Quantum versus Classical nature of the early universe and its Consequences (Entanglement?)

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Abstract

This document is for submission to the Kiev Bogoliubov Institute conference, as a conference paper, as requested by the Institute, in the follow ups of talks given in its September 2017 conference, in Astro-particle physics, and Quantum theoretical foundations. Upon review, it should be considered a candidate pending review for submission to the Ukrainian journal of physics:

We look at early universe space-time which is characterized by a transition from Pre Planckian to Planckian space-time. In doing so we also invoke the geometry of Octonionic non commutative structure and when it breaks down as a trigger point for the release of entropy. Following Lloyd, as to entropy production with 1 count of entropy linked to one graviton via Ng Infinite quantum statistics, and we follow up on this modeling of entropy production by examining if we can relate the presumed graviton production with the behavior of Planck sized mini black holes, in the early phases of cosmological expansion. This analysis is in tandem with considerations as to what is essential as to accessing the quantum versus classical nature of the early universe, with the above listed as consequences. We close with the 2^{nd} half of our work which is reviewing relic gravitons, and their role in presumed entanglement from a prior universe construction to the present universe, possibly for the unification of physical law, from cycle to cycle.

Key words: Entropy production, entanglement, relic gravitons, Octonionic Geometry

1. What is special about Octonionic structure? Why should one care about it?

Our plan is as follows. We state the Modified HUP results, as a Pre Octonionic space-time result, and then we will specify that we are transitioning to Octonionic space time. The transition to Octonionic space time will then preserve one key result,that we have, due to the earlier pre Octonionic space-time, a minimum time step. And then also making use of [1] as a bridge between the physics of the Nucleation of octonionic structure and black hole physics.

In a word, this is the setup of the new physics, plus our resolution

a. In Pre-Octonionic (Pre-Planckian) Space-time there exist conditions for which we form an initial smallest time step, and that the Pre-Planckian Space-time is where we specify initially a modified HUP (Heisenberg Uncertainty principle).[1], [2]

b. I.e. the division line between the Pre Octonionic Model and the Octonionic model directly correlates a transformation from Pre Planckian physics to Planckian physics. Through a massive increase in entropy, at the same time a Pre Octonionic to Octonionic transition occurs. [2]

c. At the same time this occurs, we reference, how this Pre Octonionic to Octonionic transition will be linked to an increase initially in Microscopic black holes.[3]

d. The tie in with entropy increase, via the Seth Lloyd argument [4] , in tandem with a production rate in black hole entropy generation will be used as a short hand as to the actual number of microscopic black holes.

In effect, what we will be arguing is that the Seth Lloyd argument, as held in conjuction with a production rate for gravitons, from microscopic black holes, gives a qualitative linkage

Having said that, we will introduce a few things about the Seth Lloyd quantum computer model for perusal. Then we will link this to a mechanism for the production of mini black holes

2 . SETH LLOYD'S UNIVERSE AS A QUANTUM COMPUTER MODEL, WITH MODIFICATIONS

We use the formula given by Seth Lloyd (2002) [3] that defines the number of operations the "Universe" can "compute" during its evolution. Lloyd (2002) [3] uses the idea attributed to Landauer that the universe is a physical system with information processed over its evolutionary history. Lloyd[3] also cites 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. He specifies 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 of [3]

$$[\#operations/\sec] \leq 2E/\pi\hbar \tag{1}$$

The **second limi**t to this number of operations is strictly linked to entropy, due to considerations of limits to memory space, which Lloyd writes as[3]

$$[\#operations] \leq S(entropy)/(k_B \cdot \ln 2) \tag{2}$$

The **third limit,** based on strict considerations of a matter-dominated universe, relates the number of allowed computations (operations) within a volume for the alleged space of a universe (horizon). Lloyd identifies this spacetime volume as $c^3 \cdot t^3$, with *c* the speed of light, and *t* an alleged time (age) for the universe . We further identify $E(energy) \sim \rho \cdot c^2$, with ρ as the density of matter, and $\rho \cdot c^2$ as the energy density (unit volume). This leads to [3]

$$\left[\#operations/\sec\right] \leq \rho \cdot c^2 \times c^3 \cdot t^3 \tag{3}$$

We then can write this, if $\rho \sim 10^{-27}\, kil/meter^3$ and time as approximately $t \sim 10^{10}\, years$. This leads to a present upper bound of

$$\left[\#operations\right] \approx \rho \cdot c^5 \cdot t^4 \leq 10^{120} \tag{4}$$

Lloyd further refines this to read[3]

$$\#operations = \frac{4E}{\hbar} \cdot \left(t_1 - \sqrt{t_1 t_0}\right) \approx \left(t_{Final}/t_P\right) \leq 10^{120} \tag{5}$$

We assume that $t_1 =$ final time of physical evolution, whereas $t_0 = t_P \sim 10^{-43}$ seconds and that we can set an energy input by assuming, in early universe conditions, that $N^+ \neq \varepsilon^+ << 1,$ and $0 < N^+ < 1$. So that we are looking at a graviton-burst-supplied energy value of

$$E = (V_{4-Dim}) \cdot \left[\rho_{Vac} = \frac{\Lambda}{8\pi G}\right] \sim N^+ \cdot \left[\rho_{graviton} \cdot V_{4-vol} \approx \hbar \cdot \omega_{graviton}\right] \tag{6}$$

Our idea is to review with this in mind the context of the following energy value within the horizon, as follows

Furthermore, assuming the initial temperature is within the range of $T \approx 10^{32} - 10^{29}$ Kelvin, we have a Hubble parameter defined along the route specified by Lloyd. This is in lieu of time $t = 1/H$, a horizon distance defined as $\approx c/H$, and a total energy value within the horizon as

$$\text{Energy (within the horizon)} \approx \rho_C \cdot c^3 / \left(H^4 \cdot \hbar\right) \approx 1/\left(t_P^2 \cdot H\right) \tag{7}$$

And this for a horizon parameter Lloyd (2002) defines as [3]

$$H = \sqrt{8\pi G \cdot \left[\rho_{crit}\right] / 3 \cdot c^2} \tag{8}$$

And a early universe

$$\rho_{crit} \sim \rho_{graviton} \sim \hbar \cdot \omega_{graviton} / V_{4-Vol} \tag{9}$$

Then

$$\begin{aligned} \#operations &\approx 1/\left[t_P^2 \cdot H\right] \approx \sqrt{V_{4-Vol}} \cdot t_P^{-2} \Big/ \sqrt{\left[8\pi G \hbar \omega_{graviton} / 3c^2\right]} \\ &\approx \left[3 \ln 2/4\right]^{4/3} \cdot \left[S_{Entrophy}/k_B \ln 2\right]^{4/3} \end{aligned} \tag{10}$$

The number of MINI black holes comes from two datum which will be examined during this presentation. [5]

[6] we have that

Quote:

In principle, a black hole can have any mass equal to or above the Planck mass (about 22 micrograms). To make a black hole, one must concentrate mass or energy sufficiently that the escape velocity from the region in which it is concentrated exceeds the speed of light.
End of quote:

I.e.

Keep in mind one basic fact. If we restrict ourselves solely to Octonionic geometry, we are embedded deeply in only what the Standard Model of physics allows. The idea of black hole generation is to obtain what occurs, initially with a Pre Octonionic structure , which is then, at the moment of crystallization of space-time shifts to octonionic. This shift into the Octonionic regime would be commensurate with a change in octonionic space commutation relationships. The change to Octonionic structure would be in effect a space time phase transtrion which would be in itself enough to generate entropy according to the ideas given by Lloyd, as to the formation of mass-energy and its linkage to entropy. This will give a nod, as we do it to the ideas given in [7], [8], and [9]

$$
\begin{aligned}
& S \leq 2\pi RE/\left(\hbar \cdot c\right) \\
& R \approx l_{Planck} \\
& E \propto mass \cdot c^2 \\
& mass \propto M_{Planck} \approx \# \cdot m_{graviton} \\
& \approx 2.17645 \times 10\text{^-5grams} \\
& m_{graviton} \approx 10\text{^-65grams} \\
& \& \\
& 10\text{^}20 \leq \# \leq 10\text{^}60
\end{aligned}
\tag{11}
$$

Having said this, the next step will be to examine what is intended as far as delineation of the degree of classical and quantum interface of properties, as seen through a review of General relativity.

Introduction to Kieffer' [10]; [22] Reviewing an argument by Kieffer about his page 265, with its modified Einstein equation put in, and what it portends as for semi classical approximations linked to quantum systems in cosmology.

As was stated by Kieffer, there is a relationship between a Hamiltonian form,, H(Hamiltonian), and a constraint equation, for momentum p_N , along the lines of[10],[11]

$$
\begin{aligned}
& p_N \\
& \& \\
& \{ p_N , H(Hamiltonian) \} \approx 0
\end{aligned}
\quad (12)
$$

This is , according to Kieffer [10],[11], the Poisson brackets, equivalent to the following

What we are looking at is, if we set the Lapse function, N, as = 1

$$
\begin{aligned}
& \dot{a}^2 = -1 + a^2 \cdot \left(\dot{\phi}^2 + \frac{\Lambda}{3} + m^2 \cdot \phi^2 \right) \\
& \Leftrightarrow \ddot{\phi}^2 + 3\frac{\dot{a}}{a} \cdot \dot{\phi} + m^2 \phi = 0
\end{aligned}
\quad (13)
$$

Here, the ϕ is a scalar field (here, called a 'homogeneous field') , m is amass term, and a the scale factor, and Λ the cosmological constant. If m is set equal to zero, this has a simple m= 0 solution with

$$
\begin{aligned}
& p_\phi = a^3 \cdot \dot{\phi} = \kappa = const \\
& \& \\
& \phi = \pm \frac{1}{2} \cdot ar\cosh \frac{\kappa}{a^2}
\end{aligned}
\quad (14)
$$

It cannot be solved analytically, if m is not equal to zero. Now as to a general problem between the Solvay 1927 conference methods and the application to GR will be alluded to, next

I.e. this is in part why the problem of quantum gravity is so difficult. We will see that there is both by argument given by Dirac, as to inter relationships between the Poisson brackets and quantum equations of motion which create serious difficulties. But more seriously than that, using a very general set of principles, we will also see that there is a problem where one could conceivably make a quantum-classical bridge to the Fluid equation, relating evolution of the energy density, expression of GR, and quantum averaging to mimic classical conditions. However, in order to have acceleration of the universe covered, which is needed, we have different results of the Friedman equation (classical form) and Friedman equation (general relativistic form), which means that Ehrenfest type methods for connecting general relativity and Quantum systems would probably be next to impossible. So with that, we go to the next section.

4. A generalized problem to making quantization of the Einstein field equations elucidated by first principles.

Worse than that, we do not have a quantum mechanical equivalent, and this due to the difficulties in terms of finding a quantum mechanical equivalent to the Poisson brackets $\{ p_N , H(Hamiltonian) \} \approx 0$ which is readily transferrable to the Friedman equation , i.e. so far a quantum bridge between quantized versions of Eq. (54) and Eq. (55) does not exist, right now.

i.e. the lectures on quantization of a classical Hamiltonian given by Dirac, in [11], [12], pages 25 – 43 is ironically made more fraught by the requirement of extending the Hamiltonian i.e. if we have say $\phi_{a'}$ as so called first class secondary constraints, page 25 of [11], [12] we find that there is an inability to do the following, if we wish to transfer to quantum systems, we need to do the following, i.e. add to the initial classical Hamiltonian, H_T

$$\begin{aligned} H_E &= H_T + v_{a'} \cdot \phi_{a'} \\ \dot{g} &\approx \{g, H_E\} \end{aligned} \tag{15}$$

Eq. (15) , in a Poisson bracket formulation, was used by Dirac to transform to a set of quantization conditions, in pages 25 to 43 of. The problem is, that it is difficult to come up with constraint equations, as given in the top level of Eq . (15)

The following is easy to do, if you ignore constraints

$$\begin{aligned} &\frac{d\langle P\rangle}{dt} = -\frac{i}{\hbar}\langle\Psi\|[P,H]\|\Psi\rangle = \frac{1}{i\hbar}\langle\Psi\|[P,V]\|\Psi\rangle \\ &\xrightarrow[3\text{dim}\to 1\text{dim}]{} -\int \Psi^* \cdot \frac{dV(x)}{dx} \cdot \Psi dx \\ &\xrightarrow[1\text{dim}\to Any\ \text{dim}]{} \left\langle -\frac{dV(x)}{dx}\right\rangle \sim \langle -\vec{\nabla} V\rangle \equiv F(\,force) \end{aligned} \tag{16}$$

Try doing this, to have equivalence with Eq. (15) i.e. what is so difficult is to put in a Hamiltonian system, for gravity, which is commensurate with Eq. (15) which then leads to an extended Hamiltonian.

Dirac claims the bridge from Poisson brackets to the situation represented by Eq. (16) always involves a carefully set extended Hamiltonian situation. I,.e. see his discussion in 33 to page 35 of [11], [12]. The challenge would be to make those extensions somehow commensurate with Eq.(13) and Eq. (14).

Having said, this, we will next go to the problem of Quantum Geometrodynamics. Before going to it, a notice as to the problems of bridging to general relativity using conventional Quantum mechanics, will be raised as a bridge to the use of $H_{ADM}\Psi = 0$ which makes a plausible bridge to the Fluid equation of general relativity, [13] but also a summary as to how and why the connection to the rest of general relativity is extremely difficult, i.e. the Friedman equation as seen in [11], [13] has a classical analogue which cannot be linked to its general relativistic form, but the fluid equation of General relativity in [11], [13] does have a Newtonian derivation yielding the exact same result in both Newtonian and GR physics. Hence, the quantum-classical bridge as exemplified by Eq. (16) works for the fluid equation, but would not work for the GR Friedman equation, since the Friedman equation classical would be the only bridge to the quantum result, using the Eq. (16) bridge. And of course, both the GR Friedman bridge plus the fluid cosmology bridge are both needed in the acceleration equation, i.e. from [11], [13] the following cannot be linked to quantum mechanics, via Eq. (58), namely the acceleration equation of GR has[10], [11]

$$\left(\frac{\ddot{a}}{a}\right) = -\frac{4\pi G}{3c^2}\cdot\left(\varepsilon + 3P\right) \tag{17}$$

This requires two equations, namely, [11]

$$\begin{aligned}
&\left(\frac{\ddot{a}}{a}\right) = -\frac{4\pi G}{3c^2}\cdot\left(\varepsilon + 3P\right) \\
&Due - to \\
&\dot{\varepsilon} + 3\left(\frac{\dot{a}}{a}\right)\cdot\left(\varepsilon + 3P\right) = 0 \\
&And \\
&\dot{a}^2 = \frac{8\pi G}{3c^2}\cdot\varepsilon a^2 - \frac{\kappa c^2}{R_0^2}(GR - Friedman) \\
&as - opposed - to, if \quad U = const. \\
&\dot{a}^2 = \frac{8\pi G}{3c^2}\cdot\rho a^2 + \frac{2U}{r_s^2}(Newtonian - Friedman)
\end{aligned} \tag{18}$$

The derivation of the acceleration equation for GR, using the two equations cited is in [11], [13] page 60

In addition we will derive the Fluid equation also used, which is the same form used in Eq. (58) making a linkage to relativity and quantum mechanics, possible, if one uses the following steps, as given on page 59 of [11], [13] . I.e. If exists a commoving radius r_S

We then will get a clean derivation of the so called fluid equation, used in Cosmology. This fluid equation, which has the same form used in both GR and Newtonian physics may be in principle linkable to the quantization program outlined in Eq.(16) . So with that, we go to the interactions given in Eq. (19)below. See [11] for where this comes from.

$$V(t) = Volume(universe) = \frac{4\pi r_s^3 a^3}{3}$$
&
$$\dot{V} = V \cdot \left(\frac{3\dot{a}}{a} \right)$$
$$E = V(t) \cdot \varepsilon(t)$$
$$\dot{E} = V \cdot \left(\dot{\varepsilon} + \frac{3\dot{a}}{a}\varepsilon \right)$$
&
$$First - law - thermo(universe)$$
$$\dot{E} + P\dot{V} = 0$$
$$\Rightarrow V \cdot \left(\dot{\varepsilon} + \frac{3\dot{a}}{a}\varepsilon + \frac{\dot{a}}{a}P \right) = 0$$
$$\Rightarrow \dot{\varepsilon} + \frac{3\dot{a}}{a}\varepsilon + \frac{\dot{a}}{a}P = 0 \qquad (19)$$

The GR and classical physics forms of the fluid equation, so derived, in Eq. (19) and the results at the bottom of Eq. (18) would allow us to make connection, with a lot of work to the sort of reasoning used in Eq. (16) above, but due to the difference in the Friedman equation, in classical and GR form, as noted in Eq. (17)(59), it would be using the Solvay methods , extremely difficult to make connection between an acceleration equation, using scale factors, as given in Eq. (17) and Eq. (18) with the Eq. (16) connection between classical and quantum mechanics with respect to an acceleration of the universe acceptable in both GR and quantum form.

We can state though that a bridge to the Fluid equation, as given in Eq. (19) and Eq. (16) would at least in principle very doable.

So, let us now delineate how this could relate to the issue of Octonions

5. Discussion of the geometry alteration due to the evolution from pre Planckian to Planckian regimes of space time

The simplest way to consider what may be involved in alterations of geometry is seen in the fact that in pre **octonionic** space time regime (which is Pre Planckian), one would have [2] (Crowell, 2005)

This Pre Octonionic space-time behavior should be seen to be separate from the flatness condition as referred to in [18]. But retuning to [2] we have that, in Pre Planckian space- time, that

$\left[x_j, x_i \right] \neq 0$ **Under ANY circumstances, with low to high temperatures, or flat or curved space.** (20)

Whereas in the octonionic gravity space time regime where one would have Eq.(21) to (23) that we have to consider how to obtain data for a phase transition

6 . Now about conditions to obtain the relevant data for phase δ_0

This paper examines geometric changes that occurred in the earliest phase of the universe, leading to values for data collection of information for phase δ_0, and explores how those geometric changes may be measured through gravitational wave data. The change in geometry is occurring when we have first a pre-quantum space time state, in which, in commutation relations [2] (Crowell, 2005) in the pre Octonionic space time regime no approach to QM commutations is possible as seen by.

$$\left[x_j, p_k\right] \neq -\beta \cdot \left(l_{Planck}/l\right) \cdot \hbar \cdot T_{ijk}$$
$$and \quad does \quad not \rightarrow i\hbar\delta_{i,j} \tag{21}$$

Eq. (8) is such that even if one is in flat Euclidian space, and i= j, if there is no phase shift then there is no way to move beyond a flat space representation of

$$\left[x_j, p_{k=j}\right] \neq i\hbar\Big|_{\mathrm{Pr}e-Octonionic} \tag{22}$$

If one does not have the phase transition, then one observes that without the Pre Octonionic to Octonionic phase shift that there is a permament stuck at the inequality given by Eq. (8a) above.

In the situation when we approach quantum "octonionic gravity applicable" geometry, Eq. (21) becomes

$$\left[x_i, p_j\right] = -\beta \cdot \left(l_{Planck}/l\right) \cdot \hbar \cdot T_{ijk}$$
$$\xrightarrow[approaching-flat-space-after-\delta_0]{} i \cdot \hbar \cdot \delta_{i,j} \tag{23}$$

Eq. (23) is such that even if one is in flat Euclidian space, and i= j, then if the phase transition from Pre Octonionic to Octonionic has occurred,

$$\left[x_j, p_{k=j}\right] = i\hbar\Big|_{Octonionic} \quad flat-space-Octonionic \tag{24}$$

.Also the phase change in gravitational wave data due to a change in the physics and geometry between regions where Eq. (21) and Eq. (23) hold will be given by a change in phase of relic GW.

Now in the case of enormous temperature increases (23) , then by [2] (Crowell, 2005)

$$\left[x_j, x_i\right] = i\,\Theta_{j,i} \xrightarrow[Temp \rightarrow \infty]{} 0 \tag{25}$$

Here,

$$\Theta_{j,i} \sim \Lambda_{NC}^{-2} \sim \Lambda_{4-\dim ensional}^{-2} \propto 1/T^{2\beta} \xrightarrow[T \rightarrow \infty]{} 0 \tag{26}$$

Specifically Eq. (23) and Eq. (25) will undergo physical geometry changes which will show up in δ_0 .

Not that when quantum geometry holds, as seen by Eq.(23) and Eq. (25) , GW information is loaded into the **Octonion** space time regime, and then transmitted to the present via relic GW which identified via the phase shift in GW as measured in a GW detector. This phase shift is δ_0. The following flow chart is a bridge between the two regimes of [2] (Crowell, 2005) the case where the commutators for QM

$$\begin{gathered}\left[x_i, p_j\right] \neq -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk} \\ \xrightarrow[Transition-to-Planckian-space]{} \\ \left[x_i, p_j\right] = -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk}\end{gathered} \tag{27}$$

Eq. (27) above represents the transition from pre Planckian to Planckian geometry.

Also questions relating to how pre and post Planckian geometries evolve can be answered by a comparison of how entropy, in flat space geometry is linked with quantum mechanics [13] (Lee, 2010). Once Eq.(27) happens, Beckwith hopes to look at the signals in phase shift δ_0

$$\begin{gathered}\left[x_i, p_j\right] = -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk} \\ \xrightarrow[Transition-to-release-of-relic-gravitational-waves-in-flat-space]{} \\ Planckian-era-generated-gravitational-wave\end{gathered} \tag{28}$$

Lee's paper [13] (Lee, 2010) gives the details of information theory transfer of information from initially curved space geometry to flat space. When one gets to flat space, then, by Eq. (28) one then has a release of relic GW. One of the primary results is reconciling the difference in degrees of freedom versus a discussion of dimensions. Also, as Eq. (27) occurs, there will be a buildup in the number of degrees of freedom, from a very low initial level to a higher one, as in the Gaussian mapping [14] (Beckwith, 2010)

$$x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i\right] + \tilde{\beta} \tag{29}$$

The feed in of temperature from a low level, to a higher level is in the pre Planckian to Planckian thermal energy input as by (Beckwith, 2010a)[14], [15]

$$E_{thermal} \approx \frac{k_B}{2} \cdot T_{temperature} \propto \Omega_0 \cdot T_{temperature} \sim \tilde{\beta} \tag{30}$$

This setting of the thermal contribution to energy, and its linkage to Octonionic geometry leads to the next issue. Namely.

7. Setting the HUP, and discontinuity in a 5 dimensional Setting, as part of embedding to the Octonionic state.

This among other things is a fulfillment of the dream by Kaluza Klein [16], [17] , of sorts as far as how to unify Gravity and Electromagnetism in cosmology, but it has a much bigger cache than this, mainly as to understand the role of time, itself in quantum statistical ensembles, i.e. the idea of a deterministic large scale state, which would encompass quantum microstates in an ensemble within which the quantum microstates would be a way to analyze basic quantum thinking in terms of time dependence. In doing this, it also links itself to the question of why Schrodinger was so aghast at the idea of quantum jumping.

Let us now, briefly allude to the [11], [16], [17] reference, namely:

Start with the idea of an embedding of four dimensional space-time in a 5 dimensional time interval. [16], [17], and realize its inter connections with [11], [18], [19], [20] where L = length of canonical metric in 5 Dimensional theory

$$
\begin{aligned}
& dS_{5-\dim}^2 = \frac{L^2}{l^2} ds_{4-\dim}^2 - \left(\frac{L^2}{l^2}\right)^2 dl^2 \\
& x_4 = l = h / mc \\
& \Lambda = 3 / L^2 \\
& L = scale - of - scale - of - (universe) - Potential - well
\end{aligned}
\tag{31}
$$

And then we present, the five momenta as given by

$$
\begin{aligned}
& P_\alpha = \frac{2L^2}{l^2} g^{\alpha\beta} \frac{dx^\beta}{dx} \\
& P_l = -\frac{2L^4}{l^4} \frac{dl}{ds}
\end{aligned}
\tag{32}
$$

Then, if

$$
\begin{aligned}
& P_\alpha = \frac{2L^2}{l^2} g^{\alpha\beta} \frac{dx^\beta}{dx} \\
& P_l = -\frac{2L^4}{l^4} \frac{dl}{ds} \\
& \int P_A dx^A = \int P_\alpha dx^\alpha + P_l dl = 0 \quad iff \quad dS_{5-\dim}^2 = 0 \\
& \Leftrightarrow l = l_0 e^{\pm s/L} \,\&\, \left(dl / ds\right) = \pm l / L
\end{aligned}
\tag{33}
$$

One eventually, as given by [11], [18], [19] obtains the Heisenberg type of relations that

$$
\left| dp_\alpha dx^\alpha \right| = h \cdot \left\{ \frac{n}{c} \cdot \left(\frac{dl}{l} \right)^2 \right\}
\tag{34}
$$

In this case, looking at a re write of the Eq. (35) to read, approximately as [11], [18] , [19]

$$dp^{\alpha}dx_{\alpha} \xrightarrow[\alpha \to 0]{} dp^{0}dx_{0} \tag{35}$$

Where we start off with, say:

$$\left| dp_{\alpha}dx^{\alpha} \right| \sim h \cdot \left\{ \frac{n}{c} \cdot \left(\frac{dl}{l} \right)^{2} \right\}_{\alpha} \tag{36}$$

With the $\alpha = 0 \Rightarrow \left| dp_{0}dx^{0} \right| \sim h \cdot \left\{ \frac{n}{c} \cdot \left(\frac{dl}{l} \right)^{2} \right\}_{\alpha=0} \Rightarrow \delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2}$ (37)

$Unless \quad \delta g_{tt} \sim O(1)$

This also has some flavor of the arguments given in [21] which we urge the readers to consult.

Having said this, and including in the description of embedding of the HUP in 4 space in quasi deterministic reasoning for 5 dimensions, we will the make the following assertions as to what this is saying about Octontonionic commutation relationships.

First, we will be examining what happens if [22]

$$\begin{aligned} &\delta t \Delta E \geq \left. \frac{\hbar}{\delta g_{tt}} \right|_{\Pr e-Octonionic} \xrightarrow[\delta_0 \quad phase-change]{} \delta t \Delta E \geq \hbar \big|_{Octonionic} \\ &with \quad \delta t \geq \frac{\hbar}{\delta g_{tt} \Delta E} \quad fixed \end{aligned} \tag{38}$$

I.e. by

First a pre-quantum space time state, in which, in commutation relations [2] (Crowell, 2005) in the pre Octonionic space time regime no approach to QM commutations is possible as seen by.

$$\begin{aligned} &\left[x_{j}, p_{k} \right] \neq -\beta \cdot \left(l_{Planck} / l \right) \cdot \hbar \cdot T_{ijk} \\ &and \quad does \quad not \rightarrow i\hbar \delta_{i,j} \end{aligned} \tag{39}$$

In the situation when we approach quantum “octonionic gravity applicable” geometry, Eq.(39) becomes

$$\left[x_i, p_j\right] = -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk} \xrightarrow[approaching-flat-space-after-\delta_0]{} i \cdot \hbar \cdot \delta_{i,j} \qquad (40)$$

This commutation behavior should not be seen to contravene the structures given in [2] .

Eq. (39) and Eq. (40) are such that even if one is in flat Euclidian space, and i= j, then if the phase transition from Pre Octonionic to Octonionic has occurred, and Eq.(41) is key to what we say next here.

i.e

The point is this, i.e. by [23]

$$\begin{aligned}
&\frac{\overline{\mathrm{p}}_j}{m_j} = \frac{\hbar}{i \cdot m_j} \int \psi^* \frac{\partial \psi}{\partial x_j} dv \\
&= \frac{i}{\hbar} \int \psi^* \left(H_{hamiltonian} x_j - x_j H_{hamiltonian}\right) \psi \, dv \\
&\frac{d\overline{x}_j}{dt} \\
&\Rightarrow \overline{\mathrm{p}}_j = m_j \frac{d\overline{x}_j}{dt}
\end{aligned} \qquad (41)$$

Put this set of values of average momentum

$$\begin{aligned}
&\overline{\mathrm{p}}_j = m_j \frac{d\overline{x}_j}{dt} \\
&\& \\
&\left[x_i, p_j\right] = -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk} \\
&\Rightarrow \left[x_i, \frac{d\overline{x}_j}{dt}\right] = -\frac{\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk}}{m_j}
\end{aligned} \qquad (42)$$

The last line of Eq.(42) will be crucial to what we say next

$$\frac{d\bar{x}_j}{dt} = \sqrt{\frac{H_{hamiltonian}}{\sqrt{2m_j}}} \approx \sqrt{\frac{\Delta E}{\sqrt{2m_j}}}$$

$$\Rightarrow \left[x_i, \sqrt{\frac{\Delta E}{\sqrt{2m_j}}} \right] = -\frac{\beta \cdot \left(l_{Planck} / l \right) \cdot \hbar \cdot T_{ijk}}{m_j}$$

$$\& \qquad (43)$$

$$\Delta E \approx \frac{\hbar}{\delta t \cdot \delta g_{tt}}$$

$$\Rightarrow \left[x_i, \sqrt{\frac{\hbar}{\delta t \cdot \delta g_{tt} \cdot \sqrt{2m_j}}} \right] = -\frac{\beta \cdot \left(l_{Planck} / l \right) \cdot \hbar \cdot T_{ijk}}{m_j}$$

In doing this, we will make the final, identification [24]

i.e.

$$a\left(t^* + \delta \cdot t\right) < a\left(t^*\right) \Leftrightarrow \hat{\varepsilon}_1 < \Delta\hat{\varepsilon} < \hat{\varepsilon}_2 \qquad (44)$$

i.e satisfying Eq.(43) will enable to help us to consider the causal barrier situation as given in Eq. (44) and this is the linkage between the idea of a causal discontinuity, Octonionic geometry and non commutativity, and the onset of new physics.

We claim that the details of reconciling Eq. (43) and Eq. (44) and the problem of finding a suitable time step, δt which will be solidly linked to the embedding of the HUP, as is given in Eq.(34) to Eq. (36) of our manuscript.

8. What Eq. (43) and Eq. (44) says about new physics.

What we are being told, as to the relative position of the co ordinates as to Pre Planckian, to Planckian physics, at a would be causal barrier situation, just before the expansion of the Universe. I.e. decoding the information in Eq. (43) and Eq. (44) will be crucial to all that.

The main point in decoding Eq.(43) and Eq.(44) will be in the assembling of a suitable value for the minimum time step, i.e. what we suspect is that an optimal δt will be heavily dependent upon making sense of both Eq. (43) and eq. (44) with δt a bi product of the embedding procedures given in Eq. (34) and Eq. (35)

Secondly, if we wish to go to the idea of many mini black holes, initially, say of mass one Plank mass each, initially, we can look at

$$
\begin{aligned}
&S \ \leq \ 2\pi RE/(\hbar \cdot c) \\
&R \approx l_{Planck} \\
&E \propto mass \cdot c^2 \\
&mass \propto M_{Planck} \approx \# \cdot m_{graviton} \\
&\approx 2.17645 \times 10\text{^-5grams} \\
&m_{graviton} \approx 10\text{^-65grams} \\
&\& \\
&10\text{^}20 \leq \# \leq 10\text{^}60
\end{aligned}
\tag{45}
$$

Eq. (45) is relevant right after a presumed shift after a causal discontinuity. And it would be

$$
\begin{aligned}
&S \ \leq \ 2\pi RE/(\hbar \cdot c) \\
&R \approx l_{Planck} \\
&\delta t \Delta E \geq \left. \frac{\hbar}{\delta g_{tt}} \right|_{\Pr e-Octonionic} \xrightarrow[\delta_0 \quad phase-change]{} \delta t \Delta E \geq \hbar \big|_{Octonionic} \\
&\Delta E \geq \frac{\hbar}{\delta t \delta g_{tt}} \\
&\Delta S \ \approx \ 2\pi RE/(\hbar \cdot c) \approx 2\pi l_{Planck}/(\delta t \cdot \delta g_{tt} \cdot c)
\end{aligned}
\tag{46}
$$

This above should be compared to the following, from Octonionic reasoning

$$
\begin{aligned}
&\left[x_i, \sqrt{\frac{\Delta E}{\sqrt{2m_j}}} \right] = -\frac{\beta \cdot (l_{Planck}/l) \cdot \hbar \cdot T_{ijk}}{m_j} \\
&\& \\
&\Delta E \approx \frac{\hbar}{\delta t \cdot \delta g_{tt}} \\
&\Rightarrow \left[x_i, \sqrt{\frac{\hbar}{\delta t \cdot \delta g_{tt} \cdot \sqrt{2m_j}}} \right] = -\frac{\beta \cdot (l_{Planck}/l) \cdot \hbar \cdot T_{ijk}}{m_j}
\end{aligned}
\tag{47}
$$

The key point is this, that the presumed massive increase in entropy, due to $\delta t \cdot$ say at the boundary of a Causal structure would be also reflected in the aftermath of making sense of inputs of $\delta t \cdot$ in a Pre Octonionic to

Octonionic geometrical setting. Satsifying both, and keeping in mind that the final details would also have $\delta t \cdot$ heavily influenced by the results of Eq. (34) from Wesson.

9. Presenting the Kieffer example also, of how to keep a classical super structure to represent appearances of Quantum activity.

From his reference.Quantum Geometrodynamics and Semi classical approximations, as reference [10], [11] and evolutionary Equations, for quantum states,

Due to how huge this literature is, we will be by necessity restricting ourselves to pages 172 to 177 of ,[11]; as that encompasses Hamiltonian style formalism and also has some connections to the Hamilton Jacobi equation.

We will make this limitation so our methods are not too far removed from the Solvay conference, [11], 1927, i.e. the Hamilton-Jacobi equation makes an appearance, as well as a full stationary Schrodinger equation.

In this discussion, the wave functions are often quantized, or nearly so, albeit usually added gravitational background is semi classical.

To begin our inquiry as to Geometrodynamics, which has some fidelity to the Solvay 1927 conference, we look at the following expansion of the Klein Gordon Equation, without an external potential. i.e.[10], [11] gives us

$$\begin{aligned}
&\left(\frac{\hbar^2}{c^2} \cdot \frac{\partial^2}{\partial t^2} - \hbar^2 \Delta + m^2 c^2 \right) \Psi_{KG} = 0 \\
&\& \\
&\Psi_{KG} = \exp(i \cdot S_{example} / \hbar) = c^2 S_0 + S_1 + c^{-2} S_2 + \\
&\& \\
&S_0 \sim \pm m \cdot t \Rightarrow \left(\Psi_{KG} at \quad c^2 \right) \sim \exp(-imc^2 t / \hbar) \\
&\& \\
&\left(\Psi_{KG} at \quad c^0 \right) \sim \exp(iS_1 / \hbar) \Rightarrow i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi \\
&\& \\
&\left(\Psi_{KG} at \quad c^{-2} \right) \sim \exp(iS_2 / \hbar) \Rightarrow i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi - \frac{\hbar^4}{8m^3 c^2} \Delta\Delta\Psi \\
&\& \\
&\frac{\hbar^4}{8m^3 c^2} \Delta\Delta\Psi = first - relativistic - correction - term
\end{aligned} \tag{48}$$

As a Klein Gordon result, this leads directly to the idea of quantum mechanics, as embedded within a larger theory.

I,e this methodology as brought up by Kieffer, in page 177 of [10], [11] in its own way is fully in sync with some of the investigations of the embedding of quantum mechanics within a larger structure, as has been mentioned in a far more abstract manner by t'Hooft, in [25], although to make further connections, it would be advisable to have a potential term put in, as well as to have more said about relativistic corrections.

As mentioned by [10], [11] , Lammerzahl , C. in [26] has extended this sort of reasoning to quantum optics in a gravitational field. The virtue of this, is that one is NOT using the functional Schrodinger equation, as seen in page 149 of the Wheeler De Witt equations, given in [10], [11 . i.e. the above derivation, within the context of the orders of c, given above, has explicit time dependence put in its evolution equations, and avoids some of the issues of the Wheeler De Witt program. I.e. read page 149 and beyond in [10], [11] as to some of the perils and promises as to this approach.. This also means paying attention to [26].

In addition the c^0 recovery of the Schrodinger equation, and the c^{-2} recovery of a Schrodinger equation within the context of the Klein Gordon equation is fully in sync with some of the Solvay 1927 deliberations. As given in [27] . And also directly linkable to [25]

10. Comparing the terms in Eq. (48) with the expression in Eq. (47), i.e. what this says about Octonionic structure and emergence of Quantum effects within deterministic embedding.

The c to the zeroth term in Eq. (48) is, without a potential term, Quantum mechanics, and this is in turn similar to what is being done with the last line of Eq. (47), what the equivalence does is to highlight what is to be admissible to T_{ijk} i.e. in Crowell, [2] (2005), Crowell identifies it as a so called Structure constant as on his page 308, of his reference, and further writes

$$[x_j, x_k] = \beta \cdot l_{Planck} \cdot T_{jkl}\Big|_{Octonionic} \xrightarrow[transition-to-Euclidian-geometry]{} 0 \qquad (49)$$

As well as [2]

$$[x_j, p_i] = -\beta \cdot \left(l_{Planck} / L\right) \cdot T_{ijk}\Big|_{Octonionic} \xrightarrow[transition-to-Euclidian-geometry]{} i\hbar\delta_{i,j} \qquad (50)$$

Where we do have from Eq. (42) that

$$\left[x_i, \frac{d\overline{x}_j}{dt}\right] = -\frac{\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar \cdot T_{ijk}}{m_j} \qquad (51)$$

In essence, the left hand side of Eq. (49) before it goes to Euclidian geometry can be seen as comparable to

$$\left(\frac{\hbar^2}{c^2}\cdot\frac{\partial^2}{\partial t^2}-\hbar^2\Delta+m^2c^2\right)\Psi_{KG}=0$$

&

$$\Psi_{KG}=\exp(i\cdot S_{example}/\hbar)=c^2S_0+S_1+c^{-2}S_2+ \tag{52}$$

&

$$\left(\Psi_{KG}at\quad c^0\right)\sim\exp(iS_1/\hbar)\Rightarrow i\hbar\Psi_t=\frac{-\hbar^2}{2m}\Delta\Psi$$

Not the same, i.e.there are differences between Eq. (49), and Eq. (51) with respect to the situation in (52) but the similarities are startling. Even more so, we have that

$$\delta t\Delta E\geq\left.\frac{\hbar}{\delta g_{tt}}\right|_{\Pr e-Octonionic}\xrightarrow[\delta_0\quad phase-change]{}\delta t\Delta E\geq\hbar\big|_{Octonionic}$$

$$\Delta E\geq\frac{\hbar}{\delta t\delta g_{tt}}$$

$$\Delta S\ \approx\ 2\pi R\cdot\Delta E/\left(\hbar\cdot c\right)\approx 2\pi l_{Planck}/\left(\delta t\cdot\delta g_{tt}\cdot c\right)\propto N_{Particle-count} \tag{53}$$

&

$$\left[x_i,\sqrt{\frac{\Delta E}{\sqrt{2m_j}}}\right]=-\frac{\beta\cdot\left(l_{Planck}/l\right)\cdot\hbar\cdot T_{ijk}}{m_j}$$

It means we need to take into account, if Eq. (54) is true, the nature of relic Gravitons.

$$N_{Particle-count}\approx N_{relic-graviton-count} \tag{54}$$

This will be the second half of our manuscript.

What we are doing here, is then an extension, and elaboration of what we did in [28], when we attempted to ascertain if gravitons from a prior universe, in some fashion reappeared in our present universe? Rather than use the blunt methodology given in [28], what we are doing here, is to appeal to an initial un-squeezed initial graviton state, which we will call $\left|0\right\rangle$ in the present universe, and then appeal to the methodology as to quantum entanglement, as to make a bridge from Prior to Planckian physics conditions to our present universe $\left|0\right\rangle$ state before the squeezing , as alluded to in the next section becomes a serious factor. Hence, we go to Section 11, next.

11. What can be said about squeezing of initial gravitons, the nature of relic Gravitons and the idea of Quantum entanglement of Pre Universe Graviton (information) coupled to the present Graviton(information)

We begin with the presumed squeezing of the initial graviton state which we call $|0\rangle$ by Squeezing operator $D(\alpha)$ leaving us with [29]

$$|\alpha\rangle = D(\alpha)|0\rangle \qquad (55)$$

This equation will have two routes as far as analysis, one which is given by [29] , i.e. Venkatartnan and Suresh, as opposed to what was promoted by Grischkuk [30], [31] . We will also after having said this, present a template as to how information in quantum entanglement can be complicit in the following schematic as far as information exchange.

$$|0\rangle_{\text{Prior-to-Present-Universe}} \xleftrightarrow[\text{Entanglement}]{} |0\rangle_{\text{Present-Universe}} \qquad (56)$$

This Entanglement end game will be to try to come up with ways to come with a protocol where the following is not inconceivable

$$(bits-for\quad \hbar_{\text{Prior-to-Present-Universe}}) \xleftrightarrow[\text{Entanglement}]{} (bits-for\quad \hbar_{\text{Present-Universe}}) \qquad (57)$$
$$\Leftrightarrow \hbar_{\text{Prior-to-Present-Universe}} \equiv \hbar_{\text{Present-Universe}}$$

To do this though we will first of all outline squeezing as given by the two Indian researchers, then do the same for what was said by Grishchuk [30], [31] , and why we disagree with it. The final part will then be analyzing $|0\rangle$ as a template for answering if the early universe is primarily classical, i.e. classical description of GW, or if it is semi classical or quantum, and then detail how an implemented entanglement transfer of information could be explained to the present universe.

12. $|\alpha\rangle = D(\alpha)|0\rangle$ according to Venkatartnan and Suresh, and then the following analysis by Grishchuck.

To do this, notice that Venkatartnan and Suresh make the following definitions, i.e [29], [32] .

Not now. Current limits would be, for $h_{rms} \sim 10^{-32}/\sqrt{Hz}$ as a de facto limit for sensitivity. Now what could be said about forming states close to classical representations of gravitons? Venkatartnam, and Suresh, 2007 [29] as built up as a coherent state via use of a displacement operator $D(\alpha) \equiv \exp(\alpha \cdot a^{+} - \alpha^{*} \cdot a)$, applied to a vacuum state , where α is a complex number, and a, a^{+} as annihilation, and creation operations $[a, a^{+}] = 1$, where one has to use Eq. (55), so then repeating Eq. (55), as [29], [30], [31], [32]. So we repeat Eq. (55) again, as

$$|\alpha\rangle = D(\alpha) \cdot |0\rangle \tag{55}$$

However, what one sees in string theory, is a situation where a vacuum state as a template for graviton nucleation is built out of an initial vacuum state, $|0\rangle$. To do this though, as Venkatartnam, and Suresh did [29] , involved using a squeezing operator $Z[r, \vartheta]$ defining via use of a squeezing parameter r as a strength of squeezing interaction term , with $0 \le r \le \infty$, and also an angle of squeezing, $-\pi \le \vartheta \le \pi$ as used in $Z[r, \vartheta] = \exp\left[\frac{r}{2} \cdot \left([\exp(-i\vartheta)] \cdot a^{2} - [\exp(i\vartheta)] \cdot a^{+^{2}}\right)\right]$, where combining the $Z[r, \vartheta]$ with Eq.(55) (53)leads to a single mode squeezed coherent state, as they define it via

$$|\varsigma\rangle = Z[r, \vartheta] \alpha\rangle = Z[r, \vartheta] D(\alpha) \cdot |0\rangle \xrightarrow[\alpha \to 0]{} Z[r, \vartheta] \cdot |0\rangle \tag{58}$$

The right hand side of Eq. (58) given above becomes a highly non classical operator, i.e. in the limit that the super position of states $|\varsigma\rangle \xrightarrow[\alpha \to 0]{} Z[r, \vartheta] \cdot |0\rangle$ occurs, there is a many particle version of a 'vacuum state' which has highly non classical properties. Squeezed states, for what it is worth, are thought to occur at the onset of vacuum nucleation , but what is noted for $|\varsigma\rangle \xrightarrow[\alpha \to 0]{} Z[r, \vartheta] \cdot |0\rangle$ being a super position of vacuum states, means that classical analog is extremely difficult to recover in the case of squeezing, and general non classical behavior of squeezed states. Can one, in any case, faced with $|\alpha\rangle = D(\alpha) \cdot |0\rangle \neq Z[r, \vartheta] \cdot |0\rangle$ do a better job of constructing coherent graviton states, in relic conditions, which may not involve squeezing ?. Note L. Grishchuk wrote in (1989) [30], [32] ;[57] in "On the quantum state of relic gravitons", where he claimed in his abstract that 'It is shown that relic gravitons created from zero-point quantum fluctuations in the course of cosmological expansion should now exist in the squeezed quantum state. The authors have determined the parameters of the squeezed state generated in a simple cosmological model which includes a stage of inflationary expansion. It is pointed out that, in principle, these parameters can be measured experimentally'. Grishchuk , et al, [30], [31], [32] reference their version of a cosmological perturbation h_{nlm} via the following argument. How we work with the argument will affect what is said about the necessity, or lack of, of squeezed states in early universe cosmology. From Class. Quantum Gravity: 6 (1989), L 161-L165 [30], [31], [32], where h_{nlm} has a component $\mu_{nlm}(\eta)$

obeying a parametric oscillator equation, where K is a measure of curvature which is $= \pm 1, 0$, $a(\eta)$ is a scale factor of a FRW metric, and $n = 2\pi \cdot [a(\eta)/\lambda]$ is a way to scale a wavelength, λ , with n, and with $a(\eta)$[31], [32]

$$h_{nlm} \equiv \frac{l_{Planck}}{a(\eta)} \cdot \mu_{nlm}(\eta) \cdot G_{nlm}(x) \tag{59}$$

$$\mu''_{nlm}(\eta) + \left(n^2 - K - \frac{a''}{a} \right) \cdot \mu_{nlm}(\eta) \equiv 0 \tag{60}$$

If $y(\eta) = \dfrac{\mu(\eta)}{a(\eta)}$ is picked, and a Schrodinger equation is made out of the Lagrangian used to [30], [31], [32] formulate Eq.(60)(56) above, with $\hat{P}_y = \dfrac{-i}{\partial y}$, and $M = a^3(\eta)$, $\Omega = \dfrac{\sqrt{n^2 - K^2}}{a(\eta)}$, $\breve{a} = [a(\eta)/l_{Planck}] \cdot \sigma$, and $F(\eta)$ an arbitrary function. $y' = \partial y / \partial \eta$. Also, we have a finite volume $V_{finite} = \int \sqrt{{}^{(3)}g}\, d^3x$

Then the Lagrangian for deriving Eq.(60) is (and leads to a Hamiltonian which can be also derived from the Wheeler De Witt equation), with $\varsigma = 1$ for zero point subtraction of energy

$$L = \frac{M \cdot y'^2}{2a(\eta)} - \frac{M^2 \cdot \Omega^2 a \cdot y^2}{2} + a \cdot F(\eta) \tag{61}$$

$$\frac{-1}{i} \cdot \frac{\partial \psi}{a \cdot \partial \eta} \equiv \hat{H}\psi \equiv \left[\frac{\hat{P}^2{}_y}{2M} + \frac{1}{2} \cdot M\Omega^2 \hat{y}^2 - \frac{1}{2} \cdot \varsigma \cdot \Omega \right] \cdot \psi \tag{62}$$

then there are two possible solutions to the S.E. Grushchuk created in 1989 [30], [32], one a non squeezed state, and another a squeezed state. So in general we work with

$$y(\eta) = \frac{\mu(\eta)}{a(\eta)} \equiv C(\eta) \cdot \exp(-B \cdot y) \tag{63}$$

The non squeezed state has a parameter $B|_\eta \xrightarrow[\eta \to \eta_b]{} B(\eta_b) \equiv \omega_b / 2$ where η_b is an initial time, for which the Hamiltonian given in Eq. (62); (58) in terms of raising/ lowering operators is 'diagnonal', and then the rest of the time for $\eta \neq \eta_b$, the squeezed state for $y(\eta)$ is given via a parameter B for squeezing which when looking at a squeeze parameter r, for which $0 \le r \le \infty$, then Eq. (63) has, instead of $B(\eta_b) \equiv \omega_b/2$ as given in [32]

$$B\big|_{\eta} \xrightarrow[\eta \neq \eta_b]{} B(\omega, \eta \neq \eta_b) \equiv \frac{i}{2} \cdot \frac{(\mu/a(\eta))'}{(\mu/a(\eta))} \equiv \frac{\omega}{2} \cdot \frac{\cosh r + [\exp(2i\vartheta)] \cdot \sinh r}{\cosh r - [\exp(2i\vartheta)] \cdot \sinh r} \tag{64}$$

Taking Grishchuck's formalism literally, a state for a graviton/ GW is not affected by squeezing when we are looking at an initial frequency, so that $\omega \equiv \omega_b$ initially corresponds to a non squeezed state which may have coherence, but then right afterwards, if $\omega \neq \omega_b$ which appears to occur whenever the time evolution, $\eta \neq \eta_b \Rightarrow \omega \neq \omega_b \Rightarrow B(\omega, \eta \neq \eta_b) \equiv \frac{i}{2} \cdot \frac{(\mu/a(\eta))'}{(\mu/a(\eta))} \neq \frac{\omega_b}{2}$ A reasonable research task would be to determine, whether or not $B(\omega, \eta \neq \eta_b) \neq \frac{\omega_b}{2}$ would correspond to a vacuum state being initially formed right after the point of nucleation, with $\omega \equiv \omega_b$ at time $\eta \equiv \eta_b$ with an initial cosmological time some order of magnitude of a Planck interval of time $t \approx t_{Planck} \propto 10^{-44}$ seconds The next section will be to answer whether or not there could be a point of no squeezing, as Grishchuck implied [30], [32] , for initial times, and initial frequencies, and an immediate transition to times, and frequencies afterwards, where squeezing was mandatory. Note that in 1993 [58] , Grischchuk further extended his analysis, with respect to the same point of departure, ie. What to do with when $|\alpha\rangle = D(\alpha) \cdot |0\rangle \neq Z[r, \vartheta] \cdot |0\rangle$. Having $|\alpha\rangle = D(\alpha) \cdot |0\rangle$ with $D(\alpha)$ a possible displacement operator, seems to be in common with $B(\eta_b) \equiv \omega_b/2$, whereas $|\alpha\rangle = Z[r, \vartheta] \cdot |0\rangle$ which is highly non classical seems to be in common with a solution for which $B(\omega_b) \neq (\omega_b/2)$ This leads us to the next section, i.e. does $B(\eta_b) \equiv \omega_b/2$ when of time $t \approx t_{Planck} \propto 10^{-44}$ seconds, and then what are the initial conditions for forming 'frequency' $\omega \equiv \omega_b$?

13.Why we in part disagree with both of the analysis, in 12, and our own questions. About the nature of the state which is $|0\rangle$

The analysis of the squeezed states in the above section, has several fundamental flaws. The two Indian researchers do not delineate the nature of the state which is $|0\rangle$

Neither does Grishchuck, although he presented, a statement that $|0\rangle$ was due to quantum fluctuations at the beginning of the universe. [30], [31], [32]

The possibility that $|0\rangle$ was/ is semi classical and possibly connected with entanglement never occurred to either of the researchers we have cited in Section 12, and we disagree on their thinking.

Moreover, Grischchuk, in $\omega \equiv \omega_b$ is also setting up a description of his thinking, for a preferred initial frequency.

We do not have enough information to obtain $\omega \equiv \omega_b$ as stated above.

For the mean time our preference is for the $|0\rangle$ was/ is semi classical and possibly connected with entanglement. So we will discuss Entanglement issues next. This means looking at [33] and other additional references.

14. What information is exchanged between entangled states, and at what speeds of propagation? , i.e. doing away with the presumed 'necessity' of hidden variables. The Quantum entangled states may not be a separable physical phenomenon.

What we are doing here, is to look at what information is exchanged between entangled states, and what this pertains as to the question of presumed hidden variable theories.

Renato Renner∗ and Stefan Wolf in [34] characterize the issue of locality (preferred by Einstein as a guiding principle) or the issue of nonlocal quantum states, which is elucidated in [35].

THE PROBLEM IS, that LOCALITY, as demanded by Einstein "demands" Faster than light transferal of 'information' which violates special and general relativity.

Now, [62] has a novel introduction as to how to avoid this presumed problem, namely first starting off with what was presumed to be impossible:

Quote, from page 4 of [11], [33]

The EPR paper constituted a full frontal attack on the very foundations of quantum theory. In response to that attack, Niels Bohr – one of the greatest proponents of, and contributors to, quantum theory – pointed out that the so-called "EPR paradox" was entirely predicated on the aforementioned fundamental principle of relativity theory which states that action taken at one location cannot have an instantaneous effect at some other location, a principle often referred to as the Locality Principle. Bohr struck back at the EPR paper by arguing that the Locality Principle simply must not be valid. In other words, according to Bohr, measuring the location of one of a pair of entangled photons does have an instantaneous effect on the other entangled photon, even though it may be located a great distance away. Bohr dismissed the EPR paradox by saying that the Locality Principle simply must not be part of our reality, despite Einstein's belief that it should be.

End of quote:

So what is a reasonable replacement for "locality"?

First here is a description of the famous Bell's inequality which has been repeatedly shown to be problematic.

Quote, from page 5 of [11], [33]

Bell's Inequality is written as some version of the following equation:

$$\mathbf{n[X,-Y] + n[Y,-Z] \geq n[X,-Z]} \quad \textbf{(65)}$$

That equation, however written, expresses a relationship between three related quantities (X, Y and Z). Stated most simply, Bell's Inequality says that -- for any three categories or groups of any kind of items or objects of any sort one wishes to consider -- the number which will fall into the first category, but not into the second category, plus the number which fall into the second, but not the third category, will always be equal to or greater than the number which fall into the first, but not the third category

End of quote. From page 5 of [11], [33]

You can look up how [11], [34] re-stated the Bell's inequality, but the gist of it, is that the terms which are described as in different categories, are thereby linked in what is a 'non-local' state.

So what is a "nonlocal" state, and what does this happen to say about propagation between point A, and Point B, of different positions in a 'generalized' 'nonlocal' state?

Here is a working definition to consider:

*In theoretical **physics**, **quantum nonlocality** most commonly refers to the phenomenon by which measurements made at a microscopic level contradict a collection of notions known as **local** realism that are regarded as intuitively true in classical **mechanics**.*

So, how does one create a state consistent with all of this? [11]

In short, entanglement of a two-party state is necessary but not sufficient for that state to be nonlocal. It is important to recognise that entanglement is more commonly viewed as an algebraic concept, noted for being a precedent to nonlocality as well as quantum teleportation and superdense coding, whereas nonlocality is interpreted according to experimental statistics and is much more involved with the foundations and interpretations of quantum mechanics.

So what is entanglement? And why is this not necessarily the same as nonlocality ? What we are interested, in, in entangment is the process of exchange of 'information'[11]

***Quantum teleportation** is a process by which quantum information (e.g. the exact state of an atom or photon) can be transmitted (exactly, in principle) from one location to another, with the help of classical communication and previously shared quantum entanglement between the sending and receiving location. Because it depends on classical communication, which can proceed no faster than the speed of light, it cannot currently be used for faster-than-light transport or communication of classical bits. While it has proven possible to teleport one or more qubits of information between two (entangled) atoms. That is for now technically all which is allowed*.

Any application of Entanglement in terms of information exchange by necessity involves application of Quantum Teleportation.

Note that the fact is, that we are using classical equipment, means the process is bound by the speed of light.

However, the entangled positions, may, by 'quantum' logic sharing information at 'superluminal speed' which we cannot measure.

We can only measure the teleportation phenomena, through classical devices, which restrict the information to the speed of light. [11], [34], [35], [36], [37], [38], [39]

I/.e. the encoding of teleported information is done through classical devices, but the precursor of interconnectivity between the 'entangled' states may be 'instantaneously set' at superluminal speeds (i.e. effective instantaneously). [11]

Sounds confusing? It is, but the precursor of quantum teleportation of information is quantum entanglement, and

A. Quantum teleportation in the present time, due to classicality in the emission/ receiver ends of allegedly separated states, is bound by the speed of light.

B. Entanglement, as a precursor for states being "aligned" as a necessary condition for Quantum teleportation may, indeed have NO 'speed of light' restrictions!

I.e. the mix up in the language of entanglement and, of quantum teleportation, is then solved though a careful reading of the two references, above, plus a review of two others, i.e. [11], [36]; and [37];

Note that a careful reading of reference[11], [38] and its remarks, as we will quote: below

Quote [11], [38] in the abstract.

Quantum mechanics, information theory, and relativity theory are the basic foundations of theoretical physics. The acquisition of information from a quantum system is the interface of classical and quantum physics. Essential tools for its description are Kraus matrices and positive operator valued measures (POVMs). Special relativity imposes severe restrictions on the transfer of information between distant systems. Quantum entropy is not a Lorentz covariant concept. Lorentz transformations of reduced density matrices for entangled systems may not be completely positive maps. Quantum field theory, which is necessary for a consistent description of interactions, implies a fundamental trade-off between detector reliability and localizability. General relativity produces new, counterintuitive effects, in particular when black holes (or more generally, event horizons) are involved. Most of the current concepts in quantum information theory may then require a reassessment

End of quote,

We now have to re examine what the above implies for possibly having $|0\rangle$ as entangled states before the present universe to the present universe, today,

15. Preliminary assumptions about representing ψ (and by extension, later on $|0\rangle$) *as entangled states before the present universe to the present universe, today*

To start, note that t here is a well known Friedman cosmology result we can quote, namely, [15], with T as temperature, and t as time, and g^{*} as degrees of freedom as defined by Kolb and Turner, [15], i.e. this will lead to

$$T^{2}t \approx 2.42 \cdot \left(MeV \wedge 2\right) s \Big/ \sqrt{g^{*}} \tag{66}$$

Presuming that we put in , say the time as Δt as an initial time step, according to the Author, as seen in [15] , and re name g^* as $g^*_{initial}$ we can re write, Eq. (66) as

$$T^2 \Delta t \Big|_{Planckian-space-time} \approx 2.42 \cdot \left(MeV \wedge 2 \right) s \Big/ \sqrt{g^*_{initial}} \qquad (67)$$

If this is after H=0 in the vicinity of a 'bounce bubble' of H = 0 , then this will lead to the necessity of forming matter- energy right at the start of the big bang, and we will reference that issue in this section of this document.i.e. from [15] we can , as a start consider a well known generalization of the Langevin equation, i.e.what is referred to in [40] as a conserved order parameter equation, of the form right after the bubble region of H = 0 [41] , where H is the expansion rate equal to

$$H_{\exp ansion}(Hubble) = \dot{a} / a \qquad (68)$$

Right outside the regime where we have H set equal to zero, we will be presuming, according to [40], [41] a situation where the 'graviton wave function will be initially affected by ψ in an initial set of dynamics looking like [40]

$$\frac{\partial \psi}{\partial t} = -\nabla^2 \cdot \left[\psi - \psi^3 + \nabla^2 \psi \right] \qquad (69)$$

We will also, then for the sake of making this not completely divorced from phase transitions, our supposition is that we can also define , if ψ , as representations of a graviton, that if ψ is also proportional to a space dependent order parameter, that we can write, by use of Landau Ginsburg theory a free energy for this situation we can write as[42]

$$F\left(Free-energy\right)\Big|_{Planckian-space-time} = \frac{\hbar^2}{2m} \cdot \left|\nabla \psi\right|^2 + \alpha \cdot \left|\psi\right|^2 + \frac{\beta}{2} \cdot \left|\psi\right|^4 \qquad (70)$$

I.e. it would be by the author's lights, very hard to define a free energy within the Bubble of space time, before a time interval of $t_{Planck} \propto \Delta t$ Having said this, it is useful to ,keep in mind that as given by Wikipedia [43]

Quote, i.e.

The free energy is the internal energy of a system minus the amount of energy that cannot be used to perform work. This unusable energy is given by the entropy of a system multiplied by the temperature of the system.

Like the internal energy, the free energy is a thermodynamic state function. Energy is a generalization of free energy, since energy is the ability to do work which is free energy.

End of quote

In other words, in the Planckian regime of space time, we can to approximation write [42]

$$\begin{array}{l} \frac{\hbar^2}{2m}\cdot\left|\nabla\psi\right|^2+\alpha\cdot\left|\psi\right|^2+\frac{\beta}{2}\cdot\left|\psi\right|^4 \\ \sim T_{Planckian-temperature}\cdot s\left(Entropy-density\right)\cdot V\left(initial-volume\right) \\ \& \\ s\left(Entropy-density\right)\cdot V\left(initial-volume\right)\propto n(relic-graviton-count) \\ \Leftrightarrow n(relic-graviton-count)\propto\dfrac{\frac{\hbar^2}{2m}\cdot\left|\nabla\psi\right|^2+\alpha\cdot\left|\psi\right|^2+\frac{\beta}{2}\cdot\left|\psi\right|^4}{T_{Planckian-temperature}} \end{array} \quad (71)$$

Here, we can also make the following identification, i.e. that this is tied into would be collection of gravitons in the following manner. Afterwards. We will wrap this up by considering forms of the wave function used in Eq. (71) . This will allow us to find a closed form solution for $\left|0\right\rangle$ **.**

We claim that Eq. (71) is a precursor to the bounds which will need to be observed by a entangled graviton state, which we assume is what ψ is. I.e. at a later date, we will be writing out a squeezed graviton state, as to ψ whose components will have to obey Eq. (71) above.

But before we do, we will go into another way to recast the relic graviton count, as we do in the next section. i.e. now how we can put in electromagnetics into our graviton/ information theory treatment of early universe data.

16. Preliminary assumptions about representing ψ (and by extension, later on $\left|0\right\rangle$) *affected by degrees of freedom.*

We assume that there will be a buildup in the number of degrees of freedom, from a very low initial level to a higher one, as in the Gaussian mapping [14] (Beckwith, 2010)

$$x_{i+1}=\exp\left[-\tilde{\alpha}\cdot x_i^2\right]+\tilde{\beta} \quad (72)$$

The feed in of temperature from a low level, to a higher level is in the pre Planckian to Planckian thermal energy input as by (Beckwith, 2010a) [44], [15]

$$E_{thermal}\approx\frac{1}{2}k_B T_{temperature}\propto\left[\Omega_0\breve{T}\right]\sim\tilde{\beta} \quad (73)$$

Eq. (72) would have low numbers of degrees of freedom, with an eventual Gauss mapping up to 100 to 1000 degrees of freedom, as described by (Kolb and Turner, 1990) [15] .

Furthermore, the assumption is that there is an initial fixed entropy, with $\bar{N}$ as a nucleated structure in short time interval as temperature $T_{temperature}\varepsilon\left(0^{+},10^{19}GeV\right)$ arrives. Then as will be discussed by the author later on in this document, along the lines given by Ng for infinite quantum statistics [45] , [46]

$$S \sim n(particle - count) \tag{74}$$

This entropy count later on, will be seen as linked to an inflaton, given as ϕ, and also we claim that the value $n(particle - count) \propto \bar{N}$, as will show up in a modeling of the degrees of freedom which get enormously greater , due to the input into Eq. (75) below.

If the inputs into the inflaton ϕ, as given by a random influx of thermal energy from temperature, we will see the particle count on the right hand side of Eq.(75) below, (74); (25) as a random creation of $n_{Particle-Count}$. The way to introduce the expansion of the degrees of freedom from zero to **N(T) ~ 10^2 - 10^3** is to define the classical and quantum regimes of gravity to minimize the point of the bifurcation diagram affected by quantum processes As by [14]

$$\frac{\Delta\tilde{\beta}}{dist} \cong \left(5k_B \Delta T_{temp}/2\right)\cdot\frac{\bar{N}}{dist} \sim qE_{net-electric-field} \sim \textbf{Change in degrees of freedom} \tag{75}$$

We will state this is linkable to the idea of making the following linkage between photons and gravitons and Photon flux, in the early universe. Doing this means we will have to consider the following. All of which will be relevant, finally to the problem of $\left|0\right\rangle$

Important since it relates to the problem of a Q factor in a Gravity wave detector, which will be discussed in the final part of this manuscript.[47]

17. **Understanding how phase shift in Gravitational waves may be affected by the transition to a causal discontinuity, and different models of emergent structure**

In research work as given by [48];[38] (Li, and Yang, 2009), [49]; [39] (Beckwith, 2010b) outlined in Chongqing November 2010 the following representation of amplitude, i.e. as by reading [48] (Li, and Yang, 2009) the following case for amplitude

$$A_{\otimes} = A_{\oplus} = \breve{A} \tag{76}$$

Furthermore, first order perturbative terms of an E&M field have its components written as.[48] (Li, and Yang, 2009)

$$\tilde{F}^{(1)}_{0\ 2} = i\tilde{F}^{(1)}_{0\ 1} \tag{77}$$

Secondly, there is a way to represent the" number" of transverse first order perturbative photon flux density as given in an earth bound high frequency GW detector [48]; [38] .(Li, and Yang, 2009). It should be noted that his is for the number of photons, (photon flux) associated with gravitons!

$$n_r^{(1)} = \frac{c}{2\mu_0 \hbar \omega_{e^-}} \mathrm{Re}\{\ \} \tag{78}$$

$$\{\ \} = i(\exp[-i\theta]) \cdot \tilde{F}_{0\ 1}^{(1)*} \cdot \left[\frac{i}{\omega_{e^-}} \cdot \left(\frac{\partial \Psi_x}{\partial y} - \frac{\partial \Psi_y}{\partial x} \right) \right] \tag{79}$$

Here the quantity $\frac{i}{\omega_{e^-}} \cdot \left(\frac{\partial \Psi_x}{\partial y} - \frac{\partial \Psi_y}{\partial x} \right)$ represents the z component of the magnetic field of a Gaussian beam used in an EM cavity to detect GW. We introduce the quantity Q, the quality factor of the detector cavity set up to observe GW, and $\breve{A}$, the experimental GW amplitude. In the simplest case, $\hat{B}_y^{(0)}$ is a static magnetic field. Then $\tilde{F}_{0\ 2}^{(1)} = i\tilde{F}_{0\ 1}^{(1)}$ leads to [48] (Li, and Yang, 2009)

$$\tilde{F}_{0\ 1}^{(1)} = i2\breve{A}\hat{B}_y^{(0)} Q \cdot \left[\sin\left[\frac{n\pi z}{b} \right] \right] \cdot \exp\left[i\left(-\omega_g t + \delta_0 \right) \right] \qquad \{80\}$$

The formula $E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto \tilde{\beta}$ is a feed into ω_g provided time $t \propto$ Planck time, and set Eq. (80)(40) with $\omega_g \sim \omega_g$ by setting up $E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \approx \tilde{\beta}$. In other words, for relic GW production, an interrelationship between $\tilde{\alpha}$ and $E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto \tilde{\beta}$ for increases in degrees of freedom. This is a different perspective than what is normally used in analyzing what happens in a transition between initial Planck time ~ 10^{-44} seconds, and cosmological evolution up to 10^{-30} seconds The next discussion is on research done by [48] (Li, et al, 2003), as to identifying traces of massive gravitons. [49] (Beckwith, 2011b)

The radical DEGREE OF FREEDOM INCREASE WILL BE CRUCIAL TO THE DEVELOPMENT OF $|0\rangle$

18 . Re casting the problem of GW / Graviton in a detector for "massive" Gravitons

We now turn to the problem of detection. The following discussion is based upon with the work of Li, Beckwith, and other physics researchers in Chongqing University .(Li, et al, 2003), [50] (Beckwith,2010b)[49] **.** What (Li et al, 2003) [50] have shown in 2003 which Beckwith made an extension (Beckwith, 2011b) [51] is to obtain a way to present first order perturbative electromagnetic power flux, i.e. $\overset{(1)}{T}{}^{uv}$ in terms of a non-zero four dimensional graviton rest mass, in a detector , in the presence of uniform magnetic field (Li et. al., 2003) [50] , (Beckwith, 2010b) [51] .What if we have curved space time with an energy momentum tensor of the electromagnetic fields in GW fields as given by (Li et. al., 2003) [50] ?

$$T^{uv} = \frac{1}{\mu_0} \cdot \left[-F_\alpha^\mu F^{v\alpha} + \frac{1}{4} \cdot g^{\mu v} F_{\alpha\beta} F^{\alpha\beta} \right] \tag{81}$$

(Li et al, 2003) [50] States that $F_{\mu v} = F_{\mu v}^{(0)} + \tilde{F}_{\mu v}^{(1)}$, with $\left|\tilde{F}_{\mu v}^{(1)}\right| << \left|F_{\mu v}^{(0)}\right|$ will lead to

$$T^{uv} = \overset{(0)}{T}{}^{uv} + \overset{(1)}{T}{}^{uv} + \overset{(2)}{T}{}^{uv} \quad (82)$$

The 1st term to the right side of Eq. (82) is the energy – momentum tensor of the back ground electromagnetic field, and the 2nd term to the right hand side of Eq. (82) is the first order perturbation of an electromagnetic field due to the presence of gravitational waves [49] Here the term about the count of gravitons should be held as similar, but not necessarily exactly the same as the photon perturbative flux given in Eq. (78). !! This should be reviewed in lieu of [50], and [51], in any case we define

$$J_{effective} \cong n_{count} \cdot m_{4-D-Graviton} \quad (83)$$

As stated [52] $m_{4-D-Graviton} \sim 10^{-65}\, grams$, while n_{count} is the number of gravitons which may be in the detector sample. What Beckwith and Li intend to do is to isolate out an $\overset{(1)}{T}{}^{uv}$ assuming a non-zero graviton rest mass and use $\tilde{\beta} \cong |F|$ and make a linkage with $\overset{(1)}{T}{}^{00}$. The term $\overset{(1)}{T}{}^{00}$ isolated out from $\overset{(1)}{T}{}^{uv}$. The point is that detected GW helps constrain Eq.(83) (43). If this is done, the next step will be different GW measurement protocols. As one can try working with, using the ideas of [53]we can set

$$h_0^2 \Omega_{GW} \sim 10^{-6} \quad (84)$$

Next we note the results of using $h_0^2 \Omega_{GW} \sim 10^{-6}$ in GW measurements

19 Wavelength, sensitivity and other such constructions from Maggiore, with our adaptations and comments

We will next give several basic considerations as to early universe geometry which are appropriate as to the[53] (Maggiore, 2000) treatment of both wavelength, strain, and Ω_{GW}. The idea will be to look at how the ten to the tenth stretch out of generated wave length may tie in with early universe models. We want to, if $h_0 = .51 \pm .14$, understand what affects an expansion of GW wave lengths.

Table 1: Managing GW generation from Pre Planckian physics [53][43] (Maggiorie, 2000), [54] [44] (Beckwith, 2011)

$h_C \le 2.82 \times 10^{-33}$	$f_{GW} \sim 10^{12}\, Hertz$	$\lambda_{GW} \sim 10^{-4}\, meters$
$h_C \le 2.82 \times 10^{-29}$	$f_{GW} \sim 10^{8}\, Hertz$	$\lambda_{GW} \sim 10^{0}\, meters$
$h_C \le 2.82 \times 10^{-25}$	$f_{GW} \sim 10^{4}\, Hertz$	$\lambda_{GW} \sim 10^{1}\, kilometer$
$h_C \le 2.82 \times 10^{-23}$	$f_{GW} \sim 10^{2}\, Hertz$	$\lambda_{GW} \sim 10^{3}\, kilometer$

What Beckwith expects, [2] Crowell, 2011) is that initial waves, in the Planckian regime have about $\lambda_{GW} \sim 10^{-14} meters$ for $f_{GW} \sim 10^{22} Hertz$ which would turn into $\lambda_{GW} \sim 10^{-1} meters$, for $f_{GW} \sim 10^{9} Hertz$**,** and sensitivity of $h_C \leq 2.82 \times 10^{-30}$**.** It is important to note that the $h_0^2 \Omega_{GW} \sim 10^{-6}$ is the first measurement metric which is drastically altered. h_C Which is mentioned in **Eq. (86)** is an upper bound. In reality, only the 2nd and 3rd columns in table 1 above escape being inaccurate. , since the interactions of gravitational waves / gravitons with quark – gluon plasmas deform by an order of magnitude h_C. So for table 1, the first column is an upper bound which, even if using **Eq.(86)** is off by an order of magnitude. More seriously, the number of gravitons per unit volume of phase space is dependent upon $h_0^2 \Omega_{GW} \sim 10^{-6}$. If that is changed, **Eq. (85)** is less valid.

The particle per phase state count is, [53]; [43] (Maggiorie, 2000)

$$n_f \sim h_0^2 \Omega_{GW} \cdot \frac{10^{37}}{3.6} \cdot \left[\frac{1000Hz}{f} \right]^4 \tag{85}$$

Secondly detector strain for device physics is given by[53] (Maggiorie, 2000)

$$h_C \leq \left(2.82 \times 10^{-21}\right) \cdot \left(\frac{1Hz}{f} \right) \tag{86}$$

These values of strain, the numerical count, and also of n_f give a bit count and entropy which will lead to limits as to how much information is transferred. Note after the start of inflation with at the beginning of relic inflation $\lambda_{GW} \sim 10^{-1} meters \Rightarrow n_f \propto 10^6 graviton/unit-phase-space$ for $f_{GW} \sim 10^{9} Hertz$ This is to have, say a starting point in pre inflationary physics of $f_{GW} \sim 10^{22} Hertz$ when $\lambda_{GW} \sim 10^{-14} meters$, i.e. a change of $\sim 10^{13}$ orders of magnitude in about 10^{-25} seconds. **The challenge will be to** come up with an input model which will justify a new data model, [53]; [43] (Maggiorie, 2000), which is what we are trying to do in our research in this manuscript.

Having said all this, we claim that Eq. (85) would preferably being set up so that we can make the following identification, namely

$$\begin{aligned} n(relic-graviton-count) &\propto \frac{\frac{\hbar^2}{2m} \cdot \left|\nabla \psi\right|^2 + \alpha \cdot \left|\psi\right|^2 + \frac{\beta}{2} \cdot \left|\psi\right|^4}{T_{Planckian-temperature}} \\ &\propto n_f \sim h_0^2 \Omega_{GW} \cdot \frac{10^{37}}{3.6} \cdot \left[\frac{1000Hz}{f} \right]^4 \end{aligned} \tag{87}$$

We will now then proceed for a description of what can be said about reconciling a description about $\left|0\right\rangle$ and also ψ, in terms of entropy (counting of relic gravitons) , which we will relate to information (bits) via the hypothesis of Seth Lloyd [3] . Needless to say though, that our ψ will take in a staggering amount of equation input, which we will list. I.e. ψ will be influenced by Eq. (58), Eq. (67), Eq. (69), Eq. (71), and Eq. (87)

Doing so will allow us to give more detail to what was a heuristic brush given in Eq. (56) and Eq. (57) which will then lend ourselves to the FINAL question of our document, which is to what degree is the early universe, say especially in quantum information , classical versus quantum in characterization of the genesis of gravity and what this may imply as to gravitons.

To make this final point, we will review all we have brought up against the meme of say up to 1 million relic plank mass black holes in the initial phases of cosmological expansion, which by necessity has many classical/ semi classical features, and see how our emerging formalism matches up against it.

That will be covered in the next several pages of our document.

20 Looking at how to form entangled gravitons, from Prior to the Present Universe.

From [54] .In the Dalton paper, the key formulation as to how to signal the existence of entanglement, is in a general sense given by

$$\left(\Delta\tilde{x}_A^{\,2}\right)_{\tilde{x}_B}\left(\Delta\tilde{p}_A^{\,2}\right)_{\tilde{p}_B} < \frac{\hbar^2}{4} \tag{88}$$

Where we make the following identifications

$\left(\Delta\tilde{x}_A^{\,2}\right)_{\tilde{x}_B} =$ (conditional probability for measuring $\tilde{x}_A$ for sub system A , having measured $\tilde{x}_B$ for system B)

$\left(\Delta\tilde{p}_A^{\,2}\right)_{\tilde{p}_B} =$ (conditional probability for measuring $\tilde{p}_A$ for sub system B, having measured $\tilde{p}_B$ for system B)

I.e. Eq. (88) is proof of a linkage, information wise between the sub systems A and sub system B, i.e. as stated in [54] the above is akin to information transfer between A and B components at say 10^5 times the speed of light, effectively making 'instantaneous information correlation between two states, in sub systems A and B "instantaneous" for all practical purposes.

Having said that, again quoting Dalton, [54], we have that for a Boson, we can write entangled states via the methodology of what is referred to as first quantization,

$$\left|\Psi\right\rangle_{Boson} = \frac{1}{\sqrt{2}}\cdot\left[\left|A(1)\right\rangle\otimes\left|B(2)\right\rangle+\left|A(2)\right\rangle\otimes\left|B(1)\right\rangle\right] \tag{89}$$

What Eq. (89) is saying is that particle (1) in sub system A is measured at the same time as Particle (2) in sub system B, whereas particle (2) in subsystem A is measured at the same time particle (1) is measured in subsystem B.

I.e. the Eq. (89) in first quantization is a representation as to the interexchangability of information in two sub systems. Due to the fact we have bosons in this representation, it is a statement as to the almost instantaneous transfer between two states, of information and signaling.

Having said this, we will make several specific caveats as to our analysis of how this relates to EPR and cosmology

We will start with our take in terms of a modification of a string theory start to evaluating a graviton, in a pre-squeezed state $|0\rangle$ in prior notation, and then taking into account the string theory idea that a graviton is due to the harmonics of a CLOSED string in space time, and then connect this with the idea of a particle in a completely spherical potential, i.e. the idea being a takeoff of what was done in [11] by the author, To do this, look at the next section which takes a simple string theory based analysis, which we then alter in several specific ways as to ascertain what happens if we have initially complete spherical symmetry.

21. First principle creation of initial 'graviton state' $|0\rangle$

To do this look at the paper given by Li [55] which has the following included in it, i.e.

Quote

Now the world-volume DBI action is extremized if (*see page 4 of that article* [55] *by Li*)

$\psi \simeq \frac{\mathrm{n}\pi}{k}$ **(*which is their Eq. (15) of page 4 of that article,* [55])**

End of quote

The extremized version of the action on a D2 brane will be necessitating having the existence of a flux $\mathrm{F} = -\frac{\mathrm{n}}{2} d\Omega_2$, with n a number, and with ψ a constant on the D2 brane, , as quoted just before Eq. (15) of [ ] by Li, with n a number, hence, we will be from here, examining, what we can do with

$$\psi \simeq \frac{\mathrm{n}\pi}{k} \tag{90}$$

I.e. the approximation chosen by this author is to use the following for *k*, i.e. for the initial pop up state assume that to first order we have that $k = \sqrt{2mE_0 / \hbar^2}$

$$
\begin{aligned}
&\psi \simeq \frac{\mathrm{n}\pi}{k} \\
&k = \sqrt{2mE_0 / \hbar^2} \\
&\Rightarrow \psi \sim \frac{\mathrm{n}\pi}{\sqrt{2mE_0 / \hbar^2}} \\
&\textit{Then} \\
&|0\rangle \propto fcn\left(\frac{\mathrm{n}\pi}{\sqrt{2mE_0 / \hbar^2}}\right)
\end{aligned}
\tag{91}
$$

Having said that, the approximation which the author choses is to use the idea of a perfectly symmetrical potential in terms of a spherical Bessel function, of zeroth order, so as to have the following, i.e. if $r \propto l_{Planck}$

$$
|0\rangle \propto \sqrt{1/4\pi} \left\{ \frac{\sin\left(\frac{\mathrm{n}\pi \cdot r}{\sqrt{2mE_0 / \hbar^2}}\right)}{\left(\frac{\mathrm{n}\pi \cdot r}{\sqrt{2mE_0 / \hbar^2}}\right)} \right\} \approx \sqrt{1/4\pi} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}^2 \cdot \pi^2 \cdot r^2 \cdot \hbar^2}{2mE_0} \right\}
\tag{92}
$$

Now use the idea of quantum entanglement i.e. to first approximation, then

$$|0\rangle \propto \sqrt{1/4\pi}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}^2\cdot\pi^2\cdot r^2\cdot\hbar^2}{2mE_0}\right\}$$

$$|\Psi\rangle_{Boson} = \frac{1}{\sqrt{2}}\cdot\left[|A(1)\rangle\otimes|B(2)\rangle + |A(2)\rangle\otimes|B(1)\rangle\right]$$

$$A(1) \propto \sqrt{1/4\pi}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}_A{}^2\cdot\pi^2\cdot r_{\mathrm{Prior}}{}^2\cdot\hbar^2}{2mE_0}\right\}$$

$$B(2) \propto \sqrt{1/4\pi}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}_B{}^2\cdot\pi^2\cdot r_{\mathrm{Present}}{}^2\cdot\hbar^2}{2mE_0}\right\}$$

$$A(2) \propto \sqrt{1/4\pi}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}_A{}^2\cdot\pi^2\cdot r_{\mathrm{Present}}{}^2\cdot\hbar^2}{2mE_0}\right\}$$

$$B(1) \propto \sqrt{1/4\pi}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}_B{}^2\cdot\pi^2\cdot r_{\mathrm{Prior}}{}^2\cdot\hbar^2}{2mE_0}\right\}$$

$$\Rightarrow |\Psi\rangle_{Boson} = \frac{1}{\sqrt{2}}\cdot\left[|A(1)\rangle\otimes|B(2)\rangle + |A(2)\rangle\otimes|B(1)\rangle\right]$$

Then

$$\begin{aligned}\psi_{Entangled} &\propto \frac{1}{\sqrt{8\pi}}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}_A{}^2\cdot\pi^2\cdot r_{\mathrm{Prior}}{}^2\cdot\hbar^2}{2mE_0}\right\}\otimes\left\{1-\frac{1}{3!}\frac{\mathrm{n}_B{}^2\cdot\pi^2\cdot r_{\mathrm{Present}}{}^2\cdot\hbar^2}{2mE_0}\right\} \\ &+\frac{1}{\sqrt{8\pi}}\cdot\left\{1-\frac{1}{3!}\frac{\mathrm{n}_A{}^2\cdot\pi^2\cdot r_{\mathrm{Present}}{}^2\cdot\hbar^2}{2mE_0}\right\}\otimes\left\{1-\frac{1}{3!}\frac{\mathrm{n}_B{}^2\cdot\pi^2\cdot r_{\mathrm{Prior}}{}^2\cdot\hbar^2}{2mE_0}\right\}\end{aligned} \tag{93}$$

The squeezing would occur afterwards, with respect to the entangled state, according to

$$Squeezed \quad \psi_{Entangled} \approx Z(r,\vartheta)\cdot\psi_{Entangled} \tag{94}$$

In essence what we are seeing here is that **r(present)** is for the present universe position, whereas **r(prior)** is for the position of the prior universe, and that the information transfer between these A(1), B(2), and A(2),B(1) couplets of gravitons would be effectively instantaneous and would be moving at up; to 100,000 times the speed of light, with the Eq. (93) components would be, if defined appropriately obeying Eq. (88) above.

Having said that, the next step would be then to ascertain as to the degree of classicality versus quantum mechanical aspects of the early universe, which will then be the concluding part of our presentation save the issue of would be future projects and impingement upon the CMBR.

22. The issue of classical versus quantum, in terms of information, and initial conditions for cosmological expansion (due to entanglement?)

Our claim is that for the purpose of analysis, what we will be observing is along the lines of

$$
\begin{aligned}
&\psi_{Entangled} \\
&\propto \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&+ \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&\frac{\partial \psi_{Entangled}}{\partial t} = -\nabla^2 \cdot \left[\psi_{Entangled} - \psi_{Entangled}{}^3 + \nabla^2 \psi_{Entangled} \right]
\end{aligned} \tag{95}
$$

The re set in the 2nd equation in Eq. (95) is such that we should, in effect re write the above as having

$$
i\hbar \frac{\partial \psi_{Entangled}}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \cdot \left[\psi_{Entangled} - \alpha_1 \cdot \psi_{Entangled}{}^3 + \alpha_2 \cdot \nabla^2 \psi_{Entangled} \right] \tag{96}
$$

We should make the match up as to the two embeddings of quantum mechanics, within another structure,

$$
\begin{aligned}
&\psi_{Entangled} \\
&\propto \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&+ \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&i\hbar \frac{\partial \psi_{Entangled}}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \cdot \left[\psi_{Entangled} - \alpha_1 \cdot \psi_{Entangled}{}^3 + \alpha_2 \cdot \nabla^2 \psi_{Entangled} \right] \\
&as - compared - to \\
&\left(\frac{\hbar^2}{c^2} \cdot \frac{\partial^2}{\partial t^2} - \hbar^2 \Delta + m^2 c^2 \right) \Psi_{KG} = 0 \\
&\& \\
&\Psi_{KG} = \exp(i \cdot S_{example} / \hbar) = c^2 S_0 + S_1 + c^{-2} S_2 + \\
&\& \\
&S_0 \sim \pm m \cdot t \Rightarrow \left(\Psi_{KG} at \quad c^2 \right) \sim \exp(-imc^2 t / \hbar) \\
&\& \\
&\left(\Psi_{KG} at \quad c^0 \right) \sim \exp(i S_1 / \hbar) \Rightarrow i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi
\end{aligned} \tag{97}
$$

If we make the following assumptions, i.e. $\alpha_1, \alpha_2 \sim O(\varepsilon^+)$, then the top and bottom entries in Eq. (97) have similar comparable evolutionary bona fides. Although the method of relationship between

$$
\begin{aligned}
& i\hbar \frac{\partial \psi_{Entangled}}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \cdot \left[\psi_{Entangled} - \alpha_1 \cdot \psi_{Entangled}{}^3 + \alpha_2 \cdot \nabla^2 \psi_{Entangled} \right] \\
& as - compared - to, \quad if \quad \alpha_1, \alpha_2 \sim O(\varepsilon^+) \\
& \left(\frac{\hbar^2}{c^2} \cdot \frac{\partial^2}{\partial t^2} - \hbar^2 \Delta + m^2 c^2 \right) \Psi_{KG} = 0 \\
& \& \\
& \Psi_{KG} = \exp(i \cdot S_{example} / \hbar) = c^2 S_0 + S_1 + c^{-2} S_2 + \\
& \& \\
& \left(\Psi_{KG} at \quad c^0 \right) \sim \exp(iS_1 / \hbar) \Rightarrow i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi \\
& \& \\
& \left(\Psi_{KG} at \quad c^{-2} \right) \sim \exp(iS_2 / \hbar) \Rightarrow i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi - \frac{\hbar^4}{8m^3 c^2} \Delta\Delta\Psi
\end{aligned} \tag{98}
$$

The top equation is most similar to the last equation as can be seen in the following schematic

$$
\begin{aligned}
& i\hbar \frac{\partial \psi_{Entangled}}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \cdot \left[\psi_{Entangled} - \alpha_1 \cdot \psi_{Entangled}{}^3 + \alpha_2 \cdot \nabla^2 \psi_{Entangled} \right] \\
& compared \quad to \\
& i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi - \frac{\hbar^4}{8m^3 c^2} \Delta\Delta\Psi \\
& if \ |\alpha_2| >> |\alpha_1|, the \quad two \quad almost \quad match \\
& if \ |\alpha_2|, |\alpha_1| \sim O(\varepsilon^+) \\
& i\hbar \frac{\partial \psi_{Entangled}}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \cdot \left[\psi_{Entangled} - \alpha_1 \cdot \psi_{Entangled}{}^3 + \alpha_2 \cdot \nabla^2 \psi_{Entangled} \right] \\
& should \quad be \quad compared \quad to \\
& i\hbar \Psi_t = \frac{-\hbar^2}{2m} \Delta \Psi
\end{aligned} \tag{99}
$$

I.e. the details of this match up need to be vetted and examined.

We can say that this is an unexplored but vial area in terms of determination as to how we can link the idea of linking a modification of the the presentation of [40] Mazenko (“Introduction of Growth Kinetic Problems “) with the TGCL model as seen in a NATO conference, in 1995 compared to the Kieffer model of how the Klein Gordon Equation can be linked to Quantum mechanics. I.e. will state that we should spend more time examining the particulars of the following Equation, for insights

$$
i\hbar \frac{\partial \psi_{Entangled}}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \cdot \left[\psi_{Entangled} - \alpha_1 \cdot \psi_{Entangled}{}^3 + \alpha_2 \cdot \nabla^2 \psi_{Entangled} \right] \tag{100}
$$

Having said that, we will next go to the idea of information, and the problem of mass, i.e. how to make sense of m, in Eq.(100) above.

23. Quantum information, and the matter of mass, in terms of Quantum entanglement.

We begin with a non standard expression of mass, and cosmology which is our Eq. (102) . From there we will be examining the role of mass, in terms of Eq. 95, Eq. (99) and Eq. (100). Afterwards, a comparison with the idea of entropy, in terms of a particle count will be done as far as Eq. (87) where we examine the role of black holes of Planck size as far as generators of entropy, and the relative graviton emissions of graviton per Planck mass black hole in the beginning of space-time. In doing so we will be re examining the ideas of what makes the onset of gravity either classical or quantum. The close to what we present will be a precursor of what we think may pertain to an information based treatment of the formation of mass question, which will be the subject of our next paper. Having said that, we begin with a review of the idea of how to use Eq. (101), but before implementing Eq. (101), we need to have a statement as to the mass term, m, which shows up in the first term of Eq. (101)

$$n(relic-graviton-count) \propto \frac{\frac{\hbar^2}{2m}\cdot\left|\nabla\psi\right|^2+\alpha\cdot\left|\psi\right|^2+\frac{\beta}{2}\cdot\left|\psi\right|^4}{T_{Planckian-temperature}} \qquad (101)$$

And this expression of relic gravitons will be contrasted that with the idea of creation of Planck sized black holes also generating Gravitons

To begin our inquiry let us first of all say something pertinent to the formation of mass problem.

We begin with a non standard representation of mass from Plebasnki and Krasiniski [56] which affirms the likelihood of the synthesis of mass, if and when the radii of a universe, due to a metric is non zero. I.e. from [56] , page 295, and page 296

If one assumes a metric given by[56], page 295

$$dS^2 = \left[\exp\left(C\left[t,r\right]\right)\right]\cdot dt^2 - \left[\exp\left(A\left[t,r\right]\right)\right]\cdot dr^2 - R^2\left(t,r\right)\cdot\left[d\vartheta^2+\left(\sin^2\vartheta\right)\cdot d\phi^2\right] \qquad (102)$$

Pick, in this case, R is equal to r, usual spatial distance, due to the following argument given below.

$$\begin{aligned} &S\left(surface\right)=4\pi\cdot R^2\left(x,t\right)\\ &\Leftrightarrow R^2\left(x,t\right)=square,\quad of \quad areal \quad radius\\ &\Leftrightarrow R^2\left(x,t\right)=r^2\left(x,t\right) \end{aligned} \qquad (103)$$

Leading to an effective mass which we can define via page 296 of [56] as given by

$$m(effective)=\frac{C^2\left(r,t\right)}{2G}\cdot\left(R+\left(\exp\left(-C(r,t)\right)\cdot R\cdot\left(\frac{\partial R}{\partial t}\right)^2-\left(\exp\left(-A(r,t)\right)\cdot R\cdot\left(\frac{\partial R}{\partial r}\right)^2+\frac{\Lambda\cdot R^3}{3}\right) \qquad (104)$$

This expression for an effective mass, would be zero if the R goes to zero, but we are presuming due to Beckwith, [ ] that we have a finite, nonzero beginning to the radius of expansion of the universe.

Furthermore, to get this in terms of R = r, that the above is, then at H = 0 re written as, if R= r = Planck length,

$$m(effective)\Big|_{H(Hubble)=0} = \frac{C^2(r,t)}{2G} \cdot \left(r^2 - \left(\exp\left(-A(r,t)\right)\right) \cdot r + \frac{\Lambda \cdot r^3}{3} \right)\Bigg|_{r \propto l(Planck)}$$

$$\approx \frac{C^2\left(r = l_{Planck}, t_{Planck}\right)}{2G} \cdot \left(l_{Planck}{}^2 - \left(\exp\left(-A(l_{Planck}, t_{Planck}\right)\right) \cdot l_{Planck} + \frac{\Lambda \cdot l_{Planck}{}^3}{3} \right)\Bigg|_{r \propto l(Planck)} \quad (105)$$

We claim that this effective mass should be put into the following wave function at the boundaries of the H = 0 causal boundary, as outlined by Beckwith, in [41]. Then we make the following approximation at the H = 0 causal boundary, for the entangled wavefunction for Faster than light transmission of 'quantum information', i.e.

$$\psi_{Entangled}$$

$$\propto \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{n_A{}^2 \cdot \pi^2 \cdot r_{Prior}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{n_B{}^2 \cdot \pi^2 \cdot r_{Present}{}^2 \cdot \hbar^2}{2mE_0} \right\}$$

$$+ \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{n_A{}^2 \cdot \pi^2 \cdot r_{Present}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{n_B{}^2 \cdot \pi^2 \cdot r_{Prior}{}^2 \cdot \hbar^2}{2mE_0} \right\} \quad (106)$$

The particulars of what the value of mass **m** are, to be put in will probably be similar to Eq. (105) whereas the value of E_0 will be discussed in the next section when we discuss what may be admissible as far as Entropy generation, ie. And comparing how a scenario as to a million or so Planck sized black holes, affects the treatment of if, or not we have a classical or quantum mechanical origin for gravity, and the start to cosmological evolution.

24. First principle treatment as far as recovering value of E_0

To get at a value of E_0, one can look at values given in [57] by Gorbunov, and Rubakov, with

$$E_0 \sim T_{00}^{EM} + T_{00}^{SC} \approx \frac{(E_{Electric}^2 + H_{Magnetic}^2) + \left(\partial_0 \phi\right)^2 + \left(\partial_i \phi\right)^2 + 2V\left(\phi\right)}{2} \quad (107)$$

Use the following, i.e. look at first a treatment of

$$E_0(sc) \sim T_{00}^{SC} \approx \frac{\left(\partial_0 \phi\right)^2 + \left(\partial_i \phi\right)^2 + 2V\left(\phi\right)}{2} \quad (108)$$

We will do the Electric and Magnetic field contributions secondly. So first of all review the Inflaton generated $E_0(sc)$

Another way to look at the Eternal inflation paradigm involves a review of a similar situation as the one given in reference [58] (.Gurzadyan, Penrose, 2011) . That is to consider what we have brought up before in an earlier publication, [59] which is conditions for where we have kinetic energy larger than potential energy in Pre Planckian space-time. Readers can refer to the earlier arguments in [59] whereas we will proceed to another argument which is more along the lines of the similarities with Pre Octonionic to Octonionic space time transtions.

To do so, in our new argument, we look at first a simple way to frame the cosmological constant problem as given by Guth [60] as given by

$$\begin{aligned}
&\Lambda_{\text{C}.Const}\, g_{uv} = \langle 0 | T_{uv} | 0 \rangle \xrightarrow[(u,v)\to(0,0)\Pr e-Planckian]{} \Lambda_{\text{C}.Const}\, g_{00} = \langle 0 | (T_{00} = \rho) | 0 \rangle \\
&\Leftrightarrow \rho = \frac{\dot{\phi}^2}{2} + V(\phi) + \frac{(\nabla \phi)^2}{2} \xrightarrow[(u,v)\to(0,0)\Pr e-Planckian]{} \rho = \frac{\dot{\phi}^2}{2} + V(\phi) \\
&\Leftrightarrow \Lambda_{\text{C}.Const,\Pr e-Planckian} = \langle 0 | (T_{00} = \rho)_{\Pr e-Planckian} | 0 \rangle \cdot g_{00}^{-1}
\end{aligned} \tag{109}$$

This last line, namely $\Lambda_{\text{C}.Const,\Pr e-Planckian} = \langle 0 | (T_{00} = \rho)_{\Pr e-Planckian} | 0 \rangle \cdot g_{00}^{-1}$ is assumed to have the same value as the cosmological constant today, i.e. no quintessence, so what we will be doing is to examine what this says about an inflaton mass, in the spirit of what was said by Corda in [61]. In the pre Planckian regime we are having that $(\nabla \phi)^2$ would be of small import, and that there is still though, a small regime of space-time, i.e. a bounce ball of the form given in [62] and [63] and [64] which would have the inflaton only change by time, not space, and then refer to [65] which has an inflaton mass of the form given by , if we use the variable change of $z = \dot{\phi} / H$, and assume that $\dot{\phi}$ is approximately a constant in the interval of time, in the Pre Planckian space-time regime, so that the inflaton mass is given by, if in Pre Planckian space-time

$$d\tau^2 = a^2(\tau)\, dt^2 \sim \left(a_{\Pr e-planckian} = a_{\min}\right)^2 dt^2 \tag{110}$$

(54)

With $a_{\min}$ defined in [63] , then the equation given in [65] for inflation mass would in the Pre Planckian space-time

$$m^2 \sim -z^{-1} \frac{d^2 z}{d\tau^2} \tag{111}$$

Becomes

$$m^2 \sim -\frac{H}{a_{\min}} \cdot \frac{d^2 H^{-1}}{dt^2} \tag{112}$$

In order to do this, we will be setting the following presentation for the inverse of the Hubble parameter

$$H^{-1} = H^{-1}_{Planckian-regime} + \frac{H^{-1}_{\Pr e-Planckian-regime}}{2} \cdot \left(t \cdot t_{Planck} - t^2\right) \tag{113}$$

The parameter $H^{-1}_{\Pr e-Planckian-regime}$ is set for half of the Planck time interval, and the net result is that Eq(113) .(15)(56) becomes scaled as

$$m^2 \sim -\frac{H}{a_{\min}} \cdot \frac{d^2 H^{-1}}{dt^2} \sim \frac{H^{-1}_{\Pr e-Planckian-regime}}{a_{\min} \cdot \left[H^{-1}_{Planckian-regime} + \frac{H^{-1}_{\Pr e-Planckian-regime}}{2} \cdot \left(t \cdot t_{Planck} - t^2 \right) \right]} \tag{114}$$

Then inflaton based kinetic energy would be , if M_{Planck} is Planck mass

$$\begin{aligned} \frac{\dot{\phi}^2}{2} &\sim \frac{3M_{Planck}}{\left[H^{-1}_{Planckian-regime} + \frac{H^{-1}_{\Pr e-Planckian-regime}}{2} \cdot \left(t \cdot t_{Planck} - t^2 \right) \right]} \\ &\Leftrightarrow V(\phi)\Big|_{\Pr e-Planckian-regime} \sim \lambda \phi^4 \Big|_{\Pr e-Planckian-regime} << \frac{\dot{\phi}^2}{2} \end{aligned} \tag{115}$$

Having said this, we will next introduce the Inflaton to use in this situation. [66], [67] [68]

$$\begin{aligned} & a \approx a_{\min} t^{\gamma} \\ & \Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln \left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right\} \\ & \Leftrightarrow V \approx V_0 \cdot \exp \left\{ -\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t) \right\} \end{aligned} \tag{116}$$

$$\begin{aligned} & a_{\min} \sim \alpha_0 \cdot \left(\frac{\alpha_0}{2\tilde{\lambda}} \cdot \left(\sqrt{\alpha_0{}^2 + 32\pi\mu_0 \omega \cdot B_0^2} - \alpha_0 \right) \right)^{1/4} \\ & \alpha_0 = \sqrt{\frac{4\pi G}{3\mu_0 c^2}} B_0 \\ & \tilde{\lambda} = \frac{\Lambda_{Einstein} c^2}{3} \end{aligned} \tag{117}$$

Then, we have to first order

$$E_0(sc) \sim T_{00}^{SC} \approx \frac{\left(\partial_0 \phi\right)^2}{2} \sim \frac{\gamma}{(8\pi G) \cdot t^2} \tag{118}$$

Specifically, we will be filling in the details of Eq. (114) to Eq. (118) with the adage that we will be using of all things, a modified version of the Noether Current, [69] ; [2] according to a simplified version of the treatment given in [8] with a scalar field we will define as

$$\tilde{\phi} = \left[\exp(i \cdot \omega \cdot t)\right] \times \phi \qquad (119)$$

Which will allow, after calculation, that the Noether current will be, if linked to its time component, real valued. Which is a stunning result. Our next trick will be then to put this effective quantum bubble "current' as the magnetic field, B_0, using the results of both Giffiths, [70]; [9] and Landau and Liftschitz, [71] for a magnetic field, for Eq. (117) .This, then will be the plan of what we will be working with in this article, in subsequent details

We start off with Ohm's law [70], [71] assuming a constant velocity within the space-time bubble, of

$$j = \sigma E \qquad (120)$$

Where the velocity of some 'particle' ,. Or energy packet, or what we might call it, does not change. Then use the Griffith's relationship [70] of

$$\begin{aligned} B_0(magnetic - field) &= B_{net} \\ &= \sqrt{\varepsilon\mu_0} \cdot \left(1 + \left(\frac{\sigma}{\varepsilon\mu_0}\right)^2\right)^{1/4} E_0 \\ &= \sqrt{\varepsilon\mu_0} \cdot \left(1 + \left(\frac{\sigma}{\varepsilon\mu_0}\right)^2\right)^{1/4} \cdot \frac{j}{\sigma} \end{aligned} \qquad (121)$$

We will comment upon the σ later, but first say something about what j as current is proportional to

The modus operandi chosen here is to employ the following. Use a scalar field defined by Eq. (119) and a Noether conserved current [69] proportional to:

$$j^{\mu} = i \cdot \left[\left(\partial_{\mu}\tilde{\phi}^*\right) \cdot \tilde{\phi} - \tilde{\phi}^* \cdot \left(\partial_{\mu}\tilde{\phi}^*\right)\right] \qquad (122)$$

Here we take the time component of this Noether current, and use Eq. (119) for $\tilde{\phi}$, and Eq. (116) for ϕ . Therefore [70], [71], [72], [73]

$$I = j^0 \sim \frac{\gamma}{2\pi G} \cdot \frac{\omega}{\Delta t} \cdot \left[1 - \frac{1}{\Delta t} \cdot \sqrt{\frac{\gamma \cdot (3\gamma - 1)}{8\pi G \cdot V_0}}\right] \qquad (123)$$

Then our net magnetic field, is to first approximation given by [72], [73]

$$\begin{aligned} &B_0(magnetic - field) = B_{net} \\ &\sim \frac{\sqrt{\varepsilon\mu_0}}{\sigma} \cdot \left(1 + \left(\frac{\sigma}{\varepsilon\mu_0}\right)^2\right)^{1/4} \cdot \frac{\gamma}{2\pi G} \cdot \frac{\omega}{\Delta t} \cdot \left[1 - \frac{1}{\Delta t} \cdot \sqrt{\frac{\gamma \cdot (3\gamma - 1)}{8\pi G \cdot V_0}}\right] \end{aligned} \qquad (124)$$

Then, the net energy will be of the order of

$$E_0(energy-net) \sim \frac{\gamma}{(8\pi G)\cdot(\Delta t)^2} + \frac{B_0^2}{2} \sim \frac{\gamma}{(8\pi G)\cdot(\Delta t)^2} + \frac{1}{2}\cdot\left(\left(\frac{\sqrt{\varepsilon\mu_0}}{\sigma}\cdot\left(1+\left(\frac{\sigma}{\varepsilon\mu_0}\right)^2\right)\right)^{1/4}\cdot\left(\frac{\gamma}{2\pi G}\cdot\frac{\omega}{\Delta t}\cdot\left[1-\frac{1}{\Delta t}\cdot\sqrt{\frac{\gamma\cdot(3\gamma-1)}{8\pi G\cdot V_0}}\right]\right)\right)^2 \quad (125)$$

Having said this, for the contribution to the entangling graviton wave function, we will next go to the issue of if we have Classical, versus Quantum, in terms of gravitons, and comparing our ideas to what would happen if we had 1 million Planck sized black holes, initially, as generators of Gravitational wave radiation, and its effects upon the CMBR

25. Decay rate of Planck Mass Black holes, and the contribution to Gravitational radiation and graviton production

From Hawking, [74] and Page [75] and the Wikipedia reference as to Hawking Black hole radiation [76] comes the figure given, as of the time for decay of a Planck mass sized black hole

$$t_{Lifetime-Planck-mass-black-hole} \sim \frac{5120\pi G^2\left(M_{Black-hole} \sim m_{Planck}\right)^3}{\hbar c^4} \approx 5120\pi\cdot\left(t_{Planck} = Planck-time\right) \approx 8.671\times10^{-40}\sec \quad (126)$$

This will lead to a lot of evaporating black holes! In the initial phases of cosmological expansion.

This is for a black hole of Planck mass **2.435×10**^{18} GeV/c^2. Hence, we have that we can concern ourselves with the ratio of the decay of gravitons, versus an electromagnetic counterpart in the early universe, as given by Kieffer, in [10] of a ratio between Quantum mechanical graviton producing decay, and that of electromagnetics, as seen in pp 39-40 of [10]

$$\begin{aligned} &\Gamma_{graviton} = P(power)/\hbar\omega_{graviton} \\ &\& \\ &\Gamma_{graviton}/\Gamma_{Electromagnetic-signals} \\ &\sim \alpha\left(Fine-structure-constant\right)\cdot\left[m_{e^-}/m_{Planck}\right] \\ &\sim 1.28\times10^{-47} \end{aligned} \quad (127)$$

What we estimate here, is that

$$\begin{aligned}&\Gamma_{graviton} = P(power)/\hbar\omega_{graviton}\\&\&\\&\Gamma_{graviton}/\Gamma_{Electromagnetic-signals}\\&\sim \alpha\left(Fine-structure-\mathrm{co}\,ns\tan t\right)\cdot\left[m_{e^-}/m_{Planck}\right]\\&\sim 1.28\times 10^{-47}\end{aligned} \tag{128}$$

Figure, here that we have 1 million or so primordial black holes, i.e. say that each black hole has

$$\Gamma_{graviton} = P(power)/\hbar\omega_{graviton} \tag{129}$$

If there exists, a graviton frequency so that the following is true, namely, How do you calculate wavelength when given frequency? If you want to calculate the wavelength of a wave, then all you have to do is plug the wave's speed and wave's frequency into the equation. Dividing speed by frequency gives you the wavelength.

In the case of gravitons, in terms of the initial Planckian space-time regime the following relic regime frequency value for gravitons

$$Frequency \propto \omega_g \sim \frac{c = 3\times 10^{8}\, meters/\sec}{10^{-35}\, meters} \sim 3\times 10^{43}/\sec \sim 3\times 10^{34}\, GHz \tag{130}$$

If we had this, almost undoubtedly, we would be seeing the onset of definite quantum gravity effects..

Keep in mind that in this situation, we have to consider the presumed expansion of the universe, by about 10^65 e-folds, or about 1.69 times 10 ^ 28, or then that to see definite quantum effects, would need to see today

$$\begin{aligned}&Frequency \propto \omega_g\Big|_{quantum-effects,\, from-today's-data}\\&\sim \frac{c = 3\times 10^{8}\, meters/\sec}{10^{-35}\, meters\times 1.69\times 10^{28}} \sim 2\times 10^{15}/\sec\\&\sim 2\times 10^{15}\, Hz \sim 2\times 10^{6}\, GHz\end{aligned} \tag{131}$$

Lower than this frequency, for Gravitons, would lead to then say semi classical behavior for the emission of Gravitons.

Having said this, this would definitely put the origins of GW as a quantum phenomenon. i.e. the next stage of what we want to do is to ascertain the necessary power, of emission from say the behavior of 1 million Planck black holes, so as to fill in the details of what may be entailed as far as bits of information which may be exchanged from a prior to a present universe, and set the stage for the conclusion of our inquiry. i.e. how much information, using Seth Lloyds ideas of the universe as a quantum computing device,[3], and the ideas of entanglement, may be realizable experimentally speaking.

26. Filling in the details as far as Power, in Eq. (128) and Eq. (129) in order to answer the issue of information bits transferred from a prior to a present universe. Universe as a quantum computer examined.

We will use the following approximation, for power as given in page 509 of Lightman, Press, Price, and Teukolsky, [77]

$$
\begin{aligned}
& P_{GW(gravitons)} \sim (E/r)^2 \sim (\hbar\omega_{Gravitons}/r)^2 \\
& \& \\
& n(number-gravitons) \sim E^2/\hbar \sim \hbar\omega^2{}_{Gravitons}
\end{aligned}
\qquad (132)
$$

T he last number, n, is for the gravitons emerging, and we will be assuming a frequency of the order of Eq. (130) at the site of Planckian regime expansionary dynamics.

With this in mind, if one is having expression of the number of emissions per solar mass black hole, we would be looking at the total mass of a black hole, namely as given by page 67 of Mann, [78] as tied into Entanglement entropy, as given by Mann [78]

$$
\begin{aligned}
& n \sim emergent-particles \sim (M\left(Mass-of-Black-hole\right)/M_{Planck})^2/\sigma \\
& \sigma \sim O(1) \\
& n \sim emergent-particles\big|_{Solar-mass-black-hole} \sim 10^{76} \\
& n \sim emergent-particles\big|_{Planck-mass-black-hole} \sim 1 \\
& En\tan glement-entropy \sim n \cdot \ln 2
\end{aligned}
\qquad (133)
$$

Assuming a million or so Planck sized black holes, this means that there have been roughly 1 million or so entropy 'units' dumped. If we go to the Seth Lloyd and his Eq. (3) as has been cited in our text, it means that there were , if we had entanglement entropy used, then if there were 1 million black holes, then there were say 1 million or so operations done, in an information transfer from a prior universe set up to the present universe.

The details of this have to be thoroughly investigated. And now we will come to the final question. Is the Universe classical or quantum, in its origins, and how can we ascertain this?

To answer this question, we will look at the frequency, i.e. the initial one, which we gauge as far as graviton information, and secondly the question if worm holes, say as information transfer were involved in the transmission of say 1 million bits of information, from prior to our present universe conditions to what is the Planckian regime of space-time.

To do this, we will go to a conclusion where we will summarize models in order to ascertain the following.

a. Bridges from Pre Plankian to Planckian physics will be examined.
b. Review of the evidence to look for, which may answer if quantum processes are in a higher dimensional setting which may be, in terms of 5 dimensions, deterministicd
c. The arguments as to worm holes, and entanglement.

These components will lead to a tentative conclusion which we will highlight is a direction for future research endeavors

27. Conclusions and future research directions, as we ascertain it.

The linkage from Pre Planckian to Planckian physics is , as alluded to , given by having a generalized wave function with the connection given by Eq. (134) as given below

$$
\begin{aligned}
&\left|\Psi\right\rangle_{Boson} = \frac{1}{\sqrt{2}} \cdot \left[\left|A(1)\right\rangle \otimes \left|B(2)\right\rangle + \left|A(2)\right\rangle \otimes \left|B(1)\right\rangle \right] \\
&A(1) \propto \sqrt{1/4\pi} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&B(2) \propto \sqrt{1/4\pi} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&A(2) \propto \sqrt{1/4\pi} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&B(1) \propto \sqrt{1/4\pi} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&\Rightarrow \left|\Psi\right\rangle_{Boson} = \frac{1}{\sqrt{2}} \cdot \left[\left|A(1)\right\rangle \otimes \left|B(2)\right\rangle + \left|A(2)\right\rangle \otimes \left|B(1)\right\rangle \right] \\
&Then \\
&\psi_{Entangled}[pre-Planckian-to-Planckian-bridge] \\
&\propto \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&+ \frac{1}{\sqrt{8\pi}} \cdot \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_A{}^2 \cdot \pi^2 \cdot r_{\mathrm{Present}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \otimes \left\{ 1 - \frac{1}{3!} \frac{\mathrm{n}_B{}^2 \cdot \pi^2 \cdot r_{\mathrm{Prior}}{}^2 \cdot \hbar^2}{2mE_0} \right\} \\
&\& \\
&\left|0\right\rangle_{\inf ormation-bit} \propto \psi_{Entangled}[pre-Planckian-to-Planckian-bridge] \\
&\sim \inf ormation-bit
\end{aligned}
\tag{134}
$$

The point being that the information bit, as we see it, with each information bit tied to 1 black hole of at least Planck mass, and this before and then after the universe forms, forms an information bridge. If or not this is connected to a quantum process, will be ascertained if in today's GW collection we could obtain

$$
\begin{aligned}
&Frequency \propto \omega_g \Big|_{quantum-effects,\, from-today's-data} \\
&\sim 2 \times 10^{15} Hz \sim 2 \times 10^{6} GHz
\end{aligned}
\tag{135}
$$

This represents a 10^28 order of magnitude decrease in the initial frequency, so the frequency corresponds to about a 1/Planck length contribution. i.e. the wavelength of the order of magnitude of a Planck length, such tiny length contributions probably necessary for the onset of quantum gravity effects.

I.e. if we have such high frequencies detected, for the onset of nucleated particles, leading to signals from relic cosmological conditions, we probably have the smoking gun as to gravity being quantum mechanical.

The next thing to consider is, if there is a necessary involvement as to worm holes, and entangled initial graviton states connected to Pre Planckian graviton states , which may be given by Eq. (134) which is brought up by Baez and Vicary, in [79]

Our reading is, simply this, that the quote given below, in Baez and Vicary [79] which is actually due to

Quote

In Maldacena and Susskind's argument [80] , the system H is a wormhole and the systems A and B are its two ends. These ends may superficially appear to be two separate particles, but in reality they are just two 'views' of the same wormhole.

End of quote

Then, we are probably seeing information from a Pre Planckian state, transferred to a Planckian state, transferred along the lines of Quantum entanglement. Note, also, if the objects entering in the worm hole, as given in Eq. (134) are amendable as topological defects as spoken of in this quote

Quote (from **John C Baez and Jamie Vicary [79])**

We should emphasize that this rigorous version of ER=EPR makes use of special features of 3d topological field theories: for example, that particles can be described as topological defects. We should not naively extrapolate these ideas to realistic 4- dimensional physics. However, our treatment applies to the condensed matter physics of thin films whose ground states are effectively described by a 3d TQFT.

End of quote

I.e. then the connection between the pre Planckian to Planckian physics is probably a worm hole entanglement connection.

I.e. we should revisit Eq. (134) and determine if this is consistent with topological defects. And their modeling

For the record, as far as determining if we have topological defects, what this author believes is that we do have topological defects if we can make a connection between n, i.e. for graviton counts, with the n given in the following equation, i.e. if the following can be shown to be true, we are on our way to identifying if we have quantum information exchanged from Pre Universe, to Present universe states according to the following line element. As given by Jerzy Plebasnki and Andrezej Krasinski [56]

$$
\begin{aligned}
&if \quad dS^2 = \left[\exp\left(C[t,r]\right)\right]\cdot dt^2 - \left[\exp\left(A[t,r]\right)\right]\cdot dr^2 - R^2(t,r)\cdot\left[d\vartheta^2 + \left(\sin^2\vartheta\right)\cdot d\phi^2\right] \\
&\& \\
&2\pi R \sim 2\pi l_{Planck} \\
&n(particle - count) \\
&\sim Mass(total, at \quad H=0)/m_{graviton} \\
&\approx \frac{C^2\left(r = l_{Planck}, t_{Planck}\right)}{2Gm_{graviton}}\cdot\left(l_{Planck}{}^2 - \left(\exp\left(-A(l_{Planck}, t_{Planck}\right)\right)\cdot l_{Planck} + \frac{\Lambda\cdot l_{Planck}{}^3}{3}\right)\Bigg|_{r\propto l(Planck)}
\end{aligned}
\tag{136}
$$

Doing this, and giving further informational modeling will lead to, we believe, a quantum information interpretation which may permit having the constant value of Planck's constant, $\hbar$ kept as an invariant per cyclical rebirth's of our cosmological structure, from cycle to cycle. Final takeaway, if we ascertain, that say Eq. (136) holds, then if it is also commensurate with the following, i.e.

$$
\begin{aligned}
&if \quad dS^2 = \left[\exp\left(C[t,r]\right)\right]\cdot dt^2 - \left[\exp\left(A[t,r]\right)\right]\cdot dr^2 - R^2(t,r)\cdot\left[d\vartheta^2 + \left(\sin^2\vartheta\right)\cdot d\phi^2\right] \\
&\& \\
&2\pi R \sim 2\pi l_{Planck} \\
&Mass(total, at \quad H=0)/m_{graviton} \sim N_{Particle-count} \\
&\approx \frac{C^2\left(r = l_{Planck}, t_{Planck}\right)}{2Gm_{graviton}}\cdot\left(l_{Planck}{}^2 - \left(\exp\left(-A(l_{Planck}, t_{Planck}\right)\right)\cdot l_{Planck} + \frac{\Lambda\cdot l_{Planck}{}^3}{3}\right)\Bigg|_{r\propto l(Planck)} \\
&\& \\
&n(number - gravitons) \sim \left(\Delta E\right)^2/\hbar \sim \hbar\omega^2{}_{Gravitons} \sim N_{Particle-count} \\
&\& \\
&\delta t\Delta E \ge \frac{\hbar}{\delta g_{tt}}\Bigg|_{\Pr e-Octonionic} \xrightarrow[\delta_0 \quad phase-change]{} \delta t\Delta E \ge \hbar\big|_{Octonionic} \\
&\Delta E \ge \frac{\hbar}{\delta t\delta g_{tt}} \\
&\Delta S \;\approx\; 2\pi R\cdot\Delta E/\left(\hbar\cdot c\right) \approx 2\pi l_{Planck}/\left(\delta t\cdot\delta g_{tt}\cdot c\right) \propto N_{Particle-count} \\
&\& \\
&\left[x_i, \sqrt{\frac{\Delta E}{\sqrt{2m_j}}}\right] = -\frac{\beta\cdot\left(l_{Planck}/l\right)\cdot\hbar\cdot T_{ijk}}{m_j}
\end{aligned}
\tag{137}
$$

The author believes, if all this can be done, that then we have a shot at implementing the program given in Eq. (43) and Eq. (44) and are on our way toward an entanglement picture as to how to utilize Eq. (134) as to coming up with an entangled state version of $|0\rangle$ as an information carrier, which in turn can be linked to further developing what was states as far as Eq. (43) and Eq. (44) as far as embedding our four dimensional HUP, as referenced in Eq. (137) into a deterministic 5 dimensional cosmology, as given in Wesson, [40] and also brought up by Beckwith, in [11]

We also look forward to expanding the state of known background in terms of entanglement and worm holes, as seen in [81].

Finally, we argue that this should be settled, i.e. is this actually true? i.e. the idea of different laws, with different cosmological dynamics? The author emphatically disagrees, but leaves the idea of a multiverse as open and intriguing. I.e.

One of the main things to consider is resolution of the following: [82] [47] (Feeney, et.al. 2011) at University College London say they've found evidence of four collisions with other universes in the form of circular patterns in the cosmic microwave background. In their model, called "eternal inflation," the universe is a bubble in a much larger cosmos. This cosmos is filled with other bubbles, all of which are other universes where the laws of physics may be different from ours. As seen in Figure 1. And also investigating [83]

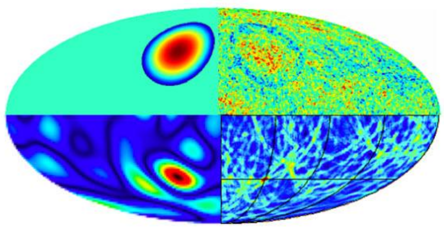

Figure 1,

The issues brought up in References, [83] to [102] deserve a brief comment in passing. i.e.for [83], confirmation or refutation of this idea would either confirm or kill the hypothesis given in our document as far as the entanglement of prior universe 'information' possibly by entangled graviton states, as mentioned. In truth this should be investigated for exactly this reason

In [84] Smolin gives justification for Figure 1 ABOVE.; FOR THE RECORD

In [85] t"Hoof" does foundational work on if or not quantum mechanics is embedded within a deterministic theory. I.e. our hypothesis, to the degree possible in this area should be compared and contrasted with [84]

In [85] to [102], if entanglement is testable, and confirmed, as we are supposing, then all of these ideas would be far more easy to access, confirm or deny with falsifiable data sets. Entanglement would in particular allow for confirming if gravity and the graviton hypothesis is either on quantum mechanical or semi classical structural grounding

My hypothesis is that QM in GR would confirm the invariance of the Planck's constant from cycle to cycle, if confirmed, and that it is urgent to vet if entanglement of cosmological information is amendable to gravitational astronomy vetting and investigation.

In addition the details of Eq (45) and Eq. (46) need to be confirmed via experimental data sets, in the future investigations of experimental gravitational wave astronomy. Finally, reference [100] by Corda has experimental gravity considerations which need to be reviewed promptly in formulating future experimental data set analysis to confirm if Gravity is classical or quantum in its foundations.

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