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THE UNITY OF SPACE AND TIME PART 1: A SPACE-TIME-MOTION MODEL

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Abstract

The purpose of this paper is to present a relational model that portrays space and time as conformal projections of motion. It is not biased by the presumption that time is 1D, and thus reveals the universality of relationships between space-time (relativistic model) and energy-frequency (quantum model); it accurately depicts the well-known relationship for total relativistic energy of a particle; it includes the Lorentz factor as the magnification that results from projection of the rest-frame units onto the moving reference frame; and provides a reinterpretation of the "event horizon" as an "event reference" that is a perceptual separation between past and future.

Introduction[1]

The space-time-motion (STM) diagram presented in Figure 1, is a simple yet rigorous model that shows the relationship between space, time and motion and provides a clear and concise illustration of how the equations of relativity mesh with those of quantum theory. The model is based on the premise that

- the word "motion" represents a complementary concept, i.e. "motion" is a single word used to express complementary antonyms (moving and not moving or at rest); yet the moving state can be expressed in terms of gradable parameters (displacement (s) and clock-time (t))
- the *moving* state is expressed as a gradable spectrum $v = \frac{s}{t}$; s and t numerate (i.e. quantize) and denominate (i.e. reference to standard time scale) motion, and
- space (S) and time (T) are also complementary concepts that are expressed in terms of gradable parameters s and t, where $(S = s^2)$ and $(T = t^2)$.

When represented graphically as orthogonal dimensions, S and T are conformal projections of motion onto a two-dimensional ST plane, which is divided into complementary angles by $s^2 = c^2t^2$ (similar to $s = ct$ in the Minkowski ST diagram[2]). The STM model superimposes energy-frequency (quantum[3]) relationships with space-time (relativistic[4]) relationships, so it depicts a scale

[1] Numerous references to Wikipedia are included as footnotes, not as an authoritative source of scientifically tested information, but for the convenience of the reader that is unfamiliar with terms or concepts.

[2] http://en.wikipedia.org/wiki/Minkowski_diagram and http://en.wikipedia.org/wiki/Minkowski_diagram

[3] http://en.wikipedia.org/wiki/Matter_wave

[4] http://en.wikipedia.org/wiki/Mass_in_special_relativity#The_relativistic_energy-momentum_equation

transformation[5] of linear space/time to inverse frequency relationships $\left(\xi = \frac{1}{S} \text{ and } f = \frac{1}{T}\right)$ where ξ is spatial frequency, f is temporal frequency. The unit reference is the point where $S = s^2 = \frac{1}{S} = 1$ and $T = t^2 = \frac{1}{T} = 1$. Thus the unit reference separates the at-rest and moving reference frames and is shown in the figure as the "event reference" (a reinterpretation of the "event horizon" - a concept that Steven Hawkings recently called into question (Hawking, 2014)).

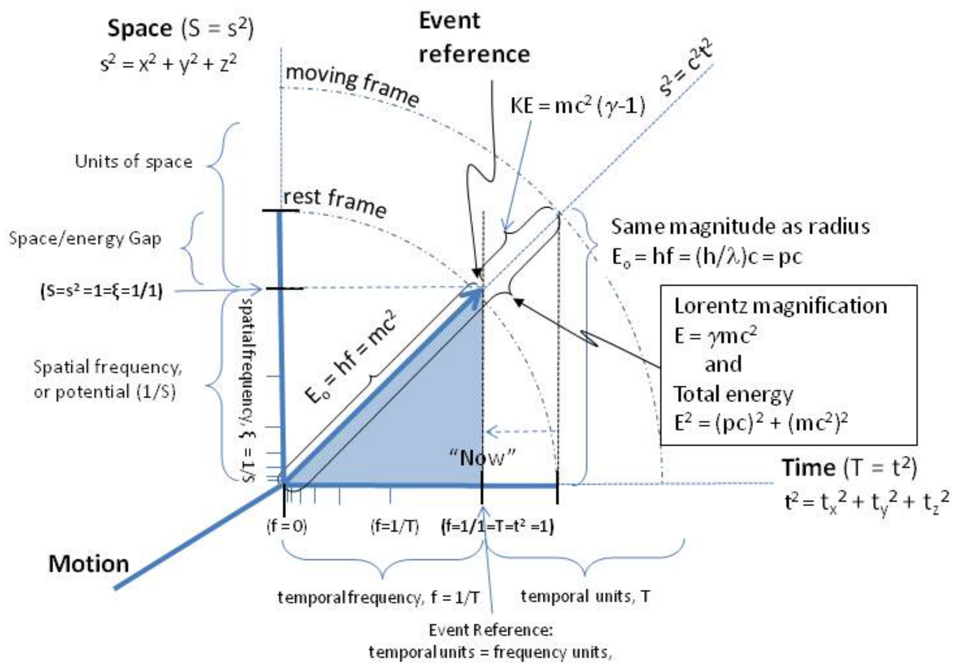


Figure 1 Space-Time-Motion (STM) model

The vector (E_o with components $S = s^2 = 1$ and $T = t^2 = 1$ in natural units and outward direction) in Figure 1 represents a quantum particle (or soliton[6]) at rest with energy $E_o = mc^2 = hf$. It lies on the hypotenuse of similar right isosceles triangles: the smaller (rest frame) and the larger triangle (moving frame). Notice that the horizontal and vertical legs of the larger triangle have the same magnitude as the radius of the smaller one, i.e. $E_o = mc^2 = hf = \frac{hc}{\lambda} = pc$. These triangles accurately depict the well-known relationship (Halliday, et al., 1993) for total relativistic energy (E) of a particle:

$$E^2 = (pc)^2 + (mc^2)^2. \tag{1}$$

[5] an important part of quantum field theory
[6] http://en.wikipedia.org/wiki/Soliton

The larger hypotenuse represents total energy $E = mc^2 + KE$ where KE is the relativistic kinetic energy

$$KE = mc^2(\gamma - 1). \quad (2)$$

Combining equations, the total energy is thus

$$E = mc^2 + KE = mc^2 + mc^2(\gamma - 1) = mc^2 + mc^2(\gamma) - mc^2. \quad (3)$$

or

$$E = mc^2(\gamma). \quad (4)$$

The Lorentz term (γ) is simply the magnification factor that results from projection of the rest-frame units onto the moving frame. Since the moving frame is parameterized in terms of s and t, where $s = ct$, the equation for energy is in terms of c by $E_o = pc$. Back-projection onto the space axis makes the apparent surface of the particle appear stepwise larger when seen from a moving frame (e.g. using scattering spectrometry) than it would from its own rest frame. Thus the total energy of the particle *is* the rest energy, expressed in the moving frame of reference by equation (1).

The back-projection of E onto the S axis can also be considered a rotational transformation of coordinate frames that aligns E_o with the S axis, giving rise to angular momentum of the particle.

In contrast to the Minkowski approach or black-hole interpretation, an "event" (measurement or observation[i]) in the STM approach is considered a *perceptual reference* that corresponds to the *perceived surface* of any quantum unit. The "event reference" is a snap shot that defines (synchronizes or renormalizes) "now" on the time axis and surface or "here" on the space axis. Motion creates an *apparent* separation of a particle from space (its position in space) yet it reappears in the next instant as a self-similar object. Observation renormalizes it (collapses the wave function) so that it appears as the same size only rotated slightly (phase-shifted). Thus the event reference (the "present") separates inner- (actual "past") from outer- (potential "future") spacetime.

Thus, in the STM model:

- axes are linear in S and T outside the event reference to model relative motion, but inverse inside, to model de Broglie wave frequency,
- there are no negative values,
- previous events are represented as points closer to the origin (shifted inside the perceived boundary of particle, into the "past"),
- the ST plane is a conformal projection of motion so the back-projected limit ($s \to 0, t \to 0$), means zero relative motion i.e. rest state, not zero space or time, and therefore
- no beginning or end of space or time and thus no paradox about creation, causality or time travel.
- the renormalization that collapses the apparent surface of the particle back to its original size is effectively the same as the effect of gravity: rather than pulling other particles inward, a particle

expands and then pulls the surrounding spacetime into itself on a spiral path (similar to Faraday and Maxwell's molecular vortex model[7] and black hole theory).

The STM model also reveals a natural quantization of events that is related by the "Golden ratio". Each event transfers reference to the new perceived surface and rotates the frame, inducing angular momentum to the inside, nuclear particle. *Inner particles (i.e. matter), being Lorentz contractions of the surrounding outer world (i.e. space), are thus interpreted as units of "memory". Physical reality is thus interpreted to be a self-projected, self-reflected and self-organizing resonance — a perpetual vibration that is sustained by relative motion.*

This process applied repeatedly reveals a time-independent spectrum of complex structures expected to match the standard atomic models, a subject of future research.

Background

Spacetime is a multidimensional continuum, but if you ask a physicist what that means, you may get an answer that describes a mixture rather than a continuum: "*Space really is 3 dimensional and time really is 1D. This is not an arbitrary division. Spacetime is unified in that different states of motion cause time and space to "mix", i.e. time moves at different rates to different observers. But a piece of paper is 2D because it takes two numbers to say where a point is. The room is thus 3D (3 numbers to describe position) and time is 1D because it takes only one number (the time) to say where you are in it.*[8]"

On the other hand, some admit that they don't really understand what time actually is. In the January 2013 edition of Foundations of Physics, University of Pennsylvania physics professor Vijay Balasubramanian emphasized that *"time remains the least understood concept in physical theory. While we have made significant progress in understanding space, our understanding of time has not progressed much beyond the level of a century ago when Einstein introduced the idea of space-time as a combined entity.*(Balasubramanian, 2013)". He provides extensive references and a synopsis of the various perspectives on why there is an arrow of time, including geometric considerations, i.e. Minkowski vs. Euclidean, supersymmetric four dimensional Yang-Mills theory, and multi-dimensional string theory. He points out that nobody knows *why there is only one dimension of time* and concludes that "*We have more questions about time than answers*."

The problem with trying to answer the question *why is there only one dimension of time* is: *How can we be so certain that there is only one dimension of time if we don't even know what it is?*

True, it only takes one number to describe time, but not because it is a one-dimensional entity; it's because everyone agreed upon a single time standard in order to describe motion. Nothing prevents us from using a different clock for each direction of motion, giving time the same 3D character (t_x, t_y, t_z) as spatial dimensions. Using the same standard clock has nothing to do with the nature of

[7] http://en.wikipedia.org/wiki/History_of_Maxwell%27s_equations

[8] Personal communication with an expert, professional physicist - a University of California Professor of Astrophysics who will remain anonymous (email dated May 15, 2013).

time; it only synchronizes the clocks allowing a single symbol to represent time in every equation, $(t_x = t_y = t_z = t)$.

One-dimensional time is an assumption that has been considered self-evident since Newton presupposed "a single ordered sequence of instants that form the totality of history. (Maudlin, 2012)" Einstein didn't even bother to mention it before discussing the transformation between stationary and moving coordinate systems. His derivation started with, "*To any system of values x, y, z, t, which completely defines the place and time of an event in the stationary system…"*(Einstein, 1905 p. 5) In a lecture, "The Nature of Space and Time"[9], Stephen Hawking defined components of the spacetime diagram saying, *"There are similar definitions in which plus is replaced by minus and future by past. I shall regard such definitions as self evident."* (Hawking, et al., 1996)

But Newton's predecessor, Isaac Barrow clearly stated that it was an *assumption* in his 1735 "Geometrical Lectures":

"Time is commonly regarded as a measure of motion, and… consequently differences of motion (swifter, slower, accelerated, retarded) are defined by assuming time is known [underline emphasis added]; *and therefore the quantity of time is not determined by motion but the quantity of motion by time: for nothing prevents time and motion from rendering each other mutual aid in this respect."(Burtt, 2003 p. 158)*

Modern Cosmology does not challenge this assumption. It is based on the equation that relates space and time $(s^2 = c^2t^2)$, which is asymmetrically unfolded to give $(x^2+y^2+z^2 = c^2t^2)$. The advantage of unfolding $s^2 = x^2+y^2+z^2$ is that it fits our perception of 3D space, but the disadvantage of unfolding one side of an equation without doing the same to the other (leaving it "enfolded" as David Bohm might say(Bohm, 1980)) is that it creates an artificial asymmetry – a lop-sided perspective that complicates the math, requiring parameterization in terms of hyperbolic functions (Jackson, 1975 p. 517). The result is a transformed coordinate system that must be calibrated by using the original ($c^2\Delta t^2 + \Delta x^2 = n^2$) to mark increments on the distorted axes.(Penha, et al., 2007)

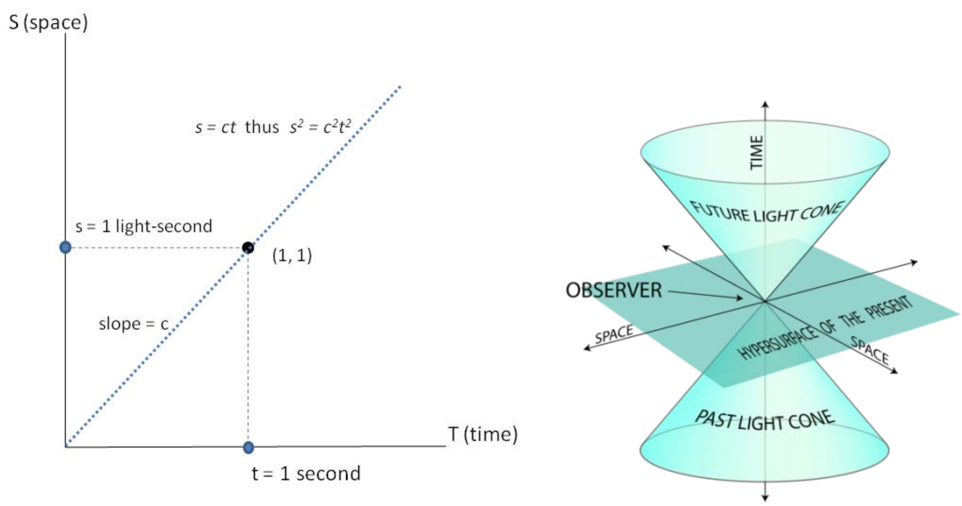
Furthermore, mirroring the T axis to represent the past as *negative time* (to make the Minkowski model as discussed below) has the advantage of providing a sense of past, present and future as we seem to experience time, but it also complicates the math because it centers on zero as the reference, which introduces singularities into otherwise simple relationships. The alternative approach presented in this paper is to represent a unit of measurement (i.e. the first increment on either scale rather than crossing axes at zero) as the reference. This reinterprets the origin of the graph (zero *motion*) as being the rest state of the quantum model; and the region between zero and the first unit of measurement on either complementary axis S or T as the energy that the particle potentially contains if measured (which requires a moving frame and thus the relativistic model).

[9] The first of three illustrated lectures given by Stephen Hawking as part of a series of six lectures with Roger Penrose. http://arxiv.org/abs/hep-th/9409195

This important unification between quantum and relativistic models is hidden when the space and time axes are allowed to extend linearly through zero. There can be no zero on the space or time axes because zero measures of space and zero time have no meaning. A measurement requires an actual quantity or modulus – some integer unit with non-zero absolute value. Furthermore, according to quantum mechanics, time is not even an observable quantity, but rather a parameter that scales a change in space, which cannot be zero. Zero relative motion, on the other hand, means "at rest" relative to the observer, and this will be used to develop the STM model after a brief review of the Minkowski model.

The Minkowski model

The Minkowski space-time (ST) formalism, developed in 1908 by Hermann Minkowski, is commonly used to illustrate space and time as a continuum (Penha, et al., 2007). An explanation of the ST diagram usually begins with time and space considered equally with one variable representing three-dimensional space (as a single dimension, S) and one representing time (T), see Figure 2a. Note that upper case $S = s^2 = x^2+y^2+z^2$ and T are used to mean the modulus of space and time whereas s and t can either be positive or negative. So we imagine a flash of light at the origin ($t = 0, s = 0$) that expands spherically at the speed of light and since $S = CT$, $s^2 = c^2t^2 = x^2+y^2+z^2$.



a. b.

Figure 2 (a) A normalized plot of time vs. space that illustrates the point that light travels one unit of distance (light-second) in one unit of time (second)

(b) Minkowski's time vs. space diagram is normally shown with time as the verticle axis and space as a horizontal plane. The time axis is mirrored to include the past as negative time and the future as positive time. However there is no representation of direction in space since 3D space is represented as a 2D "hypersurface of the present".

It is then *assumed* that the T axis can be mirrored so that the negative axis represents the past. A "light cone" in Figure 2b is formed by revolving the line (c in Figure 2a) that connects the origin with the point (1, 1) around the T axis to represent the limit of causality (causal influences such as signals cannot travel faster than the speed of light) and the intersection of the time axis with the space "plane" is said to represent the *event horizon* – later interpreted as the boundary of a theoretical black hole (a concept that Steven Hawkings recently called into question (Hawking, 2014)).

This ST model is a non-Euclidean model. Regardless of the true nature of space and time, once the equation is unfolded on one side and not the other, it *is* non-Euclidean so interpretation becomes a foregone conclusion: *"Geometrically, time is different from space because the geometry of space-time is locally Minkowski (Lorentzian metric signature (1, 3)), not Euclidean (metric signature (0, 4))."* (Balasubramanian, 2013) But why unfold space into 3D ($s^2 = x^2+y^2+z^2$) without doing the same for time? Isn't that what makes it locally Minkowskian?

The Space-Time-Motion (STM) Model

It is mathematically correct to leave the equation as the symmetrical version[10], ($s^2 = c^2t^2$). If neither side is unfolded, the squared terms represent the absolute values[11] of space and time, which are symbolized by upper case $S = s^2$ and $T = t^2$ in the STM model. The symbols S and T represent complementary (as opposed to gradable) concepts whereas $s = \pm\sqrt{S}$ and $t = \pm\sqrt{T}$ are the gradable scales. Then $s^2 = c^2t^2$ can be written as

$$S = Tc^2. \quad (5)$$

In this form, the equation means that ***space and time are equivalent***, exactly as $E = mc^2$ means that *mass and energy are equivalent*. They are simply different scales for the same *process*, where the word *process* is used to include both verb and noun form[12]. Equation (5) suggests that motion is a process that transforms infinite potential (parameterized as time) into units of space (actual physical quantities). The term c^2 is thus the factor that relates the units of measurement. And since the relationship is the same between space and time as it is between energy and mass, the same relational model should apply to both. The equations that tie the two perspectives together are $E_o = mc^2 = pc = \frac{hc}{\lambda} = hf$, where m is mass and p is momentum, h is Planck's constant, λ is wavelength and f is frequency.

The ST diagram, in Figure 2a represents the motion of a spherical wavefront. But motion is quantified by measurement of space divided by time and thus *conformally projected* onto an S-T plane. It is a projection because the graph on a two-dimensional plot is a collection of individual points, (s_i, t_i). Motion itself is inferred from the shape (slope) of an imaginary line that connects one point to another. The magnitude of motion is represented in the figure by the symbol, c, which is one side of a square surface c^2 – the "motion plane". The one-dimensional line is a projection that *refers to* or *implies* motion but motion is not actually part of the *S-T* plane. Therefore, in order to graphically illustrate it as a

[10] In fact, it is incorrect to transform coordinates for one side of an equation and not the other.

[11] This does not suggest absolute space or absolute time à la Newton. Instead, it suggests that the modulus (module or quanta) represents a physical measurement and negative represents direction.

[12] The verb form of *process* refers to an action of change and the noun refers to an object such as a bony protrusion (e. g. spinal process)

related concept it must be represented as a *tangent (perpendicular dimension)* as shown in the STM diagram in Figure 3.

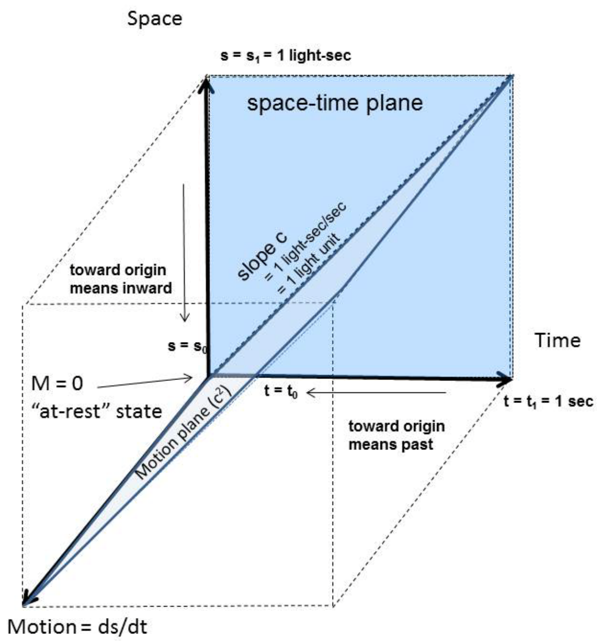


Figure 3 The Space-Time-Motion (STM) diagram

Motion is a *change* in space that is quantified by referencing it to another, agreed-upon standard unit of change (a unit of time). *Change* is the operative word; change is what is ultimately experienced as motion. Space and time are merely the two scales used to gauge motion. The difference in the two is that space plays the role of numerator, i.e. it *numerates* (quantifies or quantizes) motion whereas time *denominates* the quantity as a fraction of some reference (some denomination such as a second, minute, etc). So a quantity of motion is a fractional change in space (change in position in any direction). The denominator that it is referenced to is an arbitrary scale that was once measured by motion of the sun, moon, sand in an hour glass, etc. and eventually standardized to a device that moves more consistently[13]. By convention, motion is quantified as "per unit time" but it could just as easily be "per unit grain of sand". The key words are "per unit" because the "units" that are used for both the spatial standard and the temporal standard define the magnitude of the resulting constants relating the two, i.e. they *modularize* or *quantize* a unit of motion.

Graphically, the quantity of motion is represented by the slope of the space-vs-time plot – numerically it is the fractional change in space measured by the variable, s, with respect to the reference scale, t, so it could never exceed a value of one-to-one, which is graphically represented by a 45° line. The region above 45° ("elsewhere" in Minkowski terminology) is meaningless in terms of speed and it has nothing to do with the structure of space or time. Instead, it refers to the inverse concept, call

[13] The decay of cesium is measured by the movement of a particle to a detector, so time is still measured by motion.

it lapse: the change in time with respect to space. It would be equally correct to say a car drives at a speed of 60 miles/hour (1 mile/minute) as it would be to say a lapse of $\frac{1}{60}$ hours/mile (1 minute/mile). A passenger in the car could perceive the experience as stillness – zero motion (his integrated, at-rest perspective) by closing his eyes, or he could choose to compare himself to his surroundings (his differentiated perception) in one of two ways:

1) as speed - by looking at and counting mile markers while listening to his watch tick, concluding number of “space-like” markers per tick; or
2) as lapse - by looking continuously at his watch and counting seconds while listening for beeps each time a marker is passed, concluding number of “time-like” ticks per marker.

His perception, and therefore his experience would be a function of his choice of *perspective*. All three of these perspectives are legitimate choices and different people could choose any one of them with equal correctness. And all three are represented on the STM diagram.

In contrast to the Minkowski diagram, the STM model considers change to be positive (an absolute value, just as vectors are always positive) so there are no negative axes. Just as the radius of a sphere is a positive measure from the center outward to the surface of a sphere, positive s values represent outward-directed change in space. Similarly, positive t values represent outward-directed change in time. The “arrow of time” simply means that regardless of which “direction” motion happens in 3D space, once movement happens, it is positive[14]; it can never “un-happen”.

Mathematically, it is not incorrect to use negative variables, such as $-s \text{ and } -t$ because the magnitudes of $S = (-s)^2 = s^2$ and $T = (-t)^2 = t^2$ give the same result. So it makes perfect sense to include the negative as the opposite direction - a mirror image of each axis on a graph. But mirror images can be distorted if seen from the wrong perspective, especially at the point of reflection. And two mirrors create the appearance of multiple images of the same object.

Rather than using the reflection, the STM diagram uses the region between zero and one to represent the past. This corresponds to inward in space, toward the center of the sphere – where the light flash originated at some position, s_0 and time, t_0. What appears to be the intersection of the two axes is neither zero time nor zero space; it represents the zero-motion-perspective or “at-rest” state. The word *state* has the same meaning as *perspective*. The at-rest state of a light flash is what the light sphere itself would measure if it could measure itself. From its perspective, it is not expanding or moving. It is a unit of light, with a given amount of energy that does not change with time. An outside observer would see it expanding and measure a decreasing energy density, but the light itself would not. If it were conscious and able to observe itself in reference to the S and T scales that an outside observer uses to gauge its outward motion, it would see the flash bulb along with the coordinate scales on the ST axes shrinking or collapsing into its infinitesimal center.

[14] If it is desired to model direction in space, then the space axis can be unfolded, which would hide the time axis from the 3D representation. Effectively, it would be “understood” or “collapsed” into the mind as information. see (Matzke, 2002).

Therefore the STM model represents the present (here and now: position, s_1 and time, t_1 in Figure 4) as the event point of reference. The future is outside (all coordinate values of space and time greater than 1) and the past is inside (all coordinate values are fractions of 1). The "present" corresponds to Minkowski's "event horizon" but in the STM model, it is called the *event reference* for both space and time (here, now). An observation simply resets or renormalizes the reference used in the mathematical model and has nothing to do with the unit of light itself, with the structure of space, or the nature of time.

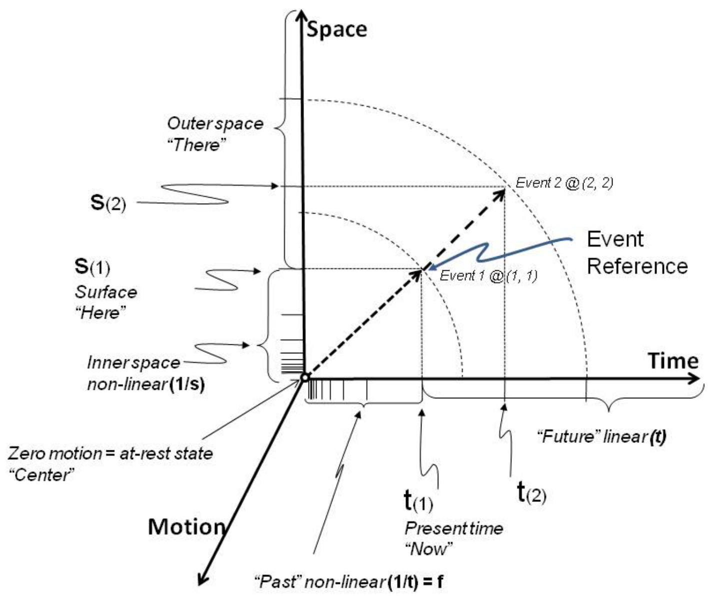


Figure 4 Event Reference from the at-rest perspective of the flash bulb. *Event 1* represents the flash (at position 1 and time 1) and *Event 2* represents the measurement of the light reaching 1 light-second in 1 second. Every event that came before *Event 2* (the "past") is thus represented as a point closer to the origin.

"Outside" of the event reference, a linear scale on both space and time axes corresponds to measureable increments of change. For example in Figure 4, *Event 1* represents the flash and *Event 2* represents the measurement of the light reaching 1 light-second in 1 second. Every event that came before *Event 2* is thus represented as a point closer to the origin. The values of S and T for *Event 1* are one-half the values for *Event 2*. Therefore events that have "passed" must be represented on a non-linear, inverse scale. A measurement of *Event 2* would reset it or *collapse* it (perceptually, graphically, and mathematically) to (1, 1), i.e. the present moment

- 2 light-sec/2 sec = 1 light-sec/sec = 1 light-unit= ½ light-unit/ ½ unit.

Event 2 collapses to (1, 1) and *Event 1* collapses to (½, ½). Compare this to the collapse of the wave function in quantum mechanics.

Both events are in essence, the same integral light unit (i.e. a conscious light unit that could observe and measure itself would not perceive any difference in itself from one event to the next). Yet they are differentiated (perceived as separate) by referencing them to space and time scales that are conceptually different, thus orthogonal to each other. That in turn differentiates each axis into inside/outside and past/future. The non-linear scale (inside/past) in Figure 4 makes the graph look like the axes *bend* into the page, but this is just a conceptual model, so it simply represents information at the “surface” of the here/now that transforms outside/future into the inside/past, becoming an integral part of the particle.

In other words, an event is a snapshot that establishes the reference, thereby separating space into regions. The outside/ future, is the region with infinite potential, and the inside/ past is the infinitesimal center - a *potential well* scaled as spatial frequency $\frac{1}{s}$ (like the classical form of electric potential, $V = \frac{q}{s}$) and temporal frequency, $\left(f = \frac{1}{t}\right)$.

The major advantage of the STM diagram is that it graphically represents universality: the superposition of the in-motion and at-rest perspectives, as functions of space and time (in-motion perspective), as well as functions of energy and frequency (at-rest perspective), on appropriately scaled axes. It brings together well-known relationships and reveals how coupling parameters used in one scale relate to those used in the other. Both scales are necessary in order to fully represent a quantum particle because both perspectives apply simultaneously.

It makes no difference *to the particle* if it is viewed from the at-rest reference or from a moving frame of reference, but there is a distinct difference in how the two states are perceived. Figure 1 illustrates that there is a gap on the space/energy axis that reveals a minimum amount of energy required to change the perception of the particle. The STM model also predicts that this gap is a natural quantization due to the relationship commonly known as the *Golden ratio*: $\frac{S+T}{S} \approx \frac{S}{T}$. Whether or not this is the same as the photo electric energy gaps is a subject for further investigation.

Conclusion

The STM Model provides a conceptual framework very similar to the Minkowski model, but it differs in two critical ways: it does not asymmetrically unfold spacetime by expanding space and mirroring time in two directions and as such, it does not include any singularities. The Minkowski model separates space and time and then attempts to mix them back together, which requires extremely complicated math in order to handle hyperbolic relationships and deal with poles that produce branch points. Instead, the STM model unifies space and time as a seamless whole and illustrates how branch points and quantum leaps, that appear in nature, are boundaries of transformation – part of the process of transforming the infinite potential of empty space into the actual particles of matter.

Thomas Kuhn compared the current crisis in physics with the period just prior to the Copernican revolution that refocused scientists on a new and simpler paradigm than the Ptolemaic model. Scientists of that era had come to realize that “no system so cumbersome and inaccurate as the Ptolemaic had become could possibly be true of nature. And Copernicus himself wrote… that the astronomical tradition he inherited had finally created only a monster." (Kuhn, 1962 pp. 68, 69) The evolution of science, as explained by Kuhn, is very much like the process of solving jigsaw puzzles using puzzle pieces from different boxes. It can be impossible to solve if you don't sort out the pieces and build the right frames – the new paradigms.

While a paradigm provides a valuable guide for scientists to choose research questions, old paradigms can "insulate the community from those socially important problems that are not reducible to the puzzle form, because they cannot be stated in terms of the conceptual and instrumental tools the paradigm supplies"(Kuhn, 1962 p. 36). The socially important problems that we face today have been emphasized by physicists such as David Bohm and Lee Smolin (Bohm, 1980)(Smolin, 2006) and science writer Jim Baggott in his book, "Farewell to Reality: How modern physics has betrayed the search for scientific truth" (Baggott, 2014).

The STM diagram is a simple relational-geometric model that clearly illustrates how numerous important relationships in physics fit together exactly like a puzzle. The relationships are the puzzle pieces that come from different puzzles - one that models outer (potentially moving) space, which requires a relativistic model and one that applies to the inner space, in which the quantum model applies. Similar attempts have been made to model the perceived surface of a subatomic particle as the perceptible surface of a standing wavefront (Wolff, 1993), (Shanahan) but the wave structure of matter, or WSM model, does not posit a source of the wave components nor does it address how it fits the fine structure of the quantum model. According to the STM model, relative motion itself creates the perception of separateness between space and time and because the separateness is only a *perception*, the apparent separation creates tension - an *apparent force* that appears to pull particles of matter toward each other.

The STM model provides fertile ground for research to verify its applicability to other areas of science, such as chemistry, biology and cosmology. Relative motion, which is ubiquitous, forces an observer's perspective of a particle to change from the at-rest perspective to the in-motion perspective, creating the psychological time flux and expanding the perceptible surface of the particle. This expansion of every perceptible particle would be unnoticeable at the small scale of unaided human perception, but at astronomical distances, one would expect the effect to be amplified, accounting for the observed expansion. If motion is the cause of the expansion, then increasing motion by the presence of living beings would account for the acceleration of that expansion.

It also agrees with the Holographic Principle: a property of string theories suggesting that the universe can be seen as a holographic projection of a two-dimensional information structure (Susskind, 1994),(Bousso, 2002). The STM model *is* a two-dimensional information structure that may be exactly what David Bohm called the "holomovement". It is also reminiscent of the "molecular vortex model" presented by James C. Maxwell in his 1861 paper, "On Physical Lines of Force".(Maxwell, 1861), (Siegel, 2002)

Ontologically, the physical manifestation of the particle is a *process* that can be perceived in different ways, i.e. when perceived at rest it is the process of *being* (a noun) and in motion the process of *becoming* (a verb). It exists whether we as observers observe it or not, but since we are the same process as the particles, we can only physically observe or measure the “reflection” of spacetime that is projected onto and expanding in space, just as Plato described in his allegory of the cave.

There is much work to be done, but it is hoped that the STM model will provide the basis for a new paradigm that will allow physicists to lead the world out of the current crises. To understand our unity is to rise above the apparent differences that continue to push mankind toward its own destruction.

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[i] Observation or measurement does not necessarily mean by a human or laboratory device. It could be any interaction such as two particles passing or orbiting each other. In the case of a circular orbit, the moving particle is continuously "falling" towards it without changing the distance between the particles creating a gap between the actual and *perceived* surface of the center particle.