The Holomorphic Quanta

Part 2: Projection

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"We live in a house of mirrors and think we are looking out the windows"
– Frederick Salomon Perls

Abstract

This is the second part of a four-part presentation. In part 1 I introduced a relational model that allowed me to demonstrate the equivalence of space and time as $S = Tc^2$ and showed that S represents energy as the product of scalar space with spatial frequency and T represents energy as the product of time units with temporal frequency. Doing so revealed the equations for quantum energy of a particle to be the inverse domains scaled by Planck's constant. In this context, they served as two components (base vectors) of a quantum wave function (a composite space-time vector). In this part, I will continue to develop the model and discuss how the projection of a unified concept onto a plane that represents their separation creates a scaling problem that can be dealt with a different ways.

Introduction

In part 1 of this paper I introduced the space-time-motion diagram, a visual tool for representing the relationships between space and time as two equivalent aspects of motion that are conceptually separated, but in essence two different aspects of the same thing. To analyze this, I superimposed the relativistic space-versus-time plot in the linear domain with the plot of inverse time-versus-inverse space as the frequency domain, linked by the plot of motion itself. This produced the space-time-motion or STM diagram, shown here as Figure 1.

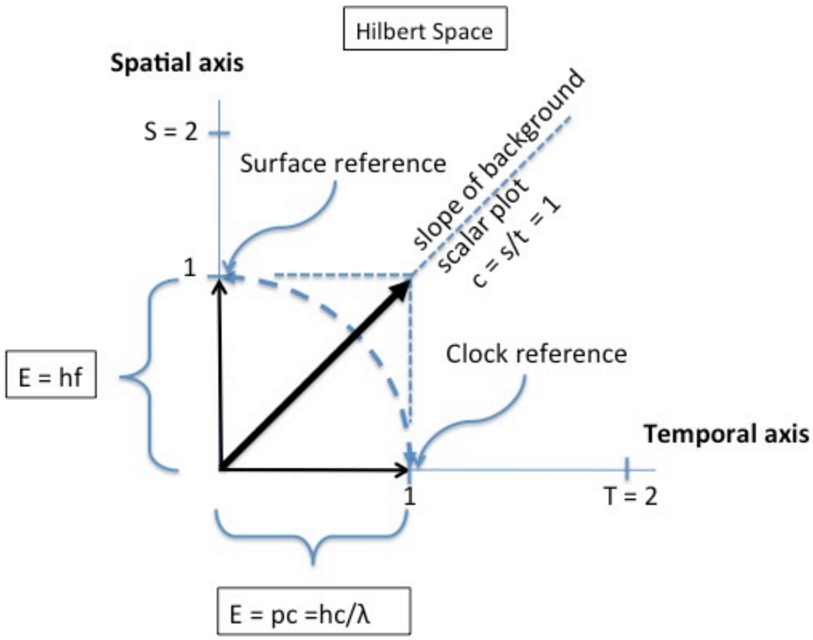

Figure 1 The space-time-motion or STM diagram interposes the inverse-space and inverse-time domains, scaled to units of *h* in the linear axis, reveals the deBroglie relations for energy. Since they are both quantum units, they are represented as base energy vectors in Hilbert space.

This showed energy expressed in the temporal frequency domain as a quantum unit in space and energy expressed in the spatial frequency domain as a quantum unit in time. The effect of this flipping of domains is the realization that they are asymmetric reflections of each other; the linear domain being represented as the relativistic part of the plot and the inverse domain represented as base vectors, or unit vectors $\hat{s}$ in the space domain and $\hat{t}$ in the time domain. In other words, without ever having to mention a particle, wave or particle-wave duality, a quantized unit of empty space and a quantized unit of time are shown to be equivalent units of energy themselves.

The STM diagram visually illustrated how separation, the first step in the transformation process, splits the unified concept of energy into two pairs of conceptually independent domains that are hyperlinked at a boundary called the event reference. Comparing this to quantum information theory, these units are equivalent to quantum bits or "qbits" since energy, a unified concept, was separated into two orthogonal yet equivalent measures: space – quantified as scalar units of displacement (digital increments of "1"), and time – quantified as scalar units of "1 clock increment", which transitions to "0" at each event. In this section I will use the STM diagram to illustrate the second step in the transformation process, projection, and show that motion is a superposition of the base vectors. Motion *projects* this energy from the quantum domain into the relativistic domain producing a distortion that can be viewed as a curvature of either space or time.

It gets a "bit confusing" because the labels cross over domains, so you have to keep them separate in your mind. Normally we introduce new variables to help keep them separate, but this introduces additional distortion factors so that will be avoided. Instead, I occasionally reflect and remind the reader of the intended meaning.

A DROPLET of Energy

The unit vector $\hat{s}$ is the temporal frequency domain associated with $E = hf$ interposed on the spatial axis and $\hat{t}$ is the spatial frequency domain interposed on the temporal domain. They are integral parts of the energy domain that is the vector sum of the two base vectors, $\hat{S} = \hat{s} + \hat{t}$.

Temporal frequency is what we normally think of as frequency. The term spatial frequency is not used in quantum physics and rarely in classical physics except for optics, especially holography. Instead, it is referred to as wave number ($k = \frac{1}{\lambda}$) because it is just a number that indicates a cycle. In Medical Physics, it is used as a measure of image quality in line pairs per cm. But in electrostatics (Field Theory), $\frac{1}{r} = \emptyset$ is called the scalar potential of a unit charge. So the spatial frequency could be used to represent the potential field of a charge or the potential field of gravity surrounding a unit mass. In fact, a potential field is a scale so it doesn't even need a mass or charge to exist. According to Quantum Field Theory there is no need for a point charge to provide the field, only a point. Instead, the "field quanta" is like an orb or a droplet of energy, a part of an underlying field that is somehow excited.

Imagine a field of absolute nothingness and imagine points in this field laid out in a grid with scales. Scales themselves (s = 0, 1, 2, … or $f = 1, \frac{1}{2}, \frac{1}{3}$ …) represent a gradient, $\nabla\emptyset = \frac{d\emptyset}{ds}$ or $\frac{d\emptyset}{dt}$ i.e. something is changing, even if it just the scale itself. If the size of the increments is changing, as in the inverse scale, the *change in the gradient* – called the gradient of potential – represents a force, $F = -\nabla\emptyset$.

Looking outward (positive on the scale) the change is linear, and there is no change in the unit Δ between the linear scale marks so that gradient $\nabla(\Delta s)$, is constant. But there is still a gradient and it still has a sense of direction, so $\nabla(\Delta s) = \hat{s}$. However, the *change in the gradient* is zero unless some outside action attempts to change it, so it presents as inertia or momentum in classical and quantum physics. But in relativistic physics, it is recognized to be the curvature of space that provides a downward slope for gravitation. With the STM model, no wave or graviton is needed.

Space is the imaginary scale, $\emptyset$, which serves as the base of transformation (of formless energy into form). Combining the linear scale with the inverse scale results in two different gradients in space. Looking outward, in the linear domain where we live, the curvature or gradient of static space is constant so it appears flat, $\nabla\emptyset = \frac{d}{ds}(s) = 1$ yet diverges in all directions. So even though potential is just the inverse scale, i.e. a scalar, it has an inherent direction in which it changes and is thus a *potential* force, $\boldsymbol{F} = -\nabla\emptyset$, (the temporal component of potential energy) that will become a real force if acted on. But motion creates a separation of space and time resulting in a gradient made up of two pairs of different gradients. As a vector, call it $\vec{C}$, the gradient has two parts, as shown in Figure 2.

$$\nabla \emptyset \Longrightarrow \vec{C} = C_s \hat{s} + C_t \hat{t} \tag{1}$$

where $C_s = \vec{C}cos(\vartheta)$ and $C_t = \vec{C}sin(\vartheta)$ are the magnitude of each unit vector, defined as one unit. In Dirac notation, this would be

$$|\psi\rangle = \psi_s|s\rangle + \psi_t|t\rangle. \tag{2}$$

In terms of derivatives, this is

$$\nabla \emptyset = \frac{d\emptyset}{ds}\frac{ds}{d\emptyset} + \frac{d\emptyset}{dt}\frac{dt}{d\emptyset}. \tag{3}$$

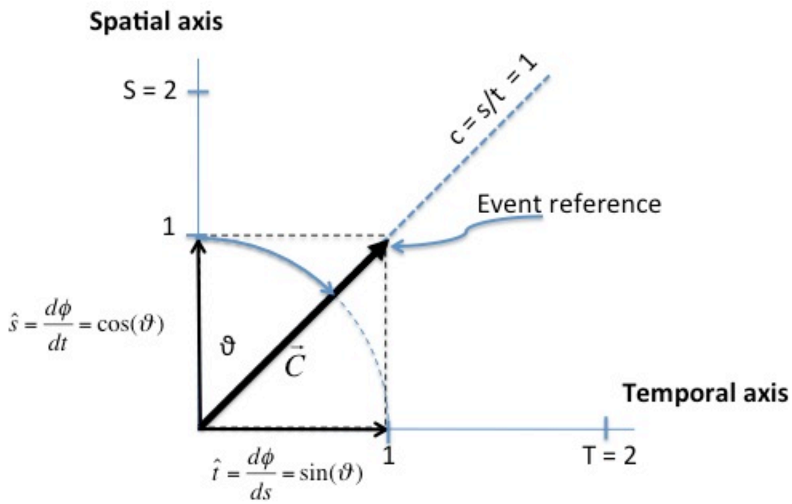

Figure 2 Scales themselves represent gradients. Combining the linear scale with the inverse scale results in two different gradients on each axis.

The terms $\frac{ds}{d\emptyset}$ and $\frac{dt}{d\emptyset}$ represent the magnitude of the scale in the given domain, which is always one unit by definition of a unit regardless of which domain you are in. So they are not needed and Equation (3) becomes

$$\nabla \emptyset = \frac{d\emptyset}{ds} + \frac{d\emptyset}{dt}. \tag{4}$$

also shown in Figure 2.

The first term is a change with respect to space, so it refers to *s* and is thus scaled by the linear domain, so it is a scalar potential divergent in all directions, i.e. $\nabla \cdot \emptyset$. But the second term, the change with respect to time, is the inverse spatial term interposed in the temporal axis. So it is the derivative with respect to the inverse of space. From Equation (1), this is $\vec{C}sin(\vartheta)$, which is the cross-product and compares to a vector potential in Field Theory as the curl of the vector, $\nabla\times\emptyset$, since $\vec{C}$ is the vector notation for the gradient.

$$\nabla\emptyset = \frac{d\emptyset}{ds} + \frac{d\emptyset}{d(^1/_s)} = \nabla\cdot\emptyset + \nabla\times\emptyset. \tag{5}$$

This is a form of Helmholtz Theorem (Wangsness 1986, pg. 37) rearranged as

$$\boldsymbol{F} = -\nabla\emptyset + \nabla\times\mathbf{A} \tag{6}$$

where $\boldsymbol{F}$ is the divergent field – a real force simply due to the field of motion, pointing inward transforming the square grid into a circular droplet. According to David Hestenes, Equation (5) is the fundamental decomposition of the geometric product (Hestenes 2003, pg. 15). First he treats the curl term as an imaginary component and then removes the imaginary label and calls it the "outer product", a term from Geometric Algebra, and proceeds to derive all of Maxwell's equations as a single unified equation.

Remember that Figure 1 represented the flash of light expanding in 3D space and time, and the flash bulb only flashed once so the light sphere would actually be a shell. The boundary conditions on each axis are represented by the tips of the vectors, where the boundary conditions are satisfied. They are the hyperlinks to the scalar domain, the one unambiguous point in either domain. They all represent the same field $\emptyset$, and the boundary is where $\emptyset = \frac{1}{\emptyset} = \emptyset^2$. On the spatial and temporal axes they are called the "Surface reference" and "Clock reference" and on the motion vector it is called the "Event reference". It is the only place that actually represents the surface of the light sphere – the present (here and now). The "Surface reference" and "Clock reference" are back-projections of the present.

The DROPLET App

If we were to write an App for that, you could click on a hyperlink to select the perspective you want to observe. Click at the surface reference, unit number 1 on the space axis, and another window would open showing the axis unfolded with the unit enfolded into a 3-D *avatar* of the droplet. A popup message would call this "Here". We could click and drag out along the spatial axis "scroll bar" to zoom out and make the avatar collapse to a tiny icon (a unit drop of energy out "There") and the S-T coordinate system expand in the background. We could scroll all the way in to the origin, or double click on the icon to put the view point on the inside (the inverse-time domain section of the spatial axis) and the screen would go dark. Add a "Direction" button to switch viewing angle from inward to outward, but the screen would still be dark. A popup message would read "Stillness".

We could do the same thing in the time domain, clicking on the clock reference – unit 1 on the temporal axis. This new window would open with the inward direction selected to unfold the spatial frequency domain section of the time axis and we would be looking from the inside out again. Another button labeled "View grid lines" would turn on spatial frequency grid lines at the surface. Rather than zooming out, the scroll bar would just move the time scale to the left on the STM plot.

So we could click the play button and let it run.

Now if you look at the spatial domain window, zoom back out and change viewing direction to inward, with each increment of time you would see grid lines collapsing in from outer space labeled "Future" until they reached the surface, where they would flash the word "Present". Half of the energy (they would change to a lower frequency color, say red) would reflect off the surface and the other half would paint the surface. The label would change from "Future" as the grid moved in, flash the word "Present" for an instant, then to change to "Past" as it moved outward.

So what would be displayed if we click off-axis, on the *S*-*T* plane? Because the diagonal (composite) vector stretches out beyond the dashed arc in Figure 1 and Figure 2, the display would be a *conformal projection* of a motion vector *projected* out of the energy domain and onto the background scalar plane. So if we click on the diagonal, another slightly larger avatar would appear to envelope the first icon, on a flat, very fine background grid, linear and evenly spaced. If we click the play button, the grid would appear to get closer and closer. The grid spacing would grow (decreasing temporal frequency) but remain linear until the drop fit inside one unit of the grid. The entire grid would suddenly collapse into the drop, but another grid would follow and then it would collapse. Double click on the surface reference to look inward and now, rather than being dark, we would see the grid, non-linearly shrinking, like the focal point of a lens, toward the smaller icon inside. Again, part of it would reflect off the surface and one spatial unit of red would fit between the two spheres. This frequency split will be presented graphically and mathematically in part 3.

To make the App display relative motion I would just hide the collapsing grid lines and show the linear grid lines from another particle, moving linearly across the background in whatever direction the particle was moving. If the other particle were not moving relative to the screen, we would see grid lines collapsing into it. And since we share the same space, it would gravitate toward the screen.

So I would call the App, The *Digital Round Optical Particle with Linear Energy Transport* or DROPLET.

As a projection out of the energy domain, the composite vector presented as a swollen particle – stretched out in comparison with the base vectors. Relative to it, the base vectors appear to be contracted. This is due to a parallax that is the same relationas the Lorentz factor (explained in the next section).

Projection Creates a Scaling Problem

As I mentioned before, physicists and mathematicians can handle vectors with their eyes closed, so a conformal projection is not a problem. But for a student, it is important to remember that one unit of measure in the energy domain is different from one unit in the scalar domain. To illustrate this, I refer to Figure 3. The area of the large square (c^2) represents one unit of energy, $E = c^2$ (so one unit of mass). It is equal to 2 units of measure (one each for s^2 and t^2) in the scalar S-T domain. So when projected onto the linear scalar S-T domain, the hypotenuse of the triangle (c) is $c = \sqrt{s^2 + t^2}$.

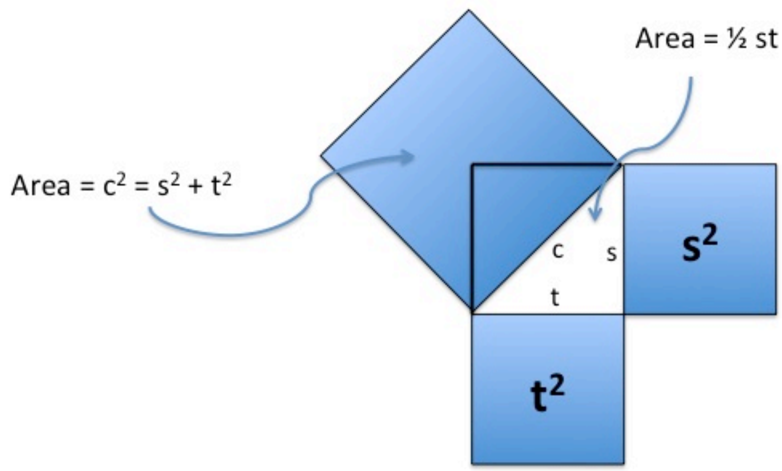

Figure 3 The square of the hypotenuse of a triangle represents the area of the large square, which is four-times the area of the triangle.

Now recall that the hyperlink between the two domains is the slope (c) of the graph in the S-T plane, which is equal to the ratio of the space unit with respect to the time unit. Taken to the limit, speed is the derivative $v = \frac{ds}{dt}$. If this example represents an object of unit mass, m, and velocity v, we would calculate the kinetic energy by using the Work-Kinetic energy Theorem[i] changing variables and integrating along the hypotenuse (units of velocity), so that $KE = m\int_0^v vdv = \frac{1}{2}mv^2$. But that is only half the area of the large square[ii] (mv^2). Therefore, to get total energy we either have to correct the result by a scaling factor or by adding a constant of integration[iii]. The scaling factor is just the ratio of one of the small areas (s^2 since velocity is always denominated to 1 unit of time) to the large area. In this case, since the areas are equal, they are each half of the total. So the scaling factor is 2. But that won't work for the total energy of an object because its total energy includes rest energy, which is not a function of kinetic energy.

Vectors provide a solution because they allow us to represent the entire area (the integration of more than one concept, in this case two) in one symbol. To find the total energy we can represent the area of the large square as a vector of magnitude $c^2 = 1$, as shown on the vertical axis in Figure 4. It is on the vertical axis to represent no relative motion, i.e. time-independent; the energy vector has not been separated into space and time[iv]. Then introduce time by rotating the vector to align with the hypotenuse (to separate energy into two measures of space and time with a 1:1 relation) while keeping its magnitude constant. Comparing its back-projection on the spatial axis to the back-projection of the "stretched out" composite-vector, it appears to be "contracted" by a value, call it 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.

$$\gamma^2 = \frac{c^2}{c^2 - v^2} = \frac{1}{1 - \frac{v^2}{c^2}}. \tag{7}$$

If the base of the small triangle is scaled by mass, then it's area is the same equation as kinetic energy.

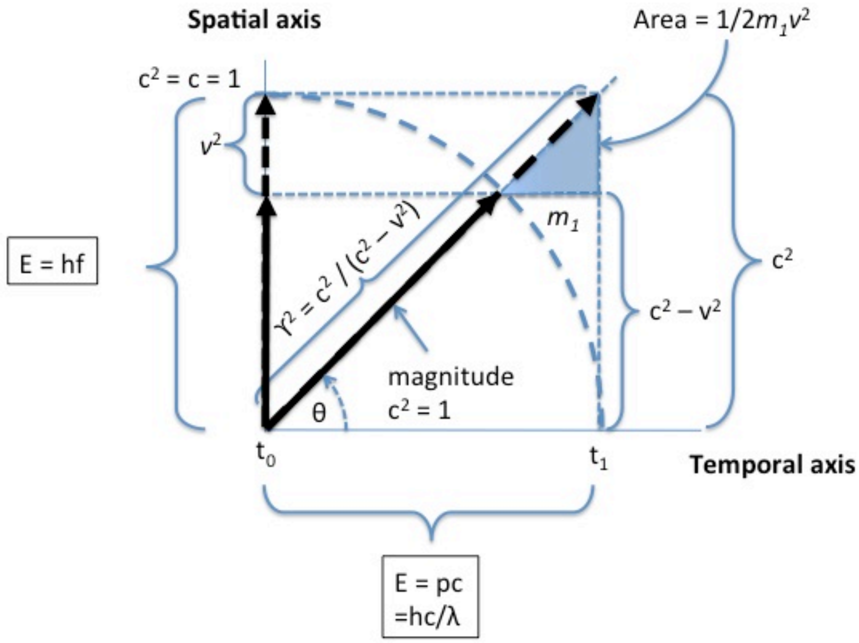

Figure 4 The Lorentz factor is a magnification factor that results from using scalar quantities to set the scale for a vector quantity. The composite vector is magnified to $c^2\gamma^2$. In this case $c^2 = 1$.

If we apply this to the expanding light sphere example, but forget that these vectors are map symbols that need to be scaled to fit the hyperlinked coordinate system, this factor might be interpreted as meaning that the radius of the expanding light sphere (the *measure* of the projection of the vector onto the spatial axis in Figure 4) is smaller than it really is and that there is some extra energy that is unaccounted for. And we could apply this correction factor so that our measurements fit the relativistic model, to include a kinetic energy term. This can be done by scaling the magnitude of total energy vector by γc, which can be separated into a sum as

$$\gamma c = c - c + \gamma c = \; c + c(\gamma - 1). \tag{8}$$

We then use this to scale momentum, (i.e. multiply it by mc) to get the Hamiltonian (equation for total energy of a particle)

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

as shown in Figure 5(a). The "extra energy" is the relativistic (kinetic) energy that the light sphere would have if it were a particle itself moving relative to something else in the scalar plane.

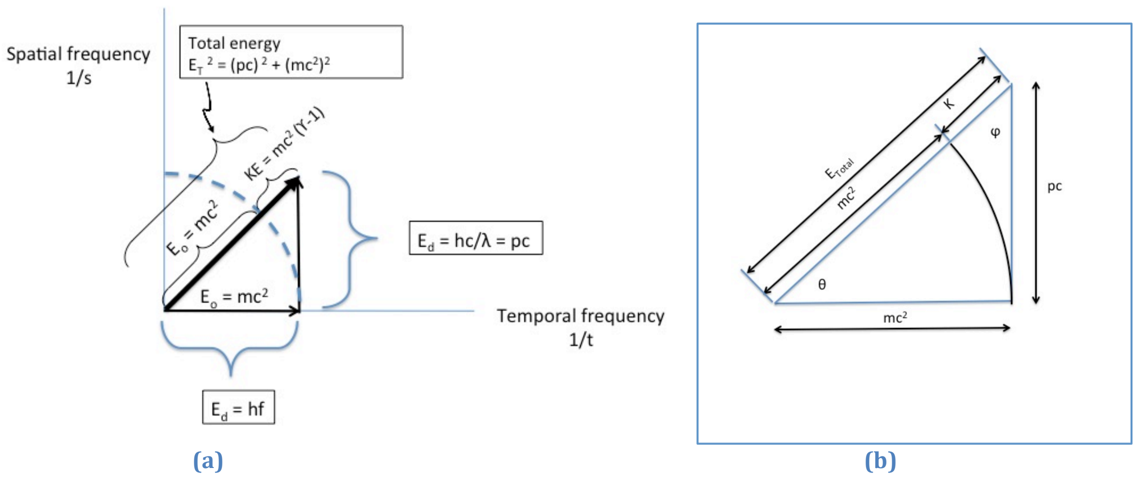

Figure 5 (a) Vector representation of the light sphere scaled by units of space and time. The same triangle and relations are in the Energy diagram of Figure 1 because the rest energy E_o is equal to the de Broglie energy E_d.

(b) A relational triangle provided by a 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, regardless of the angle θ.

So this scaling problem is dealt with by applying a correction factor. Figure 5(a) and (b), show how this was illustrated in a Fundamentals of Physics text (Halliday, Resnick and Walker 1993). It is used as a mnemonic device to help remember the relativistic relations among the total energy "Hamiltonian" (E_T), rest energy (E_o), kinetic energy (KE) and momentum (p). The angles θ and φ are related to $\beta = vc$ and γ as $sin\theta = \beta$ and $sin\varphi = \frac{1}{\gamma}$. The quantum energy in either form ($E = hf$ or $E = pc$) is equal to the rest energy, $E_o = mc^2$ of a quantum particle so it is more than a mnemonic device. It is an STM diagram. From the legs of the triangle in Figure 5(a) we get the relativistic energy dispersion relation

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

The two diagrams in Figure 5(a) and (b) represent the exact same geometric relationships. The difference is only in scale[v], since $mc^2 = hf = \frac{h}{t}$, the time axis is scaled by

$$t = \frac{h}{mc^2}, \quad (11)$$

which is a Planck-second times 2π, i.e. one cycle (period or wavelength). In part 3 of this paper, this will be accounted for by using yet another domain and coordinate system: polar coordinates.

The Background

There is no such thing as a particle at rest, isolated from the relativistic background. Any and every particle can *potentially* be projected onto the background and compared to any other moving particle in the universe, seemingly giving it kinetic energy *instantly*. What we normally call potential energy is actually "potential-energy-of-motion". Nothing happens to the particle when you decide to include the moving background; it is just a difference in perspective that changes our method of quantification.

In classical physics, we tend to think of the background as nothing more than a scale, separate from the particle. But in mechanics, the background around mass is the gravitational potential field. In electromagnetics, the background is the potential field of a point charge, and it is what gives the particle its form in space (as momentum $p = \frac{h}{\lambda}$), which is resistant to de-form $\left(F = \frac{dp}{dt} = h\frac{df_s}{dt}\right)$, where F is force. According to the STM diagram, energy is projected onto the background by motion, and that energy is then reflected back to the quantum domain at the event reference as a unit of spatial frequency. This gives energy to the boundary and form to the droplet. So in essence, the background is truly part of the particle.

Conclusion

Our perception of the world is both quantum and relativistic, so the STM model represents both perspectives. Equal representation of time and space as well as their mirror images, spatial and temporal frequency, allows the model to morph between the two perspectives.

Understanding this opens the door to a better understanding (part 3 of this presentation) of how the scalar quantities persist in the form of the wave equation and how statistical equations used in quantum mechanics give the same results as vector operations. It also provides insight into why the speed of light is not relative to the speed of its source, how an electron seems to take form as a wave pattern in the double-slit experiment, and how quanta (pairs of quantum particles) can be described as a spherical standing wave (The Holomorphic Quanta) discussed in part 4.

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[i] See (Halliday, Resnick and Walker 1993, pg. 172) for example

[ii] Had we not changed variables we would have calculated the area of the small triangle, which is one-fourth that of the large triangle.

[iii] In EM theory, this is handled by a gauge transformation $\nabla\chi(\boldsymbol{r})$ added to a vector potential, where $\chi(\boldsymbol{r})$ is a scalar potential field the satisfies Laplace's equation, $\nabla^2\chi(\boldsymbol{r}) = 0$. In this case, $\chi(\boldsymbol{r})$ represents the scalar measure of the extension beyond the arc in Figure 2

[iv] The scalar representation of zero motion would be zero slope, so the vector would be on the horizontal axis.

[v] Scales are very useful, but they can be confusing. It makes perfect sense to say that a bowling ball is bigger than a marble. But what if someone said that red is *bigger* than violet? In physics, the form or wavelength of red (620–750 nm) is about twice as *big* as violet (380–450 nm) and therefore, *it is* bigger in this form. So thinking in terms of physical size creates confusion. It is much clearer to refer to energy quantization. Red light is a lower energy than violet light. It is about half the spatial frequency, half the temporal frequency and half as much energy. Frequency implies comparison: per unit time or per unit space. Thus, it is directly proportional to energy. And the minimum quantity that describes a frequency is one cycle (per unit time or per unit length).