The Holomorphic Process

Understanding the Holographic Nature of Reality as a Metamorphic Process

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Abstract

The holographic principle, derived from black hole mathematics in cosmology, is gaining interest as a theory of reality, but it is missing the part that explains how the information gets from the surface of a black hole to every quantum particle in the universe. The purpose of this paper is to present a current research project that is attempting to answer that question. The approach presented here is to treat space and time as two equivalent yet perceptively different aspects of motion. This is an approach that reframes the problem by changing the fundamental interpretation of space and time, which have historically been treated as two fundamentally different entities, somehow mixed to form spacetime. This new approach allows the use of temporal frequency (the inverse of time), and spatial frequency (the inverse of space) to be superimposed on a space-time-motion diagram, which helps to visualize the relationship between the inverse (frequency or quantum) domain and linear (relativistic) domain. The result is a composite model that eliminates the need for a black-hole concept. Instead, it portrays the two aspects of motion as two coherent "rays" of energy projected outward into the linear space-time domain (future) from every point in the universe and immediately reflected (into the past within a Planck second) back to the quantum domain, which is phase-shifted due to the very same motion, forming a perceptible surface at the event reference. This approach does not theorize anything new in terms of unfathomable dimensions, undiscovered particles, extra-particulate forces, or the like. It only requires a different perspective of what we already know, one that does not require knowledge of any specialized mathematical language beyond undergraduate-level physics and engineering.

Contents

Introduction

The idea of a holographic universe as proposed in 1993 by Gerard t Hooft, developed in 1995 by Leonard Susskind, and supported by others (t Hooft 2000), (Suskind 1995), (Bekenstein 2007), (Sutter 2018), (Afshordi, et al. 2017) is gaining ground with recent observational tests of holographic cosmology. Bekenstein said, "our universe, which we perceive to have three spatial dimensions, might instead be written on a two-dimensional surface, like a hologram. Our everyday perceptions of the world as three-dimensional would then be either a profound illusion or merely one of two alternative ways of viewing reality." Afshordi's team used attosecond pulses to film electron motion, producing an image that portrays the electron as a spherical standing wave, which they relate to a holographic image. (Afshordi, et al. 2017)

> *"Holography offers a new framework that can accommodate conventional inflation but also leads to qualitatively new models for the very early Universe. While conventional inflation corresponds to a strongly coupled QFT, the new models are associated with a weakly coupled QFT. These models correspond to a nongeometric bulk, and yet holography allows us to compute the predictions for the cosmological observables. We emphasize that the application of holography to cosmology is conjectural, the theoretical validity of such dualities is still open, and different authors approach the topic in different ways. Here we seek to test these ideas against observations." (Afshordi, et al. 2017, 1-2)*

The "holographic principle" was inspired by black hole thermodynamics and is interpreted to mean that the hologram, i.e. the entity that would carry the holographic information necessary to project a 3-dimensional image, is either on the surface of a gigantic black hole or the outer surface of the universe. (Suskind 1995) If the universe is a holographic image, then how could this information be produced and projected from the edge of the universe into our 3-dimensional reality as a pattern of images with solid boundaries?

The word “hologram” refers to the imprint of spatial gratings on a film, not the image itself. The gratings are produced by the interference patterns of two coherent laser beams, a signal beam, projected onto an object from outside of the object (and reflected onto the film) and a reference beam, projected directly onto the holographic film. The interference patterns between the two beams are recorded as gratings or fringes on the film. In order to form a holographic image, a reconstruction beam must illuminate the film and reflect off of the gratings to form a similar pair of beams to those that formed the gratings. These reflections then become reintegrated in space, forming local resonant patterns at every point where the original beams had reflected off of the object.

This is a fairly involved process. So the idea that the universe is a “holographic image” from a hologram written on the surface of a black hole somewhere out in space or on the surface of the expanding universe seems ridiculous. In fact, some people (namely Jim Baggott in his book “Farewell to Reality, How Modern Physics Has Betrayed the Search for Scientific Truth” (Baggott 2013)) consider it “fairy tale physics” or a new version of the “creation hypothesis” that comes with unanswerable questions. Where did the information come from? Who or what set up the objects, recorded the images and continuously performs the process of projecting the images in real time?

The answer, proposed in this paper, is that the holographic nature of reality is possible because the spatial gratings are not on the surface of a black hole but rather they are spatial frequencies that are continuously formed by relative motion. In essence, our regular 3-D space is both the holographic media and the holographic image. Rather than being written on a black hole or anything else, the process happens at every point in the universe where motion separates into space and time, which form quantum bits as it happens. The infinitesimal sphere (circle in Hilbert space) surrounding these points called the “event reference”, which defines “here” and “now”, forms the gratings in space and is the apparent surface of the holographic image itself.

Relative motion is a form of energy, a unitary concept, and it is ubiquitous. And we understand that energy can neither be created nor destroyed, but only changed in form. Physical matter is one form of energy and motion is another. The transformation, or morphing, of motion into matter is the same process described above that makes the hologram:

1) separation, 2) projection, 3) reflection, and 4) reintegration.

The first step is separating motion into two *apparently* different yet coherent forms. One problem with the current consensus model of physics stems from the way that the “spacetime continuum” is framed as a 4-dimensional tensor. This framework is fundamentally based on the difference between space and time in that space is treated as 3-D and time as 1-D. But Hermann Minkowski initially presented a visual model of spacetime as a symmetric space-time diagram. In this paper, the symmetric version of the space-time diagram will be used, with a dimension of motion as the source of space and time.

The Space-Time-Motion Diagram

Minkowski space-time

The Minkowski space-time (ST) formalism begins with a graph of space (S) versus time (T) as shown in Figure 1a. We are told to imagine a flash of light at the origin that expands spherically outward in space ($S = s^2 = x^2+y^2+z^2$) at the speed of light $s^2 = c^2t^2$, or $S = CT$, represented by the diagonal line (with $C = c^2 = 1$ in "natural units") from the origin. So when the clock ticks 1 second, (a *coordinate point* on the T axis), the surface of the light sphere (a coordinate on the S axis) is moved outward 1 light-second.

In Figure 1b the axes are rotated (time is vertical and space horizontal) to show the Minkowski diagram as it is normally presented. It is important to emphasize that $s = ct$ represents the radius as a single dimension that increases with time as a single dimension. But Minkowski treats time in the classical manner, as if it is actually one-dimensional – independent of space – so he uses t, which is $\pm\sqrt{T}$ and claims (*a priori*) that the negative axis represents the "past". Then he tries to represent 3D space on the same diagram. But 3D space cannot be represented as three dimensional in the diagram, so it is portrayed as a "hypersurface" of the present. At this point, the ability to visualize the relations with angles on the graph has failed.

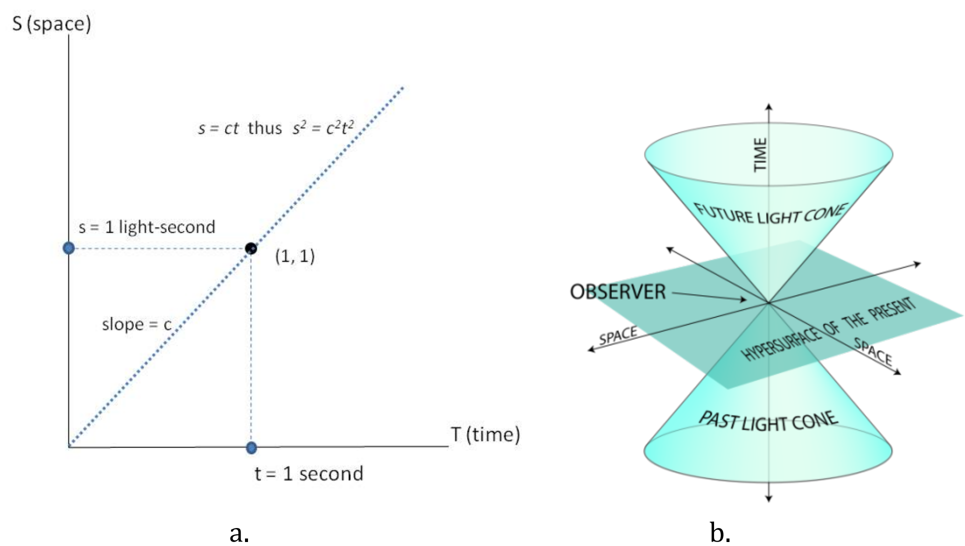

Figure 1 **(a) A plot in natural units (c=1) of space vs. time that illustrates that light travels one unit of distance (light-second) in one unit of time (second) (b) Minkowski's time vs. space diagram is normally shown with time as the verticle axis and space as a horizontal plane. The time axis is mirrored to represent the past as negative time and the future as positive time. However the ability to visualize the relations with the graph has failed since space is represented as a 2D "hypersurface of the present".**

The intersection of the time axis with this "hypersurface" is said to represent an event, i.e. the present at $t = 0$. Then the equation ($s^2 = c^2t^2$) is expanded on one side to give ($x^2+y^2+z^2 = c^2t^2$) and rearranged to give the four-dimensional spacetime manifold $x^2+y^2+z^2 - t^2 = 0$, with $c = 1$. No physicist or mathematician would blink an eye at the equation that describes a spherical expansion of light ($s^2 = c^2t^2$), written as ($x^2+y^2+z^2 = c^2t^2$). It is mathematically correct, because the equation for a sphere is $S = s^2 = x^2+y^2+z^2$ and "everyone knows" that time must be treated as one scalar dimension. So time is treated as the forth element of a quaternion. The math used to advance this model includes abstract algebra and topology but these will not be required in this paper. As brilliantly advanced and complex as they are, some physicists admit that the advanced approach has ended in failure (Smolin, The Trouble With Physics 2006). The obstacle, I submit, is that nobody really knows what time is, and the way that it is used has resulted in a distorted and thus unnecessarily complicated model. There are several different opinions about the meaning or essence of time, but until it is understood, it is either treated classically or as something that somehow mixes with space to give us space-time. (Barbour 1999) (Burtt 2003) (Hawking 1990) (Smolin 2013).[i]

Symmetry of space and time

In this paper, as in Burtt's *Metaphysical Foundations of Modern Science* (Burtt 2003), time is considered to be nothing more than a standardized measure of motion. According to Burtt, in the days of Newton, the treatment of time as an independent entity was considered by many to be a philosophical blunder.

> *"Clearly, just as we measure space, first by some magnitude, and learn how much it is, later judging other congruent magnitudes by space; so we first reckon time from some motion and afterwards judge other motions by it; which is plainly nothing else than to compare some motions with others by the mediation of time; just as by the mediation of space we investigate the relations of magnitudes with each other."*

If time is a measure of motion, you cannot treat time as one-dimensional while treating space as three. Motion in space ***is*** motion in time and vice versa (like sand through an hour glass or the cyclic motion of the sun or a pendulum). They are equivalent yet different characteristics of the same essence. If the term for space (radius of the sphere) is unfolded to represent three orthogonal dimensions, then the same must be done for time, so $s^2 = x^2+y^2+z^2 = c^2(t_x^2 + t_y^2 + t_z^2)$. If not, then they both must be kept enfolded.

Notice that I use upper case S and T in the previous section to mean the *modulus* of space and time, where $S = s^2$ and $T = t^2$ are "square spaces", i.e. they require at least 2 dimensions to describe them. S and T are always positive, but neither are directly measurable. Lower case s represents the measurable radius of the light sphere and therefore, the distance that the surface of the sphere travels in a given amount of time, also as one positive increment - lower case t. Both scalars are also positive but unlike S, the scalar, s, is measurable, i.e. quantifiable as one dimension – radial distance. And unlike T, a unit of t means a quantified unit of time.

Writing the equation $s^2 = c^2t^2$ as

$$\boldsymbol{S = Tc^2} \tag{1}$$

means that space and time are equivalent, just as

$$\boldsymbol{E = Mc^2} \tag{2}$$

means that energy and mass are equivalent. The term c^2 is just the conversion factor that comes from arbitrary units of measurement (meters, miles, seconds, light-years, etc). In natural units, it is just 1.0. I submit that equations **(**1) and (2) are exactly the same relationships and only differ by their units of measurement. This will be illustrated below.

The Inverse Problem

Consider the "Inverse problem," i.e. the multiplicative inverse of the equation $s = ct$, that is, $\frac{1}{t} = c\frac{1}{s}$. In terms of frequency, this is

$$f_t = cf_s \tag{3}$$

where $\frac{1}{t} = f_t$ is temporal frequency and $\frac{1}{s} = f_s$ is spatial frequency. When plotted on a space-time diagram, as shown in Figure 2, c represents the exact same line as in Figure 1a.

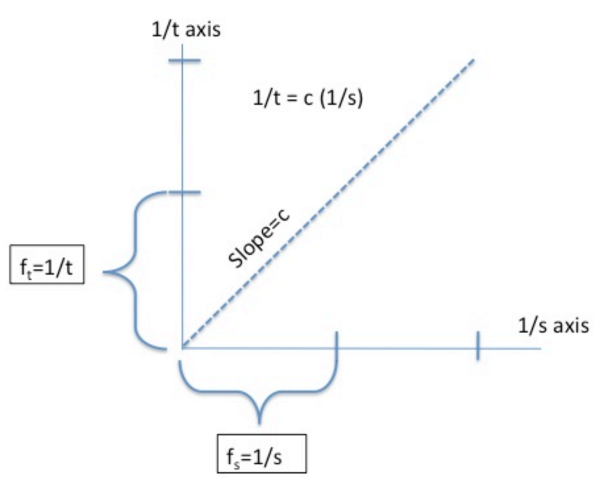

Figure 2 The Inverse Problem: Inverse time versus inverse space $\frac{1}{t} = c\frac{1}{s}$, is the same as temporal frequency versus spatial frequency or $f_t = cf_s$.

Combining the two plots in Figure 1a and Figure 2, will provide an improved relational model (in the sense that it contains more information and shows the relationship between the different domains). Notice that the spatial and temporal axes are flipped or rotated, in Figure 2 as compared to Figure 1a, so each axis represents two different domains – an inverse domain and a linear domain. There is only one point in each domain that is numerically equal, and that is at the first increment, i.e. 1 unit, where $t = \frac{1}{t} = t^2 = s = \frac{1}{s} = s^2 = 1$. That is not a problem because that is how we always make graphs, – like S vs. T is constructed by intersecting them where they are numerically equal to zero. We call it the origin and it is just a reference point.

So with the two domains superimposed, see Figure 3, the first increment on the vertical axis represents the temporal frequency of the sphere of light *and* the radial distance that the light travels in one increment of time, in whatever units you choose. Now because $f_t = \frac{1}{t} = c\frac{1}{s}$, the inverse domain can be scaled by Planck's constant to represent energy as $E_t = hf_t = hc\frac{1}{s}$. Substituting wavelength, λ, for s, we get $E_t = hcf_s = hc\frac{1}{\lambda} = E_s$, which is the spatial component of energy, to scale the horizontal axis. These are the two equations for energy of a quantum particle, $E = hf_t$ and $E = pc$, where $p = \frac{h}{\lambda}$ is the momentum. Therefore, Figure 3 represents the domain of a quantum particle on a background scalar domain.

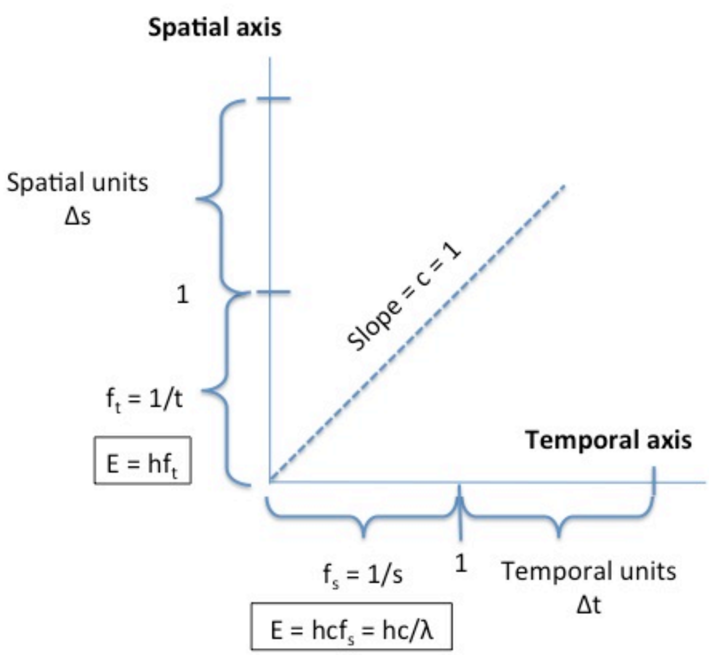

Figure 3 The inverse temporal domain scaled by Planck's constant is the energy of a quantum unit.

The horizontal axis represents the spatial frequency of the light, f_s *and* the time elapsed between the origin (another reference point) and the first measurable event ($t = 1$). In other words, the first measurable point in the linear domain is 1, because regardless of how small your measurement is, a measurement would be represented as 1 unit. So the region between 0 and 1 cannot be expressed in the linear domain. On the other hand, it can be expressed as a phasor (a phase vector) as follows.

Speed ($v = \frac{\Delta s}{\Delta t}$) is the measure of motion and is represented by the slope of the diagonal line, which is projected from the origin through the region between 0 and 1. In calculus it is $\lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t}$, and since $c = 1, s = t$. Thus $\lim_{t \to 0} \frac{t}{t} = 1$ unit quantum of motion. The variables, s and t, that represent the linear domain are hidden in this region, the quantum domain. However, the limit is the definition of the derivative: $\frac{ds}{dt} = \lim_{t \to 0} \frac{s}{t}$ so the quantum units of space and time are the integral units

$$\text{One unit of space: } s' = \int \frac{1}{s} ds = \ln(s) -> s = e^{s'} \tag{4}$$

$$\text{One unit of time: } t' = \int \frac{1}{t} dt = \ln(t) -> t = e^{t'}. \tag{5}$$

Therefore the origin – that nearly infinitesimal region about (0, 0) – can be represented as two unit circles, superimposed as one. And since speed is the ratio of space over time, we have (dropping the prime marks)

$$s/t = e^s/e^t = e^{s-t}\,. \tag{6}$$

Now in order to use this to represent an increment of time (a reoccurring event), it must be scaled to one revolution. Multiplying equation (6) by unity, $e^{2\pi i} = 1$ (Euler's identity) inserts the scale of 2π and the rotational component, i so that

$$s/t = e^{2\pi i(s-t)}. \tag{7}$$

Normalizing s and t (which just means scaling them to one unit: wavelength, λ, and period, T) with $k = \frac{2\pi}{\lambda}$ and $\omega = \frac{2\pi}{T}$, gives us a wave function that represents a quantum unit of energy in the form of motion, $\mathcal{M}$.

$$\mathcal{M} = e^{i(ks-\omega t)}. \tag{8}$$

Equation (8) is graphically represented as a phasor (a phase vector). It is superimposed on the space-time diagram in Figure 4 to graphically represent motion. This composite diagram is called the Space-Time-Motion (STM) diagram. The value of this diagram is that it shows the relationship between the relativistic representation of energy and the quantum representation of the same energy. On one hand, energy is represented as a phasor, a simple wave function of unit magnitude. On the other hand, it is a vector that is a magnification of the phasor and thus projected outward in linear space and time. In the next section, the magnitude of this projection will be shown using the STM diagram to be the Lorentz factor.

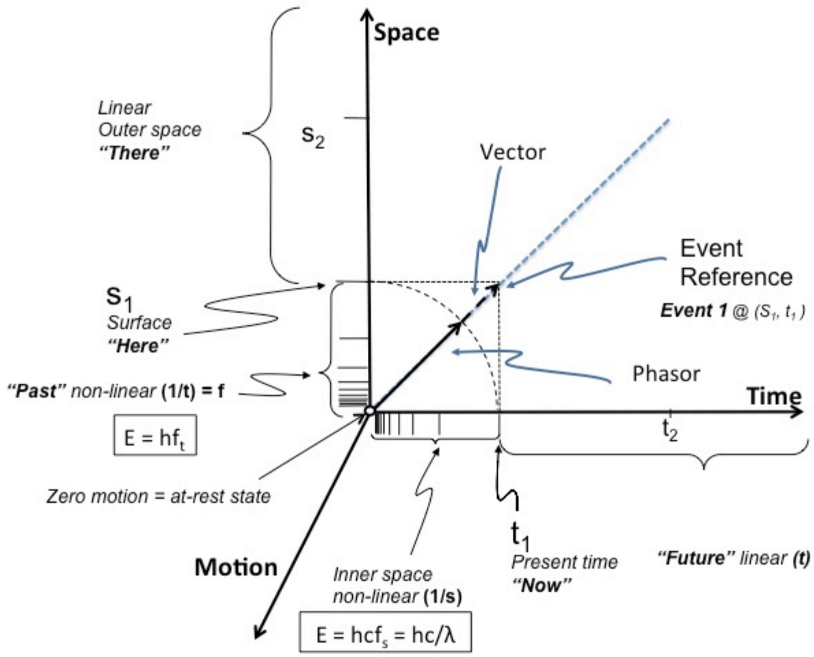

Figure 4 Space-Time-Motion diagram. The vector is a representation of energy in the linear, space-time domain. It is the superposition of two base vectors. The phasor represents the same energy in the quantum domain.

Figure 5 is a diagram from a physics text that shows the relations between the total energy (Hamiltonian) and the rest energy, kinetic energy and momentum. Figure 6 shows the exact same relations drawn on the axes of the STM diagram. The length of the phasor is $E = hf = mc^2$, so the magnitude of the vector is

$$\gamma mc^2 = mc^2 - mc^2 + \gamma mc^2 = mc^2 + mc^2(\gamma - 1) = E_{Tot}, \tag{9}$$

which is the relativistic equation for the total energy of a particle.

From the legs of the triangles we get the relativistic energy dispersion relation

$$E_{Tot}{}^2 = (pc)^2 + (mc^2)^2 \tag{10}$$

The two diagrams represent the exact same geometric relationships. The difference is only in scale. Since $mc^2 = hf = \frac{h}{t}$, the time axis is scaled by

$$t = \frac{h}{mc^2}, \tag{11}$$

which is one Planck-second times 2π, i.e. one cycle (period or wavelength).

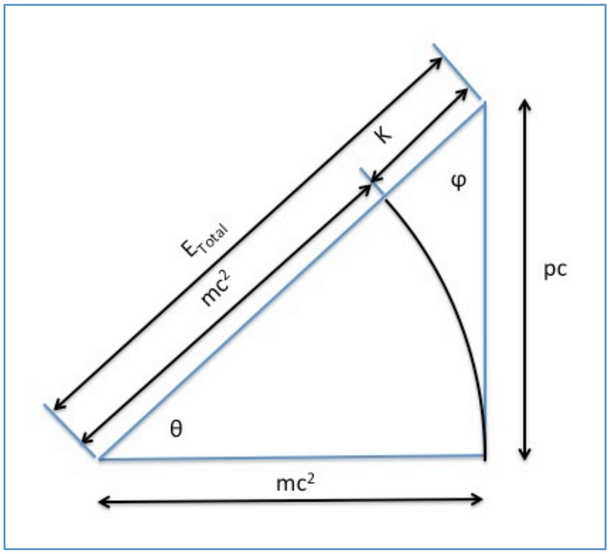

Figure 5 A relational triangle provided in a physics text book (Halliday, Resnick and Walker 1993) as a mnemonic device to help the student remember the relativistic relations between the total energy (Hamiltonian) and the rest energy, kinetic energy and momentum. The arc in the figure is meant to illustrate that the magnitude of mc^2 on the hypotenuse is the same as that on the horizontal leg.

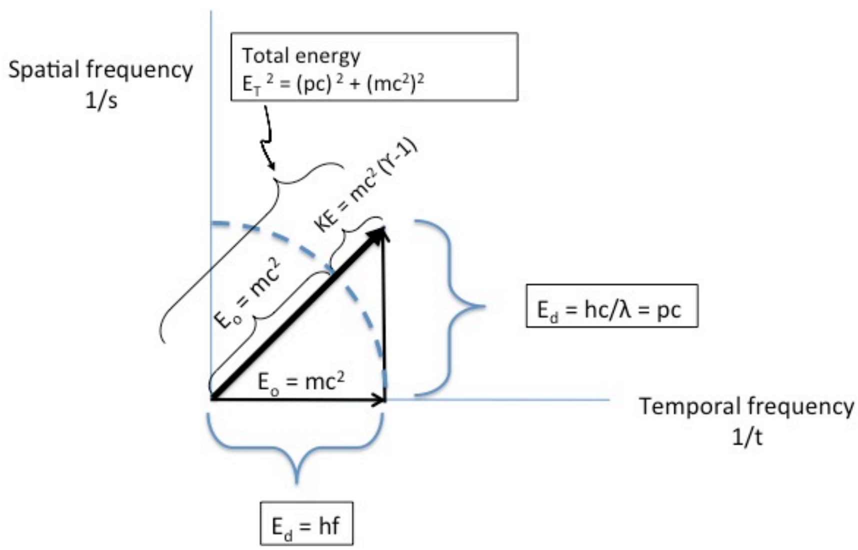

Figure 6 Vector representation of the light sphere scaled by units of space and time. The same triangle and relations are in the Energy diagram Figure 5.

The STM Transformation Model

Separation

Consider the expanding sphere of light discussed with the Minkowski diagram. Let's say that it takes 1 nsec from the flash event at t_0 for the light to reach the observer who's holding the bulb. A measurement at 1 nsec after the flash corresponds to Event 1 at t_1 (the Event Reference in Figure 7). From the light sphere's perspective[ii], the surface of the quantum domain at Event 1 corresponds to "Here" on the *S* axis and "Now" on the *T* axis. The next event (in the future) is shown as Event 2 at s_2 and t_2. The other vector arrow is shown referenced to t_1 (in the past) and back-projected to t_0, to represent relative motion in the photon's inverse (quantum) domain, which is at $\frac{1}{t} = \frac{1}{2}$. The observer's relativistic perspective would be plotted at $s = 2$ and $t = 2$, which is a point farther out than what is shown as s_2 and t_2, but the vector from t_1 to t_2 must be the same magnitude as from t_0 to t_1. Therefore, both vectors in the quantum domain are half the length of the vector that would project from 0 to 1 in the relativistic domain[iii].

As it expands, the photon is still one light unit, moving at1 light sec/sec or 1 light year/year so if it could see itself, it "sees" Event 2 as the new "Now" and Event 1 in its "past", which corresponds in the diagram to "inner space". Effectively, this measurement event **separates** the two perspectives. The relativistic observer at the center sees the sphere expand, but the photon *resets the world domain* to a new "Here" and "Now" pulling the *scale* of space and time into itself, back to the Event Reference. For the next measurement, the first arrow would be shifted inward and contracted to fit between $\frac{1}{2}$ and $\frac{1}{3}$, creating the apparent curvature of space-time. If it were conscious, the photon would experience a psychological flow of time, yet it would see itself as just another stationary, unchanging particle. Energy, which was *perceived* as being separated as space and time, is thus reintegrated as a whole.

This quantum perspective is the at-rest perspective, the photon's own center-of-mass frame – from the outside looking in at the unchanging surface of the sphere with the flashbulb at the origin. From here, the photon or an outside observer would just see an orb, a unit of illumination ("phot"). The photon could only perceive of motion if it could see, (or imagine - it would have "insight") the flash bulb at its center appearing to shrink. It would "remember" the bulb, the observer, and its former-self (qbits of Event 1) shrinking into its center, into the past. As a quantum computer, this would be in its memory.

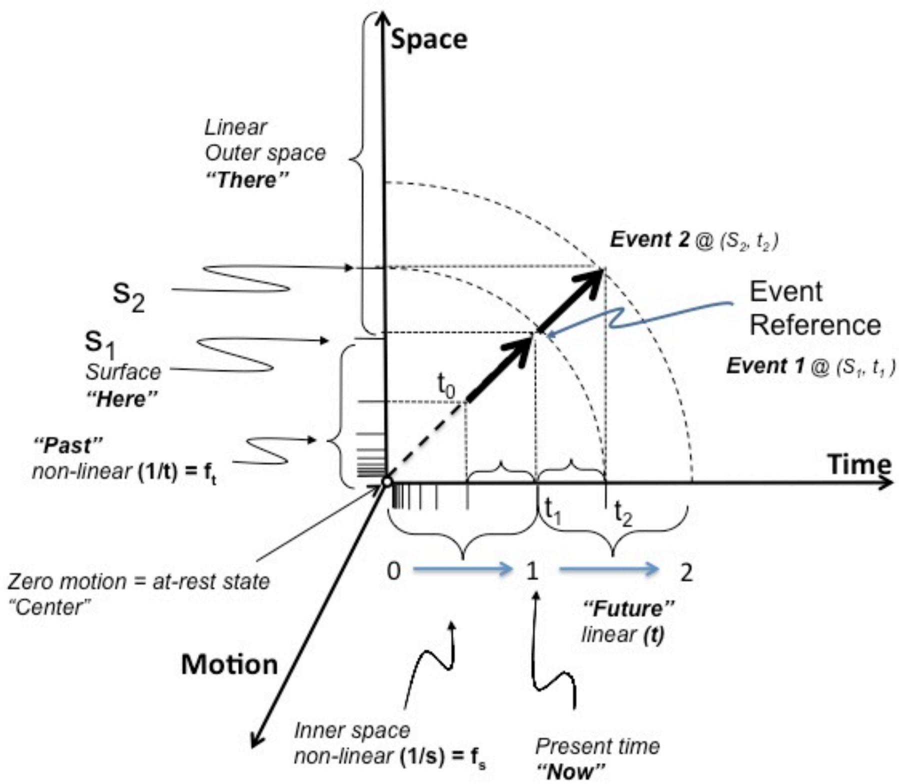

Figure 7 Two events plotted on the STM diagram. To the observer at the center, the spherical shell expands outward but the photon always sees itself as its own surface in the present time represented as the Event Reference.

Projection - Reflection

Although it will be used again to relate the scales of the two domains, there is a problem with the STM model in Figure 7, a frequency problem. Since the inverse scale is superimposed on the linear scale, as the clock ticks, two different sets of marks could be plotted on the axes: one that is projected *outward* (on a linear scale from 0 to 1 to 2…) and the other that moves *inward* as a reflection on the inverse scale in fractionally smaller increments toward an infinitesimal point at the origin ($0 = \frac{1}{\infty}$ the singularity problem, one of the root causes for the problems listed by Smolin. It cannot use $t = 0$ either because $\frac{1}{0} = \infty$). Therefore, as time passed ($t = 1, 2, 3, \ldots$), the frequency would be modeled as changing ($f = 1, \frac{1}{2}, \frac{1}{3}, \ldots$), which would not model a quantum particle. The problem is that the only point that actually represents the energy at the surface of the light shell is the boundary where $\emptyset = \frac{1}{\emptyset} = \emptyset^2 = 1$, ($\emptyset$ being a dummy variable to represent either s or t). The solution to the frequency problem is to use the phasor discussed in the previous section for the quantum domain.

In both coordinate systems the arrow ("arrow" refers to the "vector" in the rectangular coordinate system and the "phasor" in the polar system) represents the velocity of the expanding light sphere, with a magnitude of one unit of motion.

But there's still something wrong with this. The direction of the vector is *divergent* – projected radially outward, whereas the phasor rotates, so its "direction" is perpendicular to the direction of the arrow. Also, before we start a clock, both arrows should be positioned vertically on the Space axis to represent the *real* magnitude of motion (1 unit) outward in space. But then when we start a clock, the two models would split. They immediately become de-coherent. If we use the textbook procedures, the phasor would rotate one full rotation (increasing time) and the vector would immediately be switched to the diagonal to indicate one unit of change with respect to time. At that point, only part of the vector (the projection on the Space axis) would represent the real motion[iv] (motion in space) so the two domains, which are supposed to be reflections (inverse domains) of each other, would appear to represent different quantities. In effect, the reflection is warped.

Reintegration

This de-coherence of models can be avoided if we use *the event* as the reference rather than the coordinate frames. This means that rather than rotating the phasor or switching the vector, we can rotate the map as shown in Figure 8. By doing this we see that the two coordinate systems are 45° out of phase before the clock starts, and that the magnitude and direction of the phasor now corresponds to the vector (both are the same solid arrow in the figure). Then when we start the clock, we could rotate the polar frame rather than the phasor and represent the relativistic motion as a sliding vector (the dashed arrow from s_1 to s_2). That way the magnitude and directions of both remain constant. The dashed vector shows that a sliding vector can be moved from events 0 and 1 to fit between events 1 and 2, but if we slide the divergent relativistic scale inward, one unit with each event, rather than sliding the vector, the vector and phasor become *reintegrated* as one symbol so that motion is represented by the *moving domains* instead of the moving vectors.

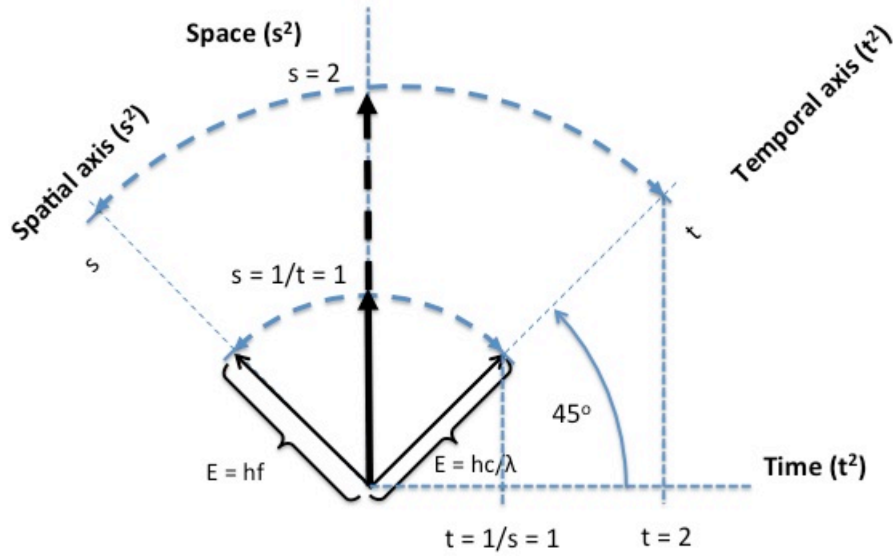

Figure 8 A phasor-type of vector models each event as one rotation of the phasor, solving the frequency problem. Rotating the polar coordinate system rather than the phasor and sliding the relativistic scale removes the scaling problem.

Because the observer at the center lives in the relativistic frame, his perspectives still separate (Space and Time axes in Figure 8) when the clock starts. He can still use the polar wave function (Spatial axis and Temporal axis) to represent motion, but if he measures one unit of space and one unit of time, he can only represent them in the linear domain, and he will get the un-rotated vector and have to apply a Lorentz factor. But a measurement of subatomic particles as integral units will reveal the frequency characteristic. So the rotating coordinate system would be interpreted from the observer's frame of reference as separate particles with spin (fermion or gauge boson) or as the frequency characteristic itself (scalar bosons). The apparent differences between these types of particles can be attributed in the STM model to the fact that one cycle can be separated into different quadrants.

Since the polar coordinate system is scaled to λ as one complete rotation, then the energy of the particle $E = \frac{hc}{\lambda}$ would also be scaled by 2π. Figure 9 shows that there are 8 states in the cycle where the space-time relationships are the same. If that means that there are *potentially* 8 distinct units in one cycle of 2π, the energy would be the same magnitude for each but scaled by 2π. So each one would be at exactly one Compton wavelength, $r = \frac{1}{2\pi}\frac{h}{mc} = \frac{\hbar}{mc}$, (where, $\hbar = \frac{h}{2\pi}$), and have a potential angular momentum of $J = \frac{1}{2\pi}h = \hbar$, all pointed in different space-time directions. This could be interpreted as one particle with 8 distinct states or 8 different types of particles (e.g. 8 different types of gluons).

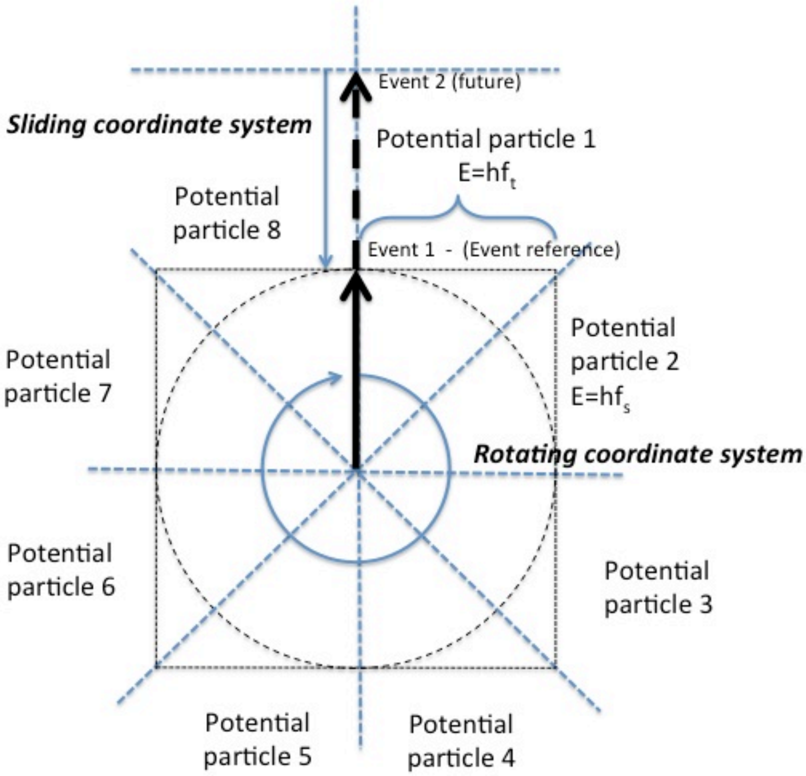

Figure 9 An Octet of potential particles, each having the same energy but different angular momentum (up, down or zero). The position in space relative to the center is constant, represented by the vector aligned with the space axis. The circle represents phase relations between 8 potential states.

When we didn't move the coordinate systems and viewed the expanding sphere of light from the outside (as a quantum unit of energy – a unit of mass with $m = 1$ – represented by the magnitude of the vector $E = c^2$ as shown in Figure 10) we switched the vector to line up with the diagonal line. And according to the relativistic equation for total energy, $E_{Tot} = c^2 + c^2(\gamma - 1)$, it is a "Lorentz boosted" vector.

Comparing the back-projection on the spatial axis to the back-projection of the "boosted" composite-vector, it appears to be "contracted" by a value, v^2. The ratio of the actual vector, c^2 to the contracted vector, $c^2 - v^2$ is a magnification factor, which is the square of Lorentz factor, γ.

$$\gamma^2 = \frac{c^2}{c^2 - v^2} = \frac{1}{1 - \frac{v^2}{c^2}}. \tag{12}$$

The difference, shown in Figure 10 as v^2, looks just like, and could be interpreted classically as the velocity, and thus kinetic energy, of a particle with respect to the background reference frame. A classical calculation of kinetic energy is $KE = \frac{1}{2}mv^2$, which is the area of the small shaded triangle (if the horizontal leg was scaled to represent a unit of mass, m_1 in the figure). But this would not make sense because the photon in this example is an isolated, massless orb of light at rest with respect to itself. The only relative velocity is the velocity of the flash bulb at the center "moving" deeper into the photon's center. But the photon has no way of detecting this.

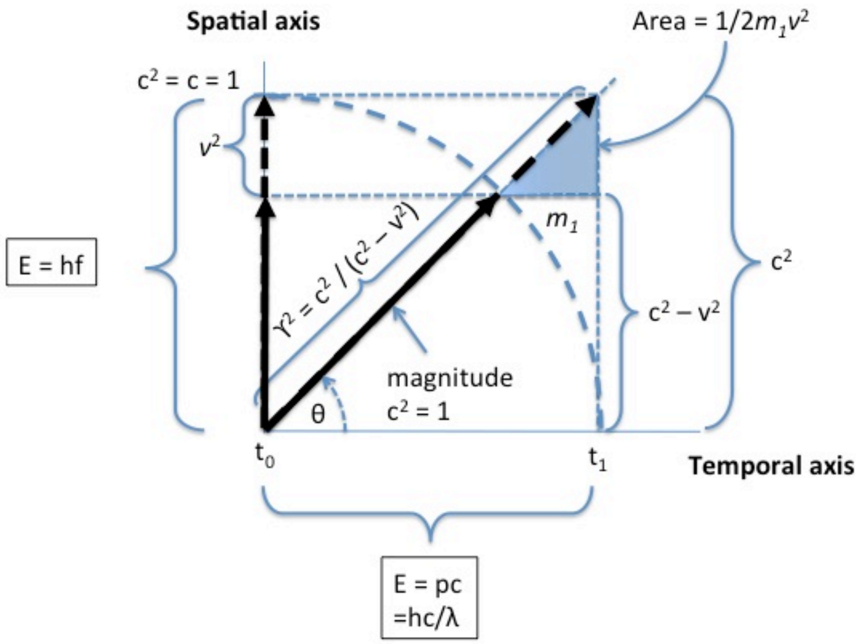

Figure 10 Lorentz magnification

Therefore, the photon might take a classical approach and say that the entire photon could *potentially* be a mass orbiting a central point at a distance r from the center. Regardless of whether or not there really is mass in this massless orb, we can calculate a radius and a momentum. The STM diagram shows that momentum is a measure of the spatial characteristic, as a vector in the quantum domain (inverse domain on the temporal axis)) related to space by Planck's constant. It does not provide a model of actual position in 3-D space[v]. By assuming that the total energy of the orb is contained within the mass, we can equate a unit of energy on the temporal axis ($E = \frac{hc}{\lambda}$) to a unit of mass-energy, ($E = mc^2$). We get

$$mc^2 = \frac{hc}{\lambda} = \frac{hc}{r} \tag{13}$$

and, solving for $r = \frac{h}{mc}$, gives us the Compton wavelength times 2π, i.e. one cycle, and an angular momentum of

$$J = pr = (mc)\frac{h}{mc} = h, \tag{14}$$

which is the total angular momentum of an electron in ground state[vi] (also times 2π). Thus the particle would be modeled as a point sphere at a distance, r, from the center. The frequency characteristic would appear as the total angular momentum: an orbital component and spin[vii].

Figure 10 illustrated that the STM model allows us to arrive at the same relations for energy, radial distance and angular momentum as we do with quantum mechanics. Note that there is no indication of *azimuthal* position in 3-D space, only their radial distance from the center to the potential "shell". The orientation of these potential particles in the diagram is an indication of their relative *phase*, not azimuthal position.

Interpretation

The fact that the actual position of a particle cannot be predicted is not a weakness in this model or quantum mechanics, but a characteristic of reality. Interpreting this characteristic is where the STM model differs, and hopefully improves on the interpretation of quantum physics. In the Copenhagen interpretation, we consider the mysterious wave function ψ, whose amplitude is ϕ, as a *probability* amplitude. In other words, it is assumed that there already exists a position in space and time where a particle will arrive, guided by this probability wave, and that it can be measured when and where that happens. But you can only estimate where the particle is based on the probability wave. And according to the Heisenberg Uncertainty Principle, once you measure the position, you lose all hope of knowing its momentum, since the measurement changes the velocity of the particle.

But the STM interpretation does not assume that a "position" even exists. Instead, it assumes nothing, i.e. nothingness (darkness) is transformed into "light" through a continuous process, creating a "new" scalar position in space-time with each event. So the wave function represents the scale itself. In other words, the energy that will be transformed into a particle already exists without form, but the position in space and time does not. Position and momentum are two different ways of expressing this spatial aspect, so an interaction is a transformation of temporal frequency into a spatial frequency resulting in the bit-wise expansion of the universe. It is tempting to call this a continuous "creation" process, but it is a transformation rather than a creation so energy is conserved. And this transformation is modeled by equations in relativistic quantum mechanics.

A Unified Theory

It will take a lot more work and many publications to prove a theory to be the highly coveted "unified theory". And a large part of that work will require physicists and mathematicians who have far more knowledge in the most advanced areas of physics, to determine if this model produces the same results that have been proven accurate by experiment. However, there are a few more relatively basic equations that I can present as a start to illustrate its usefulness.

In this section, I will use the STM model to illustrate some of the most important relationships: the quantum wave function, the Klein-Gordon equation, the Schrodinger equation and quantum operators. I previously used it[viii] to propose a unified theory, similar to work by David Hestenes, who combined all of Maxwell's equations into a single multivector format using Geometric Algebra (Hestenes 2003). That will be included to continue a scientifically rigorous investigation.

The Wave Function

Equation (8) is a wave function that integrates the two scale units, s and t, but it does not solve Schrodinger's equation unless it is squared. However, it does solve the Klein-Gordon equation[ix]. The reason for this can be seen with the STM model by first reviewing where the wave equation comes from. A classical wave equation is an important second-order partial differential equation, given by

$$\frac{\partial^2\phi}{\partial s^2} = \frac{1}{v^2}\frac{\partial^2\phi}{\partial t^2}. \tag{15}$$

It is a fairly simple equation that hints at the equivalence of space and time. And it is very easy to find it using the STM diagram. First, the magnitude of the spatial component of the energy vector, call it $\hat{s}$, is equal to the slope and therefore the *first derivative* of the equation for the diagonal line in rectangular coordinates, call it ϕ.

$$|\hat{s}| = \frac{\partial\phi}{\partial t} \tag{16}$$

Then, if you switch the axes, (the basis of the partial derivative) the magnitude of the temporal component of ϕ is also the slope of the same diagonal line – the first derivative with respect to s. So

$$|\hat{t}| = \frac{\partial\phi}{\partial s}. \tag{17}$$

Because the derivative is the tangent, the vector points in a direction tangent or perpendicular to the S-T plane. So the motion vector, with its base at $M = 0$, points in a direction perpendicular to the base of the phasor. This is shown in Figure 11 as $\hat{\boldsymbol{v}}$ pointing out of the page.

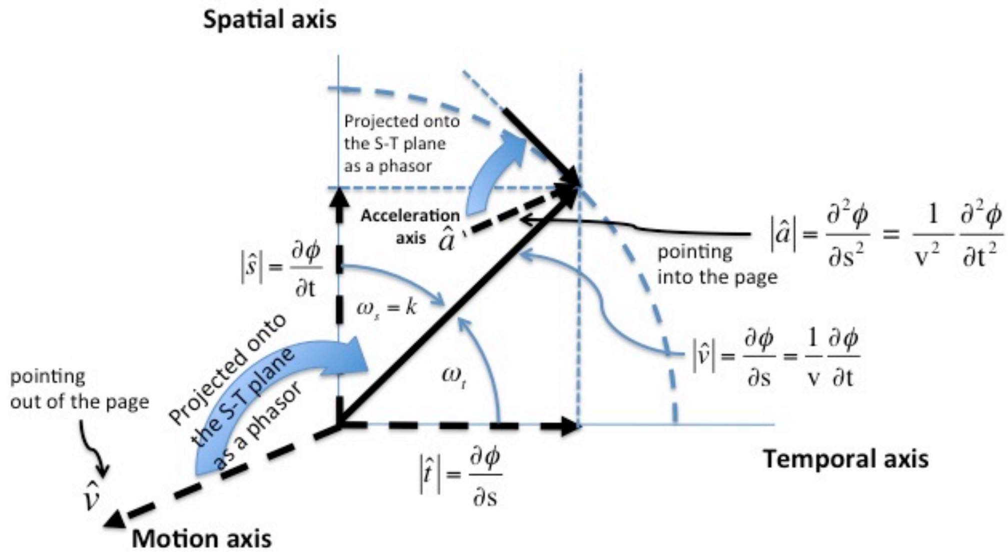

Figure 11 Vectors symbolize the derivative or slope of the scalar plot. The motion vector is shown perpendicular to the S-T plane (pointing out of the page) with *M=0* at the origin of the plot. Acceleration is also perpendicular to the S-T plane, and perpendicular to the motion phasor.

Recall that the motion axis is projected back onto the *S-T* plane in polar coordinates as a phasor that is described by two complementary and equal angles (reflections of each other); one is measured with respect to the temporal axis and the other with respect to the spatial axis, giving the projection of motion the initial 45 degree phase shift. As long as $v = 1$, the phasor is oriented in line with the diagonal on the *S-T* plane, to represent the relationship of the two derivatives, related by $|\hat{s}| = v|\hat{t}|$. Inserting Equations (16) and (17) into this relation we get

$$|\hat{s}| = v|\hat{t}| \;\rightarrow\; \frac{\partial\phi}{\partial t} = v\frac{\partial\phi}{\partial s} \;\text{ or }\; \frac{\partial\phi}{\partial s} = \frac{1}{v}\frac{\partial\phi}{\partial t} \tag{18}$$

A first-order differential equation such as this is *not* normally considered a wave equation (which is a second-order differential equation). But it is said to have "characteristics" that remain constant as the function progresses in time (Haberman 1983, 417-421). It has a general solution of the form $w(s,t) = P(s - vt)$ so at any value of t, the solution is the same shape, shifted a distance vt. In fluid mechanics, this is called an advective transport equation, which describes the transport of a substance such as a fluid, by bulk motion. The conserved properties of the substance, such as energy, are carried with it[x]. That is exactly what a photon is – the bulk motion of energy. In field theory, if we associate a direction with ϕ, in this case outward, Equation (18) rearranged, is a continuity equation – the equation for a velocity vector field that governs the motion of a scalar field.

$$\frac{\partial\phi}{\partial t} = v\frac{\partial\phi}{\partial s} = \nabla \cdot v\boldsymbol{\phi} \tag{19}$$

Equation (18) may not be a standard wave equation, but it can be solved by a wave function, that is Euler's formula, $e^{i\theta} = \cos(\theta) + isin(\theta)$, where θ is the angular position of the phasor in Figure 11. The angle θ is usually written as $\theta = ks + \omega t$. In terms of the STM model, $\theta = 2\pi f_s s + 2\pi f_t t = \omega_s s + \omega_t t$. So Euler's formula, is the same as Equation (8) with a phase shift

$$\psi = e^{i(ks+\omega t)}, \tag{20}$$

and this solves Equation (18) since $\frac{\partial \psi}{\partial t} = \frac{\partial e^{i(ks+\omega t)}}{\partial t} = i\omega e^{i(ks+\omega t)}$ and $\frac{\partial \psi}{\partial s} = \frac{\partial e^{i(ks+\omega t)}}{\partial s} = ike^{i(ks+\omega t)}$. Therefore $i\omega\psi = v(ik\psi)$ since $\frac{\omega}{k} = \frac{2\pi f_t}{2\pi f_s} = \frac{1/t}{1/s} = \frac{s}{t} = v$.

If you try to use Equation (20) to solve Schrodinger's equation, you will find that it has to be squared again. I will explain why after presenting the Klein-Gordon equation in the next section.

Since the second derivative of space with respect to time is acceleration and is orthogonal to space, time and the projection of motion (v), it is shown in Figure 11 as being perpendicular to the *S-T* plane *and* perpendicular to the phasor. It is parallel to the motion axis, but it points into the page, and is shifted to the tip of the diagonal vector (since the first derivative is the integral of the second, so the shift is the constant of integration). This, I submit, is the real meaning of parallel dimensions, unlike the notions presented in science fiction. Acceleration presents as a *reflection of motion,* reflected off of the *S-T* plane when motion changes.

The acceleration vector, projected onto the *S-T* plane is a phasor with an angle, call it θ, written as either $f_t^a t$ or $f_s^a s$. Now we have to be careful since this frequency is different than the frequency associated with velocity, i.e. it is zero at constant speed and increases as the speed is being changed. So time, t must be treated as if were different from time in the first derivative (separation of variables). If it wasn't, then the time component would cancel, i.e. $f_t t = \frac{1}{t} t = 1$. Instead, the derivatives are separated and f_t^a is taken out of the first derivative. Then for the second derivative it is changed to $f_t^a = \frac{1}{t}$ and differentiated with respect to t.

$$\frac{\partial^2 \theta}{\partial t^2} = \frac{\partial^2 (f_t^a t)}{\partial t^2} = \frac{\partial}{\partial t}\left(\frac{f_t^a \partial(t)}{\partial t}\right) = \frac{\partial}{\partial t}\left(\frac{1}{t}\right) = -\frac{1}{t^2}. \tag{21}$$

Similarly

$$\frac{\partial^2 \theta}{\partial s^2} = \frac{\partial^2 (f_s^a s)}{\partial s^2} = \frac{\partial}{\partial s}\left(\frac{f_s^a \partial(s)}{\partial s}\right) = \frac{\partial}{\partial s}\left(\frac{1}{s}\right) = -\frac{1}{s^2}. \tag{22}$$

Therefore

$$\frac{\partial^2 \theta}{\partial t^2}\left(\frac{t^2}{s^2}\right) = -\frac{1}{t^2}\left(\frac{t^2}{s^2}\right) = -\frac{1}{s^2} = \frac{\partial^2 \theta}{\partial s^2}, \tag{23}$$

and

$$\frac{\partial^2\theta}{\partial s^2} = \frac{t^2}{s^2}\frac{\partial^2\theta}{\partial t^2} \; or \; \frac{\partial^2\theta}{\partial s^2} = \frac{1}{v^2}\frac{\partial^2\theta}{\partial t^2} \tag{24}$$

which is the classic second order partial differential wave equation. It is also solved by ψ in Equation (20). Recall that the second derivative of space with respect to time (acceleration) is generated by a change in velocity and it, in reflection, generates an opposite change in velocity. It doesn't even exist unless some external interaction attempts to change the existing pattern of energy (motion) we called a photon. It is simply a resistance to change, and thus presents as a force.

An important take-away from this discussion is that this is a morphic process. Separation is the first derivative, which transforms motion into a phasor (graphically a tiny circle or icon representing the vector pointing out of the page) and projects it onto rectangular coordinates and the second derivative transforms it back to an icon, shifted out to where the phasor was projected. Its phasor is then projected again, by another derivative (another change) back onto the S-T plane as a centripetal component and a tangential component. Thus, any change in frequency, which is a change in velocity, will result in a non-zero acceleration that opposes the change (a characteristic that presents as angular momentum and inertia) giving the particle its form. So mathematically, the projection dis-integrates the quantum (advection equation) and the reflection allows it to re-integrate (wave equation) and bring *closure* to the process (dispersion relation).

Another important take-away from Equations (21) and (22) is that this is a rare situation in which the second derivative of a function is equal to the square of the first derivative albeit negative (a linear reflection). In the quantum domain between 0 and 1 we use the inverse scale, $\frac{1}{s}$, which is already the first derivative of a function.

$$\frac{d}{ds}\ln(s) = \frac{d}{ds}\int \frac{1}{\emptyset}\, d\emptyset = \frac{1}{\emptyset},\ \emptyset > 0 \tag{25}$$

So the square of the first derivative, $\left(\frac{d}{ds}\ln(s)\right)^2 = \left(\frac{1}{\emptyset}\right)^2$ is equal to the second derivative $\frac{d}{d\emptyset}\left(\frac{1}{\emptyset}\right) = -\frac{1}{\emptyset^2}$. This is important for illustrating how the STM model can be used to present the Klein-Gordon equation.

The Klein-Gordon Equation

If we take the same approach as above and assume that the mass of a potential particle is located at a distance $r = \frac{\hbar}{mc}$ from the center, we can represent it on the STM diagram as shown in Figure 12.

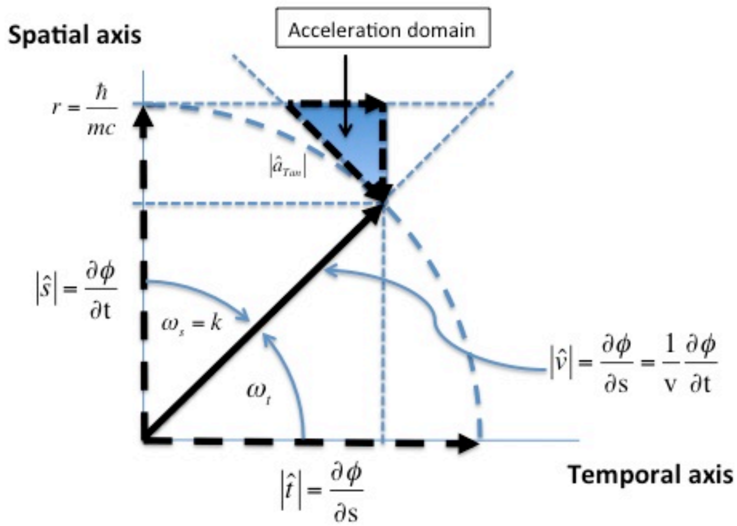

Figure 12 Acceleration domain representing a potential particle projected at the event reference

Now, focus on the acceleration domain and imagine the velocity vector (the quantum domain) collapses to an icon at the origin so the acceleration vector expands still using the inverse scale $(1/r)$ as shown in Figure 13.

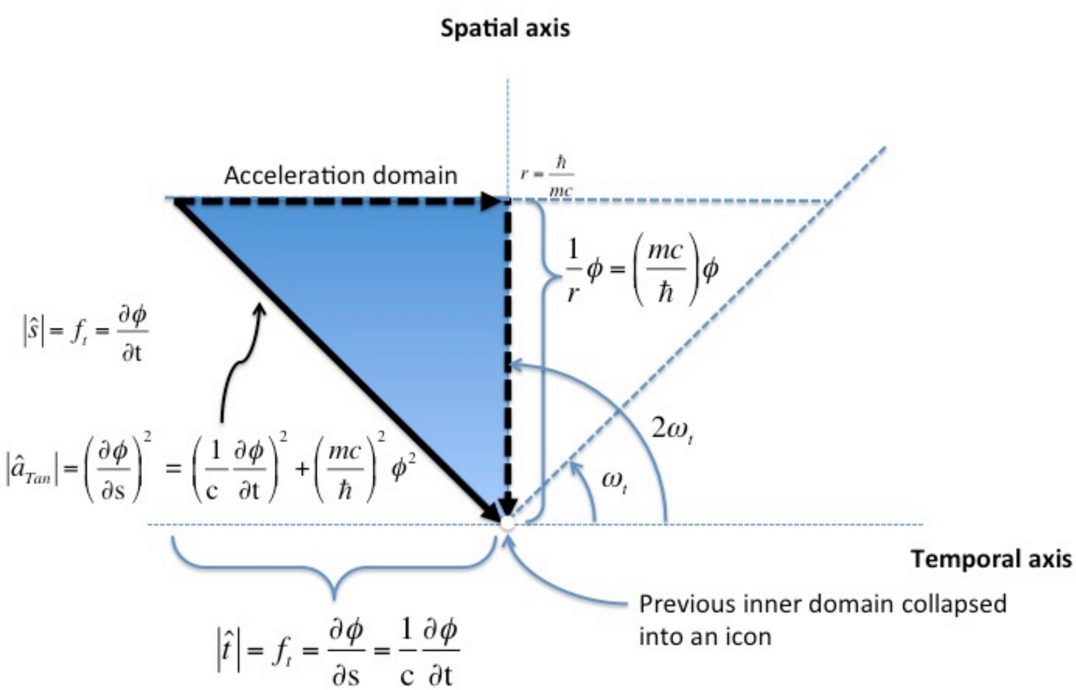

Figure 13 Focus on the small shaded triangle in Figure 12 and expand the acceleration domain to reflect the scale of the *quantum* domain

We can see the phasor that represents this potential particle is the *hypotenuse* of the shaded triangle, whose legs are $\frac{1}{r}\phi = \left(\frac{mc}{\hbar}\right)\phi$ and $\left(\frac{1}{c}\frac{\partial\phi}{\partial t}\right)$ so

$$Hypotenuse = \left(\frac{1}{c}\frac{\partial\phi}{\partial t}\right)^2 + \left(\frac{mc}{\hbar}\right)^2 \phi^2. \tag{26}$$

Notice that $\frac{1}{r}$ is multiplied by ϕ to scale the collapsed velocity domain. Equation (26) looks striking similar to the Klein-Gordon (KG) equation,

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} = \frac{\partial^2\phi}{\partial s^2} - \left(\frac{mc}{\hbar}\right)^2 \phi^2, \tag{27}$$

if the hypotenuse is $\frac{\partial\phi}{\partial s}$, except that it contains the square of first derivatives where KG has second derivatives and the negative sign (which means that acceleration opposes the change in velocity). Moving the term $\left(\frac{mc}{\hbar}\right)^2 \phi^2$ to the right side of the KG equation removes the negative sign and suggests that the hypotenuse now represents the transformation of energy into a unit of space. This unit of space contains energy in the form of time and an additional component related to mass, that was previously in the form of time, now in the form of binding energy. And as explained above, this is a rare case in which the square of the first derivative is equal to the second derivative. Thus Equation (26) can be written as

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} = \frac{\partial^2\phi}{\partial s^2} - \left(\frac{mc}{\hbar}\right)^2 \phi^2, \tag{28}$$

which is the Klein-Gordon equation. This equation is the quantized version of the relativistic energy-momentum relation and cannot be interpreted as a probability amplitude.[xi]

Therefore, rather than being a probability amplitude, the symbol ϕ, *that mysterious quantum wave function*, represents the integrated form of the domain itself, whose scale is transformed by differentiating and re-integrating, changing the perspective of the observer to another domain.

If we interpret Equation (28) as representing only mass, the separation of domains comes across as representing two separate particles. In the term, $\left(\frac{mc}{\hbar}\right)^2 \phi^2$, the amplitude, ϕ, is squared and represents the energy[xii] so this potential mass, scaled by $\left(\frac{mc}{\hbar}\right)^2$, can be written as $\frac{p^2}{\hbar^2}$. This is twice the energy of a free particle, $E_{FP} = \frac{p^2}{2m}$ and this suggests that it represents 2 distinct potential units of mass scaled by $\hbar$, each with energy E_{FP} also scaled by $\hbar$:

$$\left(\frac{mc}{\hbar}\right)^2 = \left(\frac{2m}{\hbar}\right)\frac{E_{FP}}{\hbar}. \tag{29}$$

Squaring ϕ also means that the angle to this component (ωt) with respect to the *S*-*T* frame is doubled. So it is the same function only rotated to indicate that the potential particle wave functions are phase-shifted, giving them a distinction as separate entities. Thus, the particle model works. It is also the reason that Equation (20) had to be squared in order to solve the free particle Schrodinger's equation,

$$\frac{\hbar^2}{2m}\frac{\partial^2(\Psi)}{\partial^2 s}+i\hbar\frac{\partial(\Psi)}{\partial t}=0. \tag{30}$$

This is because Schrodinger's equation is lopsided – it is partially evaluated in that one temporal derivative has already been performed. Therefore, it already has the factor of 2 that comes from the split units. In the Klein-Gordon form, the "2" would cancel when all of the derivatives are evaluated, so it is not needed. In effect, it is hidden.

The Schrodinger equation can be found in the STM diagram as well, but since it contains a mixture of domains in a single equation it is a bit more complicated. So in the interest of flow, I have moved it to the endnotes.[xiii]

Transformation of domain results in hidden variables

As I pointed out in the discussion for Figure 7 and Figure 10, the scale of the polar domain is half the size of the *S*-*T* domain, because the second increment on the inverse scale is at $\frac{1}{s}=\frac{1}{2}$ and $\frac{1}{t}=\frac{1}{2}$. This is a result of the fact that speed, the magnitude of the velocity vector, is scaled by the measured values of space denominated by a standard unit of time.

Effectively, scaling energy (s^2), in the form of motion to match the measured values of space splits it in half, which is why $KE\propto\frac{1}{2}v^2$. A measurement of displacement (Δs) quantifies a unit of space as *s*, and therefore *sets the scale* for the unit *s,* which is half the scale of motion $\frac{d}{ds}(s^2)=2s$. This relation is important because, just like the special condition defining the event reference where $s^2=s=\frac{1}{s}=1$, this is the only condition in which $s\times s=s+s$, i.e. *iff* $s=2$, meaning the quantum ***scale*** (s_q) is twice the size of the *relativistic scale* (s_r) (think about map scales: larger scale means smaller icons so it takes two quantum units to make one relativistic unit). In other words, s^2 represents space in the quantum domain (what I called *S* in Part 1) and $2s$ represents the same size unit in the relativistic domain.

The problem with linear thinking is that we ignore the geometric change that occurs from nothingness to something-ness. Mathematically, the change from zero to *s* is $\frac{d}{ds}(s)=1$, so we can't represent how change affects that quantum unit since the second derivative is zero. If, on the other hand, we use the inverse scale between zero and 1, as in Equation (25), it is clear that $\frac{1}{s}$ is already the first derivative of a function. But we can't just use this because of the frequency problem. So we have to transform it to polar coordinates, which transforms the unit to an exponential function, $s_r = e^{s_q}$, as shown previously in Equation (4).

The quantum scale (s_q) is thus hidden in the exponent of the relativistic scale, (s_r). This, I submit, is David Bohm's hidden variable. It is hidden because motion is change – a derivative – yet the derivative of e^{s_q} *is* e^{s_q}. In other words, no matter what happens in the relativistic scale, if we measure the quantum unit, it does not appear to change. It's analogous to the incredible shrinking woman or looking at yourself in the mirror and trying to catch yourself looking away. Since you have to use your eyes to see yourself, you can never see your eyes looking away. Since we have to use the outside world as our reference, the quantum unit must change relative to us.

Operators in Quantum Mechanics Bring Closure

In math, a set (or domain) has closure under an operation or multiple operations if performance of the operations on members of the domain always produces a member of the same domain. The STM model provides a bird's-eye view of multiple domains. So a projection transformation out of one domain into another is an operation that can be seen as open from a higher perspective. And reflection (an inverse transformation[xiv]) is the operation that allows for closure, if the conditions are right. The "conditions are right" means that *the domain that you are referring to* contains both the input and the output of the transform function (or combination of transform and inverse transforms) used to perform the operation.[xv]

Two of the most common transforms in physics and engineering are the Fourier transform and Laplace transform. It is interesting to note that the wave function itself, $e^{i(ks-\omega t)}$ is the product of the Laplace transform and Fourier transform of unit (Dirac delta) functions. A Fourier transform, defined as

$$\mathcal{F}[f(t)] = F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-i\omega t}dt, \tag{31}$$

converts a differential equation into a temporal frequency, and a Laplace transform, defined as

$$\mathcal{L}[f(t)] = F(s) = \int_{0}^{\infty} f(t)e^{-st}dt, \tag{32}$$

converts a differential equation into a spatial frequency. Thus, the STM diagram is simply a combination of the Fourier transform and Laplace transform with their inverse transforms. The way to describe how one function *translates* another is by a convolution integral $F(s) * F(\omega)$. So motion, expressed as $e^{i(ks-\omega t)}$ may be considered a convolution of space with time. And they introduce a natural twist by way that they relate to the diagonal (c), and this results in chirality. These two features, the natural twist and chirality become evident on the macroscopic scale as a harmonious movement, via the Golden Ratio, which will be discussed in a later section of this paper.

To show how this relates to operators in quantum mechanics, I write the phasor in space as the product of the rectangular representation $\left(\frac{1}{s}\right)$ and quantum representation $e^{i(ks-\omega t)}$. In vector mechanics, this operation is the inner product (dot product, the projection of a vector onto a basis), $S = \psi \cdot f_s = \frac{1}{s}e^{i(ks-\omega t)}$, which is the equation for a spherical wave moving outward in space.

In quantum mechanics, for lack of any physical interpretation, it is interpreted as the expectation value (the statistical approach).

$$\langle f(s)\rangle = \int \psi\psi^* f(s)ds. \tag{33}$$

But when applied to a wave function, the argument inside of the integral is simply a scaling factor because the product, $\psi\psi^*$ is just the scale times its inverse (since the inverse of $\psi = s = e^{2\pi is}$ is $\frac{1}{s} = \frac{1}{e^{2\pi is}} = e^{-2\pi is}$, which is ψ^*, the conjugate of ψ). And since the wave function maps motion as the slope of the phasor in S-T coordinates, which is the derivative of one component with respect to the other, the integral in Equation (33) gives you back the measurable scalar component (the inverse transform that brings closure). The quantum operator (which would be inserted for $f(s)$) serves the purpose of identifying the basis (an inner product, a vector projection onto the spatial axis[xvi]). It inserts the appropriate variable to work in the rectangular domain ($\hat{x}$ = x in the case of position) or converts the wave function into a momentum function by substituting $k = \frac{2\pi}{h}p$ and $\omega = \frac{2\pi}{h}E$ into

$$\psi = e^{i(ks-\omega t)} \tag{34}$$

to get

$$\psi = e^{\frac{i}{\hbar}(ps-Et)} \tag{35}$$

and then projecting that onto the momentum domain by taking the first derivative with respect to *s*. This extracts the momentum variable, *p*, along with $\frac{i}{\hbar}$. So the momentum operator is

$$\hat{p} = \frac{\hbar}{i}\nabla. \tag{36}$$

This operator is considered to be the most important operator in quantum mechanics because we can write all other classical observables as functions of **r** and **p**. (Morrison 1990, 146)

As I explained above, the quantum wave function is a function that was transformed by Fourier and Laplace transforms. Because we consider the physical, measurable world to be the reference domain (i.e. real), the quantum operators are the inverse transform functions that bring closure.

The Holomorphic Quantum Theory

The interpretation that I propose is the Holomorphic Quanta[xvii], the idea that physical reality is the materialization of energy by the holomorphic process, which echoes Quantum Field Theory and builds upon the Wave Structure of Matter (WSM)[xviii] proposed by Wolff (Wolff 2006). WSM theory identifies a quantum particle as a spherical standing wave. It is supported by equations of particle motion modeled as the phase velocity of the standing wave (Shanahan 2014). However, WSM lacks verification and it is missing parity, spin and chirality.

Presenting a standing wave within the STM model introduces parity, spin and chirality and supports the Holographic principle (Suskind 1995), the Holographic Universe (Talbot 1991), the Holotropic Mind (Grof 1993), the Holonomic Brain Theory (Pribram 1984), David Bohm's Holomovement (Bohm 1980) and Mark Germine's Holographic Principle of Mind and the Evolution of Consciousness (Germine 2008). And it is supported by recent observational tests of holographic cosmology (Afshordi, et al. 2017). By using attosecond pulses to film electron motion, they produced an image, see Figure 14, (Science Daily 2008) that shows the crests, valleys, parity and chirality (notice how the picture resembles a pair of lips with a small bump in the upper lip) of the standing wave.

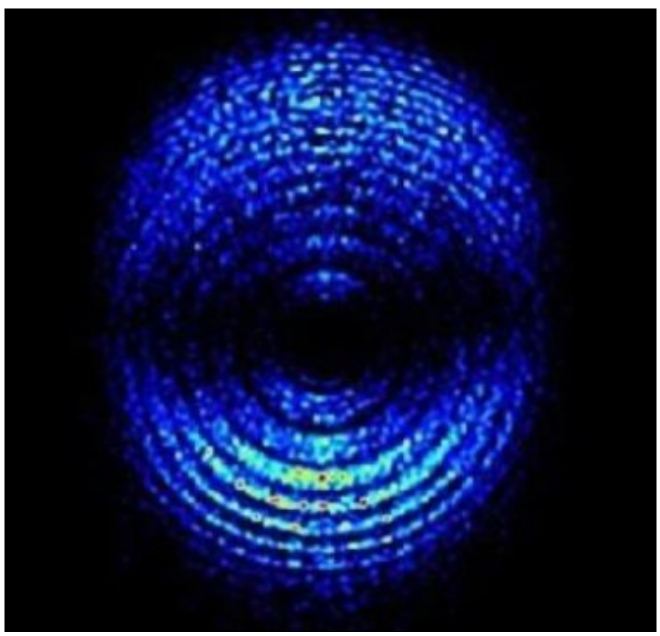

Figure 14 Image of electron "With the use of a newly developed technology for generating short pulses from intense laser light, scientists in Sweden have managed to capture the electron's motion for the first time." From https://www.sciencedaily.com/releases/2008/02/080222095358.htm

With the STM model we can visualize the transformation process – wave into particle and vice versa. So far I have used the example of a spherical flash of light as a photon, but I haven't mentioned the distinction between a massless photon and a particle that has rest-mass. The difference is that photon is the outgoing wave with the *potential* to express material form and according to WSM theory, matter is the *actual* form that results from the interaction of the outgoing wave with outside interference i.e. incoming waves.

Consider again the light sphere. It was produced in darkness (*devoid* of any contrast that contains information) by the pulse of light. The sphere is therefore just a thin shell. What's inside that shell? If there are no other sources of light, it must be darkness. As the light shell moves outward, *the void fills with darkness*. By the same reasoning, we could say that the darkness outside the shell recedes. So rather than saying that light travels at speed c, we could say that light is the constant – the only thing that doesn't move – and *darkness recedes-outward* and *fills-inward* at that speed. It's a subtle difference, but it makes more sense of how light can have the same velocity regardless of the velocity of its source. Rather than picturing a particle of light being emitted by a moving filament, which would add velocity to a particle, we imagine that a disturbance made by the light bulb transforms the darkness (call it space, field, ocean, ether, universe, information-less energy, or maybe it's dark energy) into light (radiation, information). The disturbance propagates outward, *uncovering* a ring of light (not moving, but being revealed and then re-covered). So a flash of light produced by a moving bulb would be like a bird touching the surface of a pond, just for an instant, as he flew by. The surface wave would propagate outward at the same speed as if a pebble dropped in the pond from directly overhead.

The Standing Wave

Now consider if the light bulb at the center of the sphere stays on continuously. This disturbance will have a certain frequency, so effectively it is radiating in equal cycles, pulses or events, modeled as waves. Each wave has the same frequency and wavelength. Then imagine that there are billions of other light bulbs completely surrounding the first one. According to the Huygens-Fresnel principle (along with the Fresnel-Kirchhoff diffraction theory (Cantrell 1997)) *there are*[xix]. Every point on a wave front can be considered a point source of a spherical wave. So we don't even need a flashbulb and we don't need any dedicated outside sources; they are everywhere, and we need them all. And there will be a component of their disturbance moving directly inward, toward the center of the first. Any component that is in tune (the same frequency) and coherent (in phase) will contribute to the equation for an incoming spherical wave

$$S_{in} = \psi_{in} \cdot f_s = \frac{1}{s} e^{i(ks+\omega t)} \tag{37}$$

The sum of the incoming and outgoing waves is a spherical standing wave,

$$S_{out} + S_{in} = \frac{1}{s}\left[e^{i(ks-\omega t)} - e^{i(ks+\omega t)}\right]. \tag{38}$$

This is what Daniel Shanahan used as a model particle whose relative motion is its phase velocity[xx] (Shanahan 2014). The WSM theory makes good sense, but there are details that need to be worked out in order for it to be acceptable to the mainstream.

A standing wave pattern is in space-time balance with the potential to resist a change in that balance. So any shift in phase would appear as acceleration, resulting in particle motion. But then the positive acceleration would be countered by an inverse acceleration that would act against it to rebalance and attain space-time equilibrium and then maintain that constant velocity. This gives the particle inertia.

With the STM model, we can see in Figure 15 that the outgoing phasor is aligned with the spatial axis and the incoming phasor is aligned with the temporal axis. This is because $(ks - \omega t) = 0$ for the outgoing phasor and the incoming phasor is 90° out of phase as $(ks + \omega t)$. The resulting standing wave, the vector sum of the incoming phasor and the outgoing phasor, is a tangential vector, in line with the projection of the potential acceleration vector discussed in Figure 12.

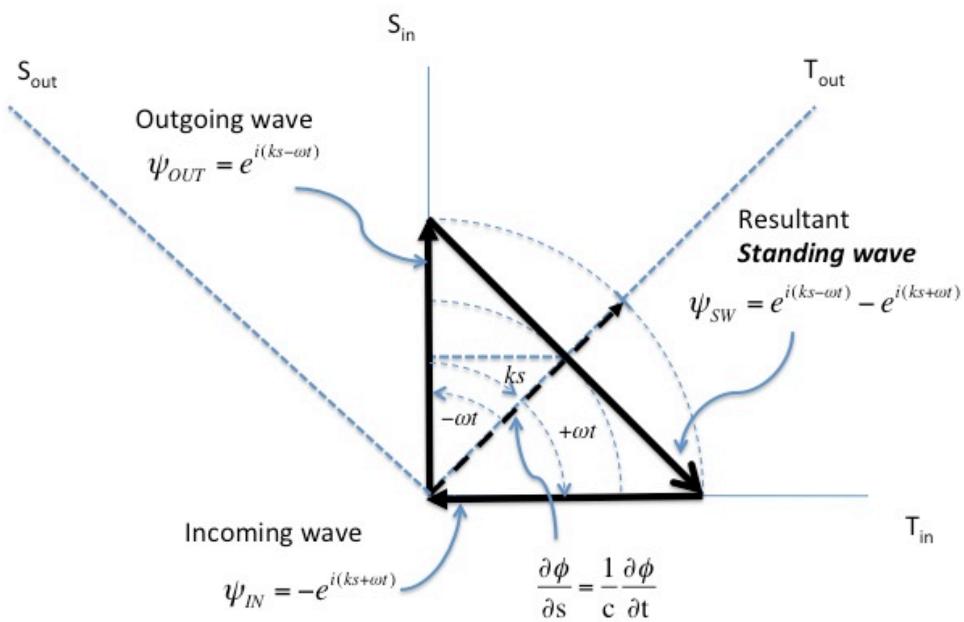

Figure 15 Resultant standing wave vector is the sum of the outgoing wave and incoming wave

The resultant vector looks suspiciously like the acceleration vector except that the tip of this vector is at the time axis. We could interpret this as meaning that it is a *potential future state*, that in the next time increment the time axis would be shifted so that the tip of the vector is at the origin, as shown in Figure 16. Then it would be exactly the same as the Klein-Gordon vector in Figure 13

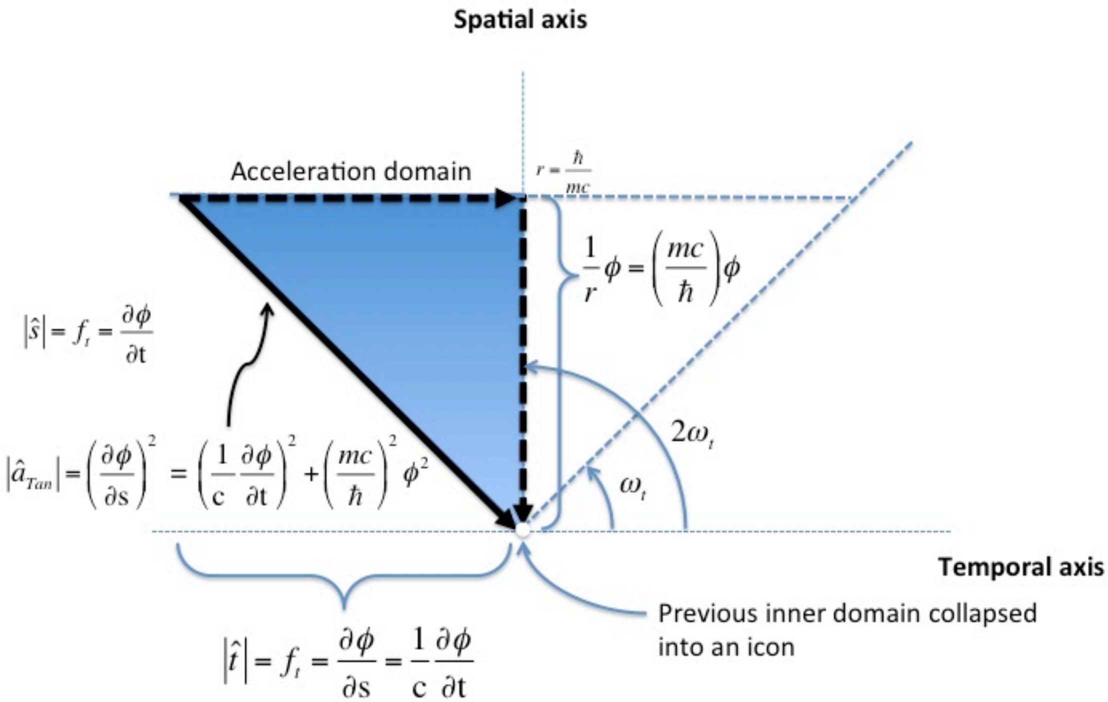

Figure 16 The spherical standing wave phasor diagram shows that the vector sum of the outgoing and incoming waves results in a vector that is described by the Klein-Gordon equation.

According to Equation (29), $\left\{\left(\frac{mc}{\hbar}\right)^2 = \left(\frac{2m}{\hbar}\right)\frac{E_{FP}}{\hbar}\right\}$ the outgoing wave could have been interpreted as the energy of two potential particles. In other words, with just the outgoing wave, there was no change in the gradient to cause a change in frequency, so there was no acceleration vector. Only the potential for the vector if something made the frequency change. The incoming wave provides that interference as a constant change in the gradient, so it makes the vector actualize. Once it does, it becomes its own unit of energy, seemingly comprised of two "particles".

Quantum Harmony Forms the Natural Scale

Unlocking the mysteries of the universe means that there is a mystery, a lock and a key. Energy is the mystery, physical form (differentiated into separate units) is the lock, and recognizing the equivalence of space and time is the key. The second mystery is how to use that key. The answer to that is found in the harmony of nature. Unlike most keys, this "golden key" is not another particle. It is the process, like a combination, that creates vibrations and every lock has its own resonant frequency.

Rather than choosing the physical aspect as the cornerstone of reality, with time as imaginary, let's focus on the energy – the units of area on the STM diagram. So instead of treating an area as a particle, I will treat it as a "ray" of monochromatic light (a laser) to produce a holographic image.

The outgoing wave (at t_0) has a specific energy that we represent as the area of the square, $s_0 \times t_0$. The incoming wave has the same energy (at t_1), so the combined energy should be shown as double the area. If we use the vector symbol, as in Figure 15, the resultant vector shows the phase relation, but cuts the quadrant in half. So even if the scale is halved, as discussed in the previous section, the area of the triangle below the resultant vector is not enough to include both waves. To account for this, and to show the phase relation, I moved the reference point to t_1 and reflected the triangle as shown in Figure 17.

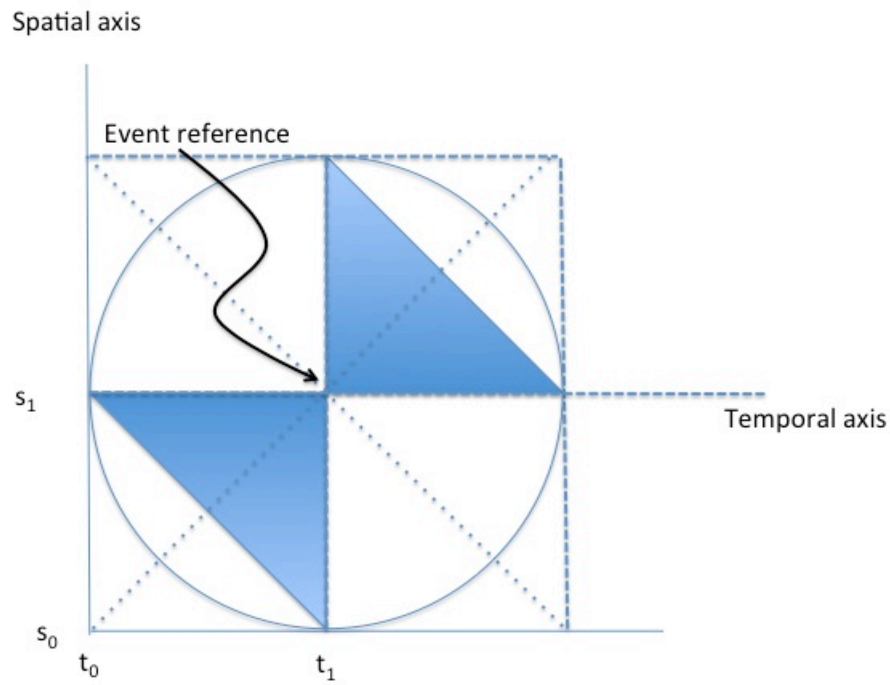

Figure 17 Resultant wave as a combination of two areas on the STM diagram

This is the energy diagram at t_1 showing the energy before t_1 as the area in the lower left and the energy after t_1 as the area in the upper right quadrant. Notice that the point of symmetry (what was previously the origin) is projected up along the diagonal line – to the Event Reference, translated from s_0 , t_0 to s_1, t_1 so it is offset from the source point of the outgoing wave. Now if we focus on the event reference, the shaded area in the lower left quadrant would collapse to an icon to represent energy "captured" inside the event reference, transforming what was a divergent field into a curled field. This forms a completely closed spherical boundary in space that would appear from the outside to be a particle.

So what happens when the clock ticks t_2? It is tempting to think that this process suggests that each event would add energy as a linear addition. But that is not the case. You have to think of energy as a characteristic, like color. Each event transforms the particle, but only with respect to the event reference. The energy from event 1 transformed from a linear to a polar representation, so one cycle is one cycle regardless of its "size". It is simply one bit-pair of information. The next event would also collapse and the first would collapse relative to it, but that just changes its characteristic distance in time (in the "past") from the event reference. Every event is just another separation, projection, reflection and reintegration that continues to morph the energy into information entropy. According to information theory, this is called Shannon entropy (Shannon 1948),

$$H = kln(W), \tag{39}$$

where H is entropy, k is a constant and W is the number of microscopic states or configurations. Comparing this to Equation (25), $\frac{d}{ds}\ln(s) = \frac{d}{ds}\int \frac{1}{\emptyset} d\emptyset = \frac{1}{\emptyset},\ \emptyset > 0$ suggests that W is the scale (s or t) itself.

The Golden Ratio

It has been known for centuries that nature somehow uses the Golden Ratio to twist and shape spatial features and produce harmony throughout the Universe (Stakhov 2014). And we know that there are many physical, as well as musical and optical patterns that involve the Golden Ratio, which shows up in natural patterns, like flowers, seashells, trees and even the shape of spiral galaxies[xxi] (Willard 1993). We even know that it is somehow linked to inter-neural synchronization during spatial-frequency coding in the brain and thus related to perception (Elliott, et al. 2015). We know it happens, and we know how to use it in art and architecture, but we don't know how it happens in nature. With the STM we can solve that.

The Golden Ratio is a special number, just like 1 (the Event Reference where $t = \frac{1}{t} = t^2$ iff $t = 1$) and 2 (the scale splitting where $s^2 = s + s = 2s$, *iff* $s = 2$) are special. But it is a bit more mysterious[xxii] because it is a ratio, which is a solution – the result of operations: division and differentiation, which correspond to separation into inverse reflections, and reunion by integration and multiplication. The Golden Ratio is golden because it is the only number that represents the condition in which the scale of the transformed polar domain is equivalent to the linear domain. It is the relationship between the linear relativistic domain and the circular quantum domain.

The STM diagram in Figure 18 shows the motion vectors projected forward and backward from the event reference. The length of each of the two vectors is half of what it was when the origin was used for a reference. This splitting of the scale in half at the event reference has a profound effect on our perception of energy. It creates a special geometric relationship that has only one solution, the Golden Ratio.

Figure 18 is a copy of Figure 7 but the polar coordinates are rotated so that Figure 18 shows the inverse domain $\left(\frac{1}{\mathrm{t}}\right)$ between the origin and t_0. Since a unit of clock time is fixed and used in the both domains, the temporal scale is held constant (labeled $\Delta 1$). Therefore, the scale that applies to speed in the quantum domain (the magnitude of the first vector) would have to be "stretched" back out to account for the inverse relation, i.e. the sum of the first increment in the linear domain and the inverse domain,

$$1 + \frac{1}{t} = t. \tag{40}$$

This is well known to be the Golden Ratio, normally written as $\Phi = 1 + \frac{1}{\Phi}$.

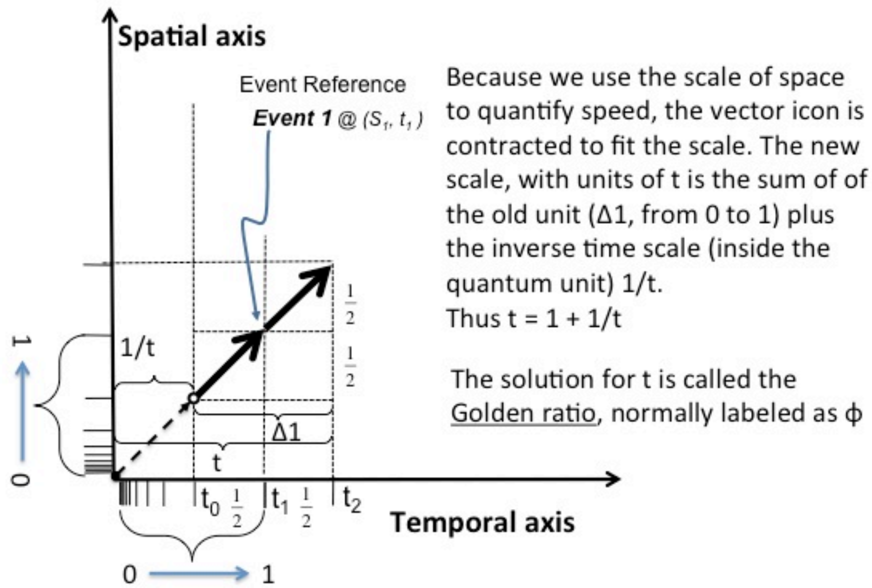

Figure 18 Using the same scale to quantify motion has the effect of splitting the unit in half. Rescaling the vector back to the clock scale changes it by an amount that is the Golden Ratio.

It may be hard to see this stretch in Figure 18 so I'll focus on the event reference (tip of the first vector) and bring it into the quantum domain leaving the scale (½) on the right as shown in Figure 19. Then determine the relation between the quantum domain labeled "a" and the relativistic domain, $\Delta 1 = (a + b)$ of the temporal scale. By placing a mark on the second vector using the spatial scale of ½ (drawing the solid arc of radius ½ from the event reference) and then rotating that onto the temporal axis, we get the stretched quantum scale unit (a). It is related to the relativistic scale (b) by the Golden Ratio in the form[xxiii]

$$\Phi = \frac{a}{b} = \frac{a+b}{a}. \tag{41}$$

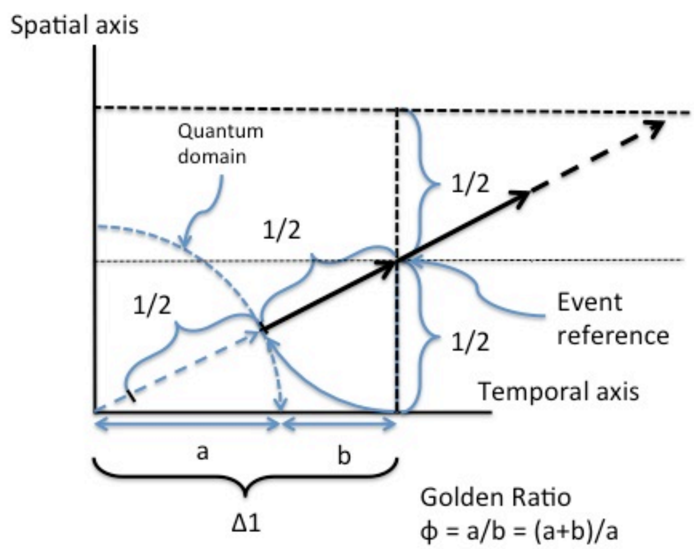

Figure 19 A standard procedure for dividing the horizontal line segment (*a + b*) to get the Golden ratio exactly like this is shown in https://en.wikipedia.org/wiki/Golden_ratio.

Thus, if we focus on the first (solid) vector and collapse the dashed phasor to an icon so a is $\left(\frac{1}{\mathrm{t}}\right)$, the value of a+b is set to 1 unit, and $\frac{1}{\mathrm{t}} + 1 = t = \Delta 1$ unit.

If we did the same analysis on the spatial axis using Figure 10, letting $b = v^2$ and $a = c^2 - v^2$, we would find that the Golden Ratio is a special value of the Lorentz factor, $\gamma^2 = \frac{c^2}{c^2 - v^2}$. Substituting for a and b in Equation (41)

$$\frac{a+b}{a} = \frac{(c^2-v^2)+v^2}{c^2-v^2} = \frac{c^2}{c^2-v^2} = \gamma^2 \tag{42}$$

and

$$\frac{a}{b} = \frac{c^2-v^2}{v^2} \tag{43}$$

Setting Equation (42) equal to Equation (43) and rearranging we get

$$v = \frac{1}{c}(c^2 - v^2) \tag{44}$$

Since the magnitude of the spatial component $(c^2 - v^2)$ represents the projection of energy in space (scaled as the radius of the particle) in Figure 10, I interpret equation (44) to represent the transformation or fractional change from the relativistic to the quantum domain. It means that $\frac{1}{c}$ is the factor by which the unit of space collapses with each event. Consider again the discussion from Figure 17. The energy that is collapsed between t_0 and t_1 creates a "germ" (but not yet a grating) for a holomorphic image. This germ is centered at the zero-frequency point (ZFP) just like that used in ray-tracing analysis of holography where ZPF means "the zero spatial frequency locus of a hologram" (Stephen Benton and V. Michael Bove 2008, 78), (Guenther 1990). Now in order for there to be a t_2 there must be relative motion, since time is motion. And if there is motion, there is a relativistic reference frame within which this energy must be fit. Even with its spatial dimension squashed to one half to account for stretching the time scale back into the inverse quantum region, there is still a component of the speed vector that doesn't fit, as shown in Figure 20.

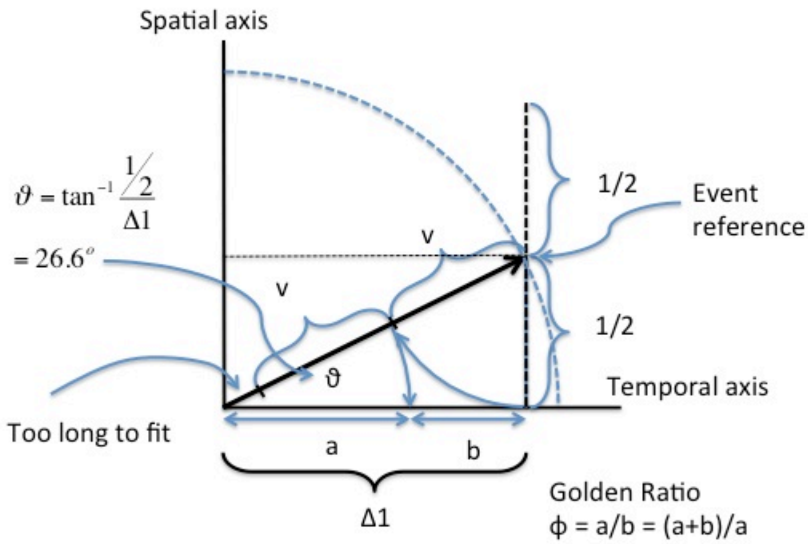

Figure 20 Scaling the temporal axis to fit the inverse temporal region into the relativistic scale is not enough to account for the speed scale

But if the reference frame is rotated slightly about the event reference, so that the speed scale fits $2v = v^2$ into the spatial scale, the center point (ZFP) would be shifted in space and time, giving it the tiny holographic grating, a zero-point vector and thus natural *quantum motion* (zero point energy) and the apparent increment of time. The amount of shift required to make the new speed scale (Φ^2) fit the temporal scale (1 unit) to include the inverse domain ($\Phi + 1$) as shown in Figure 21, will place it at the Golden Angle of 36º.

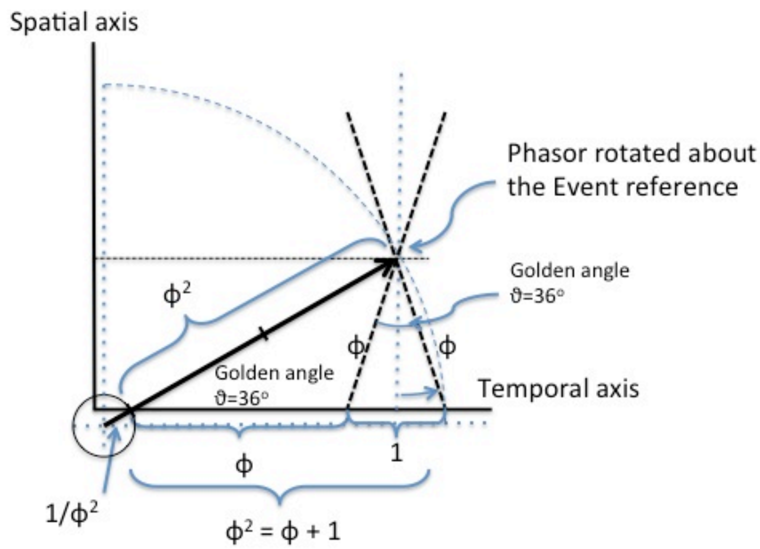

Figure 21 The Golden Angle is the phase angle that results from squeezing the extra energy of the standing wave into the quantum particle.

The slightly shifted speed vector (Φ^2) can then be separated into a linear term ($\Phi = \text{c}$) and inverse term $\left(\frac{1}{\Phi} = \frac{1}{c}\right)$ just like we did with space and time. The inverse scalar component, the same fractional change in Equation (44) by which space collapses is equal to fine-structure constant in natural units, $\alpha = \frac{1}{c}$.

Conclusion and thoughts about future research

There is a lot more work to do in order to verify the use of the STM model and find more correspondence between it and the current models to give us real closure. But this will require physicists to accept *process philosophy* as opposed *substance philosophy*. Otherwise, they will continue to think of space and time as fundamentally different with spacetime as an asymmetric mixture. Changing this perspective may be difficult because the prevailing cosmological model for the universe, the Big Bang Theory must be abandoned. With process philosophy there is no beginning to a process, no $t = 0$, only reference times. So there is no "past" in the sense of negative time, only the integrated reflection of future and past as relative to here and now.

Space and time must be thought of as projections of motion and reflections of each other, as mathematical dimensions of energy and not as an independent clock and a dependent displacement. Space and time are integrated together as equals. For the next step in analysis, you might be tempted to ask what happens at $t = 3$, but the number 3 introduces a numerical distortion that doesn't work. Instead you should think in terms of shifting the coordinate reference to a new event reference, t_1 with t_0 and t_2 to serve as scale-boundary conditions. And rather than thinking of electron orbitals as being located at greater distances from the center, they should be though of as holomorphic quanta inside the event reference with different frequencies and phases, like golden triangles of different sizes[xxiv] and pointing in different directions. With that, different elements will simply be different sets of resonant frequencies and a molecule will be the integration of elements that share resonance rather than particles with force fields.

The spatial component, collapsed inside the holomorphic germ is phase-shifted from the ZFP, resulting in a spatial frequency grating necessary to form a holographic image. It also provides a vector to compare with the ground state quantum numbers, $n = 1$, $l = 0$ and $s = \pm\frac{1}{2}$ since there is both a spatial and temporal component. The region outside the germ can still be compared to a particle with angular momentum for $n = 2$ and $l > 0$ since translating and rotating coordinate systems has no effect on the frequency of energy. I would suspect that there is a golden relationship here too since $\Phi^2 = \Phi + 1$, so multiplying the speed vector, Φ^2, by its scaling component (an inner product) gives $\Phi(\Phi + 1)$, which is strikingly similar to $L^2 = l(l + 1)$.

Then, rather than separating energy into two dimensions of space and time at 90^o, use three dimensions at 60^o apart, giving them names like $E_{1,}$ $E_{2,}$ E_3 rather than space, time, and something else. In fact, we may find that the principle quantum number corresponds to the number of dimensions used (2 for space and time) so it might be a good idea to go back and rename space and time to something that mimics the electron configuration system, $2s^1$, $2s^2$ since 1s would represent the holomorphic germ. That would help crystalize the understanding of space-time equivalence.

Our models are designed to fit our perceptions so if we see a point-like flash on a screen or a spherical bulge through an electron microscope, it makes perfect sense to call it a particle. However, even if we could reduce everything down to only one elementary particle, there is still the question, what makes that particle. The holomorphic process is not something that happens to particles when we observe them; it is what happens to our perception of the energy. Empty space, devoid of any vibrations is what we call dark; it cannot be perceived in our awareness. But it is still called energy and it provides the space into which awareness expands.

The STM model has the potential to reintegrate physics with biology, which is already centered on the life process. One of the biggest unanswered questions in physics that still makes the news[xxv] is “How did life evolve from non-living matter?” The STM model shows that the question is another fallacy. Life is the eternal process and the qualities that we distinguish what we consider to be “alive” from not alive are self-motivation, self-preservation and self-awareness. Some organic matter, flexible enough to move relative to itself, uses projection and reflection as a feedback to cause its own motion. This presents as intention, and evolves into attention, and self-reflection evolves into self-awareness.

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[i] Physicist Lee Smolin considers *the time problem* to be "the single most important problem facing science as we probe more deeply into the fundamentals of the universe." (Smolin, Time Reborn: From the Crisis in Physics to the Future of the Universe 2013)

- Newton's idea of absolute time and space –as independent and separate aspects of objective reality, and not dependent on physical events or on each other and independent of any perceiver – was superseded by Einstein who showed that a single event does not happen simultaneously to two observers moving relative to each other. So in relativistic physics, time is considered one of four dimensions of spacetime. But in quantum physics, position and time are considered separate, independent quantities. (Morrison 1990, 58)
- Physicist Julian Barbour said, "Time does not exist. All that exists are things that change. What we call time is – in classical physics at least – simply a complex of rules that govern the change." (Barbour 1999, Loc 2327)
- Stephen Hawking stated that time exists, but is comprised of a real and imaginary component. "Imaginary time is indistinguishable from directions in space." Thermodynamic and cosmological time are real – they describe the increase in entropy of the universe, which started with the big bang and

provide the arrow of time that points in the same direction as the expanding universe. (Hawking 1990, 143-155)

- And Lee Smolin says that time is real. "Embracing time [as real] means believing that reality consists only of what's real in each moment of time. Whatever is real in our universe is real in a moment of time, which is one of a succession of moments." (Smolin, Time Reborn: From the Crisis in Physics to the Future of the Universe 2013, Loc 80)

[ii] This is similar to Einstein's "thought experiment" in which he would imagine riding the wave to see the world from the photon's perspective. It is the same as imagining that the light sphere is conscious and can reflect upon itself, to see itself as an unchanging sphere of constant energy.

[iii] In Geometric algebra, this is the geometric product of the two vectors, $st = \frac{1}{2}(s\hat{t} + t\hat{s}) + \frac{1}{2}(s\hat{t} - t\hat{s})$ with the second term (the "outer product") flipped outward. The hats are used here to distinguish which vectors are being used as bases.

[iv] It would then be a complex number with a real part to represent space and an imaginary part to represent time.

[v] This is a statement of Heisenberg's uncertainty principle $\Delta x \Delta p = \frac{\hbar}{2} = \frac{h}{4\pi}$. 4π represents 2 cycles, one for each Δx and Δp.

[vi] Angular momentum of an electron is $\sqrt{l(l+1)}\frac{h}{2\pi}$

[vii] This is done in "the vector model of angular spin." (Goswami 1992, 220-221) See also https://en.wikipedia.org/wiki/Vector_model_of_the_atom

[viii] See unpublished report "The Unity of Space and Time" at http://vixra.org/abs/1401.0218

[ix] In fact Klein-Gordon equation has been derived from this form of wave function given the dispersion relation, $k^2 + \omega^2 = \frac{m^2}{\hbar^2}$ holds. See https://en.wikipedia.org/wiki/Klein%E2%80%93Gordon_equation

[x] https://en.wikipedia.org/wiki/Advection

[xi] According to http://www.phy.ohiou.edu/~elster/lectures/advqm_2.pdf and https://en.wikipedia.org/wiki/Klein%E2%80%93Gordon_equation

[xii] If we treat this the same as a time-varying signal in communications theory (see Parseval's Theorem (Stremler n.d., 85)), ϕ^2 represents energy (similar to energy delivered to a resistor).

[xiii] I only include the Schrodinger equation because it, rather than the Klein-Gordon equation, is the one that is covered by introductory QM textbooks (Goswami 1992) (Morrison 1990) (Liboff 1993). Quantum mechanics was invented because elementary particles were found to exhibit wave-like characteristics via the double-slit experiment. And Erwin Schrodinger found a way to express a particle in terms of a wave function by "creatively intuiting" what became known as the Schrodinger wave equation.

$$\frac{\hbar^2}{2m}\frac{\partial^2(\Psi)}{\partial^2 s} + i\hbar\frac{\partial(\Psi)}{\partial t} = \mathrm{V(r)}\Psi. \qquad \text{(EN-6)}$$

It is a textbook exercise (Morrison 1990, 48) worked out in (T. St. John 2014) to show that you can arrive at the Schrodinger wave equation (without including a potential field, $V(r) = 0$) from the classical wave equation

$$\frac{\partial^2(\Psi)}{\partial^2 t} = v^2 \frac{\partial^2(\Psi)}{\partial^2 s} \qquad \text{(EN-7)}$$

by squaring the wave equation, $\Psi = |\psi|^2 = e^{2i(ks+\omega t)}$, taking the first derivative with respect to time and using de Broglie relations to replace $\frac{\omega}{v^2}$ with $\frac{m}{\hbar}$. We can find the Schrodinger equation in the STM diagram by rearranging Equation (EN-6) and writing it as

$$\frac{\partial^2(\Psi)}{\partial^2 s} = -2i\frac{mc}{\hbar}\left(\frac{1}{c}\frac{\partial(\Psi)}{\partial t}\right). \qquad \text{(EN-8)}$$

Squaring the function, ψ, was necessary because it hyperlinked the function to the perpendicular map. And as long as ωt is negative, then $ks + \omega t = 0$, so doubling the argument in the exponent still represents the phasor at 45 degrees or ϕ. The first term in Equation (EN-8) is the acceleration vector $\hat{a}_T$ in Figure 11, which is on the acceleration map scale. Then from the advective transport equation (Equation (18)) the term in parentheses $\left(\frac{1}{c}\frac{\partial\phi}{\partial t}\right)$, is shown in Figure 11 as the magnitude of the diagonal phasor. It is scaled by the inverse Compton wavelength, $\left(\frac{mc}{\hbar}\right)$, just as the Klein-Gordon equation, and by $2i$, which is the eigenvalue of the "missing derivative" in the Schrodinger equation.

$$\frac{\partial}{\partial t} e^{2i(ks+\omega t)} = 2i\omega e^{2i(ks+\omega t)} = 2i(\omega\Psi) \qquad \text{(EN-9)}$$

The value of ω is 1 and it serves here as a unit vector to represent the acceleration map. So this term is one of the legs of the small shaded triangle, which represents energy. The other leg is $\frac{1}{r}\Psi = \mathrm{V(r)}\Psi$. So the Schrodinger equation is a mixture of functions from different maps, which makes it more difficult to interpret.

[xiv] Also called a reciprocal transformation. See http://mathfaculty.fullerton.edu/mathews/c2003/ComplexFunReciprocalMod.html

[xv] I point this out so that I can relate it to perception and resonance. Cognitive closure is a psychological concept that plays a direct role in mathematical solutions. Mathematically, closure is relative to what you perceive as the domain of interest, which depends on your perspective. If you focus on the quantum domain, then you perceive the particle at rest. But if the relativistic domain is of interest, then the particle is instantly transformed in your mind as being in motion, (a metamorphosis of perspective) giving you closure. So the particle-wave dichotomy is only a problem if you don't include both domains in your target domain.

[xvi] The same function could be projected onto the time axis. Can you visualize a spherical wave in time? Of course; it is exactly the same sphere because motion in time is just another way of representing motion in space. As long as you keep the variables symmetrical, in natural units, there is no need for further scale correction. The problem comes when you change the scales to match our senses so that one unit of space is defined as, say one meter, in which case a light unit is $3x10^8$ space units compared to one second (tick of an arbitrary clock). Then $c^2 \neq c \neq \frac{1}{c}$. *Breaking the symmetry* like this makes a light unit seem enormous – way out there in the cosmos, and a unit of time small – something we can measure with a wristwatch. On the other hand, thinking of time as something the stretches from the theoretical beginning of the universe makes a unit of space seem unimaginably small – a quantum particle. It also necessitates the use of all sorts of other scales and units to distinguish forms.

[xvii] In math, a holomorphic function is "a complex-valued function of one or more complex variables that is complex differentiable in a neighborhood of every point in its domain. The existence of a complex derivative in a neighborhood is a very strong condition, for it implies that any holomorphic function is actually infinitely differentiable and equal to its own Taylor series (analytic). Holomorphic functions are the central objects of study in complex analysis." https://en.wikipedia.org/wiki/Holomorphic_function. This mathematical method has been used in physics to "write classical mechanics in a way that allows a reasonable comparison with quantum mechanics" (see Holomorphic methods in analysis and mathematical physics at https://arxiv.org/pdf/quant-ph/9912054.pdf pg 31.)

[xviii] WSM has received some mixed reviews (see https://www.quora.com/search?q=milo+wolff and https://forum.philosophynow.org/viewtopic.php?t=13262), yet Daniel Shanahan strongly supported the idea in his paper, where he showed that the motion of particles is equal to the phase velocity of these standing wave patterns. (Shanahan 2014) Recently, newly developed techniques very similar to those used in holography were used to demonstrate the wave structure, also called "Space Resonance Theory," by producing quantum coherence in the lab. (Science Daily n.d.) (Carlström, et al. 2018)

[xix] In fact, the STM model is very similar to the model used to derive the Fresnell-Kirchhoff diffraction theory in (Cantrell 1997)

[xx] More outside sources at a given frequency would mean more power (flow of energy per unit time) in the standing wave. Compare this directional energy flux to the Poynting vector in electromagnetic theory, $\boldsymbol{P} = \boldsymbol{E} \times \boldsymbol{H}$, where $\boldsymbol{P}$ is the Poynting vector (energy flux or energy per unit area per unit time), $\boldsymbol{E}$ is the electric field and $\boldsymbol{H}$ is the magnetic field. The cross product is called a curl because the direction of the phasor is perpendicular to the two fields, i.e. it "curls around" $\boldsymbol{E}$ and $\boldsymbol{H}$. In our case we have the field of space and the field of time, and the curl or spin is the form of the quantum particle.

A hologram is another important comparison to make. It is a complex 3-dimensional pattern that forms by the interference patterns produced by two coherent laser beams. Any change in the relative phases of the interference pattern causes the holographic image to move across the field of view. One wavelength makes the image drift one whole "fringe".

[xxi] See https://io9.gizmodo.com/5985588/15-uncanny-examples-of-the-golden-ratio-in-nature

[xxii] The Golden Ration has held "special fascination" for millennia. According to https://en.wikipedia.org/wiki/Golden_ratio "Some of the greatest mathematical minds of all ages, from Pythagoras and Euclid in ancient Greece, through the medieval Italian mathematician Leonardo of Pisa and the Renaissance astronomer Johannes Kepler, to present-day scientific figures such as Oxford physicist Roger Penrose, have spent endless hours over this simple ratio and its properties. But the fascination with the Golden Ratio is not confined just to mathematicians. Biologists, artists, musicians, historians, architects, psychologists, and even mystics have pondered and debated the basis of its ubiquity and appeal. In fact, it is probably fair to say that the Golden Ratio has inspired thinkers of all disciplines like no other number in the history of mathematics"

[xxiii] This procedure is used as an illustration in https://en.wikipedia.org/wiki/Golden_ratio and it applies here only because the vertical leg of the triangle is ½ the length of the horizontal leg.

[xxiv] Perhaps Lie groups will fit here

[xxv] See https://www.nbcnews.com/mach/science/7-biggest-unanswered-questions-physics-ncna789666