Is a VeV due to the Bunch-Davies vacuum fluctuation a way to obtain Octonionic Quantum Gravity in the Planckian Regime of Space time? YES, but only after Planck time t_{planck}

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Abstract: Linking a shrinking prior universe via a wormhole solution for a pseudo time dependent Wheeler-De Witt equation permits the formation of a short-term quintessence scalar field. We claim that our model and the addition of the wormhole is tied to an initial configuration of the Einstein field equations, allowing for high-frequency gravitational waves (HFGW) at the onset of inflation. We examine Bunch-Davies vacuum fluctuations[1] of a scalar field, $\left\langle \delta\phi^2 \right\rangle_{reg} = 3H^4 / 8\pi^2 m^2$, if we use the wave function for an average value of the Hubble parameter $H \equiv \langle H \rangle \propto \int \Psi^* H \Psi dV$, with VeV resulting from Ψ of a pseudo time dependent WdW wave function [2],[3], and H from initial values of the Friedman equation. The benefit from defining the Bunch-Davies vacuum fluctuation this way is that there would be a way to obtain partial time evolution of the VeV and also to ask if Octonionic quantum gravity[2] constructions are relevant in the Planckian regime of space time.

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INTRODUCTION

We begin first with a restatement of the physics that leads to a wormhole solution for early-universe transferal of vacuum energy from a prior universe to today's expanding universe. The main contention of this paper is that we need to go back to early universe conditions to determine optimal conditions for graviton production. **Having stated this initial value for graviton production touches upon the issue as to the direction of time flow. As brought up by Beckwith, and Glinka [4],** (assuming a vacuum energy $\rho_{Vacuum} = [\Lambda / 8\pi \cdot G]$ initially), with Λ part of a closed FRW Friedman Equation solution.

$$a(t) = \frac{1}{\sqrt{\Lambda/3}} \cosh\left[\sqrt{\Lambda/3} \cdot t\right] \tag{1}$$

to a flat space FRW equation of the form [4]

$$\left[\frac{\dot{a}}{a}\right]^2 + \frac{1}{a^2} = \frac{\Lambda}{3} \tag{2}$$

Which is so one forms a 1-dimensional Schrodinger equation [4],[5], [6]

$$\left[\frac{\partial^2}{\partial \cdot \tilde{a}^2} - \frac{9\pi^2}{4G^2}\left[\tilde{a}^2 - \frac{\Lambda}{3}\tilde{a}^4\right]\right]\psi = 0 \tag{3}$$

, with $\tilde{a}_0$ a turning point to potential [4],[5],[6]

$$U(a) = \frac{9\pi^2}{4G^2}\left[\tilde{a}^2 - \frac{\Lambda}{3}\tilde{a}^4\right]. \tag{4}$$

What we are doing afterwards is refinement as to this initial statement of the problem in terms of giving further definition of the term $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$ in terms of an initial VeV state. After stating the existence of a worm hole contribution for the initial VeV of a scalar nucleation via a regular vacuum expectation value depending upon an evolving in time Hubble parameter , as stated above, we examine what the consequences are if the Hubble parameter $H \equiv \langle H \rangle \propto \int \Psi^* H \Psi dV$ are . To begin with the Octonionic gravity construction we are considering for analysis, we work on transforming an initial black hole positioned as a coherent state, via work done by Crowell[2], into an initial VeV state [1] as given by $\langle \delta\phi^2 \rangle_{reg} = 3H^4 / 8\pi^2 m^2$,[1] ,via use of $H \equiv \langle H \rangle \propto \int \Psi^* \tilde{H} \Psi dV$ as a time evolving 'driver' to the inflaton, as presented in $V \sim \frac{1}{2} \cdot m^2 \langle \delta\phi^2 \rangle_{reg} \sim 3\langle H \rangle^4 / 16\pi^2$, as a potential system of inflaton energy, to give a tie in with it to $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$. The present day value of Λ is known and is indeed very low, as can be accessed via arguments given by Park, [7]. This present construction is a way of coming up with initial Λ vacuum energy values, i.e. a relationship between initial $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$ results and a value for $V \sim 3\langle H \rangle^4 / 16\pi^2$. The key driver to all of this would be $H \equiv \langle H \rangle \propto \int \Psi^* \tilde{H} \Psi dV$. A way forward for such a statement would be to define $\langle H \rangle \propto \int \Psi^* \tilde{H} \Psi dV$ in terms of $\tilde{H}^2 = 4\pi G \tilde{a} T^4 N(T) / 3c^2$ as presented by R. Sanders [8], with N(T)~1000 initially as given by Beckwith[9] , and $\tilde{a}$ is the so called radiation constant. Also, how T evolves would be a function of time and distance, in initial conditions. Typically, as given by Sanders[8] a time relationship as give for radiation dominated conditions has time $t = \left(2.5 / [T(MeV)]^2 \sqrt{N(T)}\right)$ seconds. If we assume that initially the $[T(MeV)]^4 = \left(2.5 / [t(\sec)] \sqrt{N(T)}\right)^2$, and that what leaves the worm hole is close to the speed of light in travel, then if the t = v times distance, if we have a velocity at the speed of light , then we can write, $[T(MeV)]^4 = \left(2.5 / [t(\sec) = c \cdot r] \sqrt{N(T)}\right)^2$ where r is a spatial distance traveled. Then,

$$\tilde{H}^2 = 4\pi G \tilde{a} T^4 N(T) / 3c^2 = 4\pi G \tilde{a} \cdot (2.5 / c \cdot r) / 3c^2 \tag{5}$$

Having said that, with $\tilde{H}^2 = 4\pi G \tilde{a} T^4 N(T) / 3c^2$ [8] in terms of a specific function, r, of distance, usually of the order of Planck length, it is time now to look at how to form the WdW wave functions used in $\langle H \rangle \propto \int \Psi^* \tilde{H} \Psi dV$

HOW A WORMHOLE FORMS

The Friedman equation referenced in this paper allows for determining the rate of cosmological expansion. Mukhanov [10] provides the easiest derivation of this equation. The usual way is to start with the energy-momentum tensors of cosmic matter-energy and from there go to the Einstein field equation to show how the universe expands. The basics of this are in the observation that the strength of gravitational fields not only depends on energy density, but also pressure. The rescaled "distance term" $a(t)$ is part of an equation that is similar to the Newtonian equations used for the derivative of energy density with respect to time, with additional space-time metrics used to show the interrelationship of space-time components combined by the Einstein version of the stress-energy tensor. By necessity, if we look at the Friedman equation, we need to look at a metric for space-time. And wormholes are used as a way to obtain conditions for sufficient energy to be transferred from a prior to present universe to initiate relic graviton production at the onset of the universe's expansion..The wormhole picked is the so called Lorentzian Wormhole used by Visser [11] (1996) to form a bridge between two space-time configurations. Lorentzian wormholes have been modeled thoroughly. Visser [11] (1995) states that in the wormhole solution, there is not an event horizon hiding a singularity, i.e., there is no singularity in the wormhole held open by dark energy. resenting a wormhole as a bridge between a prior to a present universe, as Crowell [2], [3] refers to in his reference on quantum fluctuations of space-time. The equation for thermal/vacuum energy flux that leads to a wormhole uses a pseudo time- like space coordinate in a modified Wheeler-De Witt equation for a bridge between two universes. The wormhole solution is dominated by a huge vacuum energy value. This paper uses a special metric that is congruent with the Wheeler-De Witt equation, which can be explained as follows. If one rewrites the Friedmann equation using Classical mechanics, we can obtain a Hamiltonian, using typical values of $H = p_a \cdot \dot{a} - L$. Where p_a can be roughly thought of as the "momentum" of the scale factor a(t), and L is the Lagrangian of our modeled system. The most straightforward presentation of this can be seen in Dalarsson[5] . Afterwards, momentum is quantized via $p_a = i\hbar \frac{\partial}{\partial a}$, and then with some rewrite initially, one can come up with a time-independent equation looking like $H \cdot \Psi = 0$. Crowell, among others, found a way to introduce a pseudo-time component that changed the $H \cdot \Psi = 0$ equation to one that has much the same flavor as a pseudo-WKB approximation to the Schrodinger equation. This, with some refinements, constitutes what we used for forming a "wormhole" bridge.

We referenced the Reissner-Nordstrom metric.. Crowell [2] used this solution as a model of a bridge between a prior universe and our own. To show this, one can use results from Crowell [2] on quantum fluctuations in space-time, which provides a model from a pseudo time component version of the Wheeler De Witt equation, using the Reinssner-Nordstrom metric to help obtain a solution that passes through a thin shell separating two space-times. The radius of the shell, $r_0(t)$ separating the two space-times is of length l_P in approximate magnitude, leading to a multiplication of the time component for the Reissner-Nordstrom metric [2], [3]:

$$dS^2 = -F(r) \cdot dt^2 + \frac{dr^2}{F(r)} + d\Omega^2 \quad . \tag{6}$$

This has [3]:

$$F(r) = 1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} \cdot r^2 \xrightarrow[T \to 10^{32}\ Kelvin \sim \infty]{} - \frac{\Lambda}{3} \cdot (r = l_P)^2 \quad . \tag{7}$$

Note that Equation (7) referenced above is a way to link this metric to space-times via the following model of energy density equation, linked to a so called "membrane" model of two universes separated by a small "rescaled distance" $r_0(t)$. In practical modeling, $r_0(t)$ is usually of the order of magnitude of the smallest possible unit of space-time, the Planck distance, $l_P \sim 10^{-35} cm$, a quantum approximation put into general relativity.. The equation linking Eqn.(7) to energy density ρ is of the form [2],[3]:

$$\rho = \frac{1}{2\pi \cdot r_0} \cdot \sqrt{F(r_0) - r_0^2} \quad . \tag{8}$$

Frequently, this is simplified with the term, $\dot{r}_0(t) \cong 0$. In addition, following temperature dependence of this parameter, as outlined by Park [3],[7] leads to

$$\frac{\partial F}{\partial r} \sim -2 \cdot \frac{\Lambda}{3} \cdot (r \approx l_P) \equiv \eta(T) \cdot (r \approx l_P) \quad . \tag{9}$$

This is a wave functional solution to a Wheeler De Witt equation bridging two space-times. The solution bridging two space-times is similar to one made by Crowell [2], [3] between these two space-times with "instantaneous" transfer of thermal heat:)

$$\Psi(T) \propto -A \cdot \{\eta^2 \cdot C_1\} + A \cdot \eta \cdot \omega^2 \cdot C_2 \quad . \tag{10}$$

This equation has $C_1 = C_1(\omega, t, r)$ as a cyclic and evolving function of frequency, time, and spatial function, also applicable to $C_2 = C_2(\omega, t, r)$ with, $C_1 = C_1(\omega, t, r) \neq C_2(\omega, t, r)$ It is asserted here that a thermal bridge in wormhole form exists as a bridge between a prior and present universe. Furthermore, it is asserted that the existence of this bridge is part of a necessary condition for thermal energy transfer between a prior and present universe. The prior universe shrinks to a singularity at the time that thermal energy is transferred to our present universe, thereby helping to initiate cosmological inflation. dominated This is due in part to the absolute value of the five-dimensional "vacuum state" parameter varying with temperature T, as Beckwith writes [3]:

$$|\Lambda_{5-\dim}| \approx c_1 \cdot (1/T^{\alpha}) \quad . \tag{11}$$

This contrasts with the more traditional four-dimensional version of the same, without the minus sign of the brane world theory version (i.e., the four-dimensional cosmological constant grows large and is a positive valued expression at the same time that the five- dimensional vacuum energy expression shrinks in value and has a negative value). The five-dimensional version is based on brane theory and higher dimensions, whereas the four-dimensional version is linked to more traditional De Sitter space-time geometry, as given by Park [7]:

$$\Lambda_{4-\dim} \approx c_2 \cdot T^{\beta}. \tag{12}$$

Looking at the range of allowed upper bounds of the cosmological constant, one can note the difference between what Park [7] predicted (a nearly infinite four-dimensional cosmological constant) and Barvinsky [3], [12] , who specified an upper limit of 360 times the square of Planck's mass m. This indicates that a phase transition is occurring within a Planck interval of time.. This allows for a brief interlude of quintessence. This assumes that a release ofgravitons occurs, which leads to a removal of graviton energy stored contributions to this cosmological parameter, with m_P as the Planck mass, i.e. the mass of a black hole of "radius" on the order of magnitude of Planck length $l_P \sim 10^{-35}$ m. This leads to Planck's mass $m_P \approx 2.17645 \times 10^{-8}$ kilograms, as alluded to by Barvinsky [3], [12].

$$\Lambda_{4-\dim} \propto c_2 \cdot T \xrightarrow[\text{graviton-production}]{} 360 \cdot m_P^2 << c_2 \cdot [T \approx 10^{32} K] \quad . \tag{13}$$

Right after the gravitons are released, there is still a drop off of temperature contributions to the cosmological constant. For a small time value, $t \approx \delta^1 \cdot t_P$,where $0 < \delta^1 \leq 1$ and for temperatures sharply lower than= 10 to the 32nd power Kelvin, this difference is the ratio of the value of the four-dimensional version of the cosmological constant divided by the absolute value of the five dimensional cosmological constant, which is equal to 1 plus 1/n, where n is a positive integer. This assumes Beckwith's [3] result, where the four-dimensional cosmological constant parameter sharply decreases in value with decreasing temperature, while the absolute value of the five-dimensional cosmological parameter grows, leading to n growing far larger. Eventually, with an increase of time to about the Planck time interval, the 1/n values goes to zero, and the values of the ratio of the cosmological parameters remains in the same relative magnitude. (The five-dimensional cosmological parameter in absolute magnitude is a very large vacuum energy value.) This drop in temperature occurs because energy is removed due to the release of relic gravitons during a phase transition from a nearly infinite thermally based Park value of the cosmological constant to Barvinsky's [12] much smaller value of the cosmological constant. . The initial temperature is in the range of needed thermal excitation levels required for quantum gravity processes to be initiated at the onset of a new universe nucleation. Energy is removed due to the release of relic gravitons during a phase transition from a nearly infinite thermally based Park value of the cosmological constant to Barvinsky's [12] much smaller value.

$$\frac{\Lambda_{4-\dim}}{\left|\Lambda_{5-\dim}\right|}-1\approx\frac{1}{n} \quad . \tag{14}$$

The transition outlined in Eqn. (12) [3], [12] above has a starting point with extremely high temperatures given by a vacuum energy transferal between a prior universe and our present universe, as outlined by Eqn. (13) and Eqn. (9) above; whereas the regime where there is an upper bound to vacuum energy in four dimensions is outlined in Eqn. (14) above. We will next then, look at this model for

. The Bunch-Davies vacuum fluctuation, with WdW pseudo time component behavior put in a value for the Hubble parameter

Using a potential energy of the form

$$V \sim 3\langle H\rangle^4 / 16\pi^2 \tag{15}$$

We will next consider what happens with an approximation of the Hubble term given in Eq. (15) above which is in this case

$$\langle H\rangle \propto \int \Psi^* \tilde{H}\Psi dV = 4\pi G\tilde{a}\cdot(2.5)/3c^3 \int \Psi^* \cdot \left[r^{-1}\right]\cdot\Psi dV \tag{16}$$

Eq. (16) says something which we should expect, i.e. that the range of integration should be from a reference point zero, if that can be imagined, out to at least a Planck length in radial evolution, and not averaged over –r to +r , with the r being a nominal spatial averaging from pre inflation conditions to the onset of inflation. I.e. there is no way to define a Hubble parameter, in any shape or form for that sort of evolution. So then what can be sensibly said about evaluating $\int \Psi^* \cdot \left[r^{-1}\right]\cdot\Psi dV$? Note that [2] here,

$$\begin{aligned}\Psi(T) &\propto -A\cdot\left\{\eta^2\cdot\left[4\sqrt{\pi}\,\frac{t}{2\omega^5}\,J_1(\omega\cdot r)+\frac{4}{\omega^5}\left(\sin(\omega\cdot r)+(\omega\cdot r)\cdot\cos(\omega\cdot r)\right)+\frac{15}{\omega^5}\cdot\cos(\omega\cdot r)-\frac{6}{\omega^5}\cdot Si\cdot(\omega\cdot r)\right]\right\} \\ &+A\cdot\eta\cdot\omega^2\cdot\left\{\frac{3}{2\omega^4}\cdot\left(1-\cos(\omega\cdot r)\right)-4\exp(-\omega\cdot r)+\frac{6}{\omega^4}\cdot Ci\cdot(\omega\cdot r)\right\}\end{aligned} \tag{17}$$

The coefficients in this treatment of the wave function need to be explained, i.e. J_1 is a Bessel function of the first kind whereas $Si\cdot(\omega\cdot r)$ is a sine integral of the form $\int_{-\infty}^{x}\sin x' dx'/x'$ and $Ci\cdot(\omega\cdot r)$ is about $\int_{-\infty}^{x}\cos x' dx'/x'$

Also, $\eta\cdot r\cong\frac{\partial F(r)}{\partial r}$ when $\frac{\partial F}{\partial r}\sim -2\cdot\frac{\Lambda}{3}\cdot\left(r\approx l_P\right)\equiv\eta(T)\cdot\left(r\approx l_P\right)$. I.e η is scaled with the negative value of Λ . What is written above, for five dimensional treatments of Λ with 1/temperature, mean that there is a reduction of this Λ. Note, that as given by Crowell [2], figure 2.10, page 60, that for very small values of r, that η is very small, but non vanishing. Crowell claims that $\Psi(T)$ is very small but non vanishing. If this is the case, and one has

$$\int \Psi^* \cdot \left[r^{-1}\right]\cdot\Psi dV \propto \left|\Psi\right|^2 \int \frac{1}{r} dV \sim \left|\Psi\right|^2\left(V\approx l_{Planck}^3\right) \tag{18}$$

Crowell's Figure 2.9[2] indicates that there would be a rise from nearly zero to a peak frequency for a unit increase in frequency up to a full 'unit . This was for a $\Lambda \sim 3$ numerically. I.e. if one has a frequency which is based upon a thermal energy input from a prior universe, one could probably have a peak value of the Hubble parameter at a unit value of frequency, with a non linear plot from a zero value. I.e. it would be a chaotic rise, in line with another model we will present below. Here, we are assuming that $T_{temperature}\varepsilon\left(0^+,10^{19}GeV\right)$, and, then we can use

$\tilde{\beta} \approx |F| \equiv \frac{5}{2} k_B T \cdot \overline{N}$, as a free energy[9]. And this parameter, if $\dddot{N}$, as an initial entropy , arrow of time starting configuration, were fixed, then the change in temperature would lead to change in 'free energy' , so that work, is here, change in energy, and dE = TdS – p dV, with work is force times distance. In basic physics, this would lead to force being work (here, change in energy) divided by distance. In this case, $\Delta\tilde{\beta} \cong (5k_B \Delta T_{temp} / 2) \cdot \overline{N} \sim$ Force times $dist$ =distance

Increase in degrees of freedom in the sub Planckian regime.

Starting with [9]

$$E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto [\Omega_0 \breve{T}] \sim \tilde{\beta} \tag{19}$$

The assumption would be that there would be an initial fixed entropy arising, with $\overline{N}$ a nucleated structure arising in a short time interval as a temperature $T_{temperature} \varepsilon (0^+, 10^{19} GeV)$ arrives. So then, one will have, dimensionally speaking [13],

$$\frac{\Delta\tilde{\beta}}{dist} \cong (5k_B \Delta T_{temp} / 2) \cdot \frac{\overline{N}}{dist} \sim qE_{net-electric-field} \sim [T\Delta S / dist] \tag{20}$$

The parameter, as given by $\Delta\tilde{\beta}$ will be one of the parameters used to define chaotic Gaussian mappings. Candidates as to the inflaton potential would be in powers of the inflaton, i.e. in terms of ϕ^N , with N=4 effectively ruled out, and perhaps N=2 an admissible candidate (chaotic inflation). For N = 2, one gets [9], [13],[14]

$$[\Delta S] = [\hbar / T] \cdot \left[2k^2 - \frac{1}{\eta^2} \left[M_{Planck}^2 \cdot \left[\left[\frac{6}{4\pi} - \frac{12}{4\pi} \right] \cdot \left[\frac{1}{\phi} \right]^2 - \frac{6}{4\pi} \cdot \left[\frac{1}{\phi^2} \right] \right] \right] \right]^{1/2} \sim n_{Particle-Count} \tag{21}$$

If the inputs into the inflaton, as given by ϕ^2 become from the Bunch-Davies treatment discussed above, a random influx of thermal energy from temperature, we will see the particle count on the right hand side of Eq. (21) above a partly random creation of $n_{Particle-Count}$ which we claim has its counter part in the following treatment of an increase in degrees of freedom.

Namely, we look at In a word, the way to introduce the expansion of the degrees of freedom from nearly zero, at the maximum point of contraction to having **N(T)~ 10^3** is to first of all 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.[13], [15]

I.e. classical physics, with smoothness of space time structure down to a gird size of $l_{Planck} \sim 10^{33}$ centimeters at the start of inflationary expansion. Have, when doing this construction what would be needed would be to look at the maximum point of contraction, set at $l_{Planck} \sim 10^{33}$ centimeters as the quantum 'dot' , as a de facto measure zero set, as the bounce point, with classical physics behavior before and after the bounce 'through' the quantum dot.[13]

Dynamical systems modeling could be directly employed right 'after' evolution through the 'quantum dot' regime, with a transfer of crunched in energy to Hemoltz free energy, as the driver 'force' for a Gauss map type chaotic diagram right after the transition to the quantum 'dot' point of maximum contraction. The diagram, in a bifurcation sense would look like an application of the Gauss mapping of [9], [13], [15]

$$x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i^2\right] + \tilde{\beta} \tag{22}$$

In dynamical systems type parlance, one would achieve a diagram, with tree structure looking like what was given by Binous [14], using material written up by Lynch [9], [16] , i.e. by looking at his bifurcation diagram for the Gauss map .Binous's demonstration plots the bifurcation diagram for user-set values of the parameter . Different values of the parameter lead to bifurcation, period doubling, and other types of chaotic dynamical behavior. For the authors purposes, the parameter x_{i+1} and x_i^2 as put in Eq. (22) would represent the evolution of number of number of degrees of freedom, with ironically, the near zero behavior, plus a Hemoltz degree of freedom parameter set in as feed into $\tilde{\beta}$. In a word, the quantum 'dot' contribution would be a measure set zero glitch in the mapping given by Eq. (22), with the understanding that where the parameter $\tilde{\beta}$ 'turns on' would be right AFTER the 'bounce' through the infinitesimally small quantum 'dot' regime. Far from being trivial, there would be a specific interative chaotic behavior initiated by the turning on of parameter $\tilde{\beta}$,corresponding as brought up by Dickau [17] as a connection between octo-octonionic space and the degrees of freedom available at the beginning of inflation. I.e. turning on the parameter $\tilde{\beta}$ would be a way to have Lisi's E8 structure [18] be nucleated at the beginning of space time.As the author sees it, $\tilde{\beta}$ would be proportional to the Hemoltz free energy, F, where as Mandl [19] relates, page 272, the usual definition of F=E - TS , becomes, instead, here, using partition function, Z, with $\overline{N}$ a 'numerical count factor', so that [9],[13], [19]

$$F = -k_B T \cdot \ln Z(T,V,\overline{N}) \tag{23}$$

Note that Y. Jack Ng.[20] sets a modification of $Z_N \sim \left(\frac{1}{N!}\right) \cdot \left(\frac{V}{\lambda^3}\right)^N$ as in the use of his infinite quantum statistics, with the outcome that [5] $F = -k_B T \cdot \ln Z(T,V,\overline{N}) \equiv -k_B T N\left[\ln(V/\lambda^3) + 5/2\right]$ with V ~ (Planck length)^3 , and the Entropy obeying [9], [20]

$$S \approx N \cdot \left(\log\left[V/N\lambda^3\right] + 5/2\right) \xrightarrow[Ng-\inf inite-Quantum-Statistics]{} N \cdot \left(\log\left[V/\lambda^3\right] + 5/2\right) \approx N \tag{24}$$

Such that the free energy, using Ng. infinite quantum statistics reasoning would be [5], [20] a feed into a nucleated structure, A structure which will be examined in the next section via looking at the absolute value of $F = -k_B T \cdot \ln Z(T,V,\overline{N}) \equiv -\frac{5}{2} \cdot k_B T \overline{N}$. Note, here, that the absolute value of F given is a driver to chaotic dynamics, while $x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i^2\right] + \tilde{\beta}$, has $\tilde{\beta} \cong |F|$, with coefficient $\tilde{\beta} \cong |F|$ turning on at the start of the inflationary era due to a temperature flux starting as a driving force, and $\tilde{\alpha}$ being a coefficient of damping of degrees of freedom to near zero, as the contraction phase of the 'universe' , while x_i ~ degree of degrees of freedom, which would grow dramatically, once $\tilde{\beta} \cong |F|$ turns on .

Consequences of having a radical increase in the degrees of freedom initially.

The main idea is,that $\tilde{\beta}$ increasing up to a maximum temperature T would enable the evolution and spontaneous construction of the Lisi E8 structure as given by [18]. As Beckwith wrote up [9], including in additional energy due to an increase of $\tilde{\beta}$ due to increasing temperature T would have striking similarities to the following. We argue that the increase in degrees of freedom is connected to a nucleation space for particles, according to the following argument. Observe the following argument as given by V. F. Mukhanov, and Swinitzki [9], [22] , as to additional particles being 'created' due to what is an infusion of energy in an oscillator , obeying the following equations of motion [9], [22]

$$\ddot{q}(t) + \omega_0^2 q(t) = 0, \text{ for } t < 0 \text{ and } t > \breve{T};$$

$$\ddot{q}(t) - \Omega_0^2 q(t) = 0, \text{ for } 0 < t < \breve{T} \tag{25}$$

,Given $\Omega_0 \breve{T} >> 1$, with a starting solution of $q(t) \equiv q_1 \sin(\omega_0 t)$ if t <0, Mukhanov state that for [9], [22] $t > \breve{T};$

$$q_2 \approx \frac{1}{2}\sqrt{1 + \frac{\omega_0^2}{\Omega_0^2}} \cdot \exp\left[\Omega_0 \breve{T}\right] \tag{26}$$

The Mukhanov et al argument [9],[22]leads to an exercise which Mukhanov claims is solutions to the exercise yields an increase in number count, as can be given by setting the oscillator in the ground state with $q_1 = \omega_0^{-1/2}$, with the number of particles linked to amplitude by $\breve{n} = [1/2] \cdot \left(q_0^2 \omega_0 - 1\right)$, leading to [9],[22]

$$\breve{n} = [1/2] \cdot \left(1 + \left[\omega_0^2 / \Omega_0^2\right]\right) \cdot \sinh^2\left[\Omega_0 \breve{T}\right] \tag{27}$$

I.e. for non zero $\left[\Omega_0 \breve{T}\right]$, Eq (27) leads to exponential expansion of the numerical state. For sufficiently large $\left[\Omega_0 \breve{T}\right]$, Eq. (25) and Eq. (26) are equivalent to placing of energy into a system, leading to vacuum nucleation. A further step in this direction is given by Mukhanov on page 82 of his book leading to a Bogoluybov particle number density of becoming exponentially large [9],[22]

$$\breve{\breve{n}} \sim \cdot \sinh^2\left[m_0 \eta_1\right] \tag{28}$$

Eq. (26) to Eq. (27) are , for sufficiently large $\left[\Omega_0 \breve{T}\right]$ a way to quantify what happens if initial thermal energy are placed in a harmonic system, leading to vacuum particle ' creation' Eq. (28) is the formal Bogolyubov coefficient limit of particle creation . Note that $\ddot{q}(t) - \Omega_0^2 q(t) = 0,$ for $0 < t < \breve{T}$ corresponds to a thermal flux of energy into a time interval $0 < t < \breve{T}$. If $\breve{T} \approx \left[t_{Planck} \propto 10^{-44} \sec\right]$ or some multiple of t_{Planck} and if $\Omega_0 \propto 10^{10}\, Hz$, then Eq (25), and Eq. (27) plus its generalization as given in Eq. (28) may be a way to imply either vacuum nucleation , or transport of gravitons from a prior to the present universe.

Furthermore, consequence of Verlinde's [22] generalization of entropy, and the number of 'bits' yields the following consideration, which will be put here for startling effect. Namely, if a net acceleration is such that $a_{accel} = 2\pi k_B cT / \hbar$ as mentioned by Verlinde [22], as an Unruh result, and that the number of 'bits' is

$$n_{Bit} = \frac{\Delta S}{\Delta x} \cdot \frac{c^2}{\pi \cdot k_B^2 T} \approx \frac{3 \cdot (1.66)^2 g^*}{\left[\Delta x \cong l_p\right]} \cdot \frac{c^2 \cdot T^2}{\pi \cdot k_B^2} \tag{29}$$

This Eq. (29) has a T^2 temperature dependence for information bits , as opposed to [9]

$$S \sim 3 \cdot \left[1.66 \cdot \sqrt{\breve{g}_*}\right]^2 T^3 \sim n_f \tag{30}$$

Should the $\Delta x \cong l_p$ order of magnitude minimum grid size hold, then conceivably when T ~ 10^{19} GeV[9]

$$n_{Bit} \approx \frac{3 \cdot (1.66)^2 g^*}{\left[\Delta x \cong l_p\right]} \cdot \frac{c^2 \cdot T^2}{\pi \cdot k_B^2} \sim 3 \cdot \left[1.66 \cdot \sqrt{\breve{g}_*}\right]^2 T^3 \tag{31}$$

The situation for which one has [9] $\Delta x \cong l^{1/3} l_{Planck}^{2/3}$ with $l \sim l_{Planck}$ corresponds to $n_{Bit} \propto T^3$ whereas $n_{Bit} \propto T^2$ if $\Delta x \cong l^{1/3} l_{Planck}^{2/3} >> l_{Planck}$.

SETH LLOYD'S UNIVERSE AS A MODIFIED QUANTUM COMPUTER MODEL

Many people would not understand why computational models of the universe would be important to either cosmology or to propulsion. What we establish though this model is a way to explain why the dominant contribution to gravity waves from a wormhole transferal of vacuum energy to our present universe is tilted toward a dominant high-frequency spectrum.

One can make use of the formula given by Seth Lloyd [3], [23], which relates the number of operations the "Universe" can "compute" during its evolution. Lloyd [23] uses the idea, which he attributed to Landauer, to the effect that the universe is a physical system that has information being processed over its evolutionary history. Lloyd also makes reference to a prior paper where he attributes an upper bound to the permitted speed a physical system can have in performing operations in lieu of the Margolis/Levitin theorem, with a quantum mechanically given upper limit value (assuming E is the average energy of the system above a ground state value), obtaining a *first limit* of a quantum mechanical average energy bound value, if $\#operations/\sec = \tilde{N}$:

$$\tilde{N} \leq 2E/\pi\hbar \quad . \tag{32}$$

The second limit is the number of operations, which is linked to entropy, due to limits to memory space, as Lloyd writes:

$$\tilde{N} \cdot \sec \leq S(entropy)/(k_B \cdot \ln 2) \quad . \tag{33}$$

What we are suggesting, is that in both Eq. (32) and Eq. (33) that we replace the upper bound limits of both of the equations with

$$\tilde{N} \leq 2 \cdot (V(scalar - potential))/\pi\hbar . \approx 2 \cdot \left[V \sim 3\langle H \rangle^4 / 16\pi^2 \right] / \pi\hbar \tag{34}$$

Also, too, to compare the above, with Eq. (33), and to look at Eq. (30) as well, as to understand the inter relationship between entropy, and a Bunch-Davies treatment of an inflaton potential, as varied and affected by LQG with a pseudo time component. The problem as we will outline just below, though, is that there may be effectively no way to transmit bits of information through a four dimensional continuum. To look at this, we need to consider

Connection with the directionality of time issue, for Planckian space – time

We are re duplicating part of the argument used, in order to make a point about the origins of the Bunch – Davies representation of the initial vacuum state. We note here a subtle point, i.e. if there is, in a four dimensional representation of Λ, with a temperature component, as given by Park [3],[7], that it is then necessary for a semi classical treatment of the wavefunction of the universe, to assume, initially that the TEMPERATURE of the pre Planckian space time state, would have to be zero. The argument as presented by Beckwith and Glinka is as follows.

1. Beckwith and Glinka [4] noted in a recent publication have argued that the wave function of the universe interpretation of the Wheeler-DeWitt equation depends upon a WKB airy function, which has its argument dependent upon z. When z ~ $\left(\frac{3\pi \cdot \tilde{a}_0^2}{4G}\right)^{2/3} \cdot \left[1 - \left[\frac{\tilde{a}^2}{\tilde{a}_0^2}\right]\right] \xrightarrow[\tilde{a} \to 0]{} \left(\frac{3\pi \cdot \tilde{a}_0^2}{4G}\right)^{2/3}$ right at the start of the big bang, the wave function of the universe is a small positive value, as given by Kolb and Turner [6]. Having $\tilde{a} \to 0$ corresponds to a classically forbidden region, with a Schrödinger equation of the form (assuming a vacuum energy $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$ initially), with Λ part of a closed FRW Friedman equation solution

$$a(t) = \frac{1}{\sqrt{\Lambda/3}} \cosh\left[\sqrt{\Lambda/3} \cdot t\right] \quad (35)$$

to a flat space FRW equation of the form [4]

$$\left[\frac{\dot{a}}{a}\right]^2 + \frac{1}{a^2} = \frac{\Lambda}{3} \qquad (36)$$

Which is so one forms a 1-dimensional Schrödinger equation to mimic the Wheeler-DeWitt equation [4]

$$\left[\frac{\partial^2}{\partial \cdot \tilde{a}^2} - \frac{9\pi^2}{4G^2}\left[\tilde{a}^2 - \frac{\Lambda}{3}\tilde{a}^4\right]\right]\psi = 0 \qquad (37)$$

with $\tilde{a}_0$ a turning point to potential

$$U(a) = \frac{9\pi^2}{4G^2}\left[\tilde{a}^2 - \frac{\Lambda}{3}\tilde{a}^4\right]. \qquad (38)$$

Note that as $\tilde{a} \to 0$, the wave function in a classical sense would never leave a potential system defined by U(a) and that much more seriously, the definition of a vacuum energy, as set by the 1-dimensional Schrödinger equation is not defined, properly for a FRW classical Friedman equation. .The vacuum energy, is for $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$, for definition of the Λ FRW metric, and is undefined for the regime $0 < \tilde{a} < 1/\sqrt{\Lambda/3}$. I.e. the classically undefined regions for evolution of Eq. (36) and Eq (37) are the same.

The problem is this, having $\tilde{a} \to 0$ makes a statement about the existence, quantum mechanically about having a (semi classical) approximation for ψ, when in fact the key part of the solution for ψ, namely $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$ is not definable for Eq. (36) if $0 < \tilde{a} < 1/\sqrt{\Lambda/3}$, whereas the classically forbidden region for Eq. (36) depends upon $0 < \tilde{a} < \tilde{a}_0$ where $\tilde{a}_0$ is a turning point for Eq. (38) above. Λ is undefined classically, and is a free parameter, of sorts especially in the regime $0 < \tilde{a} < 1/\sqrt{\Lambda/3}$. As $\tilde{a} \to 0$, unless $\Lambda \to 0$, there is no "classical" way to justify the WKB as $\tilde{a} \to 0$. $\Lambda \to 0$, according to Park in a four dimensional space time if and ONLY if, the temperature in the pre Planckian space time condition were initially equal to ZERO. I.e. if there is such a regime, it means that in an interval of space time just before the Planckian regime that two conditions would happen. For times less than a Planck time interval, the following are equivalent[4]

1. $\Lambda_{4-Dim} \to 0$ if there is time BEFORE Planck time, i.e. 10^{-44} seconds, corresponding to an effective, for OUR universe zero temperature[4]

2. $\rho_{Vacuum}\big|_{4-Dim} = [\Lambda_{4-Dim}/8\pi \cdot G] \to 0$

The authors argue, that in order to make the above two conditions match up, that there has to be a causal discontinuity in 5 dimensional space time , i.e. perhaps only information which can be transmitted via evolution of the Hubble parameter would pass from a prior to the present cycle. I.e. temperature, which presumably would be transferred via a higher, fifth dimension

Causal discontinuity, and Dowkers axiomatic approach to space time physics time in the aftermath of the pre Planckian space time regime 5 dimensional discontinuity

The existence of a nonlinear equation for early universe scale factor evolution introduces a de facto "information" barrier between a prior universe, which can only include thermal bounce input to the new nucleation phase of our present universe. To see this, refer to Dr. Dowker's [24] paper on causal sets. These require the following ordering with a relation $\prec$, where we assume that initial relic space-time is replaced by an assembly of discrete elements, so as to create, initially, a partially ordered set [3],[24] C :

(1) If $x \prec y$, and $y \prec z$, then $x \prec z$

(2) If $x \prec y$, and $y \prec x$, then $x = y$ for $x, y \ \ \varepsilon \ \ C$

(3) For any pair of fixed elements x and z of elements in C, the set $\{y \mid x \prec y \prec z\}$ of elements lying in between x and z is always assumed to be a finite valued set.

Items (1) and (2) show that C is a partially ordered set, and the third statement permits local finiteness. Stated as a model for how the universe evolves via a scale factor equation permits us to write, after we substitute $a(t^*) < l_P$ for $t^* < t_P =$ Planck time, and $a_0 \equiv l_P$, and $a_0 / a(t^*) \equiv 10^{\alpha}$ for $\alpha >> 0$ into a discrete equation model of a 5 dimensional model of the Friedman equation would lead to the existence of a de facto causal discontinuity in the arrow of time and blockage of information flow, once the scale factor evolution leads to a break in the causal set construction written above [3].

CLAIM 1 : The Friedmann equation for the evolution of a scale factor $a(t)$, 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: in 5 dimensions looking at Λ_{5-Dim} going to infinity as time goes to zero. I.e. if $\delta \cdot t$ is vanishingly small, then[3]…

$$\left[\frac{a(t^* + \delta t)}{a(t^*)}\right] - 1 < \frac{\left(\delta t \cdot l_P\right)}{\sqrt{\Lambda_{5-Dim}/3}} \cdot \left[1 + \frac{8\pi}{\Lambda_{5-Dim}} \cdot \left[(\rho_{rel})_0 \cdot 10^{4\alpha} + (\rho_m)_0 \cdot 10^{3\alpha}\right]\right]^{1/2} \xrightarrow[\Lambda 5-\dim \to \infty]{} 0 \quad . \quad (39)$$

So in the initial phases before the big bang, with a very large 5 dimensional vacuum energy and a vanishing 4 dimensional vacuum energy , the following relation, which violates (signal) causality, is obtained for any given fluctuation of time in the "positive" direction within the confines of time evolution within the pre Planckian regime :

$$\left[\frac{a(t^* + \delta \cdot t)}{a(t^*)}\right] < 1 \quad . \tag{40}$$

The existence of such a violation of a causal set arrangement in the evolution of a scale factor argues for a break in information above a minimal level of complexity being propagated from a prior universe to our present universe. This has just proved non-partially ordered set evolution, by deriving a contradiction from the partially ordered set assumption.Doing this, means that in order to cement having uni directionality of the time flow itself, we would need to define a starting flow for time flow, in one direction starting at the instant of space time created by the Planckian unit of time, and not just before it. We also make a 2nd claim which will be, in five dimensions stated as follows [3]:

CLAIM 2: The following are equivalent (In a space-time evolution sense? $\big)$

1. There exists a Reisnner-Nordstrom Metric with -F(r) dt^2 dominated by a cosmological vacuum energy term, $(-\Lambda/3)$ times dt^2, for early universe conditions in the time range less than or equal to Planck's time t_P.
2. A solution for a pseudo-time dependent version of the Wheeler De Witt equation exists, with a wave function $\Psi(r,t,T)$ forming a wormhole bridge between two universe domains, with

$\Psi(r,t,T) = \Psi(r,-t,T)$ for a region of space-time before signal causality discontinuity for times $|t| < t_P$.

3. The heat flux-dominated vacuum energy value given by $\Psi(r,t,T)$ contributes to a relic graviton burst, in a region of time less than or equal to Planck's time t_P.

The third postulate of Claim 2, is in line with a minimum complexity of a structure which conceivably could transit from one universe to another.

Making sense of the impossible. What can we say about measurement of time flow and of Planckian space time ?

The above construction with its playing around with an inter – relationship between four and 5 dimensional space time representations seems to be saying that one cannot effectively probe the sub space within the Planckian space time regime. What do we make of this ? Dvali and Gomez [25] argued that the Planckian regime of space time as defined by the Planck time and Planck length as shortest intervals is the best we can do to define a rigorous treatment of space time via a back ground grid. I.e. their assumption is that a cosmological background defined by these parameters is unavoidable and unchangeable.

Our argument is different. We argue that in order to keep consistency with the Wheeler De Witt equation, and its semi classical approximation, that having an initial FOUR dimensional representation of the cosmological parameter as given by Park, for setting $\Lambda_{4-Dim} \to 0$ so that we can reconcile the Airy representation of the wave function of the universe, that we would have to have a de facto ZERO TEMPERATURE.

Carrying the duality farther, i.e. having $\Lambda_{4-Dim} \to 0$ being in tandem with $\Lambda_{5-Dim} \to \infty$ for a five dimensional embedding of a Friedman equation obeying Eq. (39) and Eq. (40) means that the arrow of time, as we can observe it is defined at the beginning of the Planckian time interval $t_{Planck} \sim 10^{-44}$ seconds, and not beforehand.

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

We argue that Eq. (39) and Eq. (40) are essential ingredients for starting a non commuting geometry construction of space time. Crowell [2] wrote on page 309 that in his Eq. (8.141) , namely

$$\left[x_j, p_i\right] \cong -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar T_{ijk} x_k \to i\hbar \delta_{i,j} \tag{41}$$

Here, β is a scaling factor, while we have, above, after a certain spatial distance, a Kroniker function so that at a small distance from the confines of Planck time, we recover our quantum mechanical behavior.

Here, this, as Crowell describes it, is a linkage between Planck scale physics, and the recovery at Planck scale of quantum geometry. His page 308 builds up Eq. (41) as a consequence of a supposed octonionic non association relation, and and an Octonionic product rule. [2]

Our contention is, that since Eq. (41) depends upon Energy- momentum being conserved as an average about quantum fluctuations, that if energy-momentum is violated, in part, that Eq. (41) falls apart completely.

How Crowell [2] forms Eq. (41) at the Planck scale depends heavily upon Energy- Momentum being conserved.

Our construction VIOLATES energy – momentum conservation, at least as far as an embedding of a Friedman Equation in 5 dimensions, making use of $\left|\Lambda_{5-\dim}\right| \approx c_1 \cdot \left(1/T^{\alpha}\right)$. and Eq. (14), i.e. $\frac{\Lambda_{4-\dim}}{\left|\Lambda_{5-\dim}\right|} - 1 \approx \frac{1}{n}$. [3]

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CONCLUSIONS

It would be useful to enumerate what has been presented. First, that there is a way to show that Dvali and Gomez [25] are correct about the Planckian regime up to a point , and the authors also found a way to state that the initial arrow of time problem is 'favoritized' in one direction [4] by the means of appealing to a causal set discontinuity [3] which Beckwith [3] presented to say that a time flow direction almost certainly could not back track , for reasons presented in this manuscript. Next, would be to enumerate what sort of structure formation is mandated by the above outlined paradigm.

For future research one should delineate in more detail what would be transferred, possibly by entanglement information transfer from a prior universe, to our own, as well as understand how additional bits of information came to be in the present Universe. It would be valuable, partly using the rich lore from liquid helium as outlined by Kopik [26] to see if there is a way to experimentally determine if the growth and the relative increase in structure and bits of "information," is in some sense connected with a cosmological equivalent to the vortex reconnection process outlined in liquid helium experiments. One guess is that there is actually a symmetry-breaking transition equivalent in early universe cosmology that could be experimentally duplicated. We do not view what Rtuu et al [27] as being the final word in this matter, and we would like to tie in structure formation in future work with the issue of a first principle creation of octonian gravity at Planck scale physics, as outlined by L. Crowell [2]. This would necessitate a re do of arguments presented by Beckwith [28], which will be done in the subsequent months and tied into relic gravitational wave/ graviton production in relic conditions. We also will re examine some of the assumptions used by Zhitinisky [29] as a way to determine how and why Dark matter initially formed. While di quarks almost certainly are not a viable candidate for Planckian regime temperatures, analogous structures strong enough to withstand prior to present universe conditions may form a basis of a redo on a different way what Zhitinisky [29] was attempting to form, and we intend to investigate them.

Finally, the datum put in, as far as conditions as to a rise up to 1000 or so initial degrees of freedom we view is vital to the eventual phase transition from pre Planckian regime physics, to Planckian physics, and is something which we intend to use as part of future structure formation arguments.

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