = mc^2 \tag{1}$$

We will use the word "Linear" instead of "Translational" to reserve the "T" subscript for "Tangential".

Linear kinetic energy is given by the standard formula:

$$KE_{Linear} = \frac{1}{2}mv_L^2 \tag{2}$$

We will use the convention that v_L and v_T are given as a percentage of the speed of light. For example, $v_L = 0.5c$.

Since vortices, or cells, all spin, they possess rotational kinetic energy:

$$KE_{rotational} = \frac{1}{2}I\omega^2 \tag{3}$$

where I is the moment of inertia and ω, omega, is the angular velocity.

The rotational kinetic energy is the potential energy; they are the same:

$$PE = KE_{rotational} = \frac{1}{2}I\omega^2 \tag{4}$$

2.1. The Square Root of the Net Potential Energy Equals the Special Relativity Time Function

The Lorentz factor, $\frac{1}{\sqrt{\left(1-v_L^2\right)}}$, is the time dilation factor used in special relativity equations. Its inverse is $\sqrt{(1-v_L^2)}$, which we will refer to as the special relativity time function.

Rearranging (1) and substituting (2) for KE_{Linear}, potential energy can be stated as:

$$PE = mc^2 - \frac{1}{2}mv_L^2 \tag{5}$$

We will define 'net potential energy' as what is left of the potential energy after subtracting the linear kinetic energy from it:

$$PE_{net} = PE - KE_{linear} \tag{6}$$

Substituting (5) into (6) gives net potential energy:

$$PE_{net} = \left(mc^2 - \frac{1}{2}mv_L^2\right) - \frac{1}{2}mv_L^2 \tag{7}$$

which reduces to:

$$PE_{net} = \left(mc^2 - mv_L^2\right) \tag{8}$$

Taking the square root of the net potential energy gives us the special relativity time function, which reveals the energy nature of the time dilation equation:

$$\sqrt{PE_{net}} = \sqrt{(mc^2 - mv_L^2)} \tag{9}$$

If we define $c = 1$ and $m = 1$, we get the standard function, which, unlike the above equation, is devoid of a clear connection to energy:

$$\sqrt{(mc^2 - mv_L^2)} \Rightarrow \sqrt{(1 - v_L^2)} \tag{10}$$

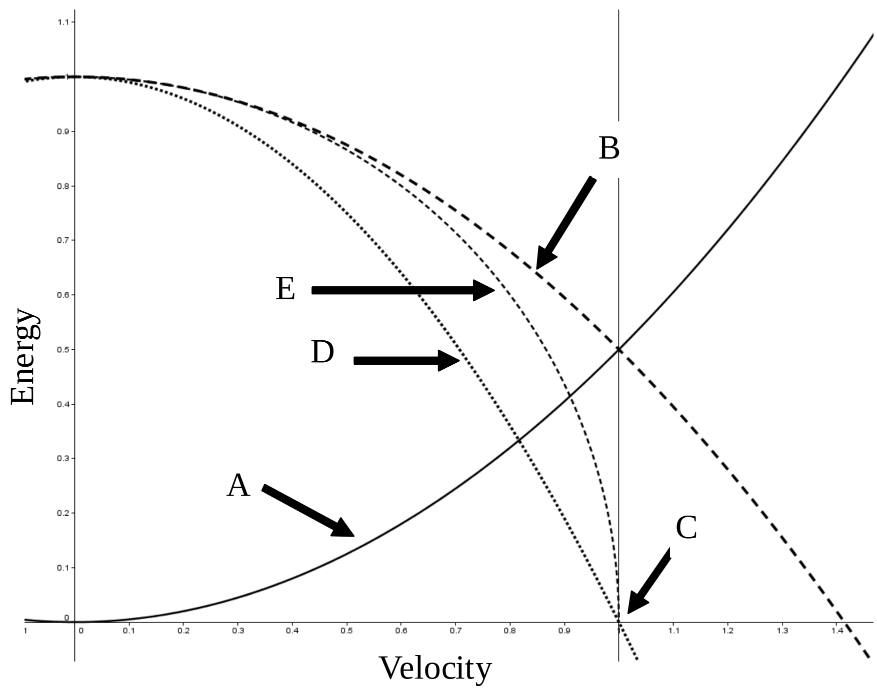


Figure 1. The relationship between linear kinetic energy (A), potential energy (B), net potential energy (D), and the square root of the net potential energy (E). Position (C) marks the location where velocity is equal to the speed of light.

2.2. Tangential Velocity

In equation (3), the rotational kinetic energy of the cell was given as $KE_{rotational} = \frac{1}{2}I\omega^2$. The moment of inertia, I, is defined as for a point particle:

$$I = mr^2 \tag{11}$$

where m is the mass of the spinning object and r is its radius.

Omega squared, ω^2, is defined as:

$$\omega^2 = \frac{v_T^2}{r^2} \tag{12}$$

where v_T is the tangential velocity, the rim speed of a spinning object. Rotational kinetic energy can thus be presented as:

$$KE_{rotational} = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(mr^2\right)\frac{v_T^2}{r^2} = \frac{1}{2}mv_T^2 \tag{13}$$

Additionally, we can express the total energy of a unit of space as the sum of the linear and potential energies:

$$mc^2 = \frac{1}{2}mv_L^2 + \frac{1}{2}mv_T^2 \tag{14}$$

If the unit has no linear velocity, then all energy, mc^2, is expressed as rotational kinetic energy, or spin:

$$mc^2 = \frac{1}{2}mv_T^2 \tag{15}$$

By solving equation (15) for v_T, we find that the tangential velocity of a vortex, one without any apparent linear kinetic energy, is the square root of two multiplied by the speed of light:

$$v_T = \sqrt{2}c \tag{16}$$

To determine the general equation for tangential velocity, we rearrange (14), substitute $\sqrt{2}c$ for v_T, cancel the mass, and solve:

$$v_T = \sqrt{2c^2 - v_L^2} \tag{17}$$

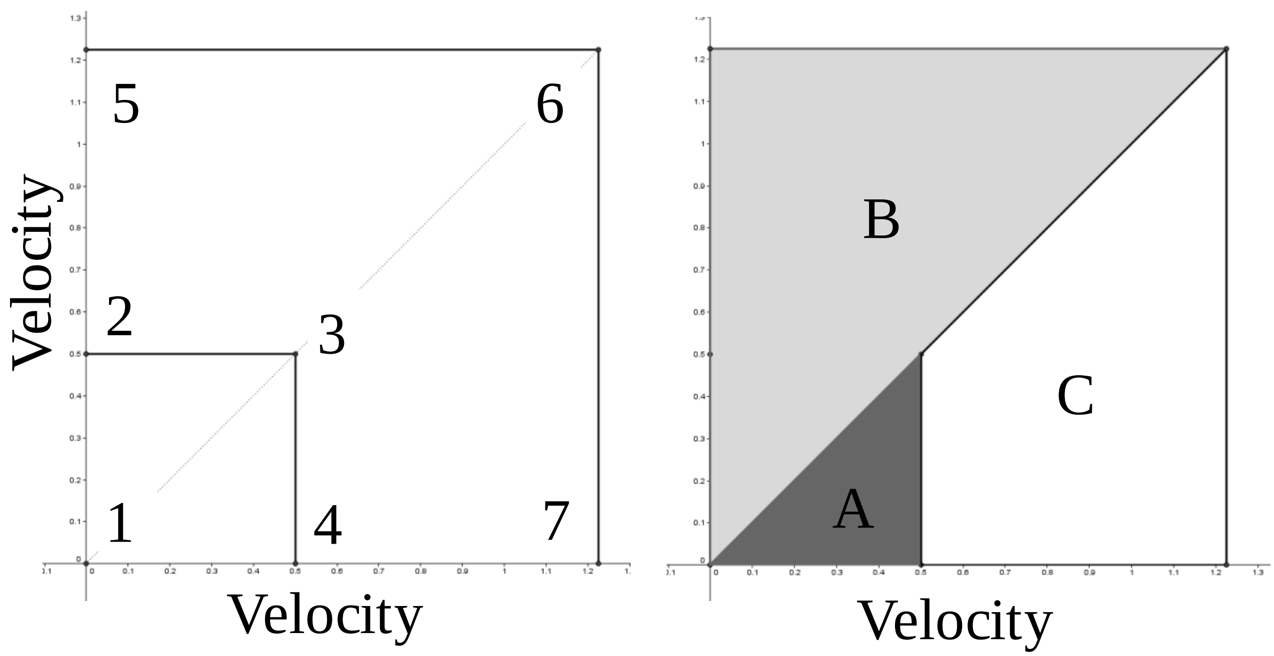
If the linear velocity is zero, the tangential velocity is equal to $\sqrt{2}c$. If the linear velocity equaled the speed of light, the tangential velocity would also be the speed of light. Thus the tangential velocity will vary from a maximum of $\sqrt{2}c$ to c as the object's linear velocity varies from rest to the speed of light.

3. Explaining Relativity

3.1. The Energy of Time

As mentioned above, we can produce the special relativity time function by taking the square root of the difference between the rotational kinetic energy and the linear kinetic energy.

To explore this more, we created a 'velocity square' to better visualize the energies. The next images show a velocity square for an object traveling at 0.5c relative to the observer. In the left hand image, the 1-2-3-4 square represents the square of v_L for a linear velocity of 0.5c. The corresponding tangential velocity square has the corners 1-5-6-7.



Figures 2A and 2B. Velocity squares. Figure 2A, left, shows the square created for the linear kinetic energy, with a velocity of 0.5c. The square is defined as 1-2-3-4. The square created by the rotational kinetic energy is defined as 1-5-6-7. In Figure 2B, right, since energy is one-half the velocity squared, we can define area A as the linear kinetic energy, and area B as the rotational kinetic energy. The remaining area, C, represents the energy associated with time.

Figure 2B displays the associated energies. Since energy is one-half of the velocity squared, only one half of each velocity square, a triangle, is shown. Triangle A represents the linear kinetic energy of the moving object, $\frac{1}{2}mv_L^2$. Triangle B represents the rotational kinetic energy, $\frac{1}{2}mv_T^2$. The tangential velocity, v_T, is $\sqrt{2c^2 - v_L^2}$, and for an object with a linear velocity of 0.5c, the tangential velocity equals $\sqrt{1.75}c$. The net potential energy is the difference between the rotational and linear kinetic energies, area C.

Area C is equal to the square of the special relativistic time function, and in the example of Figure 2, has a value of 0.75c. The structure of Figure 2B suggests there is a third energy value, one associated with time.

Kinetic energy is of the form $\frac{1}{2}mv_x^2$ where v_x is a velocity. Let us solve for this implied velocity and energy. We will call this new energy KE_{time}. We will refer to the associated velocity as v_C. The kinetic energy of time would have the following form:

$$KE_{time} = \frac{1}{2}mv_C^2 \tag{18}$$

We see from our equations and Figure 2, that the kinetic energy of time is equal to the difference between the rotational and linear kinetic energies:

$$\frac{1}{2}mv_C^2 = \frac{1}{2}mv_T^2 - \frac{1}{2}mv_L^2 \tag{19}$$

Substituting $\sqrt{2c^2 - v_L^2}$ for v_T and solving for v_C we get:

$$v_C = \sqrt{2c^2 - 2v_L^2} \tag{20}$$

In this example, where v_L is 0.5c, the value of v_C is $\sqrt{1.50}c$.

3.2. The Third Velocity is a Resultant Velocity

We now have three velocities: a linear, tangential and this new velocity. It turns out that the three velocities can always be assembled to form a right triangle. This new energy is not a fundamental energy, but an emergent energy, and the new velocity vector is not a fundamental velocity, but an emergent velocity. For example, if you were to throw a ball north while a strong wind was blowing to the east, the path of the ball would be northeast, the net direction of the two forces. In the case of the spinning and linearly moving object, the tangential and linear velocity vectors combine to a form a new vector, sometimes called a 'resultant' vector.

3.3. Centripetal Velocity

The word "centripetal" means center-seeking, and a centripetal force is what makes an object follow a curved path, pushing it towards the center of rotation. Our new velocity vector is the centripetal velocity of the vortex. It points to the center of rotation and is derived from the linear and tangential velocity vectors. Surprisingly, centripetal velocity is not discussed suitably in physics texts, which necessitates a short description here.

When a spinning circle is at rest relative to the observer, the centripetal velocity vector points to the true center of a circle. With motion relative to the observer, the centripetal velocity vector points to the instant center of rotation, a location that shifts from the true center to the very bottom of the circle (the circle is defined as moving to the right) as the circle is seen to move from rest to a roll. In Figure 3, we see that the location of the instant center of rotation can be found at point F, the intersection of the circle's vertical midline, $\overline{AH}$, and the diagonal line connecting the summed tangential and linear velocity vectors for the top and bottom, $\overline{CG}$.

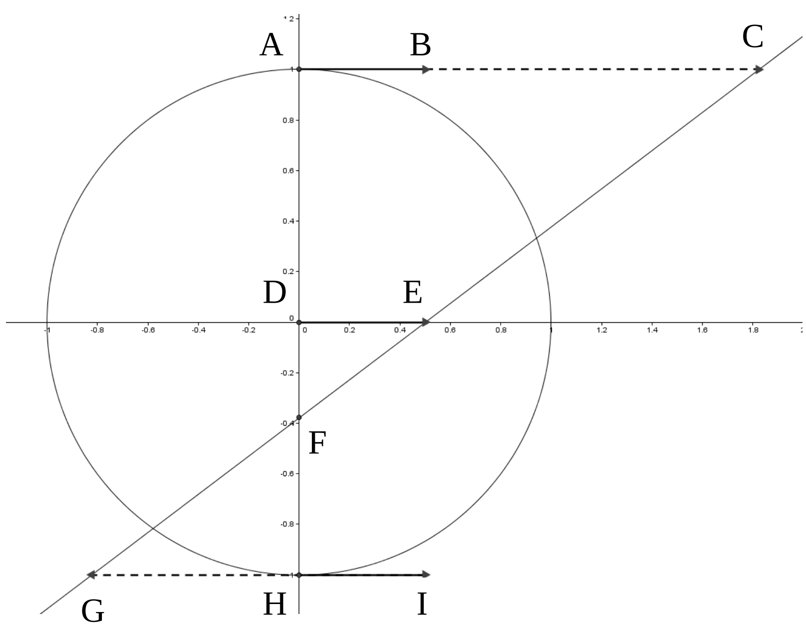


Figure 3. Locating the instant center of rotation. Segments $\overline{AB}$, $\overline{DE}$, and $\overline{HI}$ show the linear velocity vectors for our example of $v_L = 0.5c$. The tangential velocity vector is $\sqrt{1.75}c$, and at the top it adds to the linear velocity vector, the total terminating at point C. At the botom, the tangential points to the rear, and the net velocity is negative, located at point G. The center of the circle is at point D. But the instant center of rotation has dropped below the center and is at point F, located where the diagonal of $\overline{CG}$ crosses the midline ($\overline{AH}$) of the circle.

When we look at the velocity vector arrangements for our 0.5c example, Figure 4, we see the tangential velocity vector, $\overline{AB}$, is tangent to the circle and is perpendicular to the true center. The centripetal velocity vector, $\overline{AC}$, is perpendicular to the line connecting point A and the instant circle of rotation, ICR.

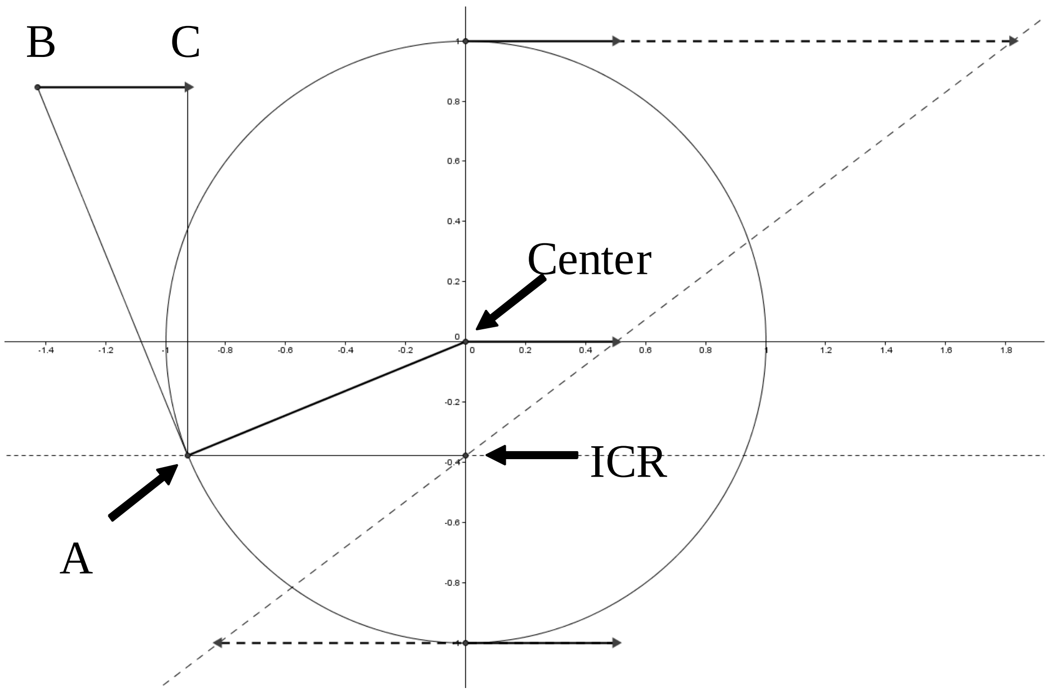


Figure 4. The line $\overline{AB}$ is perpendicular to the line connecting the center of the circle to a point on the curcumference, point A. Line $\overline{AC}$ is perpendicular to the line connecting the instant cneter of rotation to point A. Line $\overline{BC}$ represents the lineal velocity vector, $\overline{AB}$ is the tangential velocity vector, and $\overline{AC}$ is the centripetal velocity vector. This example represents a spinning object moving at 0.5c to the right.

If the linear kinetic energy is zero, then the centripetal velocity is $\sqrt{2}c$, matching the tangential velocity:

$$\text{if } v_L = 0, \text{ then } v_C = \sqrt{2c^2 - 2v_L^2} = \sqrt{2c^2 - 2\,(0c)} = \sqrt{2}c \tag{21}$$

In the case where the linear velocity is 0.5c, the centripetal velocity is $\sqrt{1.5}c$:

$$\text{if } v_L = 0.5c, \text{ then } v_C = \sqrt{2c^2 - 2v_L^2} = \sqrt{2c^2 - 2\,(0.5c)^2} = \sqrt{1.5}c \tag{22}$$

When the linear kinetic energy is the speed of light, and the object would appear to roll, the centripetal velocity is zero:

$$\text{if } v_L = 0, \text{ then } v_C = \sqrt{2c^2 - 2v_L^2} = \sqrt{2c^2 - 2\,(1c)} = 0 \tag{23}$$

Centripetal velocity is distinct from tangential velocity if there is any motion relative to the observer. Let us compare the equations of tangential and centripetal velocity side by side:

$$v_T = \sqrt{2c^2 - v_L^2} \qquad v_C = \sqrt{2c^2 - 2v_L^2} \tag{24}$$

When these equations are graphed, we can see the different behavior the equations display as velocity approaches the speed of light:

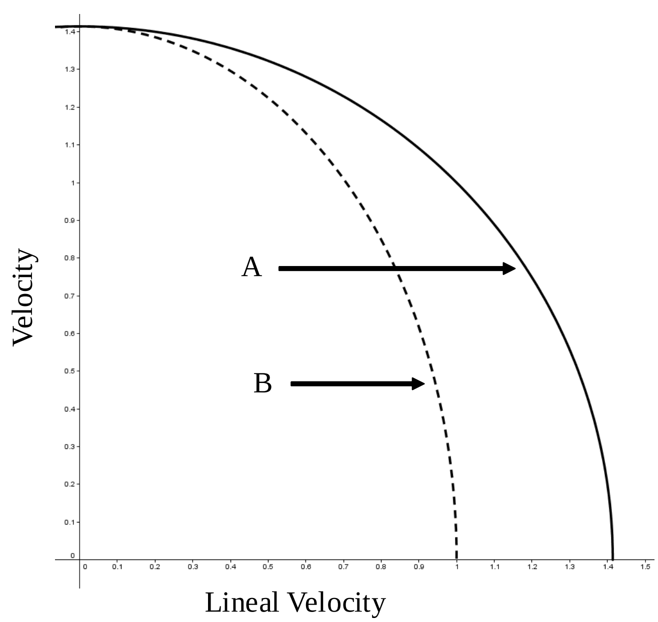


Figure 5. A comparison of tangential velocity and centripetal velocity. They are identical when the object is at rest, but diverge as the object's speed increases relative to the observer. Curve A represents the tangential velocity; curve B is the centripetal velocity.

In physics texts, equations of centripetal velocity seem always to be described as the tangential velocity, and the two are usually considered equivalent and interchangeable. The tangential velocity equation commonly used in textbooks describes objects in the observer's frame of reference, without discussion of what relative motion does to centripetal velocity.

Translational motion changes the nature of the centripetal velocity vector, causing the tangential and centripetal velocity vectors to diverge or split from one another. The equations of tangential and centripetal velocity are identical when the spinning object is at rest relative to an observer, when the linear velocity is zero, but we must use the proper centripetal velocity equation when working with an object that is translationally moving relative to the observer.

3.4. The Frequency of Rotation is Determined by the Centripetal Velocity

Centripetal velocity is related to the period of time a spinning object takes to complete a revolution:

$$v_C = \frac{2\pi r}{period} \tag{25}$$

As seen in Figure 5, an increase in the object's linear velocity decreases the centripetal velocity, which ranges from $\sqrt{2}c$ to zero, as the relative velocity goes from rest to the speed of light.

A decrease in the centripetal velocity means there is an increase in the period, or time, to complete a revolution. A long period of rotation implies a low frequency, as period and frequency are reciprocals. This gives us:

$$frequency = \frac{v_C}{2\pi r} \tag{26}$$

Substituting in the value of v_C, and factoring out c, gives:

$$frequency = \frac{\sqrt{2c^2 - 2v_L^2}}{2\pi r} = \frac{\sqrt{c^2 - v_L^2}}{\sqrt{2}\pi r} = \frac{c\sqrt{1 - \frac{v_L^2}{c^2}}}{\sqrt{2}\pi r} \tag{27}$$

3.5. The Base Frequency

The observer has an inherent frequency, and will see himself at rest, since his linear velocity is zero: $v_L = 0$. The observer's frequency is thus:

$$\text{base frequency} = \frac{c}{\sqrt{2}\pi r} \tag{28}$$

The base frequency is his clock rate, what he uses to measure time. Other clock rates must be measured against his base frequency.

3.6. The Ratio of Observed to Base Frequency

To measure the frequency of an object moving relative to him, the observer will compare the frequency of the observed to his own base frequency:

$$\frac{\text{frequency of observed}}{\text{base (observer) frequency}} = \frac{\left(\frac{c\sqrt{1-\frac{v_L^2}{c^2}}}{\sqrt{2}\pi r}\right)}{\left(\frac{c}{\sqrt{2}\pi r}\right)} = \sqrt{\left(1-\frac{v_L^2}{c^2}\right)} \tag{29}$$

Alternatively, presented in a more standard form:

$$\text{base (observer) frequency} = \frac{\text{frequency of observed}}{\sqrt{\left(1-\frac{v_L^2}{c^2}\right)}} \tag{30}$$

Atomic clocks depend on frequency to mark time. We would time an event using our clocks, in our reference frame, and our base frequency. A moving object will display a lower frequency and thus a lower clock rate to us, and we, to them. This is why we observe that a moving clock runs more slowly than ours, easily explaining special relativity.

4. Two Steps to Time

Time is a two-part phenomenon, coming from both the consequences of the 2c radial expansion and from the nature of the hypervortices comprising the surface of the hyperverse.

4.1. Hyperverse Time

The radial expansion of the hyperverse carries the hyperverse surface volume into the fourth dimension, the "true" direction of the expansion, at twice the speed of light, giving us the one way arrow of time and the sense of the fleetingly short nature of a moment. The relentless passage of time comes from the relentless 2c radial expansion. Time is everywhere in the universe; there is no escape from it, as we are not just in the universe, we are part of it, made of the same atoms of space that comprise both matter and the void of space. In hyperverse theory, matter is composed of the quanta of space, a topic discussed in detail in [7] and [9].

As calculated in [8], there are 1.506×10^{104} frame advances per second. This gives us a quantization of time at about $6.639\,87 \times 10^{-105}$ seconds per frame, for our quantum level. The duration is short before we move to the next frame. When we say events are far in the future or far in the past is surprisingly in tune with what is happening, as these events occurred in a location actually at great distances from us. The distance concept that seems so natural to use is actually correct as the universe is not anywhere near where it was just a few seconds ago.

The number of frame advances is presumed to be a constant for all points in the universe, as the universe is the same age everywhere and all points on the surface experience the same frame rate. This portion of time could be referred to as hyperverse time and can be counted in frame advances. Dividing the age of the universe by our value of the time for one frame advance gives us about 6.5×10^{121} frame advances since the expansion started.

4.2. Atomic Time

Due to a constant tangential velocity of $\sqrt{2}c$, every vortex has the same amount of energy, mc^2. All observers, regardless of their state of motion would agree that 'their' quanta have this total quantity of energy.

Self-observers in uniform, non-accelerated motion, see their own energy as fully allocated to spin. They see themselves as being at rest, and have no perceived linear movement, and no linear kinetic energy; all of the energy is rotational and the spin rate is seen as the maximum allowed. Because the total quantity of energy of spinning atoms of space is everywhere identical, and all observers can claim that they themselves are at rest, their vortices all have identical spin rates, and thus, identical clock rates.

If two observers are moving at constant, but different, velocities relative to each other, each can claim they are at rest and it is the other who is moving. Each observer deduces that the other has a decreased centripetal velocity, and therefore a lower frequency and clock rate.

Considering energy, since the total energy per atom of space is the same for each actor, if one perceives the other is moving, the mover must have linear kinetic energy, which could only have been at the expense of rotational kinetic energy. The faster the other actor appears to move, the more linear kinetic energy they would appear to possess. This decreases the energy that is seen to be allocated to spin, lowering perceived rotational kinetic energy and frequency of rotation, translating to lower perceived clock rates.

Understanding centripetal velocity is key to this concept. The vortices of both actors have the same energy and spin rates, and each self-observes the same frequency and inherent clock rate, but they would see the other actor's vortices, moving relative to them, as having a lower spin rate, or frequency, and thus a lower clock rate. We see the consequence of apparent energy allocation as relativity.

References

1. "The Top 100 Most Common Nouns | English Genie." The Top 100 Most Common Nouns | English Genie. N.p., n.d. Web. 02 Aug. 2013.

2. Smolin, L. 2013. Time Reborn: From the Crisis in Physics to the Future of the Universe. Houghton Mifflin Harcourt

3. Cartlidge, E. 2010. No Evidence of Time before Big Bang. http://www.scientificamerican.com/artic evidence-of-time-before-big

4. Carroll, S. 2010. From Eternity to Here. Dutton.

5. "Arrow of Time." Wikipedia. Wikimedia Foundation, 14 Aug. 2013. Web. 30 Aug 2013

6. Tassano, J. "The Hubble Constant is a Measure of the Fractional Increase in the Energy of the Universe." submitted, 2013

7. Tassano, J. "A Universe From Itself: The Geometric Mean Expansion of Space and the Creation of Quantum Levels." submitted, 2013

8. Tassano, J. "The Expanding Hyperverse Creates Matter to Conserve Angular Momentum at the Small Energy Quantum Level." submitted, 2013

9. Tassano, J. "A Conceptual Model of the Structure of Elementary Particles." submitted, 2013.