The Non-Local to Local Space-time Map.

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Abstract:

While for point particles a local theory seems to be sufficient, when it comes to extended objects like Strings and Branes you by rights are not dealing with a specifically fully localized particle to begin with. This also is not the case for non-inertial particles interacting with a wave field (like, e.g., an accelerated atom interacting with the quantized electromagnetic field). The fact that a wave has an extension seems to make a non-local treatment necessary. By the same fact a String or a Brane has an extension and makes non-local treatment necessary also. It is possible to define non-locally an extended frame of reference for an observer moving non-inertially or inertially in a curved space-time. We proposed to demand that the spacelike hypersurfaces providing the planes of constant time in the extended frame have to be perpendicular to the observer's time whenever an event occurs.

First, a bit of history: Newton's original law of gravitation was phrased in terms of a *non-local* force that instantaneously propagated from each object to all others in the universe. Even Newton, however, suspected that this model was only an approximation to the truth, and that eventually influences would be understood to operate locally and propagate at some limited speed. Our suggestion is not to actually recapture Newton's non-local force at all. It's to formulate a working model where in the non-local frame of reference encountered in certain quantum effects and on the Brane(The Holographic Plate)can be seen to break down in stages(Translation) to that of our local frame(the Hologram itself). This Model will utilize three manifolds:

1.) The Holographic Plate manifold: The Brane level from the Plank scale and smaller within the limits of LQFT where the information transfer takes place as geometric information in the form of encoded bits of information.
2.) The Translation Manifold: Common in String Theory seen as the String scale itself and referenced in quantum theory as the Zero Point Field.
3.) The Hologram Manifold: The Standard Model scale above that of the Plank scale were all information transfer occurs via particles whose motion is governed by the Special Theory of Relativity.

Only the First manifold is modeled as non-local and all other frames break down with scale into the common local frame. We do make one basic assumption is this that the magnitude of the spatial and temporal gap measured between any two events *varies* depending on which reference frame you are in, in a certain well-defined way. This does not contradict the invariance of C as dictated by special relativity at all. It just implies that as our vacuum state alters with scale one will encounter a widening of the lightcone within which the local value for C will always remain invariant. The demand that the spacelike hypersurfaces providing the planes of constant time in the extended frame have to be perpendicular to the observer's time whenever an event occurs guarantees that this model will on observational scales general yield a C limited information transfer, except in the case of entangled states or forced changes in the original geometric information. The one governing principle is that space and time *themselves* are not unchangeable which is well in keeping with Einstein's principles of Relativity.

Non-local implies by nature superluminal information transfer capabilities. Whether superluminal speeds are possible *in principle* depends on the **real** structure of the space-time continuum in question. Basically, there exist two distinct notions of space-time in physics, both of which represent a possibility:

- Galilean Space-Time (GST)
- Minkowski Space-Time (MST)

Briefly, whereas Galilean space-time allows the realization of faster-than-light speeds, at least in principle, Minkowski space-time by design has an invariant limit on velocity which is governed by the Stress Energy Tensor of the vacuum state in question.

It is important to note that without some definition of global time the physical *quantity* speed (and thus light-speed) has no definite meaning anyway. Why? Consider an example: Imagine an object moving from position *A* to *B*. Its speed *v* is given by the formula

$$v = \frac{\text{Distance}(A \text{ to } B)}{t(B, \text{finish}) - t(A, \text{start})}$$

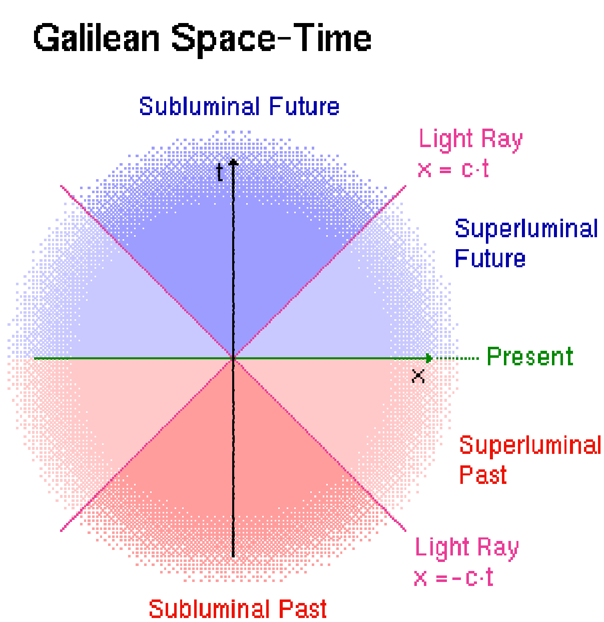
Here, the start time $t(A,\text{start})$ and the finish time $t(B,\text{finish})$ are read off from two *spatially separated* clocks: one clock is located at point *A* and the other one at point *B*. Now, the difference of the two times in the denominator $t(B,\text{finish}) - t(A,\text{start})$ is an indefinite expression, unless there exists a rule how to synchronize both clocks, because clock *B* ignores the "current" time at clock *A* at first. But, in fact, the decision in favor of a particular synchronization rule is **pure convention**, because it seems impossible to send an "instantaneous" (infinitely fast) message from *A* to *B* like "Initialize the clocks now!". Thus, the actual quantity of speed is conventional too, depending on the particular choice of the simultaneity definition.

The question concerning global time is also important in the context of different reference frames. What is a reference frame? A reference frame *R* is simply a coordinate system of some observer. (For instance, let us imagine a physicist experimenting in his laboratory.) The observer attaches to all physical events personal coordinates, ie. space coordinates x, y, z (where?) and a time coordinate t (when?). Another observer in his personal reference frame R' attaches to all physical events another (not necessarily equal) set of coordinates x', y', z' and t'. (Let us here imagine another physicist who is working in a train moving with constant velocity *v* with respect to the reference frame *R*.) While two events may appear simultaneous in reference frame *R* (happening at equal time *t*), does this still hold in reference frame *R'* (at equal time *t'*)? And while the physical laws have a particular form in frame *R*, does one obtain the same formulas in frame *R'* also? The answer is given by a theory which relates the new coordinates *x', y', z', t'* to the old ones *x, y, z, t*. Essentially, this is what a *theory of relativity* is all about.

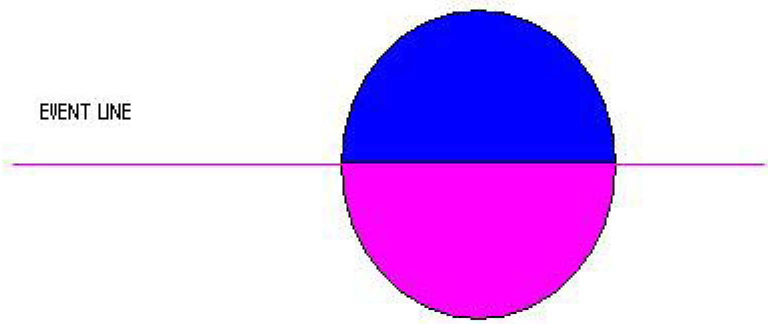
In Galilean Space-Time the physical existence of an *absolute time* is assumed. The pioneer of physics Isaac Newton defined it in the following way(1).

"Absolute, true and mathematical time, in itself, and from its own nature, flows equally, without relation to any thing external; and by other name called Duration. Relative, apparent, and vulgar time, is some sensible and external measure of duration by motion, whether accurate or unequal, which is commonly used instead of true time; as an hour, a day, a month, a year. It may be, that there is no equable motion, whereby time may be accurately measured. All motions may be accelerated and retarded, but the flowing of absolute time is liable to no change."

Because of this absolute time the global notion of past, present and future is the same in all reference frames. If two events are simultaneous in one particular reference frame, this means that they are also simultaneous in all reference frames. Thus, there is a unique separation between past and future events - the line of present in the space-time diagram



The speed of light is constant only in the absolute space-time frame, which is also called the Newtonian rest frame. The Primary frame we are proposing is a bit different from this general Galilean Space-Time. In our frame all time equals zero. Its only absolute value is that it is equal to zero. Also all events exist at the same point in space, the zero point. So Past Present and Future are all compacted to the same region forming a singular present where every event that ever has been and ever event that ever will be are joined as one. It would be like taking the above picture, pulling the top and bottom light rays down to that of the present and removing the timeline marked t, thus forming a single line or frame where the superluminal past and future all join together.

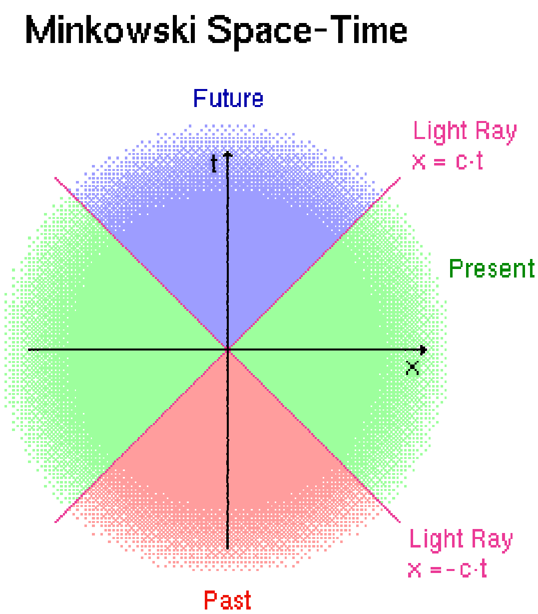


Minkowski Space-Time

Minkowski Space-Time does not know any absolute time which is physically meaningful. It was the revolutionary idea of Albert Einstein to give the notion of simultaneity a new definition. Especially, because all experimental tests to determine the motion with respect to some absolute space-time frame had failed, he decided to abandon the notion of absolute time at all. In the famous theory of relativity he postulated two principles which should hold for all physics:

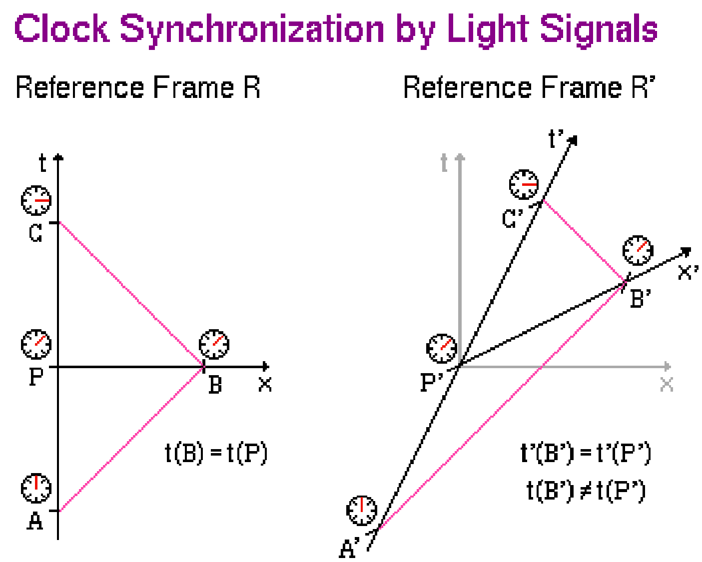
1) All physical laws appear according to the same laws in all reference frames.
2) The speed of light is Invariant in all reference frames.

Now, while the first postulate seems well established by observation and experiments, the second one is simply an assumption. It implies, in contrast to Galilean Space-Time, that simultaneity is not an absolute physical quality, but a relative one, depending on the motion of the observer. Going back to the Global time idea:



Choose two clocks (let us label them 1 and 2) in some reference frame *R*. In order to synchronize them place a mirror at position 2, then emit a light signal from clock 1 at space-time point *A*. The light signal arrives at clock 2 at space-time point *B*, it is reflected in the opposite direction and arrives at clock 1 at space-time point *C* (see the space-time diagram below). Since the speed of light is *per definition* constant and the light signal travels the same distance in both directions, the instant $t(B)$ of the reflection equals exactly $t(P)$, which is in the mean-time of *A* and *C*. Or, more formally, $t(B) = t(P) = (t(A)+t(C))/2$.

With this definition of global time, simultaneous events in one particular reference frame need not to be simultaneous in another frame. This can be checked by following the same procedure in a frame *R'* where all clocks are moving with relative speed *v* with respect to the former reference frame *R*.



With this as a starting guide we will now outline a mathematical model of our Holographic Plate Manifold.

In the quantum theory for a many-body system, the absolute square of the amplitude $|\Psi(x_1, x_2, \ldots x_n)|^2$ is interpreted as the probability density (probability/volume) for the location of each of the n particles to be at the respective space-time points (x_1, x_2, …x_n), in a 4n-dimensional space-time. In the continuum field theory, the *global extension* of this probability density is the *weighting function* $|\Psi(\psi_1(x), \psi_2(x), \ldots \psi_n(x)|^2$. This is the weighting /volume for the interaction of an n-component, closed system, at each point of a single space-time x. This is then a *nonlocal* field theory because the trajectories of individual, separable particles of matter are not specified.

Instead, the distinguishable field amplitudes $\psi_i(x)$ of the component modes of the continuum, $\{\psi_1(x), \psi_2(x), \ldots, \psi_n(x)\}$ are each a solution of a matter field equation, for a distinguishable mode of the continuum. This view is somewhat akin to Schrodinger's interpretation of the many-body wave function is terms of the normal modes of vibration of an ensemble.

The differential operator for the matter field equation, whose solution is $\psi_i(x)$, entails a functional that depends on all of the matter fields except the ith one, $I_i(\psi_1, \psi_2, \ldots, \psi_{i-1}, \psi_{i+1}, \ldots, \psi_n)$, representing the coupling of all other matter fields of the closed system to ψ_i. Since the latter matter fields similarly entail their own interaction functionals, $I_1, I_2, ..I_{i-1}, I_{i+1}, ..$, each depending on ψ_i, the functional I_i must depend implicitly on ψ_i. It then follows that the equation that yields the solutions of the ith matter field is automatically nonlinear, as well as nonlocal. Such formalism then cannot relate to a probability calculus, which is based on linearity.

The matter field equation in the ith mode of the continuum, ψ_i, asymptotically approaches a wave amplitude of the quantum theory, as the respective coupling term, I_i, either approaches zero. This is a point we can generally snuggle up as close as we wish, but not reach. And we can approximate an average background potential field, independent of the individual field amplitudes of the closed system. This limit corresponds to energy-momentum transfers within the closed system that are small enough to neglect. In this case the closed system looks like an open system, wherein, each matter field amplitude depends on its own set of space coordinates. In the latter limit of 'uncoupling' of each mode of a closed system from all of the other modes, each field amplitude may be mapped in its own space-time. The entire set of modes become a localized set, $\{\psi_1(x_1),\ldots, \psi_n(x_n)\}$. The linear equations that this approximation for the individual modes now allows their description with a Hilbert space formalism which one can translate into a normal Minkowski space-time map. This then shows us that in the limit of sufficiently small energy-momentum transfer between the modes of the Holographic Plate Medium, one reaches a linear, local limit of the equations in ψ_i.

Taking the interaction field amplitude $\Psi(\psi_1(x), \psi_2(x),\ldots, \psi_n(x))$ for an n-mode coupled closed system to transform as a spinor variable, as a basis function of the irreducible representations of the symmetry group of relativity theory, the differential expression of the postulated law of conservation of interaction has the form of a continuity equation. Using Dirac's bispinor notation, it is:

$$\partial^\mu(\Psi\gamma_\mu\Psi) = 0 \qquad (\Psi = \Psi^+\gamma_0)$$

where γ_μ are the Dirac matrices. With the condition that Ψ vanishes at the boundaries of the closed system, this equation then implies that in any local observer's frame of reference, the quantity represented by the integral in three-dimensional space:

$$\int\Psi^+\Psi d\mathbf{r}$$

is constant with respect to the time measure in this reference frame. With the required imposition of normalization on the interaction field amplitude, if it is to be interpreted in terms of a *weighting function*, the integral of the positive-definite function $\Psi^+\Psi$ over all space is unity. It is interpreted here as relating to the weighting of the total interaction within a closed system, described in a single space-time that encompasses all points in Minkowski space-time in a duration of time commonly called an Instanton or zero brane. Note that the conservation of interaction does not imply that it is necessarily uniform throughout space and time. It does mean that, given a closed material system, the intrinsic interaction generally has a flexible mapping in space and time that persists for all times with respect to any local observer's measurements. Any alteration of the environmental conditions in a local region that may be made in some experimental investigation would then give rise to a redistribution of this weighting within the entire system. But any such alteration *within the closed system* cannot cause the weighting function to vanish anywhere, at any time, even though it may become arbitrarily weak in particular regions of space and time.

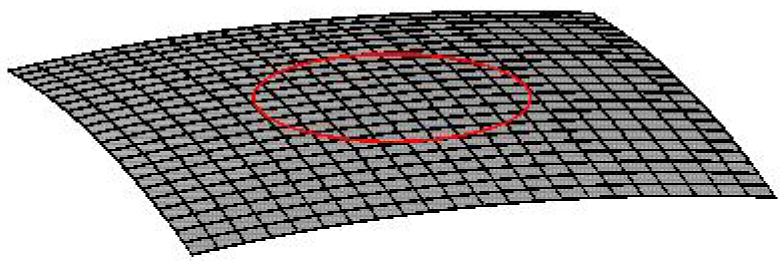
The simplest point to start at in our model is to define not only the type of information that is being carried, but, also the velocity of this information's transfer. For the sake of simplification I am going to follow the format utilized in Robert Garisto's article(2) where QI is seen as different from classical information and is seen as possible including information about the wavefunction, phases, entanglement, and even possibly some form of a time coding, etc. With this in mind, and based upon the current limits of both our own experiments with entanglement and upon a premise of the original model used we shall term $V_{Qi} \leq \infty \geq \varepsilon$ with $\varepsilon = L_{Universe}/T = 0$ which is a comfortable way of saying velocity is Infinite. The first thing then that we can derive about this frame is that it is not local, however, it still can be casual which tends towards a discrete or continuous model of the space-time involved.

Loop Quantum Field Theory has always tended towards the discrete version. The Model I have tended to employ is partly based upon LQFT with the one exception of a zero point below the smallest volume or unit of space-time. So we will assume here a discrete model basis. Models in this area can be spatially complete, they can display a preferred reference frame and some models can even display a preferred time frame. One constraint we have added to our model is that QI at any present space-time point cannot affect QI in any past space-time point so that weak and strong causality is preserved.

One method of assuring that causality is preserved is to define each set of frames entangled at this non-local point with a timelike unit vector μ^{α}. This time stamp, imposed in our model assures that while each spacelike hypersurface occupies the same general frame of non-locality, they also have their own unique temporal index. All of this is possible to achieve in a covariant way. However, this requires that each hypersurface does not actually cross each other, except perhaps in the uncompacted case once general locality is restored which appears a bit stiff a requirement and would tend to eliminate actual QI sharing from one frame to another.

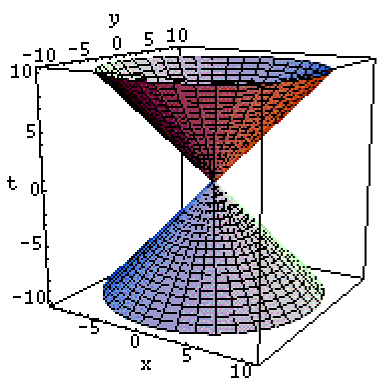
This then leads to a qualification of this present to past flow of information restraint. In this case we have modified the condition to allow some flow of information backwards along the lightcone, but only via forward in time movement around a proposed loop in time similar to that employed by Gott in his Model(3). This then dictates that our model is strictly a spatially open, yet, closed in time model. This allows us to have at the zero point crossings, yet, it also maintains each zero point frame's unique temporal index because no flow of QI is ever directly to the past. This then eliminates one set of V_{Qi} from our Model which is the Infinite negative type and maintains causality. This also may properly be the source of why our universe has no superluminal particles in general such as the proposed tachyions. However, at this level we are not dealing with the transfer of information via particles at all since the level at which particles appear is vastly higher in scale.

Think of the expanded zero points of the zero point field in this format illustrated below

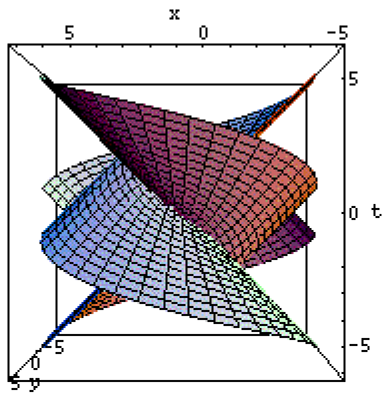


While this format could cover any distance I utilized a shortened version where the area in red is a local volume of the ZPF.   If we were to allow this picture to collapse to a single frame the area in red would still be enclosed within this single frame.

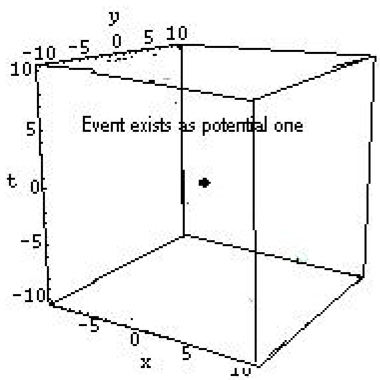
In flat space-time in two space and one time dimensions, the lightcones appear as such.



However, if we add the right kind of curvature, we can twist the light cones so that they overlap as shown below.



However, what happens if we simply compress the lightcones back to a zero point state with no twisting.



Here the event exists as a potential one. This implies that the whole event we call Cosmic history exists at the zero point as a potential event. This then is where our model starts with all events(particle states, etc) folded up into a zero point fitting the above described restraints.

FIRST NON-LOCAL METRIC MANFOLD MODEL

The Minkowski line element is:

$$ds^2 = (dt^2 - dx^2 - dy^2 - dz^2) \tag{2.1}$$

Add to this that the metrics oscillate as shown in the following line element

$$ds^2 = e^{2 \cdot p(t)} \cdot (dt^2 - dx^2 - dy^2 - dz^2) \tag{2.2}$$

Assume a periodic function, *p(t)*:

$$p(t) = \text{Periodic wave - form with angular velocity } \omega \tag{2.3}$$

$$\omega \propto 1/t_p;$$

$$t_p = \text{period of waveform}$$

In particular with *p(t)=C•cos(*w *t)=Re{C exp(-i* w *t})*. *C* =Frame dependent Lorentz Invariable Constant that alters itself with the wavefunctions effect due to Heizenburg Uncertainity at scales close to the Plank level:

$$ds^2 = e^{\mathrm{Re}\{2 \cdot C\exp(-i\omega t)\}}(dt^2 - dx^2 - dy^2 - dz^2) \qquad (2.4)$$

The use of a complex number in the exponent is to be interpreted as the real part, for example *i•exp(-iw t)* means *sin(w t).*

Motion of a spatially confined region with the line element (2.4) at the constant velocity *v* in the *x* direction is modeled by the Lorentz transformation:

$$x = \gamma \cdot (x' - v \cdot t') \qquad (2.5)$$
$$t = \gamma \cdot (t' - v \cdot x')$$
$$\gamma = \frac{1}{\sqrt{(1 - v^2)}}$$

The modulating part of the exponent in the metric then becomes:

$$2 \cdot C \cdot e^{-i\omega t} \rightarrow 2 \cdot C \cdot e^{i \cdot \omega (vx' - t')\gamma} \qquad (2.6)$$

A moving oscillating "spacetime packet" generates a phase modulation $e^{-i \cdot \omega v x'}$ reminiscent of the quantum mechanical wave function of a moving particle.

This suggest that we might associate the factor $C \cdot e^{i \cdot \omega \cdot \gamma \cdot v x}$ *with the quantum mechanical wave function* $\psi(x) = C \cdot e^{i \cdot k \cdot x}$.

The wave number is:

$$k = \omega \cdot \gamma \cdot v \qquad (2.7)$$

Thus, motion of a locally confined spatial region that depending upon the scale can evolve from a local one to a near infinite non-local(in reference to normal space-time frame) with oscillating metrics has the effect of increasing the excitation frequency and spatially modulating the phase of the excitation.

The relationship between the momentum and the wave number is:

$$p = \hbar \cdot k = m \cdot v \quad \text{which from (2.7) implies} \quad m = \hbar \cdot \omega \cdot \gamma \qquad (2.8)$$

This relation suggests that every particle might be associated with a metric excitation frequency that corresponds to its energy as given by (2.8), and that non-locality with its odd entanglement is simply a case where C goes infinite in range within the limits outlined above. It is clear that under such a condition the relativistic Compton frequency Motion causes this oscillation to be "phase modulated" in the form of a spatial wave, *exp(ikx)*, modulating the Compton oscillation. From this you get the general picture of a de Broglie matter-wave at certain scales approaching the particle level, while below this scale range, the particles tend to break down into smaller and smaller structures with expanded locality which could be described as Stringlike states at one region, and discrete units of space-time at another level eventually arriving at the Plank scale into a fully non-local system of frames extended to infinity via a spreading process of the wavefunction.

If at the zero point frame we added in both a temporal information stamp and allowed that the metric information itself for the expanded object as represented by the discrete portions was encoded in similar fashion at this scale then we could preserve the metric usage all the way to the zero point for each frame. The only case then of full sharing of particle information would occur when particles co-existed with the same temporal stamp or ID.

To explore the possible connection between GR and QM a bit further, consider the line element:

$$ds^2 = \exp(2 \cdot h(x,y,z) \cdot e^{-i\gamma\omega t}) \cdot (dt^2 - dx^2 - dy^2 - dz^2) \tag{2.9}$$

Here the possibly of complex valued wave function *h* models both amplitude and phase modulation of the Compton oscillation. The geodesic equation of GR for motion in the x-direction at low velocities becomes:

$$\frac{d^2x}{ds^2} = -\Gamma^1_{00} \cdot (\frac{dt}{ds})^2 - 2 \cdot \Gamma^1_{10} (\frac{dt}{ds})(\frac{dx}{ds}) + \text{small terms containing the squares of velocities.}$$

The two Christoffel symbols corresponding to the line element (2.4) are:

$$\begin{aligned} \Gamma^1_{00} &= (\partial h / \partial x) \cdot e^{-i\varpi t} = h_x \cdot e^{-i\varpi t} \\ \Gamma^1_{10} &= -i \cdot h \cdot \varpi \cdot e^{-i\varpi t} \\ \text{where } \varpi &= \omega \cdot \gamma \end{aligned} \tag{2.10}$$

Since all velocities are small we have from the line element:

$$\frac{dt}{ds} \approx \exp(-h \cdot e^{-i\varpi t}) \text{ and}$$

$$\frac{d^2x}{ds^2} \approx \frac{d}{ds}(\frac{dx}{dt}\frac{dt}{ds}) = \frac{d}{ds}(\frac{dx}{dt} \cdot \exp(-h \cdot e^{-i\varpi t})) =$$

$$= (\frac{d^2x}{dt^2} + [i\varpi \cdot h \cdot e^{-i\varpi t}]\frac{dx}{dt}) \cdot [\exp(-h \cdot e^{-i\varpi t})]^2 \tag{2.11}$$

The geodesic equation becomes:

$$\frac{d^2x}{dt^2} + [i\varpi \cdot h \cdot e^{-i\varpi t}] \cdot \frac{dx}{dt} = -h_x \cdot e^{-i\varpi t} + [2 \cdot i\varpi \cdot h \cdot e^{-i\varpi t}] \cdot \frac{dx}{dt} \tag{2.12}$$

Setting terms modulated by $e^{-i\varpi t}$ equal we get:

$$v = \frac{dx}{dt} = \frac{1}{\varpi}\text{Im}(\frac{h_x}{h})$$

Im = imaginary part

In general from (2.8):

$$\bar{p} = \hbar \cdot \text{Im}(\frac{\nabla h}{h}) \tag{2.13}$$

The effect as the C value alters with scale would be to below a certain scale break up general relativity into what could be termed expanded lightcone discrete units. However, due to the fact that at this level one is far below even the String scale what one ends up with is more akin to fragmented geometry of space-time that eventually becomes a set of folded time stamped frames all occupying the same exact point in space with no real passage of time. This would eliminate particle information transfer and thus establish, as backed by observational and experimental evidence that regular information always transfers in what we observe to be our local and global limited lightcone fashion.

Deriving the wave equation from General Relativity.

Einstein's GR equations are:

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = K \cdot T_{\mu\nu} \tag{3.1}$$

As usual $G_{\mu\nu}$ is Einstein's tensor, $R_{\mu\nu}$ is the Ricci tensor, $g_{\mu\nu}$ the metric tensor. K is Einstein's constant and $T_{\mu\nu}$ is the energy-momentum tensor. These ten equations reduce to four equations if the matrix $g_{\mu\nu}$ is diagonal.

Consider the line element:

$$ds^2 = e^{2h(x,y,z)\cdot p(t)} \cdot (dt^2 - dx^2 - dy^2 - dz^2) \tag{3.2}$$
$$g_{00} = e^{2h(x,y,z)\cdot p(t)}$$
$$g_{\mu\mu} = -e^{2h(x,y,z)\cdot p(t)}; \quad \mu = 1,2,3$$
$$g_{\mu\nu} = 0; \quad \mu \neq \nu;$$

The Ricci tensor is:

$$R_{\mu\nu} = \Gamma^{\alpha}_{\mu\nu,\alpha} - \Gamma^{\alpha}_{\mu\alpha,\nu} + \Gamma^{\alpha}_{\mu\nu} \cdot \Gamma^{\beta}_{\alpha\beta} - \Gamma^{\alpha}_{\mu\beta} \cdot \Gamma^{\beta}_{\alpha\nu} = R^{lin} + R^{quad} \tag{3.3}$$
$$R^{lin}_{\mu\nu} = \Gamma^{\alpha}_{\mu\nu,\alpha} - \Gamma^{\alpha}_{\mu\alpha,\nu}$$
$$R^{quad}_{\mu\nu} = \Gamma^{\alpha}_{\mu\nu} \cdot \Gamma^{\beta}_{\alpha\beta} - \Gamma^{\alpha}_{\mu\beta} \cdot \Gamma^{\beta}_{\alpha\nu}$$

where the Christoffel symbols are:

$$\Gamma^{\alpha}_{\mu\nu} = \frac{1}{2} \cdot g^{\alpha\beta} \cdot (g_{\beta\mu,\nu} + g_{\beta\nu,\mu} - g_{\mu\nu,\beta}) \tag{3.4}$$

Einstein's summation convention for repeated indices applies and all Christoffel symbols contain first derivatives of the metric as indicated by the index following the comma.

The first two terms in (3.3) are linear in the second derivatives of *h(x,y,z)p(t)* and will average to zero assuming that the both *p(t)* and its time derivatives average to zero. However, the amplitude could be large if the frequency is high. The last two terms, which are quadratic on the derivatives of the metrics, typically do not average to zero. I will treat these two contributions separately.

The contributions from the two linear terms are:

$$R^{lin}{}_{00} = \Gamma^{1}_{00,1} + \Gamma^{2}_{00,2} + \Gamma^{3}_{00,3} - \Gamma^{1}_{01,0} - \Gamma^{2}_{02,0} - \Gamma^{3}_{03,0} \tag{3.5}$$
$$= (h_{xx} + h_{yy} + h_{zz}) \cdot p - 3 \cdot h \cdot \ddot{p}$$

$$R^{lin}{}_{11} = \Gamma^{0}_{11,0} + \Gamma^{2}_{11,2} + \Gamma^{3}_{11,3} - \Gamma^{0}_{10,1} - \Gamma^{2}_{12,1} - \Gamma^{3}_{13,1} \tag{3.6}$$
$$= h \cdot \ddot{p} - [(h_{yy} + h_{zz}) + 3 \cdot h_{xx}] \cdot p$$

$$R^{lin}{}_{22} = \Gamma^{0}_{22,0} + \Gamma^{1}_{22,1} + \Gamma^{3}_{22,3} - \Gamma^{0}_{20,2} - \Gamma^{1}_{21,2} - \Gamma^{3}_{23,2} \tag{3.7}$$
$$= h \cdot \ddot{p} - [(h_{xx} + h_{zz}) + 3 \cdot h_{yy}] \cdot p$$

$$R^{lin}{}_{33} = \Gamma^0_{33,0} + \Gamma^1_{33,1} + \Gamma^2_{33,2} - \Gamma^0_{30,3} - \Gamma^1_{31,3} - \Gamma^2_{32,3}$$
$$= h \cdot \ddot{p} - [(h_{xx} + h_{yy}) + 3 \cdot h_{zz}] \cdot p \qquad (3.8)$$

The Ricci scalar based on the linear terms in (3.3) is given by:

$$R^{lin} = g^{\mu\nu} R^{lin}{}_{\mu\nu} = 6 \cdot [(h_{xx} + h_{yy} + h_{zz}) \cdot p - h \cdot \ddot{p}] \qquad (3.9)$$

If *p(t)* is a sinusoidal excitation, setting the expression inside the bracket equal to zero results in a three-dimensional wave equation expressing resonating spatial metrics in response to the vibrating scale excitation.

With

$$p(t) = \cos(\omega \cdot t) \qquad (3.10)$$

the solution is:

$$h(x,y,z) = C \cdot \cos(\pm k_x \cdot x + \varphi_x) \cdot \cos(\pm k_y \cdot y + \varphi_y) \cdot \cos(\pm k_z \cdot z + \varphi_z) \qquad (3.11)$$
$$k_x^2 + k_y^2 + k_z^2 = \omega^2$$

This is a family of three-dimensional standing waves, which might be viewed as the superposition of separate wave solutions traveling at the speed of light along the positive and negative coordinate axes. If we modify General Relativity's equation as above we get a similar breakdown picture from GR in general. The contribution to the Ricci scalar from the two last terms in relation (3.3) typically does not average to zero. These terms contain "real" energy density. However, the linear and quadratic parts of the Ricci scalar can be treated separately due to their different characters. Setting relation (3.9) equal to zero yields a relativistic wave equation, which in the special case of the modulated Minkowski metric takes the form.

$$(h_{xx} + h_{yy} + h_{zz}) \cdot p - h \cdot \ddot{p} = 0 \qquad (3.12)$$

The wave solution *h(x,y,z)* is interpreted as an amplitude and phase modulation of a high frequency carrier oscillation *p(t)*.The remaining quadratic part R^{quad} of the Ricci tensor could generate a particle's matter energy. The energy density is proportional $K \cdot (C \cdot \omega)^2$. If the diameter of the particle is in the order of 1/ω the energy is proportional to $K \cdot C^2/\omega$.Setting this equal to $\hbar \cdot \omega$ the oscillation amplitude becomes:

$$C \approx L_{pl} \cdot \omega \qquad (3.13)$$

Where L_{pl} is the Planck length.

For the electron C is in the order of $5 \cdot 10^{-23}$.Since the amplitude of the terms in R^{lin} are proportional to C and the magnitude of the contribution from the terms in R^{quad} proportional to C^2, it is not unreasonable that R^{lin} should equal zero, since in general relativity the gravitational field in vacuum is given by $R=0$.

The stress energy tensor **T** has dimensions of [energy/spatial volume = force/area] its time-time component is the local energy density at a point event. What is perhaps possible is to rewrite these into the temporal/spatio stamps for the non-local space-time. Let's suppose for the sake of making this simpler that each zero point in our expanded space-time encodes some set of information for a single particle state at that location. Let's also suppose that full particle states are the composite of many smaller fragments and as such many zero points contribute to each particle generation which supports the Loop Quantum Gravity approach. This would mean that generally speaking the only QI information that actually needs to be encoded into each zero point is nothing more than that units stress energy tensor. Only via the combination of multiple zero point effects are Strings/particles generated. Each of these small SETS(Stress Energy Tensors) would through combined effects produce the individual spin, charge, mass, etc of the particle which makes up classical information and would highly show why classical information is limited in velocity whereas quantum information is not.

In GR SETS mixed space-time components is the flux of energy and its space-space components are the stresses which are generalized pressures. In a non-local version there is only potential energy in the form of information that has the potential to generate such a condition through multiple zero points.

So the actual proper place to start with this proposed metric is not at the top, but at the zero point in such a condition as referenced above and then work you're way up through to each particle state through many combinations of zero points.

The matrix elements of the non-local pseudopotential energy information in the representation of the support functions should be able to be calculated by summing over all possible frames whose information sets overlap in the non-local frame. From this one would be deriving the actual wavefunction of the universe as a whole as based upon quantum information alone and could then compare this to that derived from any built up generally local matrix elements in the expanded picture. What you should end up with is a wavefunction at the zero point level that encompasses all the local variances in that wavefunction. Notice that above I stated that one should be able to do this. In a real world case such might be beyond full human capability, however, we should still be able to determine very local aspects of that wavefunction all the way from quantum informational levels to classical informational levels and to an extent possible achieve more global mapping of such.

THE TIME EVOLUTION OF A PHYSICAL STATE AND ITS RELATION TO INFORMATION TRANSFER

The time evolution of a physical state |s> in quantum mechanics following the Copenhagen interpretation, is given in two steps:

1) The unitary time evolution |s(t)> = U(t) |s(0)>

2) The reduction of the state |s(t)> into an eigenstate of an observable P |s(t)> in case of measurement by an observer, where P is a projection operator. This is the "collapse of the wavefunction" that different QM interpretations differ over.

The unitary time evolution is represented covariantly in a natural way, for instance, it leads to the Klein-Gordon or Dirac equation in the case of a relativistic particle. However , never properly addressed(4), is the fact that if a physical reality is attached to the wave function, then the theory of relativity as generally considered does not apply to the type of non-local frame information sharing that would be involved here. We can measure through experiments that this wave function does exist. We can also prove by experiments that some version of non-local information sharing does exist at least in the case of fully entangled particles(5). That seems to imply the wave function has a solid reality. This by logic demands that we cannot use regular relativity when it comes to modeling such a quantum level state, which in actuality is our Zero Point background field.

We do however, at this point want to stress that quantum information is not the same as classical information. Classical information by rights is only properly treated under a normal relativity approach. So we are not proposing direct particle transfer in nature faster than light, only quantum information which at its most fundamental level seems to imply geometric oriented information from which eventually at higher scales particles are built and the information they carry as well.

TIME EVOLUTION

While time and space appear somehow on equal rights footing in the Lorentz transformation equations, this is not the case within the formalism of quantum mechanics. In the quantum field equations the position of a particle is described by a linear operator (a hermitian operator) in the Hilbert space of physical states, whereas the time coordinate appears as an exterior parameter only. This proposed method addresses that problem and puts spatio as well as temporal information back into the equation on equal footing.

Generally it has always been considered that it is impossible to construct a valid time observable in quantum mechanics. However if the information is seen as geometric in nature then such a construction becomes possible. Therefore a covariant 4-position operator can be found.

One outside such attempt is that found in Canonical Quantum Gravity(6) where a background Newtonian time is invoked. Moreover, further arguments can be found which might motivate the reintroduction of (Galilean) absolute time to physics:

First, if there exists a physical absolute time, even if it has a duration of zero, then the number of fundamental constants is reduced by one, since the one-way speed of light is not a constant any longer. This leads to a simplification and a new interpretation of the physical quantities and constants(7). Second, it is well known that one can define a universal time, appearing in cosmological models. For instance, in general relativity one finds the Robertson-Walker metric(8), describing the long-range space-time structure of our universe:

$$d\tau^2 = dt^2 + R(t)^2\left(\frac{dr^2}{1-kr^2} + r^2 d\Omega^2\right)$$

Here, the time parameter t defines a universal time, the *cosmological time*. There also exists under this a measurable preferred reference frame, which can be determined, for instance, from the absolute motion towards the uniform cosmic background radiation. Recent investigations of electromagnetic radiation propagating over cosmological distances seem to reveal a true anisotropy in the structure of our universe, suggesting that the speed of light might be **not** a true constant, but dependent on direction and polarization. These results might possibly represent a further indication in favor of the existence of an absolute reference frame(9).

This is not actually Newton’s absolute space and time being invoked back in. All of our present models employ a more quantum derived version of an absolute frame as does our own here.

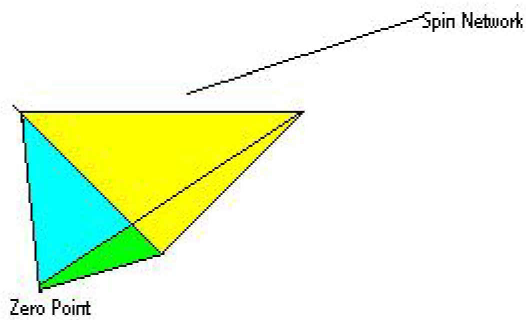
So generally what we are after is a metric that breaks down to the Robertson-Walker metric at large scales.

Redoing our Metric for an actual zero point we start with

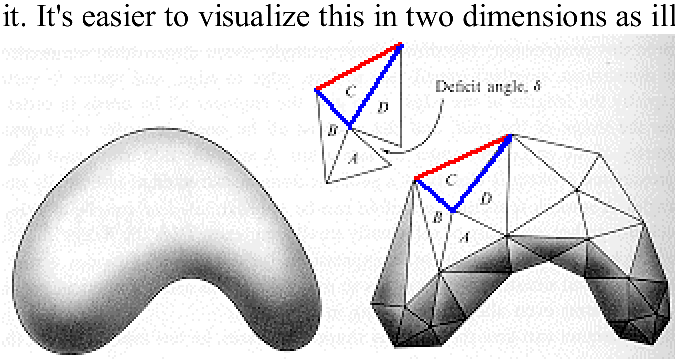
$ds^2=e^{2*p(i)}(\mu^{\alpha} - \xi_1^{\mu} - \xi_2^{\mu} - \xi_3^{\mu})$

Where μ^{α} is the temporal vector and ξ_1^{μ}, ξ_2^{μ}, ξ_3^{μ} are the spatio vectors in which case we have redone the zero point which is actually a zero dimensional frame into a system of frames we can work with that are extended in space to infinity, but embedded in a zero brane state. The interesting thing to note is you now have a way to break down the individual spin networks from loop quantum gravity into five separate pieces of information that can be summed as one e-bit of information.

What is now missing from our simple model is the information from the spin network itself that these form once we start up the translational manifold.   Remember, this metric is actually nothing more than the zero point formed when the simplest spin network folds up as illustrated below.



The Regge Calculus formalism of Gravitational Curvature was invented by Regge in 1961(10). Regge came up with a discrete analog of the usual formula for the action in classical general relativity. His formula applies to a triangulated 4-manifold whose edges have specified lengths. In this situation, each triangle has an "angle deficit" associated to it. It's easier to visualize this in two dimensions as illustrated below



The idea works similarly in 4 dimensions. **Take each triangle in your triangulated 4-manifold, take its area, multiply it by its angle deficit, and then sum over all the triangles**. In our case we want to take each triangle by itself, take its angle deficit itself and include this into our metric because each metric would be describing each triangle itself. This new information set we shall term α and use it also in the same format.

But to understand why we are going to do this let’s look a bit further at how things build up out of these simple structures.

Since the Regge Calculus formulation of Gravitational Curvature is based on a decompostion of 4-dim space-time into 4-simplices, and each 4-simplex can be regarded as an elementary "local place", and each 4-simplex is characteristically defined by the lengths of its 10 edges, and if you take one of the vertices of the 4-simplex as its "center", then the 10 edges have the characteristics of 4 vectors from center to outer vertices plus 6 outer edges, each having 2 end-points that correspond to 2 of the 4 vectors, (i.e, 6 bivectors), it has a correspondence with the MacDowell-Mansouri formulation of Gravitation which is based on a local Spin(2,3) gauge Lie group (anti-deSitter) with 10 generators, having the characteristics of

4 "big" rotations (like vector translations in 4-dim spacetime) plus
6 Lorentz transformations.
Spin(2,3) comes from the Clifford algebra Cl(2,3) with graded structure
1+5+10+10+5+1.

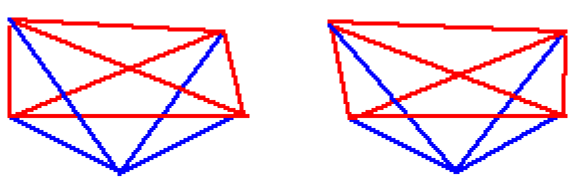
The even subalgebra of Cl(2,3) is 1+10+5 = 16-dimensional, and is the Clifford algebra Cl(2,2) with graded structure 1+4+6+4+1 and dimensionality 16 = 2^4 = 1+4+6+4+1 = 4x4 = 4^2.

The graded structure 1+4+6+4+1 of the even subalgebra of Cl(2,3) can be given a product so that it forms the 16-dimensional Lie algebra U(2,2) = U(1) x SU(2,2), with the 15-dimensional SU(2,2) corresponding to the 10+5 graded elements of Cl(2,3).
Gravitation is constructed, not just from anti-deSitter Spin(2,3) but from the larger Conformal Group Spin(2,4) of which Spin(2,3) is a subgroup.

Spin(2,4) comes from the Clifford algebra Cl(2,4) with graded structure
1+6+**15**+20+15+6+1.

The **15**-dimensional bivectors of Cl(2,4) can be given a product so that they form the 15-dimensional Conformal Lie algebra Spin(2,4) = SU(2,2), which corresponds to the **10**+**5** graded elements of Cl(2,3).

The Future Light Cone at a vertex of the 4-dim HyperDiamond lattice is a 4-simplex illustrated below



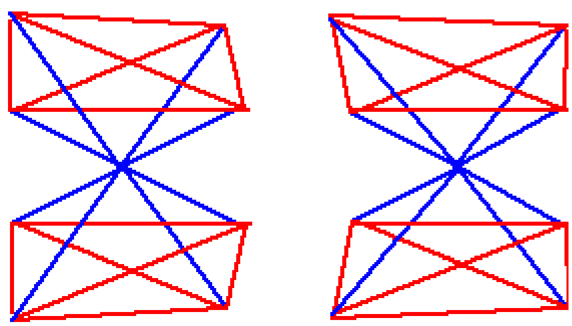
with the same graded structure 1+5+10+10+5+1 as the Cl(2,3)

- **1 empty set**,
- 5 vertices,
- **10 edges** (the **10**-dimensional grade-2 Spin(2,3) bivectors of Cl(2,3),
    - **4 edges from the given vertex to 4 Future Light Cone vertices** plus
    - **6 edges connecting the 4 Future Light Cone vertices, forming an outer tetrahedron**,

- 10 triangles,
- **5 tetrahedra** (the **5**-dimensional grade-4 elements of Cl(2,3)
    - **1 outer tetrahedron** (the Conformal Dilatation) plus
    - **4 tetrahedra with 3 edges from the given vertex** (the Special Conformal Transformations) ,
- 1 simplex itself.

When you add the Past Light Cone, you have two 4-simplices:

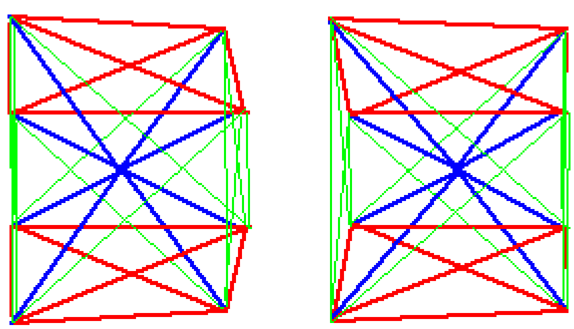
- 8 edges from the given vertex to 8 Light Cone vertices plus
- 12 edges forming two outer tetrahedra;



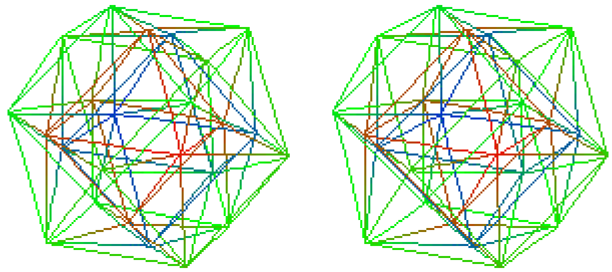
When you put in 12 further connections between Past and Future Light Cones, you have a total of six 4-simplices:

- 8 edges from the given vertex to 8 Light Cone vertices plus
- 24 edges forming four more outer tetrahedra,

so that there are a total of six outer tetrahcdra.



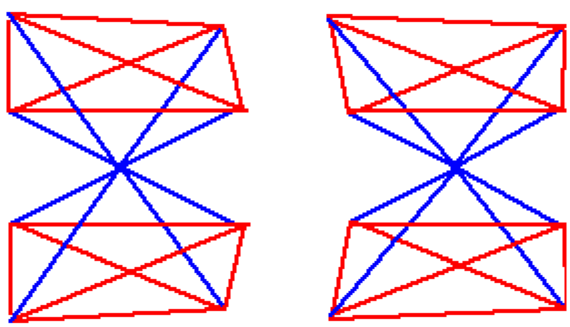
The 24 outer edges of the six outer tetrahedra correspond to the 24 vertices of a 24-cell:



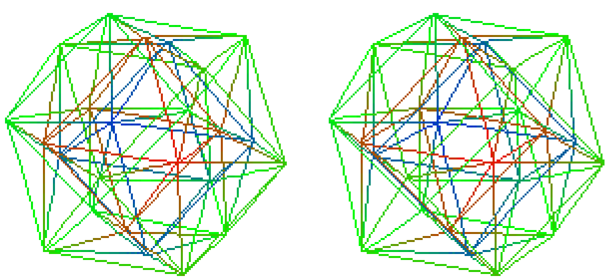
The 24-cell is the vertex figure of the D4 lattice.

What you end up with is exactly John Baez version of Loop Quantum Field Theory or Spin Foam for the Brane, while everything above the brane level becomes first rightly described by Strings and then later by the Standard Model.

But going back to this illustration



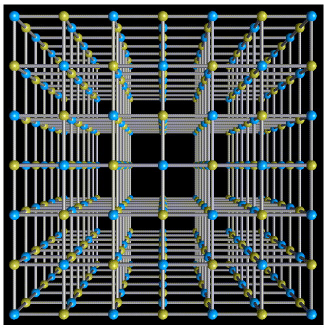
You have nearly the same basic model that Smolin illustrates in his book, “Three Roads To Quantum Gravity” on page 144 that shows a universe with one space and one time dimension while the



illustrates better a universe with three space and one time dimension. Put in Brane world terms you have an evolution from a zero brane to a 1 brane to a 2 brane on up to a 4 brane world volume. Yet the math of such seems to imply more dimensions than the four outward ones simply because these complex structures together with the zero point itself that form the translational manifold can mimic a multidimensional frame.

So actually starting with a six basic sub-e-bits of information that can be summed as one e-bit of information one can through varying this basic set construct all of Minkowski space-time clear up to the macro world we call the Hologram Manifold.

The question now to ask is what is that 24 Cell figure. To understand what it is we need to return to the concept of a Higg's field. The simplest image that shows how a Higg's field works is that of a simple crystal in three dimensions. Let's illustrate with a drawing a diamond.



Each of the dots in this diagram is an atom. The lines drawn in between show how the atoms are aligned. With the Higg's field we get an alignment of particles or more rightly, the energy that forms those particles. So in essence the 24 cell is nothing more than a diagram of how what we term the Higg's fields are aligned. Different Higg's fields generate different particles and from the interplay of these particles we get different forces in nature. However, this Higg's field is not brought about by some unseen particle. This Higg's field alignment is brought about by the simple process of restricting the lightcone as the QI projects into the more localized Hologram manifold or Minkowski space-time. This restriction process is what I term the Translation Process where QI is altered into classical information and the lightcone closes up.

REFERENCES

1.) I. Newton: "Mathematical Principles of natural philosophy", (London, Dawson, 1969)
2.) Robert Garisto, What is the Speed of Quantum Information?, arXiv Quantum – Physics 0212078
3.) Gott, J.R., III, and L.-X. Li. Preprint. Can the universe create itself? (Available at http://xxx.lanl.gov/abs/astro-ph/9712344.), 1998. Self-consistent vacuum for Misner space and the chronology protection conjecture. Physical Review Letters 80(April 6):2980.

4.) Y. Aharonov, D. Z. Albert: "Can we make sense of the measurement process in relativistic quantum mechanics?", Physical Review D 24 (1981), pgs. 359-370; A. Peres: "Relativistic Quantum Measurements", Annals of the New York Academy of Sciences, Volume 755 (1995) ("Fundamental Problems in Quantum Theory"), pgs. 445-450
5.) A. Einstein, B. Podolsky, N. Rosen: "Can quantum-mechanical description of physical reality be considered complete?", Physical Review 47 (1935), pp. 777, A. Aspect et al.: "Experimental realization of Einstein-Podolsky-Rosen-Bohm gedankenexperiment: A new violation of Bell's inequalities", Physical Review Letters 49 (1982), No. 2, p. 91; "Experimental test of Bell's inequalities using time-varying analyzers", Physical Review Letters 49 (1982), No. 25, pp. 1804
6.) C. J. Isham: "Prima Facie Questions in Quantum Gravity": Relativity, Classical and Quantum, eds. J. Ehlers and H. Friedrich, Springer-Verlag, Berlin (1994), e-print:gr-qc/9310031; G. K. Au: "The Quest for Quantum Gravity", e-print:gr-qc/9506001
7.) J. P. Hsu, L. Hsu: "A physical theory based solely on the first postulate of relativity", Physics Letters A 196 (1994), pgs. 1-6; F. Selleri: "Theories equivalent to special relativity", in Frontiers of Fundamental Physics, edited by M. Barone and F. Selleri, (Plenum Press, New York, 1994)

8.) S. Weinberg: "Gravitation and cosmology", (Wiley, New York, 1972), chapter 14

9.) B. Nodland, J. P. Ralston: "Indication of Anisotropy in Electromagnetic Propagation over Cosmological Distances", Physical Review Letters 78 (1997), No. 16. 3043-3046; e-print:astro-ph/9704196

10.) T. Regge, General relativity without coordinates, Nuovo Cimento 19 (1961), 558-571

Author's note section

Space-time: Continious or Discrete or Both? Towards experimental testing this theory.

Mathematics has the set of real numbers R, which is continuous. Physics at the quantum level appears to break down into something that is discrete. The question then becomes how much can we properly model something discrete with the assumption of a continious real numbers set.

When we take limits are we describing a physical continuum, or are we finding a continuous approximation to a physically discrete model, in which the discrete parameters are very small or very large? Most physicists tend to assume that the continuum is real, and that mathematics really describes the continuum. This is the approach I personally take, irrespective of the discreteness of the observable quantum level. I just see the quantum continuum broken into discrete units that eventually in steps works its way toward the boundary of the continuum(Zero or Infinity)in units that would not follow a normal linear math continuum of numbers.

The Standard Model approach is that we are dealing with a real continuum, though the Standard Model does not fully address the whole quantum realm below a certain scale. String Theory treats space-time as a real continuum. Normal Loop quantum approaches treat space-time as discrete. But this has been a rather radical approach that has actually shifted somewhat away from the original foundation of the spin foam idea.

In LQFT, the fabric of space-time is a foamy network of interacting loops mathematically described by spin networks. These loops are about 10-35 meters in size, called the Planck scale. The loops knot together forming edges, surfaces, and vertices, much as do soap bubbles joined together. In other words, space-time itself is quantized. Any attempt to divide a loop would, if successful, cause it to divide into two loops each with the original size. The idea is generally that space-time comes in discrete units period and that there is no continuum to time and space in at least one direction.

An important principle in quantum cosmology that LQFT is supposed to adhere to is that there are no observers outside the universe. All observers must be a part of the universe they are observing. However, because light cones limit the information that is available to any observer, the Platonic idea of absolute truths does not exist in a LQFT universe. What one is supposed to be left with is what could be termed relative truth of relational truth formulated by different interrelations of different events. This is a strong divergence from the general string theory derived concept of the brane where there can be an outside of this universe to get information from. However, LQFT actually more addresses the structure of the Brane itself and less the issue of what is outside of the universe off the brane. It only sets limits on the brane structure itself and as such does not actually eliminate an outside at all contrary to what some of its supporters tend to claim.

Unlike string theory and M-theory, LQG makes experimentally testable hypotheses. The path taken by a photon through a discrete space-time geometry would be different from the path taken by the same photon through continuous space-time. But this is only true if the loop approach is minus a variable speed of quantum information transfer. In the second case, since photons cannot travel below the Plank scale simply because they are objects larger than the Plank scale then this second approach generally supports special relativity and finds no difference in the path a photon will take irrespective of weither space-time is foamy below the plank scale or not. Something the current limits on observation(1) have begun to support which itself is, unlike normal string theory an experimentally testable hypothesis. So the first issue I would address as towards testing this model is that if we can find within the limits of our ability to test that there is any divergence of a photon predicted by a continious model then this VSQI approach would seem to be supported by experiment on two fronts:

1.) The testable speed one encounters with quantum entanglement with information transfer.

2.) The testable path of photons in general.

REFERENCES

1.) In September 2002, Ed Fomalont and Sergei Kopeikin made an indirect experimental measurement of the speed of gravity, by observing the transit of Jupiter across the line-of-sight of a bright radio source. The speed of gravity, presented in January 2003, was found to be somewhere in the range between 0.7 and 1.2 times the speed of light, which is consistent with the theoretical prediction of general relativity that the speed of gravity is exactly the same as the speed of light.

However, the result significantly constrains string theory and probably M-theory because large numbers of dimensions would allow gravity to propagate along extra dimensions. It simply rules out both large extra dimensions and certain general classes where gravity propagates off the brane.

Also, http://arxiv.org/PS_cache/astro-ph/pdf/0201/0201092.pdf sets some global constraint on the geometry.

And, http://www.nature.com/nsu/030324/030324-13.html points out some strong observational restraints on the normal loop approach at present. See also: Ragazzoni, R., Turatto, M. & Gaessler, W. The Lack of Observational Evidence for the Quantum Structure of Spacetime at Planck Scales. Astrophysical Journal, 587, L1 - L4, (2003) and Lieu, R. & Hillman, L. W. The Phase Coherence of Light from Extragalactic Sources: Direct Evidence against First-Order Planck-Scale Fluctuations in Time and Space. Astrophysical Journal, 585, L77 - L80, (2003). In both of these tests a standard loop approach is generally constrained. But this same restraint would be equally derived from the Variable Speed of Quantum Information approach. In fact, there should be no

variance under normal energy conditions from that of a continious model approach down to the Plank scale or brane level itself.

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