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The Scale Variable *c* Derived from the Zero Point Theory and its Implications

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Abstract: I will show from current experimental evidence and the implications of my own zero point theory that there must exists at least two universes tied in tandem and that our universe should display compacted regions with varying lightcones that would appear to violate Lorentz Invariance.

THE EXPERIMENTAL EVIDENCE OF A SCALE VARIABLE C

Start by considering first, a class of dispersion relations ... which in the high-energy regime takes the form:

E^2 - p^2 - m^2 = n E^2 (E / Eplanck)^a = n p^2 (E / Eplanck)^a (fig.1)

m, E and p denote the mass, the energy and the (3-component) momentum of the particle, Eplanck is the Planck energy scale (Eplanck = 10^22 MeV), while a and n are free parameters characterizing the deviation from ordinary Lorentz invariance (in particular, a specifies how strongly the magnitude of the deformation is suppressed by Eplanck).

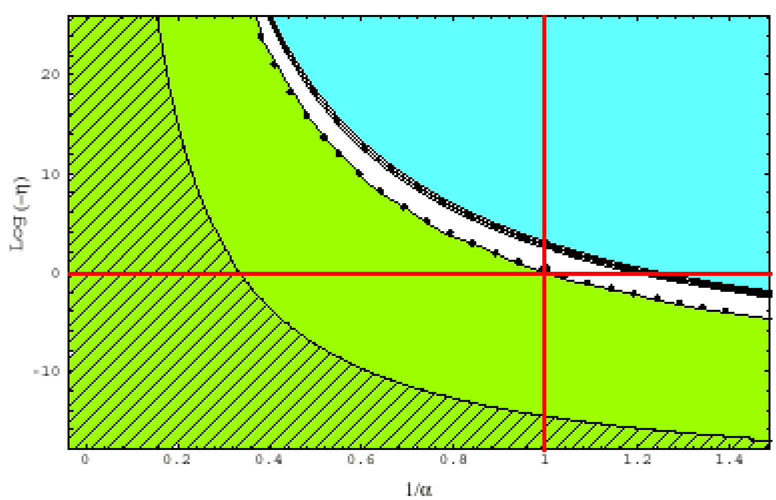

Illustration 1.

Data derived from current observations.

Figure 1: The region of the a, n parameter space that provides a solution to both the UHECR and TeV threshold anomalies while satisfying the time-of-flight upper bound on LID. Only negative values of n are considered since this is necessary in order to have upward shifts of the threshold energies, as required by the present paradoxes. The solid thick line describes the time-of-flight upper bound. The [light blue] region above this line is excluded. The solid thin line and the dotted line describe the lower bound on LID obtained from the present UHECR (solid thin line [the hatched area below it is excluded]) and TeV (dotted line [the green area below it is excluded]) threshold anomalies. The anomalies disappear in the region above the lines. Within the narrow [white] region between the dotted line and the solid thick line the time of flight constraint is satisfied and both anomalies are resolved. The ... vertical ... [red line at a = 1 corresponds to a] ... favored quantum-gravity scenario.
A quadratic a = 2 scenario favored by L. Gonzalez-Mestres(8) is not permitted by the TeV threshold anomaly, but is a solution of the UHECR anomaly and is consistent with the time-of-flight upper bound, lying on the red horizontal line in the green unhatched area.]

... The behaviour of the curves for upper and lower bounds on LID with respect to the bottom-left corner of the frame can be understood by noticing that at a fixed a ordinary Lorentz invariance can be reached taking the n -> infinity limit, while at fixed n this requires taking the a -> infinity (i.e. the 1/a -> 0) limit. ... [The red lines intersect at a = 1, n = -1, leading to a dispersion relation

$$E^2 - p^2 - m^2 = - E^2 (E / E_{planck}) = - p^2 (E / E_{planck}) \quad \text{(fig.2)}$$

that solves both the UHECR and TeV-threshold anomalies.]

Relevant for our phenomenological considerations is the process in which the head-on collision between a soft photon of energy e and momentum q and a high-energy particle of energy $E1$ and momentum $p1$ leads to the production of two particles with energies $E2$, $E3$ and momenta $p2$, $p3$. At threshold (no energy available for transverse momenta), energy conservation and momentum conservation imply

$$E1 + e = E2 + E3$$

$$p1 - q = p2 + p3 \quad \text{(fig.3)}$$

moreover, using the ordinary Lorentz-invariant relation between energy and momentum, one also has the relations

$$e = q$$

$$Ei = \sqrt{pi^2 + mi^2} = pi + mi^2 / 2\, pi \quad \text{(fig.4)}$$

... This straightforwardly leads to the threshold equation

$$p_{1,th} = ((m_2 + m_3)^2 - m^2) / 4 e \quad \text{(fig.5)}$$

This standard Lorentz-invariant analysis is modified by the deformations [of Lorentz Invariance violation] ... The key point is that ...[the equations for e and Ei] .. should be replaced by

$$e = q + n\, q^{(1+a)} / 2 E_{planck}^a$$

$$E_i = p_i + m_i^2 / 2 p_i + n\, p_i^{(1+a)} / 2 E_{planck}^a \quad \text{(fig.6)}$$

Combining ...[equations]... one obtains a deformed equation describing the p1-threshold:

$$p_{1,th} = ((m_2 + m_3)^2 - m^2) / 4 e +$$

$$+ (n\, p_{1,th}^{(2+a)} / 4 e E_{planck}^a) (((m_2^{(1+a)} + m_3^{(1+a)}) / (m_2 + m_3)^{(1+a)}) - 1) \quad \text{(fig.7)}$$

where we have included only the leading corrections (terms suppressed by both the smallness of $E_{planck}^{(-1)}$ and the smallness of e or m were neglected). ...

... in particular, if $a = -n = 1$ ...[the equations are

$$e = q - q^2 / 2 E_{planck}$$

$$E_i = p_i + m_i^2 / 2 p_i - p_i^2 / 2 E_{planck}$$

$$p_{1,th} = ((m_2 + m_3)^2 - m^2) / 4 e -$$

$$- (p_{1,th}^3 / 4 e E_{planck}) (((m_2^2 + m_3^2) / (m_2 + m_3)^2) - 1) \quad \text{(Fig.8)}$$

and] ... one would expect that the Universe be transparent to TeV photons. The corresponding result obtainable in the UHECRs context would imply that the GZK cutoff could be violated even for much smaller negative values of n ...

... it is quite remarkable that **the values expected from quantum-gravity considerations (most notably the energy scale characterizing the deformation being given by the Planck scale) are in agreement with the strict limits we derive**."

So some version of Lorentz symmetry breaking is supported by current observational evidence.   The data used in this is shown by the following graph.

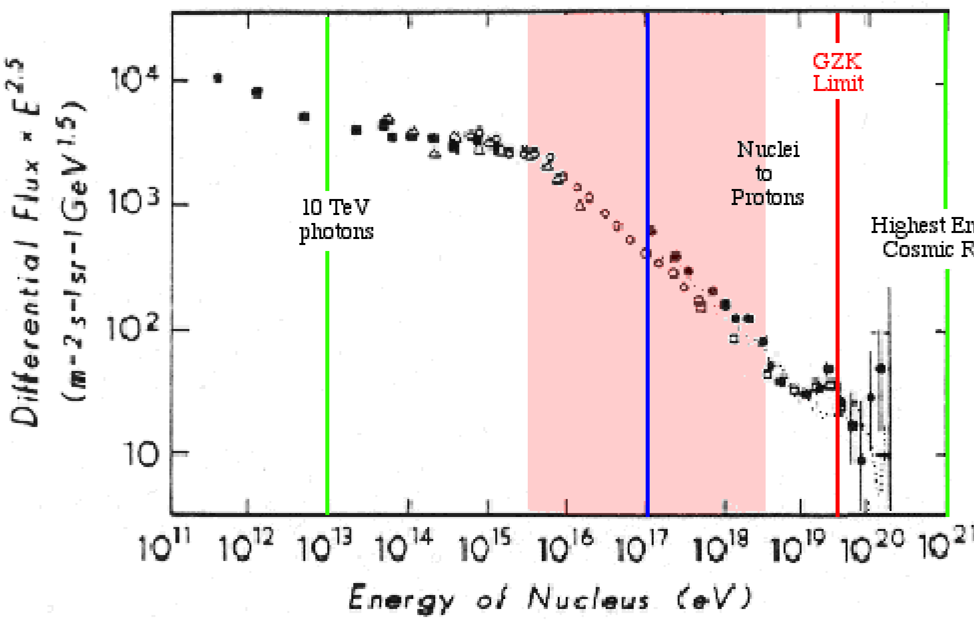

Illustration 2.

At the current time some energy scales high than these have been detected. The implication is that at higher energies(smaller scale) Lorentz Invariance is even more broken since the GZK limit set by the standard model of Lorentz Invariance has been demonstrated to be well broken. The following has been ruled on these experiments.

-) the knee has an astrophysical origin;
- b) the `sharpness' and the fine structure of the knee rule out `Galactic Modulation' as the origin of the knee;
- c) most likely the knee is the result of the explosion of a single, recent, nearby supernova.

... the case when we are inside the shock wave front. A graph below of nearby sources is given:

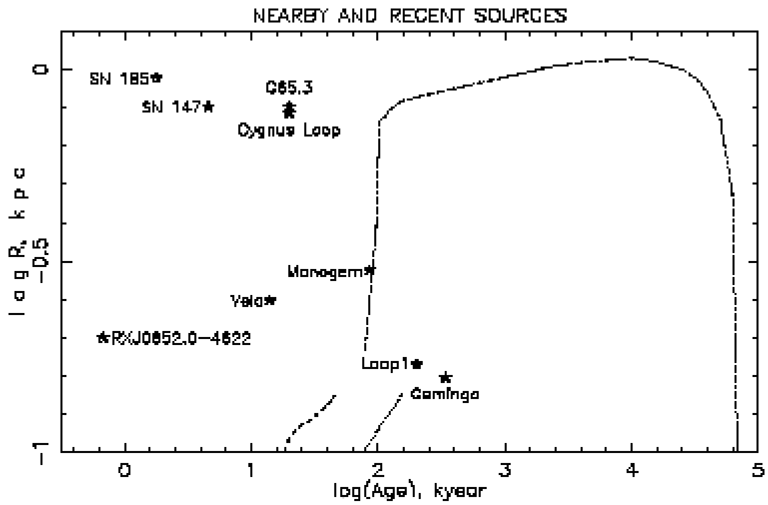

Illustration 3.

The easiest way to account for this is a vacuum energy(scale) related effect. The easiest way to describe this concept is with the Mexican hat potential. Let's say you had a system where the minimum energy was not at the origin. You could imagine a classical system with a small ball placed on top of a hill.

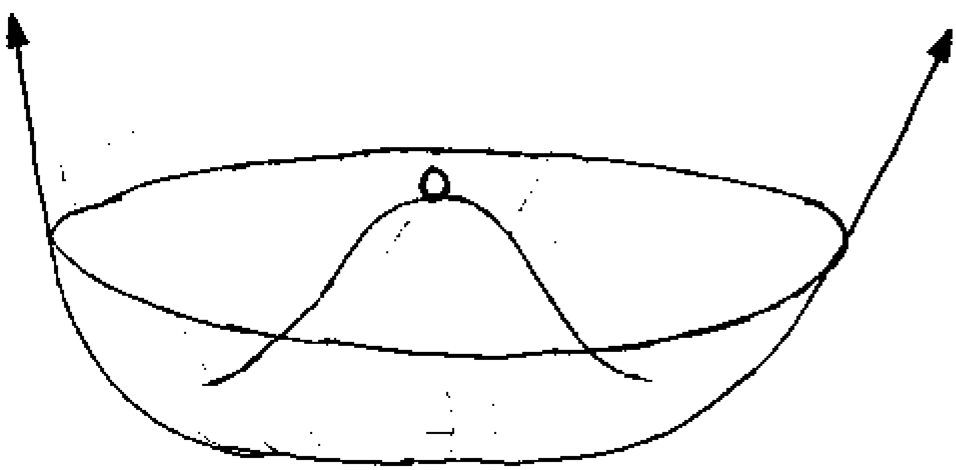

Illustration 4.

On top of the hill, the ball is at the origin, and the system is symmetric under rotations about the z-axis. However, it is unstable. The ball is not at minimum gravitational potential energy. Now, if the ball were to roll down the hill to the ring at the bottom, the system would no longer be symmetric under rotations about the z-axis. However, the ball would now be in a state of minimum gravitational energy. It's now in an energetically favorable position. This is spontaneous symmetry breaking at the classical level. But if we reversed the case then we get:

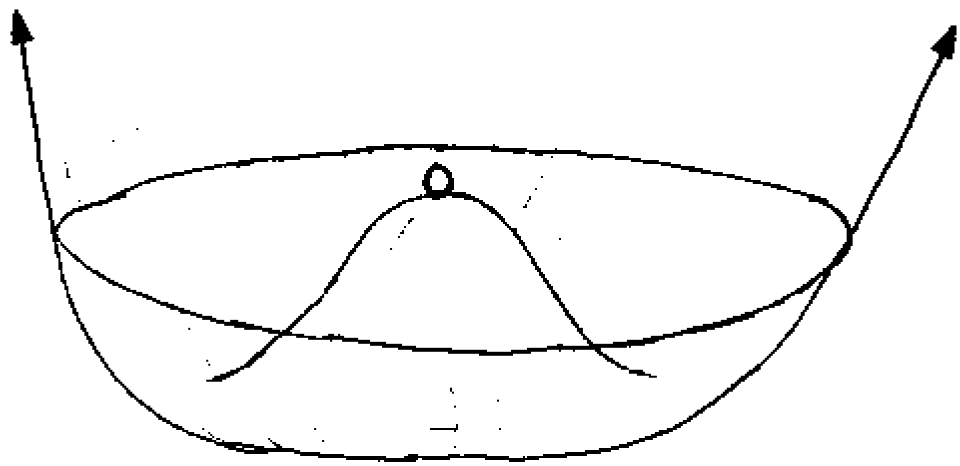

Illustration 5.

which gives a totally different picture.

In this case our ball starts at a minimum gravitational potential and is forced by inflation into a higher gravitational potential state. In this case, T_{uv} would be highest in the ground state and lowest in the false vacuum state. The effect in either case is to flatten out space-time. Except in the first model space-time flattens into a dish, where in the second it flattens to a saddle. A saddle path would yield an accelerated expansion model by nature since the curvature is automatically open. Both are examples of a degenerate vacuum. Both decay to a system that would display Lorentz Invariance. However, with the second the value of C would decrease with time. Also, the kick responcible for Inflation would with the second come from an anti-De Sitter space-time with negative time values. It's effect would be that of a much larger space-time region compacted by the process of these two regions intersecting. Enough of a kick to get inflation going, but after that point the additional second space-time brane would tend to try and expand again. Since the two branes are now fused together it simply expands the other region along with itself. In this case the Higg's field becomes locked into the particles making up this combined space-time. In short, there is no way to separate them.

The important issue is the evolution of our brane would be under this model one of a very curved space-time to a flat one and to an open one. With this you get a varying Lambda. With the first, unless you tinker with it, you get a lambda that drops to zero after inflation. So there would be no natural accelerated expansion.

The second important issue is that C becomes scale variable in this second model.

The third is that with this model the stable condition of our brane isn't actually in the condition it is in. Its stable point was at the lowest value. Inflation then becomes a forced state brought about by the intersection of two separate space-time regions into each other and their combining together into a superspace structure. Past the combination point the derived vacuum condition would be a forced stable condition with the other space-time region supplying the energy that fuels expansion and keeps the vacuum stable and in a normally, no return to zero state. But depending on how the energies of these two sub-spaces combine there could be certain regions that became compacted internally in each which would display separate values for T_{uv} with different lightcone states as the result.

Now the question must be asked is does this idea fit with our best model to date known as Loop Quantum Gravity?

THE LOOP QUANTUM GRAVITY APPROACH

Loop quantum gravity is a mathematically well-defined, non-perturbative and background independent quantization of general relativity, with its conventional matter couplings. Research in loop quantum gravity today forms a vast area, ranging from mathematical foundations to physical applications. Among the most significant results obtained are: (i) The computation of the physical spectra of geometrical quantities such as area and volume, which yields quantitative predictions on Planck-scale physics. (ii) A derivation of the Bekenstein-Hawking black hole entropy formula. (iii) An intriguing physical picture of the microstructure of quantum physical space, characterized by a polymer-like Planck scale discreteness. This discreteness emerges naturally from the quantum theory and provides a mathematically well-defined realization of Wheeler's intuition of a spacetime ``foam''.

The loop approach to quantum gravity is ten years old. The first announcement of this approach was given at a conference in India in 1987(9) The central idea is that space and time are not the central picture at all and that the universe is quantum mechanical at small scales because it has a set volume it can be divided into. So this theory starts with no basic infinity to space-time, takes that smallest volume of space and builds the framework we call space-time from that smallest form. But what is interesting in this approach is that smallest scale is far below what we term the Plank scale or zero point.

If we consider the Plank scale a built in zero point where the function we call time ceases and space itself becomes the absolute reference frame then the question must be asked: “What happens when we go below that scale?”

The answer to this is found in looking at how time shrinks as we approach the zero point. At the zero point time hits it’s own zero point. That being the case then any scale smaller than the zero point would have a negative time in relation to our manifold. The best way to illustrate this is using Hawking’s Instanton of time approach.

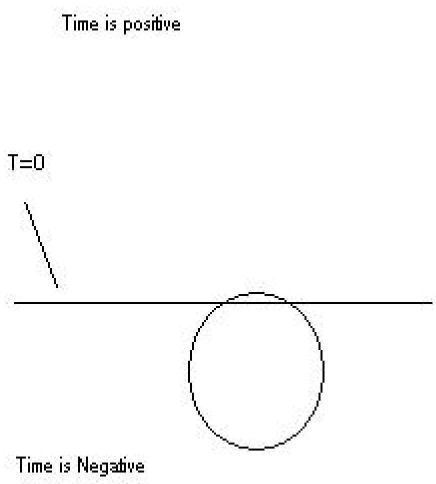

Illustration 6.

So going below the Zero Point means that whatever region of space-time we are discribing would display a phase reversed time aspect in relation to our regular manifold. This implies that what ever region we are discribing in this compacted region is part of a totally different universe and as such it can be termed off our brane world. If we accept that our universe is 4 dimensional then it follows that this universe should itself be 4 Dimensional which when the two universes are combined together makes for an 8 dimensional or higher super space-time structure. The picture we get then is illustrated below:

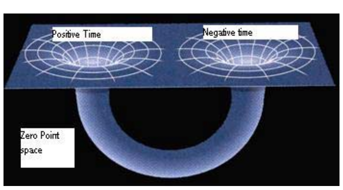

Illustration 7.

What we derive then is this type of graph for space-time as a whole.

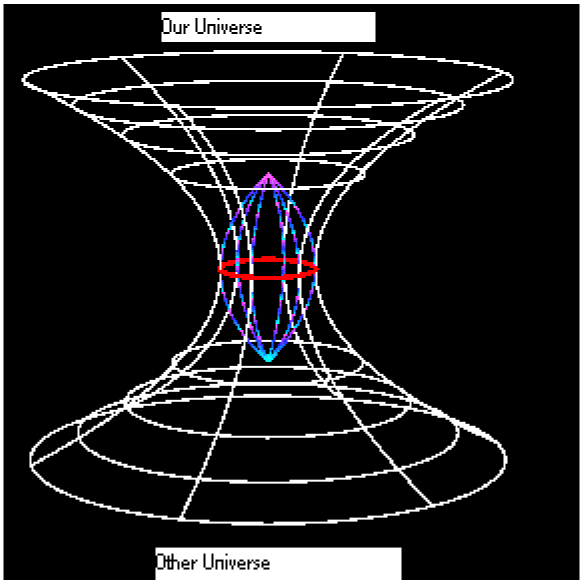

Illustration 8.

The red circle above is the zero point or that absolute space reference frame. This is almost exactly what another theory, based upon QM once predicted. That theory was the famous Kerr solution(10) to blackhole geometrodynamics illustrated below:

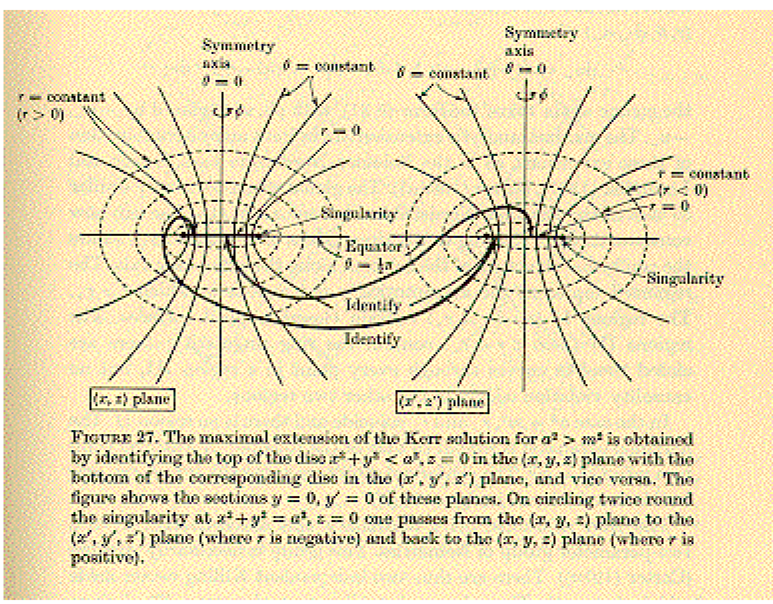

FIGURE 27. The maximal extension of the Kerr solution for $a^2 > m^2$ is obtained by identifying the top of the disc $x^2 + y^2 < a^2$, $z = 0$ in the (x, y, z) plane with the bottom of the corresponding disc in the (x', y', z') plane, and vice versa. The figure shows the sections $y = 0$, $y' = 0$ of these planes. On circling twice round the singularity at $x^2 + y^2 = a^2$, $z = 0$ one passes from the (x, y, z) plane to the (x', y', z') plane (where r is negative) and back to the (x, y, z) plane (where r is positive).

Illustration 9.

BASIS FOR A QED/QCD UNIFICATION

The electromagnetic force and the strong force simply appear different than the familiar manifestations of electromagnetic force because of the vastly different distances between the centers of charge within the quark triplet substructure with its tripolar centers and much higher amounts of energy versus the distances between centers of charge of classical electrical charge involving electrons and atomic nuclei with single centers of charge and much lower amounts of energy.

The major difference between strong force interactions and classical electrical interactions which makes them appear as different forces is the amount of energy in closed electrical field lines between the two types of interactions. When centers of charge are as close as in the strong force of the quark triplet substructure, the electrical field lines are highly deformed, and yet they contain high energy as opposed to classical electrical fields which involve much lower amounts of energy in rotation about one or two centers of charge and involving much less energy in the closed loop electrical field lines.

The strong nuclear force is a manifestation of electromagnetic force in which the distances involved between centers of electrical charge are within the structure of quarks as opposed to the distances between the centers being the distances of atomic nuclei and electrons.

High energy gluons carve tight gluon field lines whereas 'virtual photons', responcible for EM, carve much less tight electrical field lines.

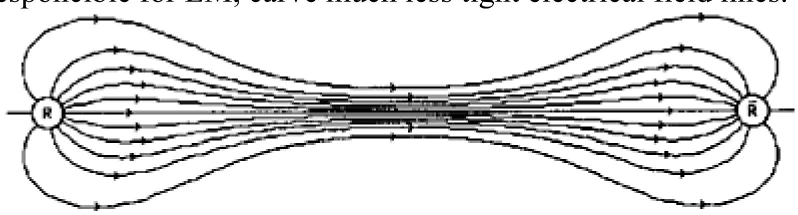

Fig. 1. The gluon field of a pair of color charges (imagined)

Illustration 10.

The other common view is that the tripolar color charge of the strong nuclear force is caused by the energy composing a quark being bound in a closed loop rotation about a quark triplet unit particle of matter substructure. The tripolar color charge is evidence of a triplet substructure of quarks, a substructure composed of three, unit charge, unit particles of matter

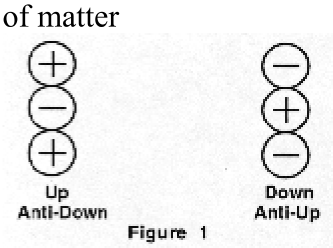

Illustration 11.

The energy bound in rotation within the quark substructure is proposed to be the same as in the case of the electron where one rotation is one half of a wavelength, only in the case of the quark, the one half of a wave rotation must contend with three centers of charge, not just one.

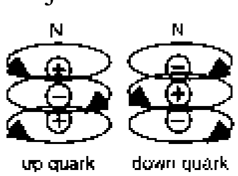

Illustration 12.

The gluons are the strong force carriers and exhibit the strong force color charge. Gluons are proposed to be the energy units composing the quark, which are in rotation about the quark unit particle of matter triplet substructure. The quark triplet substructure which gives rise to the tripolar nature of the gluons in the strong force.

Now, if we picture the first as produced by an embedded region in which say, gravity was acting in a different manor and with a stronger strength that was altered so that it decreases as things get closer and increases as things get further away then we'd end up with field lines similar to the first case.

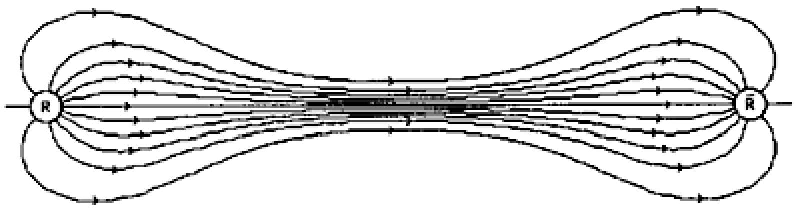

Fig. 1. The gluon field of a pair of color charges (imagined)

Illustration 13.

As compared to regular EM field lines

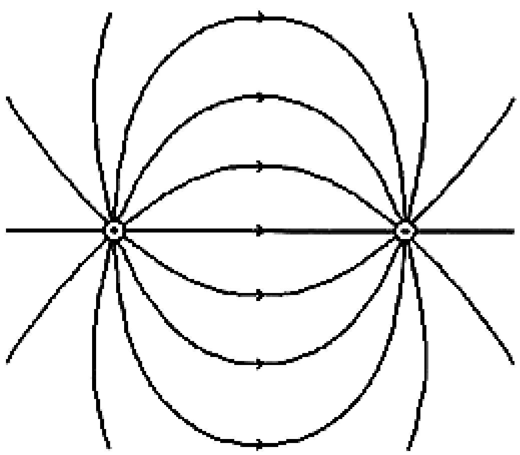

Fig. 2. The electric field for a pair of charges.

Illustration 14.

It would then be possible that the stretching is actually due to the effects of embedding in the first place if these embedded regions behave similar to how Strings from String Theory stretch as one tries to induce more energy into their state. The common acceptance that *when two color charges are far apart there may be a strong gluon field at all points along a sort of string joining them would be born out by this stretching model. The force then would not diminish with distance at all. In place of a 1/r^2 rule you'd now have a 1/(1/r^2) rule of sorts in place where the energy increases with distance. The reason it increases instead of decreasing is that the stretching would force the embedded region deeper into sub-space making its overall energy of the state involved increase.*

This idea would then make the Strong Force and EM one and the same field simply acting in different ways. Since we already have a unification of EM to the Weak Field and a partial unification of EM to GR through the scalar we'd have a 4 way unification possible simply by altering the metric of the embedded regions in question.

BELL's INEQUALITY EXPLAINED

When Bell published his inequality, he argued that it showed that in order to be consistent with experimental data, any theory of quantum physics must abandon at least one of the following: The objective reality of the properties of subatomic particles; or Einsteinian locality, which is to say the requirement that no influence can travel faster than light. Yet, we have evidence from entanglement that certain aspects of Einsteinian locality are violated. The question then becomes in what frame does this violation take place. We have experimental evidence coming from over many decades now that confirms relativity down to at least the Plank scale. This seems to rule out this normal frame we exist in being the source of these locality violations. That seems to leave us with at least a hint that other dimensional frames do exist because only in them do we seem to be able to account for movement that violates our local space-time sense of locality.
In many ways physics has been telling us this all along. We have known for nearly a Century now that in anything but a vacuum C has a different limit. In certain mediums regular particles can travel faster than photons do in the same medium. We also have experiments with quantum tunneling and with what we call acceleration mediums in which we can detect motion of photons themselves faster than normal. However, these are subject to much debate on what exactly is being measured. The point is that there has existed for a long time evidence that C is not some set in stone absolute when it comes to the value we have assigned it. If you alter the vacuum state you will alter that value period.

Relativity then becomes a guide in understanding what exactly it is that is altered in that vacuum state that changes C. In looking at General Relativity one finds that it must be the Stress energy tensor

$$T^{\Lambda}_{\mu\nu} = \rho_{\Lambda} g_{\mu\nu}, \quad \text{(fig.9)}$$

that alters. But that Stress energy tensor is itself the product of many local variables. If we turn back to Special Relativity we find one common thing that determines the value of C in the vacuum. That is determined by the electric property permittivity of the vacuum, e_o and the magnetic property permeability of the vacuum, m_0. $C=1/\text{sqrt}(e_0 m_0)$. These values are themselves determined by the energy state of the vacuum. When we refer to the vacuum we are not referring to empty space at all. We are referring to what is commonly called the Zero Point Field or ZPF. Its energy comes from the virtual particles that it is made of. To date the only model that gives similar answers to GR that employs changes in this ZPF with local changes in C is the Polarized Vacuum or PV model and certain aspects of QED and QCD.

In essence then no matter what model we care to employ the only way the vacuum could be altered is if its base energy state has been affected. This requires increasing or decreasing the amount of virtual particles present within a given area. In Casimir effect experiments this is exactly what we achieve. By placing two plates very close to each other we limit the type of virtual particles that can be present and lower their combined energy. This is why we measure the energy present as negative even though it still has some positive value. Now if nature does the same with embedded regions who's horizon effects would create a natural boundary then it is possible to account for those non-local appearing effects as the result of motion through a region who's value for C has been altered. This would make the membrane from M-Theory nothing more than the surface of that Horizon and those extra dimensions nothing more than hidden regions of our own dimensions.

Now returning to GR and looking at Einstein's Einstein's (1917)(7) revision of the field equation of general relativity where ρ_Λ is proportional to his cosmological constant Λ. In many dark energy scenarios ρ_Λ is a slowly varying function of time and its stress-energy tensor differs slightly. That new component in the stress-energy tensor looks like an ideal fluid with negative pressure
$p_\Lambda = -\rho_\Lambda.$ (fig.10)
Then the equations of energy and momentum conservation are
$\delta\dot{\rho} + (\langle\rho\rangle + \langle p\rangle)\nabla\cdot\vec{v} = 0, \qquad (\langle\rho\rangle + \langle p\rangle)\dot{\vec{v}} + c_s^2\nabla\delta\rho = 0,$ (Fig. 11)
where $c_s^2 = dp / d\rho$ and the mean density and pressure are $<\rho>$ and $<p>$. These combine to
$\delta\ddot{\rho} = c_s^2\nabla^2\delta\rho.$ (Fig. 12)
If c_s^2 is positive this is a wave equation, and c_s is the speed of sound in that medium which in our case would be the speed of light itself for a normal vacuum state or some other value for an altered vacuum state. If $p = -\rho$, the pdV work cancels the ρdV part: the work done to increase the volume cancels the effect of the increased volume. This has to be so for a Lorentz-invariant stress-energy tensor, of course, where all inertial observers see the same vacuum. However, if you alter Λ or make it time variable then you can not only get inflation you can get an accelerated expansion and a C that varies with time. If you do the same in a horizon separated region you can also get a value for C within that region that remains self invariant and yet may have nearly any value up to infinity.

Returning to our fluid model if you have a fluid with $p = -\rho/3$, and keep it homogeneous and static you in essence get a frame in which gravity does not exist. Also the active gravitational mass density is negative when ρ_Λ is positive. When this is positive the stress-energy tensor $\ddot{a}$ is positive: the rate of expansion of the universe increases.

The homogeneous active mass represented by Λ changes the equation of relative motion of freely moving test particles in the nonrelativistic limit to
$$\frac{d^2\vec{r}}{dt^2} = \vec{g} + \Omega_{\Lambda 0}H_0^2\vec{r},$$ (Fig. 13)
within our own manifold. But in those hidden manifolds this itself could take on any value since the whole fluid state under this same model approach would be different.

Going back to Bell's inequality In a Hilbert space *H* there is given for each bounded open region R of space-time an associated von Neumann algebra *A*(R) satisfying

(i)

$R_1 \subset R_2 \Rightarrow A(R_1) \subset A(R_2)$; (Fig. 14)

(ii)

the algebra of observables $A = C^*$ algebra generated by $\{\cup_R A(R)\}$;

(iii)

A is irreducible, i.e. the von Neumann algebra A'' generated by *A* is the set of all bounded operators on *H*;

(iv)

if R_1 is space-like separated from R_2 then $A(R_1)$ commutes with $A(R_2)$;

(v)

for any R, $A'' = \{\cup_x A(R+x)\}''$. (Fig.15)

In H there is a unitary representation U(x) of the translation group satisfying

(vi)

$A(R+x) = U(x)A(R)U(x)^{-1}$; (Fig.16)

(vii)

the spectrum of U(x) is contained in the closed forward light-cone;

(viii)

there is a unique vacuum vector Ω invariant under translations.

The irreducibility of A implies that the center of A is trivial and by a theorem of Borchers the algebra A is *simple.* We say that the region R_1 is *strictly* space-like separated from R_2 if there is a positive number ε such that R_1 is space-like separated from R_2^{ε}, where R_2^{ε} denotes the set of points within a distance ε of R_2. This gives us a unique vacuum state in which the spectral condition according to Schlieder have a property in which that $A(R_1)$ and $A(R_2)$ are *independent* when R_1 is strictly space-like separated from R_2. We see by this that given $P,Q \in A(R_)$, $P',Q' \in A(R_2)$ where R_1 and R_2 are strictly space-like separated, the violation of Bell's inequality depends only on $\|[P,Q]\|\ \|[P',Q']\|$ and not on the distance between R_1 and R_2. Furthermore, since A is simple, in any non-trivial representation of A there are projections in $A(R_)$ and $A(R_2)$ and vector states which violate Bell's inequality arbitrarily closely to $2\sqrt{2}$. We also know that Bell's inequality falls off exponentially with the separation of R_1 and R_2(5). So in our normal manifold whatever effect we are witnessing must be one that occurs at a limited small scale.

But, the question remains what is at the heart of this space-time frame?

In my last article(6) I introduced the idea of a Zero Point, based upon the Plank scale. I also reflected upon how that Zero Point forms an absolute space with zero time reference frame. Such a space-time forfills the requirements of a pseudo-Ether like frame in the Newtonian meaning of such without any absolute time frame of reference. This hidden ether has then always been present in both Special and General Relativity within the math. But the unique thing is following Loop Quantum Gravity this buried Ether isn't the only region of space-time that is hidden within the math, so to speak. There exists a region of another whole universe in compacted form beyond the Plank scale that we could well define as an Off the Brane Universe or hyperspace-time.

WHAT WE CAN CONCLUDE

We can conclude from both theory and the current observational evidence that there exist within our own universe regions with expanded lightcones that display, in relation to our larger space-time scale, a Lorentz Symmetry breaking. We can also conclude that there exists a region, defined by the Plank scale, at which an absolute reference frame of space and zero time exists. We can also show evidence from theory that there exists alongside of this universe another space-time region with negative time in relation to ours who's structure we can begin to map and understand from the principles of Loop Quantum gravity. This other region can be defined as an off the brane state then that forms a smaller version due to compaction of our universe. Since it was the process of compaction that turned this other universe into a smaller version of ours then it also follows that this other universe is not in it's normal ground state. This forced compaction could then possibly be the origin of both inflation and the accelerated expansion aspect we notice in observations to date.

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