Is Nature fundamentally continuous or discrete, and how can these two different but very useful conceptions be fully reconciled? Queries from L. Crowell and J. Dickau FXQi contest , 2011, presented and partly answered

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Abstract

Our contention, is that reality is actually analog, but that at a critical limit, as when the Octonian gravity condition kicks in, that for a time it appears discrete. This due to al phase transition at the start of the big bang. Our second consideration is, that symmetry breaking models, i.e. the Higgs boson are not necessary for the formation of particles with mass just before Octonionic gravity which could arise in pre Planckian physics models without a potential. Finally, the necessity of potentials for pre Octonionic gravity physics can be circumvented via Sherrer k essence physics.

Introduction

Our presentation takes note of several developments. First of all a feed into cosmological vacuum energy has been modeled, and that we have ideas as to how to inter relate four and five dimensional vacuum energies. Secondly, a mechanism for the onset of Octonian gravity is stated, as a consequence as to a build up of a peak temperature for its inception, at the time space time flattens. The onset of pre Octonionic gravity, with tiny masses associated with gravitons, is in line with Quantum mechanics as embedded within a larger, non linear classical theory Thirdly, we suggest that the transition from curved space time , which is pre Octonian gravity , ie. Non quantum state, to quantum state, is due to a chaotic mapping. That chaotic mapping also has that there would be an explosion of the degrees of freedom. I.e. this degree of freedom explosion would be where we obtain quantum dynamics. Thermal inputs for the push to quantum dynamics are the first topic brought up for our perusal of this document

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Vacuum energy , sources and commentary

Begin first with looking at different value of the cosmological vacuum energy parameters, in four and five dimensions [1]

$$\left|\Lambda_{5-\dim}\right| \approx c_1 \cdot \left(1/T^{\alpha}\right) \tag{1}$$

in contrast with the more traditional four-dimensional version of the same, minus the minus sign of the brane world theory version. as given by Park (2003) [2]

$$\Lambda_{4-\dim} \approx c_2 \cdot T^{\beta} \tag{2}$$

If one looks at the range of allowed upper bounds of the cosmological constant, the difference between what Barvinsky (2006) [3] recently predicted, and Park (2003) [2] is:

$$\Lambda_{4-\dim} \propto c_2 \cdot T^{\beta} \xrightarrow[graviton-production-as-time>t(Planck)]{} 360 \cdot m_P^2 << c_2 \cdot \left[T \approx 10^{32}\,K\right]^{\beta} \tag{3}$$

Right after the gravitons are released, one still sees a drop-off of temperature contributions to the cosmological constant .Then one can write, for small time values $t \approx \delta^1 \cdot t_P, 0 < \delta^1 \leq 1$ and integer n [4]

$$\frac{\Lambda_{4-\dim}}{|\Lambda_{5-\dim}|} - 1 \approx \frac{1}{n} \tag{4}$$

If there is an order of magnitude equivalence between such representations, there is a quantum regime of gravity consistent with fluctuations in energy and growth of entropy. The significance of Eq (4) is that at very high temperatures, it re enforces what the author brought up with Tigran Tchrakian, in Bremen,[5]. When one has, especially for times $t_1, t_2 <$ Planck time t_P and $t_1 \neq t_2$, with temperature $T(t_1) \neq T(t_2)$, then $\Lambda_4(t_1) \neq \Lambda_4(t_2)$. I.e., in the regime of high temperatures, one has $T(t_1) \neq T(t_2)$ for times $t_1, t_2 <$ Planck time t_P and $t_1 \neq t_2$, such that gauge invariance necessary for soliton stability is broken [5]. That breaking of instanton stability due to changes of $\Lambda_4(t_1) \neq \Lambda_4(t_2)$ will be where we move from an embedding of quantum mechanics in an analog reality, to the quantum regime

What leads to causal discontinuity in scale factor evolution?

The Friedmann equation [19] for the evolution of a scale factor $a(t)$,

$$(\dot{a}/a)^2 = \frac{8\pi G}{3} \cdot [\rho_{rel} + \rho_{matter}] + \frac{\Lambda}{3} \tag{5}$$

suggests a non-partially ordered set evolution of the scale factor with evolving time, thereby implying a causal discontinuity. The validity of this formalism is established by rewriting the Friedman equation as follows: $a(t^*) < l_P$ for $t^* < t_P$ =Planck time, and $a_0 \equiv l_P$,

$$\left[\frac{a(t^* + \delta t)}{a(t^*)}\right] - 1 < (value)$$

$$\xrightarrow[\delta t \to \varepsilon^+, \Lambda \neq \infty, a \neq 0]{} \left(\frac{\delta t \cdot [l_P / a(t^*)]}{\sqrt{3/8\pi}}\right) \cdot \sqrt{\frac{(\rho_{rel})_0 a_0^4}{a^4(t^*)} + \frac{(\rho_m)_0 a_0^3}{a^3(t^*)}} \approx \varepsilon^+ << 1 \tag{6}$$

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So in the initial phases of the big bang, with large vacuum energy $\neq \infty$ and $a(t^*) \neq 0, 0 < a(t^*) << 1$, the following relation, which violates (signal) causality, is obtained for small fluctuation $a(t^*) < l_P$ If we examine what happens with $|\Lambda_{5-\dim}| \sim c_2 T^{-\beta}$

Cosmological Λ in 5 and 4 dimensions [4]- Table 1

Time $0 \le t << t_P$	**Time** $0 \le t < t_P$	**Time** $t \ge t_P$	**Time** $t > t_P \rightarrow$ **today**
$\|\Lambda_5\|$ undefined, $T \approx \varepsilon^+ \rightarrow T \approx 10^{32} K$ $\Lambda_{4-\dim} \approx$ almost ∞	$\|\Lambda_5\| \approx \varepsilon^+$, $\Lambda_{4-\dim} \approx$ extremely large $10^{32} K > T > 10^{12} K$	$\|\Lambda_5\| \approx \Lambda_{4-\dim}$, T much smaller than $T \approx 10^{12} K$	$\|\Lambda_5\| \approx$ huge, $\Lambda_{4-\dim} \approx$ constant, $T \approx 3.2K$

For times $t > t_P \rightarrow$ today, a stable instanton is assumed, along the lines brought up by t'Hooft [7], due to the stable $\Lambda_{4-\dim} \approx$ constant ~ small value, roughly at the value given today. The supposition is that the value of N is actually proportional to a numerical graviton density we will refer to as <n>., provided that there is a bias toward HFGW

Consider now what could happen with a phenomenological model bases upon the following inflection point i.e. split regime of different potential behavior

$$V(\phi) = g \cdot \phi^{\alpha} \tag{13}$$

What we come up with pre, and post Planckian space time regimes, when looking at consistency of emergent structure is the following. Adjusting Weinberg we have [14],

$$V(\varphi) \propto \phi^{|\alpha|} \qquad \text{for } t < t_{PLanck} \tag{14}$$

Also, we would have

$$V(\varphi) \propto 1/\phi^{|\alpha|} \qquad \text{for } t >> t_{PLanck} \tag{15}$$

The switch between Eq. (14) and Eq. (15) is not justified analytically.. Beckwith et al (2011) designated this as the boundary of a causal discontinuity. According to Weinberg [13] , if $\in = \frac{\lambda^2}{16\pi G}, H = 1/\in t$ one has a scale factor behaving as [14]

$$a(t) \propto t^{1/\in} \tag{16}$$

Then, if [14]

$$|V(\phi)| << (4\pi G)^{-2} \tag{17}$$

there are no quantum gravity effects . I.e when there is a drop in a field from ϕ_1 to ϕ_2 for flat space geometry and times t_1 to t_2 [14]

$$\phi(t) = \frac{1}{\lambda} \ln\left[\frac{8\pi G g \in^2 t^2}{3}\right] \tag{18}$$

Then scale factors, from Planckian time scale as [14]

$$\frac{a(t_2)}{a(t_1)} = \left(\frac{t_2}{t_1}\right)^{1/\in} = \exp\left[\frac{(\phi_2 - \phi_1)\lambda}{2\in}\right] \tag{19}$$

The more $\frac{a(t_2)}{a(t_1)} >> 1$, then the less likely there is a tie in with quantum gravity. Note if this is for a flat , Roberson-Walker geometry, and if $t_1 < t_{Planck}$ then Eq. (11) no longer applies

Increase in degrees of freedom in the sub Planckian regime.

Starting with [15] , [16]

$$E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto [\Omega_0 \breve{T}] \sim \tilde{\beta} \tag{21}$$

The assumption is that there is an initial fixed entropy arising, with $\overline{N}$ as a nucleated structure arising in a short time interval as temperature $T_{temperature} \varepsilon (0^+, 10^{19}\, GeV)$ arrives. Then by [15], [16]

$$\frac{\Delta\tilde{\beta}}{dist} \cong \left(5k_B \Delta T_{temp} / 2\right) \cdot \frac{\overline{N}}{dist} \sim qE_{net-electric-field} \sim \left[T\Delta S / dist\right] \qquad (22)$$

The parameter, as given by $\Delta\tilde{\beta}$ is used to define chaotic Gaussian mappings. Candidates as to an inflaton potential would be in powers of the inflation, i.e. in terms of ϕ^N, with N=4 ruled out, and N=2 an admissible candidate (chaotic inflation). For N = 2, one gets [15], [16]

$$[\Delta S] = [\hbar/T] \cdot \left[2k^2 - \frac{1}{\eta^2} \left[M^2_{Planck} \cdot \left[\left[\frac{6}{4\pi} - \frac{12}{4\pi} \right] \cdot \left[\frac{1}{\phi} \right]^2 - \frac{6}{4\pi} \cdot \left[\frac{1}{\phi^2} \right] \right] \right] \right]^{1/2} \sim n_{Particle-Count} \qquad (23)$$

If the inputs into the inflaton, as given by ϕ^2 becomes from Eq. (6) a random influx of thermal energy from temperature, we will see the particle count on the right hand side of Eq. (23) above a random creation of $n_{Particle-Count}$. The way to introduce the expansion of the degrees of freedom from nearly zero to having **N(T)~ 10^3** is to define the classical and quantum regimes of gravity in such a way as to minimize the point of the bifurcation diagram affected by quantum processes.[15] If we suppose smoothness of space time structure to a grid size of $l_{Planck} \sim 10^{-33}$ centimeters at the start of inflationary expansion we have what would be needed to look at the maximum point of contraction, setting at $l_{Planck} \sim 10^{-33}$ centimeters the quantum 'dot' or infometron, as a measure zero set, as the bounce point, with classical physics behavior before and after the bounce 'through' the quantum dot. Dynamical systems modeling could be employed right 'after' evolution through the 'quantum dot' regime. The diagram, would look like an application of the Gauss mapping of [15].[16]

$$x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i^2\right] + \tilde{\beta} \qquad (24)$$

In dynamical systems , one would get a diagram, with tree structure given by Binous [17].Now that we have a model as to a change in space time geometry, let us consider what happen during the Higgs mechanism and why it does not apply in very early universe geometry

Dickau's observations as to utility of the degrees of freedom argument as posted in FXQi contest Feb 2010: Innate analog nature of pre Planckian physics, and why

Quote:

J. Dickau, Feb 24, 2011 in the FXQi forum wrote"

And then you would be saying that each degree of freedom provides a 'doorway' between prior and currently evolving universes. An interesting thought!

<u>The author's response:</u>

Andrew Beckwith wrote on Feb. 24, 2011 @ 21:33 GMT
The fact each degree of freedom provides a "gateway" from a prior to the present universe would lead to enable a chaotic mixing mapping. The existence of the chaotic mixing would lead to an analog description, de facto. Since such a mapping is NOT digital at all.

This cleaves to the heart of the issue. I.e. chaotic mixing due to different universes would lead to analog reality, de facto as the template as to what sort of reality picture the present universe arises from. It is the author's contention that emergent structure would, with a rise up of temperature contribute to the formation of Octonionic gravity conditions. Were we to constrain ourselves to pre Planckian regime physics, the answer to the analog versus digital would be initially analog, due to what was put up, and then a brief interlude of digital physics as de rigor making its appearance as temperature increased. To a Plank temperature value.

We shall next refer to L. Crowell's very well stated critique of degrees of freedom in emergent cosmology with our response as to what he wrote, as a reply in the FXQi contest. It is our conclusion that what Crowell puts up is appropriate as to evaluating space time as of Planck time and beyond, but it beggars the question as to what happens in the regime of space time before a Planck time interval. We substantially agree with most of what Crowell wrote as of Planckian to beyond Planckian physics.

Crowells objection to the degrees of freedom argument, as posted in FXQi contest

First start off with Crowells commentary

I think it is important to get away from these notions of assigning degrees of freedom to space or spacetme. In a lattice picture this amounts to N^3 or N^4 degrees of freedom for space and spacetime respectively. However, the boundary of spacetime, or horizons, if they contain degrees of freedom then there are only 2^N. This is a significant reduction in the amount of entropy one assigns to spacetime. This is one reason LQG has a hard time recovering a classical limit.

There is an interesting paper by Davies, where he argues there are 10^{123} bit flips in the entire universe. There are 400 to 500 bits and possible 10^{123} entangled bit flips corresponds to the total number of elementary particles, or string modes possible. The $E_8 x E_8$ has 2x248 = 496 particle states. The implication is that the universe may only contain one of every type of elementary particle. So the electrons running around the circuit board in my computer, is the same as all the electrons in the entire universe. This holographic projection of fields onto the AdS boundary, or equivalently the cosmological boundary, is a form of Feynman's original concept of the path integral where a particle in effect covers the entire universe.

I could go on with this, but is sounds utterly insane to say that there are only 496 particles in the universe. There is an associated quantum entanglement entropy and information in the universe which is considerably larger. This gives rise to decoherent classes or sets which is why we perceive there are so many particles or "atoms" in the universe.

Andrew Beckwith wrote on Feb. 25, 2011 @ 04:13 GMT
Lawrence, you seem to be tying the notion of entanglement and de coherence classes as a replacement for degrees of freedom arguments. If this is what you mean, please let me know via an e mail

Andy

Lawrence B. Crowell replied on Feb. 25, 2011 @ 14:22 GMT
The appearance of degrees of freedom can potentially be an illusion. A measurement of a quantum system is ultimately an entanglement process. You entangle a system with another, which removes the superposition of the original system and puts it into an entanglement. So if you measure a two state system with another two states system, which I break out below, a naïve assumption is there are four degrees of freedom. However, in reality there are only two. So this issue is related to the occurrence of classical physics and the measurement problem.

A spin system has in the basis of the Pauli matrix σ_z the states $|+\rangle$ and $|-\rangle$ for spin up and down. The Pauli matrix acts on these states as

$$\sigma_z |+/-\rangle = +/- |+/-\rangle. \qquad (24a)$$

Now these states are complex numbers, which means there are 2 variables for each state and thus 4 altogether. However, there are constraints, such as the probability Born rule $1 = P_+ + P_-$, $P_{+/-} = |a_{}$

+/-|^2 for a state |ψ> = a_+|+> + a_-|->, and irrelevance of a phase in real valued measurements. So this reduces the number of variables from 4 to 4 – 2 = 2. That is just what we would expect.

Now let us consider two spin systems, say two electrons. The use of electron spin state is not concrete, for these arguments hold just as well for polarization direction of photons. So we have two sets of states and operators {σ_z, | +/->}^1 {σ_z, | +/->}^2 denoted with an additional index i = 1, 2 and we still have

σ ^i_z| +/->^i = +/-| +/->^i. (24b)

We can form two independent states |ψ>^i = a^i_+|+>^i + a^i_-|->^i for the two spin systems. For each there are 4 variables and 2 constraints. This gives 4 degrees of freedom in total. Yet we can compose these spin states in various ways. One way of doing this is

|ψ> = (1/sqrt{2})(|+>|-> + e^{iφ}|-> |+>),

where I have dropped the index i, and we just implicitly see the first and second | +/-> as i = 1 and 2. This makes reading things clearer. The e^{iσ} is a phase which for it equal + and – the state |ψ> is not an eigenstate of σ^i and is an eigenstate of σ ^i respectively. So these are singlet and triplet state configurations. This is an entangled state. If you have access to | +/->^1 then you also have access to | +/->^2, and this holds no matter how far apart these states end up as. You can entangle two electrons by overlapping their wave functions. One that is done you can separate them arbitrarily far and they are still entangled.

Now let us count the degrees of freedom for this state. We have again 4 variables for each | +/->}^i but now we have one constraint from Born rule and another from the entanglement state. So you have 6 independent variables with 4 constraints giving 2 in total. This is the basic bipartite entanglement. There are also n-partite entanglements, such as the W and GHZ states.

So assume there are states given by SO(32) or E_8xE_8, which number 496. One of those states is an electron, another is an up quark and so forth. In the entire superspace each of these particle zig-zags through all space and has a configuration in a vast number of forms. These multi-threaded paths, in how Feynman originally thought of the path integral, are then eigenstates in a pure state. However, the observable universe is an entanglement with states in the rest of the superspace, and each particle is a local entanglement with particles in the whole "zig-zag." So we have this illusion of there being a vast number of degrees of freedom, with a huge number of duplicate particles. However, they may all the same particle. An electron running through you computer is the same as an electron being pushed as an exiton in photosynthesis in a leaf in Gabon and is identical to an electron in an accretion disk transport and the same electron everywhere.

Some of the machinery I am building up should lead to this understanding. At least this is one of the objectives.

I appreciate what Crowell wrote very much, and am of the opinion that his analysis actually is pertinent to Planckian physics, and beyond.

It does, though depend upon particle physics, as we know it, with actually formed particles If we review the Higgs mechanism.

My take, is that in the pre Planckian regime, that the Higgs mechanism will have no relevance, and that in such a situation that one will be well advised as to consider degrees of freedom arguments. However, that when Planckian physics is under way, and beyond, that the L . Crowell argument may actually apply.

Let us now review the Higgs mechanism and consider how and why it may not apply.

Higgs Mechanism, and its consequence in the onset of inflation. I.e. why it could break down

Let us begin first with a U(1) gauge theory, the Fermion ψ would transform locally [19]

$$\psi \to \psi' = \left(\exp[-ig\vartheta \cdot q(x)]\right)\cdot \psi \tag{25}$$

A way to allow for the mass to be factored in, i.e. look at $\phi \to \phi' = \left(\exp[-ig\vartheta \cdot q(x)]\right)\cdot \phi$, and then

$$\varsigma(\phi) = iD^{\varpi}\phi^{+}D_{\mu}\phi - \frac{1}{2}\mu^{2}\phi^{+}\phi - \frac{1}{4}\lambda\left(\phi^{+}\phi\right)^{2} \tag{26}$$

If $\mu^2 < 0$, the potential has a minimum, with $\left\langle \phi^{+}\phi \right\rangle = v^2 = -\mu^2/\lambda > 0$, with a VeV $\langle \phi \rangle = v$. Then

$$\phi = (\eta + v)\exp[i\sigma / v] \tag{27}$$

As stated a kinetic energy term for the scalar field, $g^2 v^2 A^{\mu} A_{\mu} \subset D^{\mu}\phi^{+} D_{\mu}\phi$ is such that a mass term may exist. Now as to why this procedure breaks down. A scalar field will no longer be massless if the following step is taken, namely an explicit symmetry breaking term $m^2\left(\phi\phi + \phi^{*}\phi^{*}\right)$ will allow a scalar field ϕ to be expanded about a VeV $\langle \phi \rangle = v$ with

$$\phi = (\eta + v)\exp[i\sigma / v] \sim \eta + v + i\sigma - \sigma^2 / 2v \tag{28}$$

so that the mass of σ is m^2, with σ a pseudo nambu goldstone boson. If one has VeVs, then [19]

$$SU(5) \to SU(4) \times U(1) \Rightarrow \langle \phi \rangle = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & -4 \end{pmatrix} \tag{29}$$

$$SU(5) \to SU(3) \times SU(2) \times U(1) \Rightarrow \langle \phi \rangle = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & -3/2 & 0 \\ 0 & 0 & 0 & 0 & -3/2 \end{pmatrix} \tag{30}$$

In the case of when the VeV is congruent with a broken symmetry potential, as of the form $m^2\left(\phi\phi + \phi^{*}\phi^{*}\right)$, which no longer exists in the situation where one is looking at k essence inflation, The main point why the Higgs paradigm may break down is that emergent structure is formulated without a broken symmetry potential $m^2\left(\phi\phi + \phi^{*}\phi^{*}\right)$.

To succinctly put it for our analysis, let us consider how one could form emergent forms of space time without involving broken symmetry potentials, such as $m^2\left(\phi\phi + \phi^{*}\phi^{*}\right)$. ***We argue that Sherrer k essence style continuum emergence, if true, as outlined next, may permit a degree of freedom argument. Let us now review what we can do with such an argument and how it may contribute toward an emergent gravity structure of space time. With additional analysis, we view this sort of development as a way forward to indicate how analog reality may be a precursor to Planckian physics. Of course this work is incomplete, but it is a start.***

How to have emergent state of space time without use of a broken symmetry potential, as done via Sherrer k essence.

In particular, the situation to watch [20] is the k essence scenario . So we have a small growth of density perturbations' [20], [21]

$$C_S^2 \cong \frac{1}{1+2\cdot(X_0+\tilde{\varepsilon}_0)\cdot(1/\tilde{\varepsilon}_0)} \equiv \frac{1}{1+2\cdot\left(1+\frac{X_0}{\cdot\tilde{\varepsilon}_0}\right)} \quad (31)$$

if we have a small contribution w.r.t. time variation, but a large spatial variation of phase

$$|X_0| \approx \frac{1}{2}\cdot\left(\frac{\partial\phi}{\partial x}\right)^2 >> \tilde{\varepsilon}_0 \quad (31b)$$

$$0 \le C_S^2 \approx \varepsilon^+ << 1 \quad (32)$$

and

$$w \equiv \frac{p}{\rho} \cong \frac{-1}{1-4\cdot(X_0+\tilde{\varepsilon}_0)\cdot\left(\frac{F_2}{F_0+F_2\cdot(\tilde{\varepsilon}_0)^2}\cdot\tilde{\varepsilon}_0\right)} \approx 0 \quad (33)$$

We get values for phase being a 'box' of height scaled to about $2\cdot\pi$ and width ***L***. Obtained by [22]

$$\phi \approx \pi\cdot[\tanh b\cdot(x+L/2) - \tanh b\cdot(x-L/2)] \quad (34)$$

This means that initial conditions are in line with the equation of state conditions for a cosmological constant but near zero effective sound speed . So,

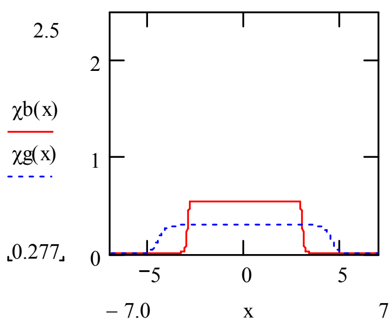

Fig 1

Evolution of the phase from a thin wall approximation to a thicker wall approximation with increasing L between S-S' instanton componets. The 'height' drops and the 'width' L increases corresponds to evolution of the thin *wall approximation. This is in tandem with a 'potential' system to the chaotic scalar* ϕ^2 *potential system of Guth***[23].**

As the 'hill' flattens, the physical system approacsed cosmological constant behavior.

This is occurring in the regime in which Octonian gravity initially does not apply and which eventually it does apply. So, let us look at the following. I.e. if there is an increase of temperature, from initially a low to a higher level, the author sees a regime of space time which becomes Euclidian. I.e. in this regime, the Octonian gravity construction as outlined below becomes important.

Relevance to Octonian Quantum gravity constructions? Where does non commutative geometry come into play?

Crowell [24] wrote on page 309 that in his Eq. (8.141), namely

$$\left[x_j, p_i\right] \cong -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar T_{ijk} x_k \rightarrow i\hbar\delta_{i,j} \tag{36}$$

Here, β is a scaling factor, while we have, above, a Kroniker function so that at a small distance from the confines of Planck time, we recover quantum mechanical behavior. Our contention is, that since Eq. (26) depends upon Energy- momentum being conserved as an average about quantum fluctuations, that if energy-momentum is violated that Eq. (36) falls apart. How Crowell forms Eq. (36) at the Planck scale depends heavily upon Energy- Momentum being conserved.[23] Our construction VIOLATES energy – momentum conservation. N. Poplawski[24] also has a revealing construction for vacuum energy, and cosmological constant reproduced here

$$\Lambda = \left[\frac{3\kappa^2}{16}\right] \cdot \left(\overline{\psi}\gamma_j\gamma^5\psi\right) \cdot \left(\overline{\psi}\gamma^j\gamma^5\psi\right) \text{ And } \rho_\Lambda = \left[\frac{3\kappa}{16}\right] \cdot \left(\overline{\psi}\gamma_j\gamma^5\psi\right) \cdot \left(\overline{\psi}\gamma^j\gamma^5\psi\right) \tag{37}$$

Poplawski [25],write his formulation of a quark- gluon QCD based condensate. Our contention is that once a QCD style condensate breaks up there will afterwards be NO equivalent structure to Eq. (37) and Eq. (38) even at the beginning of inflation. Once that condensate structure is not possible then by Eq. (8.140) of Crowell non flat space has a geometric non-commutativity protocol which is delineated by the following spatial relationship. When Eq. (40) goes to zero, we recover the regime in which quantum mechanics holds.

$$\left[x_j, x_k\right] = \beta \cdot l_P \cdot T_{j,k,l} \cdot x_l \tag{40}$$

Does the (QCD) condensate occur post plankian, and not work for pre plankian regime ? Yes. The problem lies with Eq. (8.140) of Crowell [23] .If one integrates across a causal barrier,

$$\oint [x_j, p_i] dx_k \approx -\oint p_i [x_j, dx_k] = -\beta \cdot l_P \cdot T_{j,k,l} \oint p_i dx_l \neq -\hbar\beta \cdot l_P \cdot T_{i,j,k} \tag{41}$$

Very likely, across a causal boundary, between $\pm l_P$ across the boundary due to the causal barrier, one gets

$$\oint p_i \, dx_k \neq \hbar\delta_{i,k}, \oint p_i \, dx_k \equiv 0 \tag{42}$$

I.e.

$$\left.\oint_{\pm l_P} p_i dx_k\right|_{i=k} \rightarrow 0 \tag{43}$$

If so,[23]

$$\left[x_j, p_i\right] \neq -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar T_{ijk} x_k \quad and \quad does \quad not \rightarrow i\hbar\delta_{i,j} \tag{44}$$

Eq. (44) in itself would mean that in the pre Planckian physics regime, and in between $\pm l_P$, QM no longer applies. What we will do is determining where Eq. (44) no longer holds via experimental data .

We have now outlined as to the dynamics of space time at the start of inflationary dynamics. This is likely digital. The pre Planckian space time regime is, as said before, due to ergodic mixing likely analog. We will now begin the process of outlining how the analog feed into emergent space time as we

have qualitatively brought up before could have happened. In doing so, the implications are startling. For one thing we would not have the big rip scenario of w < - 1. Other ideas will have to be investigated.

A new idea extending Penrose's suggestion of cyclic universes, black hole evaporation, and the embedding structure our universe is contained within

Beckwith strongly suspects that there are no fewer than N universes undergoing Penrose 'infinite expansion' [26] and all these are contained in a mega universe structure. Furthermore, each of the N universes has black hole evaporation, with the Hawking radiation from decaying black holes. If each of the N universes is defined by a partition function, we can call $\left\{\Xi_i\right\}_{i\,\equiv N}^{i\,\equiv 1}$, then there exist an information minimum ensemble of mixed minimum information roughly correlated as about $10^7 - 10^8$ bits of information per partition function in the set $\left.\left\{\Xi_i\right\}_{i\,\equiv N}^{i\,\equiv 1}\right|_{before}$, so minimum information is conserved between a set of partition functions per each universe

$$\left.\left\{\Xi_i\right\}_{i\,\equiv N}^{i\,\equiv 1}\right|_{before} \equiv \left.\left\{\Xi_i\right\}_{i\,\equiv N}^{i\,\equiv 1}\right|_{after} \tag{46}$$

However, that there is non uniqueness of information put into each partition function $\left\{\Xi_i\right\}_{i\,\equiv N}^{i\,\equiv 1}$. Furthermore Hawking radiation from the black holes is collated via a strange attractor collection in the mega universe structure to form a new big bang for each of the N universes as represented by $\left\{\Xi_i\right\}_{i\,\equiv N}^{i\,\equiv 1}$. Verification of this mega structure compression and expansion of information with a non unique venue of information placed in each of the N universes favors Ergodic mixing treatments of initial values for each of N universes expanding from a singularity beginning. I.e. start with Alcubierre's formalism about energy flux, assuming a solid angle for energy distribution Ω for energy flux to travel through. [27],[28]

$$\frac{dE}{dt} = \left[\lim r \to \infty\right]\left[\frac{r^2}{16\pi}\right]\oint\left|\int_{-\infty}^{t}\Psi_4 dt'\right|^2 \cdot d\Omega \tag{47}$$

The expression Ψ_4 is a Weyl scalar which we will, before the electro weak phase transition, assume no time dependence of both h^+ and h^x and that initially $h^+ \approx h^x$, so as to initiate Ψ_4 as

$$\Psi_4 \cong -\frac{1}{4}\cdot\left[+\partial_r^2 h^+\right]\cdot\left(-1+i\right) \tag{48}$$

The upshot, is that the initial energy flux about the inflationary regime would lead to [27],[28] an initial energy flux at the onset of inflation .

$$E_{initial-flux} \cong \left[\frac{r^2}{64\pi}\right]\cdot\left|+\partial_r^2 h^+\right|^2 \cdot\left[\tilde{n}\cdot t_{Planck}\right]^3 \cdot \Omega_{effective} \tag{51}$$

Inputs into both the expression $\left|\partial_r^2 h^+\right|$, as well as $\Omega_{effective}$ will be done later in modeling. The derived value of $\Omega_{effective}$ as well as $E_{initial-flux}$ will be tied into a way to present energy per graviton, as a way of obtaining n_f. The n_f value, will be used to algorithm of [9]. $S_{entropy} \sim n_f$. . How to tie in this energy expression, as in Eq. (51) will be to look at the formation of a non trivial gravitational measure which we can state as a new big bang for each of the N universes as by [27],**[28]** and $n(E_i)\cdot$ the density of states at a given energy E_i for a partition function. **[10] , [27],[28]**

$$\left\{\Xi_i\right\}_{i\ \equiv 1}^{i\ \equiv N} \propto \left\{\int_0^{\infty} dE_i \cdot n(E_i) \cdot e^{-E_i}\right\}_{i\ \equiv 1}^{i\ \equiv N} . \tag{52}$$

Each of the terms E_i would be identified with Eq.(52) above, with the following iteration for N universes

$$\frac{1}{N} \cdot \sum_{j=1}^{N} \Xi_j \Big|_{j-before-nucleation-regime} \xrightarrow[vacuum-nucleation-tranfer]{} \Xi_i \Big|_{i-fixed-after-nucleation-regime} \tag{53}$$

For N number of universes, with each $\Xi_j \Big|_{j-before-nucleation-regime}$ for j = 1 to N being the partition function of each universe just before the blend into the RHS of Eq. (54) above for our present universe. Also, each of the independent universes given by $\Xi_j \Big|_{j-before-nucleation-regime}$ would be constructed by the absorption of one million black holes sucking in energy**. I.e. in the end**

$$\Xi_j \Big|_{j-before-nucleation-regime} \approx \sum_{k=1}^{Max} \tilde{\Xi}_k \Big|_{black-holes-jth-universe} \tag{54}$$

One can treat Eq. (54) as a de facto Ergodic mixing of prior universes to a present universe, with the partition function of each of the universes defined by Eq. (53) above. Filling in the inputs into Eq. (52) to Eq. (54) is what will be done in the months ahead. ***We claim that Eq. (54) will force pre Planckian space time to have analog character, and not digital.***

Conclusion: Several reasons for the Analog nature of reality with digital a sub set of a larger Analog basis

We wish to summarize what we have presented in an orderly fashion. Doing so is a way of stating that Analog, reality is the driving force behind the evolution of inflationary physics

a) Pre Octonian gravity physics (analog regime of reality) features a break down of the Octonian gravity commutation relationships when one has curved space time. **This corresponds, as brought up in the Jacobi iterated mapping for the evolution of degrees of freedom to a build up of temperature for an increase in degrees of freedom from 2 to over 1000. Per unit volume of space time. The peak regime of where the degrees of freedom maximize out is where the Octonian regime holds. Corresponding to Octonian gravity, when one has flat space, after a significant increase in temperature.**

b) Analog physics, prior to the build up of temperature can be represented by the mappings given by Eq. (53) and Eq. (54) . The first of these mappings is an ergotic mapping , a perfect mixing regime from many universes into our own present universe. This mapping requires a deterministic quantum limit as similar to what tHooft included in his embedding of Quantum physics in a larger, non linear theory [29]. This is approximated by current Pilot model build up of an embedding of QM within a more elaborate super structure.

c) The types of discontinuities presented, in Eq. (42), in Eq. (22), Eq. (14), Eq. (15) are ways to the necessity of $\left|\frac{\eta}{s} \approx \varepsilon^{+}\right| << \frac{1}{4\pi}$ giving only $\eta \neq 0, \varepsilon \to \infty$, instead of $\eta \to 0^{+}$, with **the later case designating when entropy vanishes, which would correspond to no information from prior universes being transferred. I.e. non zero viscosity corresponding to, with almost infinite energy, of when the approach to Octonionic gravity occurs. The other case when viscosity vanishes would be tantamount to when no information is exchanged.**

Understanding the nature of the ergotic mapping in Eq. (53) and Eq. (54) would allow for a rigorous understanding of **the necessity of** $\left|\frac{\eta}{s} \approx \varepsilon^{+}\right| << \frac{1}{4\pi}$ giving only $\eta \neq 0, \varepsilon \to \infty$, instead of $\eta \to 0^{+}$ for determining how K essence physics can contribute to emergent structure. In doing so, we see first Analog physics in pre Planckian space time, then, briefly the formation of Digital reality

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