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Part II. How a Tokamak May Allow GW to Be Duplicated in Simulated Values, with Torsion Cosmology and Quantum Number *n*, and Cosmological Constant from Relic Black Holes

Andrew Walcott Beckwith

Physics Department, Chongqing University, Chongqing, China
Email: Rwill9955b@gmail.com

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Abstract

We make more specific initial contributions of prior work w.r.t. Tokamaks, relic black holes, and a relationship between a massive graviton particle count and quantum number *n*, and also add a great more to contributions of our conclusions w.r.t. the wave function of the universe. Our idea for black hole physics being used for GW generation, is using Torsion to form a cosmological constant. Planck sized black holes allow for a spin density term linked to Torsion. In doing so, we review its similarities to frequency values for GW due to a Tokamak simulation. The conclusion of this document will be in bringing up values for an initial wave function of the Universe and an open question as to the applications of a white hole-black hole wormhole bridge between a prior to the present universe as well as a speculation as to particle count, and a quantum number, *n*, as specified in our document.

Keywords

Cosmological Constant, Torsion, Spin Density, BEC Scaling of Black Hole Physics, Tokamak, Wavefunction of the Universe, Wormholes

1. First We Give a List of Questions as to the Document Which Was Reviewed Recently Which Is Put in, as It Is a Good Guide as to Foundational Issues as to This Document

I have the following questions:

Q1: Near Equation (44), if the observed cosmological constant is 10^{-122} less than the initial vacuum energy, where did the rest of this energy go?

Q2: Equation (49) Agw = should be $h^* G/c^4 \ldots$, not $h \sim G/c^4 \ldots$?

Q3: Equation (54) Power for tokamak, I recommend you include definitions for Epsilon (plasma confinement factor) & Alpha (geometric factor of tokamak, typically ~1.5).

Q4: Below Equation (67) in Unruh Temperature discussion, is the metric uncertainty in (69) derived from the HUP?

Q5: In Section 20 Penrose CCC Models, you are arguing that the non-uniqueness of the information ensemble for each nucleation cycle leads to ergodic mixing, but doesn't ergodic mixing result in a loss of information memory? Thus unique vs non-unique?

Q6: On your Claim 2, that a multi-dimensional representation of BHs enables continual mixing of STs, do you have a reference for this notion, or is this an original insight?

Q7: New Equation (98) and below, how would it be possible to simulate early universe temperatures of >10^{12} GeV with tokamak temperatures of <110 Kev? How do we step up/down or scale up/down from one case to the other?

I also made the following observations:

O1: I thought the claim 2 continual mixing of ST avoids invoking the Anthropic principle was an important insight. You reference your own work here but I'm wondering if this idea appears elsewhere?

O2: I think that the idea of using tokamak plasmas to simulate the early universe is a fascinating and wholly original idea. I had previously argued that tokamaks might be used to generate GW, based on Grishchuk & Sachin, but that's as far as I went.

We go through these issues in our document and we will answer the questions in section 28. Of this paper, with answers.

2. Introduction as to Plan of Presentation

The author has in prior work given the idea that a decay of millions of Planck sized BHs as within the very early universe as in [1] could generate GW and gravitons, due to a breakup of black holes as predicted in [1] but with the present GW spectrum of today very conservatively following [2]. The breakup of black holes may commence due to what is stated in [1] and actually be complimented by what is addressed in [3] which would be if Gravitons acting as similar to a Bose-Einstein condensate contribute to a resulting DE [1]. Either the strict breakup of black holes as in [4] or some conflation with [3] would lead to, likely GW (and Graviton frequencies) initially of the order of 10^{10} Hz to maybe 10^{19} Hz. In doing so we can consider the duration of an observed signal, its relative noisiness and stochastic noise contributions of a sort which are covered in [5]. In addition, the generation of GW in a Tokamak if commensurate with eLISA data after a step down of 10^{-25} to 10^{-26} due to 60 or more e folds [6] may allow for a review of adequate polarization states for GW which may or may not need higher dimensions to be in fidelity to the data sets obtained [7]. Having said that, what are the justifications as to using Tokamaks? This will be the subject of the final part of the document, after we present the basics of the primordial physical distribution of black holes, Planck sized according to the following.

To do this review how **Torsion may allow for understanding a quantum number *n*? And Primordial black holes and the cosmological constant.**

Following [1] [2] we do the introduction of black hole physics in terms of a quantum number *n*.

$$\sqrt{\Lambda} = \frac{k_B E}{\hbar c S_{\text{entropy}}}$$
$$S_{\text{entropy}} = k_B N_{\text{particles}} \tag{1}$$

And then a BEC condensate given by [1] [3] as to

$$\begin{aligned} m &\approx \frac{M_P}{\sqrt{N_{\text{gravitons}}}} \\ M_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot M_P \\ R_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot l_P \\ S_{BH} &\approx k_B \cdot N_{\text{gravitons}} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{\text{gravitons}}}} \end{aligned} \tag{2}$$

This is promising but needs to utilize [4] in which we make use of the following. First a time step

$$\tau \approx \sqrt{GM\delta r} \tag{3}$$

By use of [5] we use Equation (3) for energy [4] for radiation of a particle pair from a black hole,

$$|E| \approx \left(\sqrt{GM\delta r}\right)^{-1} \hbar \tag{4}$$

Here we assert that the spatial variation goes as

$$\delta r \approx \ell_P \tag{5}$$

This is of a Plank length, whereas we assume in Equation (6) that the mass is a Planck sized black hole

$$M \approx \alpha M_P \tag{6}$$

Table 1. From [2] assuming penrose recycling of the universe.

End of Prior Universe time frame	Mass (black hole): super massive end of time BH 1.98910^{+41} to about 10^{44} grams	Number (black holes) 10^6 to 10^9 of them usually from center of galaxies
Planck era Black hole formation Assuming start of merging of micro black hole pairs	Mass (black hole) 10^{-5} to 10^{-4} grams (an order of magnitude of the Planck mass value)	Number (black holes) 10^{40} to about 10^{45}, assuming that there was not too much destruction of matter-energy from the Pre Planck conditions to Planck conditions

Continued

Post Planck era black holes with the possibility of using Equation (1) and Equation (2) to have say 10^{10} gravitons/second released per black hole	Mass (black hole) 10 grams to say 10^6 grams per black hole	Number (black holes) Due to repeated Black hole pair forming a single black hole multiple time. 10^{20} to at most 10^{25}

This mass of primordial black holes is part of the first Table 1, *i.e.*

As to Table 1, we obtain, due to the quantum number n, per black hole. This makes use of [1] [2] [7]-[9].

Table 1 data will be connected to the following given consideration of spin density, as to Planck sized black holes

In [1] [9] we have the following, *i.e.*, we have a spin density term of [1] [9]. And this will be what we input black hole physics into as to forming a spin density term from primordial black holes.

$$\sigma_{Pl} = n_{Pl}\hbar \approx 10^{71} \tag{7}$$

And, also, the initial energy [7], per black hole given as

$$E_{Bh} = -\frac{n_{\text{quantum}}}{2} \tag{8}$$

We then can use for a Black hole the scaling,

$$\begin{aligned} &|E| \approx \left(\sqrt{G\cdot(\alpha M_P)\cdot \ell_P}\right)^{-1}\hbar \\ &\xrightarrow[G=M_P=\hbar=k_B=\ell_P=c=1]{} (1/M_{BH})^{1/2} \approx \frac{n_{\text{quantum}}}{2} \end{aligned} \tag{9}$$

We then reference Equation (2) to observe the following,

$$\begin{aligned} &M_{BH} \approx \sqrt{N_{\text{gravitons}}}M_P \\ &\Rightarrow (1/M_{BH})^{1/2} \approx \frac{n_{\text{quantum}}}{2} \approx \frac{1}{(N_{\text{gravitons}})^{1/4}} \\ &\Rightarrow n_{\text{quantum}} \approx \frac{2}{(N_{\text{gravitons}})^{1/4}} \end{aligned} \tag{10}$$

This is a stunning result. *i.e.* Equation (2) is BEC theory, but due to micro sized black holes, that we assume that the number of the quantum number, n associated goes way UP. Is this implying that corresponding increases in quantum number, per black hole, n, are commensurate with increasing temperature? We start off with Table 1 for conditions with the entropy as given in Equation (1) and Equation (2), for primordial black holes as brought up in Table 1. Whereas for the Tokamaks, we eventually have

$$\begin{aligned} n\big|_{\text{massive gravitons/second}} &\propto \frac{3\cdot\hbar\cdot e_j}{\mu_0\cdot R^2\cdot\xi^{1/8}\cdot\tilde{\alpha}} \times \frac{(T_{\text{Tokamak temperature}})^{1/4}}{\lambda^2_{\text{Graviton}}\cdot m_{\text{graviton}}\cdot c^2\cdot 0.87^{5/4}} \\ &\sim 1/\lambda^2_{\text{Graviton}} \text{ scaling} \end{aligned} \tag{11}$$

This value of Equation (11) as to the number of gravitons, would be then related to the quantum number N (gravitons) as related to a quantum number *n i.e.* only in the very onset of the operation of the Tokamak. *I.e.* we would have the number of gravitons go UP as we would have a shrinking graviton wavelength for a massive graviton *i.e.* more on this later. However, the wave length of the massive graviton as in Equation (11) as related to GW frequency and Tokamaks will be described when we conclude our document with respect to the Wave function of the Universe, *i.e.* a work partly drawing upon Kieffer, and also Weber. The wave function of the universe condition heavily is influenced by the similarities as to Equation (11) with the quantum number *n*, per black hole, and the number N, of black holes, as brought up in **Table 1**, initially presented. To do so we consider **Table 1** as giving a template as to a wormhole connecting a prior universe to the present universe.

3. Wave Function of the Universe, and the Assumption of Connecting the Prior to the Present Universe, on Account of Table 1

We advise readers to review [10]-[21] extensively before reading this section.

Using [10] a statement as to quantization for a would be GR term comes straight from

$$\Psi_{\text{Later}} = \int \sum_{H} \mathrm{e}^{(iI_H/\hbar)(t,t^0)} \Psi_{\text{Earlier}}\left(t^0\right) \mathrm{d}t^0 \tag{12}$$

The approximation we are making is to pick one index, so as to have

$$\Psi_{\text{Later}} = \int \sum_{H} \mathrm{e}^{(iI_H/\hbar)(t,t^0)} \Psi_{\text{Earlier}}\left(t^0\right) \mathrm{d}t^0 \xrightarrow[H \to 1]{} \int \mathrm{e}^{(iI_{H_{FIXED}}/\hbar)(t,t^0)} \Psi_{\text{Earlier}}\left(t^0\right) \mathrm{d}t^0 \tag{13}$$

This corresponds to say being primarily concerned as to GW generation, which is what we will be examining in our ideas, via using.

$$\mathrm{e}^{(iI_{H_{FIXED}}/\hbar)(t,t^0)} = \exp\left[\frac{i}{\hbar} \cdot \frac{c^4}{16\pi G} \cdot \int_{\mathrm{M}} \mathrm{d}t \cdot \mathrm{d}^3 r \sqrt{-g} \cdot (\Re - 2\Lambda)\right] \tag{14}$$

We will use the following, namely, if Λ is a constant, do the following for the Ricci scalar [17]

$$\Re = \frac{2}{r^2} \tag{15}$$

If so then we can write the following, namely: Equation (14) becomes, if we have an invariant Cosmological constant, so we write $\Lambda \xrightarrow[\text{all time}]{} \Lambda_0$ everywhere, then [10]

$$\mathrm{e}^{(iI_{H_{FIXED}}/\hbar)(t,t^0)} = \exp\left[\frac{i}{\hbar} \cdot \frac{c^4 \cdot \pi \cdot t^0}{16 G} \cdot \left(r - r^3 \Lambda_0\right)\right] \tag{16}$$

Then, we have that Equation (12) is re written to be

$$\Psi_{\text{Later}} = \int \sum_{H} \mathrm{e}^{(iI_H/\hbar)(t,t^0)} \Psi_{\text{Earlier}}\left(t^0\right) \mathrm{d}t^0 \xrightarrow[\text{at wormhole}]{} \int \exp\left[\frac{i}{\hbar} \cdot \frac{c^4 \cdot \pi \cdot t^0}{16G} \cdot \left(r - r^3 \Lambda_0\right)\right] \Psi_{\text{Earlier}}\left(t^0\right) \mathrm{d}t^0 \quad (17)$$

4. Examining the Behavior of the Earlier Wavefunction in Equation (17)

[13] states a Hartle-Hawking wave function which we will adapt for the earlier wave function as stated in Equation (6) so as to read as follows

$$\Psi_{\text{Earlier}}\left(t^0\right) \approx \Psi_{HH} \propto \exp\left(\frac{-\pi}{2GH^2} \cdot \left(1 - \sinh\left(Ht\right)\right)^{3/2}\right) \quad (18)$$

Here, making use of Sarkar [14], we set, if say g_* is the degree of freedom allowed

$$H = 1.66\sqrt{g_*} T_{temp}^2 / M_{\text{Planck}} \quad (19)$$

We assume initially a relatively uniformly given temperature, that H is constant. So then we will be attempting to write out an expansion as to what the Equation (6) gives us while we use Equation (18) and Equation (19), with H approximately constant.

5. Methods Used in Calculating Equation (17), with Interpretation of the Results

If so then

$$\Psi_{\text{Later}} = \int \exp\left[\frac{i}{\hbar} \cdot \frac{c^4 \cdot \pi \cdot t^0}{16G} \cdot \left(r - r^3 \Lambda_0\right)\right] \exp\left(\frac{-\pi}{2GH^2} \cdot \left(1 - \sinh\left(Ht\right)\right)^{3/2}\right) \mathrm{d}t^0 \quad (20)$$

Then using numerical integration [18]-[20],

$$\begin{aligned} &\Psi_{\text{Later}} \xrightarrow[t_M \to \varepsilon^+]{} \int_0^{t_M} \mathrm{e}^{i \cdot (\tilde{\alpha}1) \cdot t - (\tilde{\alpha}2) \cdot (1 - \sinh(Ht))^{3/2}} \mathrm{d}t \\ &\approx \frac{t_M}{2} \cdot \left(\mathrm{e}^{i \cdot (\tilde{\alpha}1) \cdot t_M - (\tilde{\alpha}2) \cdot (1 - \sinh(H \cdot t_M))^{3/2}} - 1\right) \\ &\tilde{\alpha}1 = \left[\frac{c^4 \cdot \pi}{16G\hbar} \cdot \left(r - r^3 \Lambda_0\right)\right], \ \tilde{\alpha}2 = \frac{\pi}{2GH^2} \end{aligned} \quad (21)$$

Notice the terms for the H factor, and from here we will be making our prediction. If the energy, E, has the following breakdown

$$\begin{aligned} &H = 1.66\sqrt{g_*} T_{temp}^2 / M_{\text{Planck}} \\ &\Rightarrow E \approx k_B T_{Temp} \approx \hbar \cdot \omega_{\text{signal}} \\ &\Rightarrow \omega_{\text{signal}} \approx \frac{k_B \cdot \sqrt{M_{\text{Planck}} H}}{\hbar \cdot \sqrt{1.66\sqrt{g_*}}} \end{aligned} \quad (22)$$

The upshot is that we have, in this, a way to obtain a signal frequency by looking at the real part of Equation (22) above, if we have a small t, initially (small time step).

6. How to Compare with a Kieffer Solution and Thereby Isolate the Cosmological Constant Contribution

This means looking at [21] Equation (11) would imply an initial frequency dependence. What we are doing next is to strategize as to understand the contribution of the cosmological constant in this sort of problem. *I.e.* the way to do it would be to analyze a Kieffer "dust solution" as a signal from the Wormhole. *I.e.* look at [21], where we assume that *t*, would be in this case the same as in Equation (21) above. *I.e.* in this case we will write having

$$\Delta\omega_{\text{signal}}\Delta t \approx 1 \tag{23}$$

If so then we can assume, that the time would be small enough so that

$$\Delta t \approx \frac{\hbar\sqrt{1.66\sqrt{g_*}}}{k_B \cdot \sqrt{M_{\text{Planck}} H}} \tag{24}$$

If Equation (24) is of a value somewhat close to *t*, in terms of general initial time, we can write [21]

$$\psi_{\tilde{n},\lambda}(t,r) \equiv \frac{1}{\sqrt{2\pi}} \cdot \frac{\tilde{n}! \cdot (2\lambda)^{\tilde{n}+1/2}}{\sqrt{(2\tilde{n})!}} \cdot \left[\frac{1}{(\lambda + i\cdot t + i\cdot r)^{\tilde{n}+1}} - \frac{1}{(\lambda + i\cdot t - i\cdot r)^{\tilde{n}+1}}\right] \tag{25}$$

Here the time *t* would be proportional to Planck time, and *r* would be proportional to Planck length, whereas we set

$$\lambda \approx \sqrt{\frac{8\pi G}{V_{\text{volume}}\hbar^2 t^2}} \xrightarrow{G=\hbar=\ell_{\text{Planck}}=k_B=1} \sqrt{\frac{8\pi}{t^2}} \equiv \frac{\sqrt{8\pi}}{t} \tag{26}$$

Then a preliminary emergent space-time wave function would be

$$\begin{aligned}\psi_{\tilde{n},\lambda}(\Delta t,r) &\equiv \frac{1}{\sqrt{2\pi}} \cdot \frac{\tilde{n}! \cdot \left(2\cdot\sqrt{8\pi}\cdot(\Delta t)^{-1}\right)^{\tilde{n}+1/2}}{\sqrt{(2\tilde{n})!}} \cdot \left[\frac{1}{\left(\sqrt{8\pi}\cdot(\Delta t)^{-1} + i\cdot\Delta t + i\cdot r\right)^{\tilde{n}+1}}\right. \\ &\quad \left. - \frac{1}{\left(\sqrt{8\pi}\cdot(\Delta t)^{-1} + i\cdot\Delta t - i\cdot r\right)^{\tilde{n}+1}}\right]\end{aligned} \tag{27}$$

Just at the surface of the bubble of space-time, with $t_{Planck} \propto \Delta t$, and $r \propto \ell_{Planck}$.

This is from a section, page 239 of the 3rd edition of Kieffer's book, as to a quantum theory of collapsing dust shells. And so, then we have the following procedure as to isolate out the contribution of the Cosmological constant. Namely, take the **REAL part of Equation (27)** and compare it with the Real part of Equation (21).

Another way to visualize this situation and this is a different way to interpret Equation (26). To do so we examine looking at page 239 of Kieffer, namely [21] where one has an expectation value to energy we can write as

$$\langle E\rangle_{\kappa=n,\lambda} = \frac{(\kappa=n)+1/2}{\lambda} \xrightarrow[\lambda\approx 1/\hbar\omega]{} \hbar\omega\cdot\left((\kappa=n)+1/2\right) \tag{28}$$

What we can do, is to ascertain the last step would be to make the Equation (28) in a sense partly related to the simple harmonic oscillator. But we should take into consideration the normalization using that if $\hbar=\ell_P=G=t_P=k_B=1$ is done via Plank unit normalization [14] [15]. If so, then we have that frequency is proportional to $1/t$, where t is time. *I.e.* hence if there is a value of $n = 0$ and making use of the frequency, we then would be able to write Equation (27) as [21]

$$\Psi_{1,\kappa=n=0} \approx \sqrt{\frac{\omega}{\pi}}\cdot\left[\frac{1}{\omega+i\cdot(t+r)} - \frac{1}{\omega+i\cdot(t-r)}\right] \tag{29}$$

Or,

$$\Psi_{2,\kappa=n=0} \approx \frac{1}{\sqrt{\pi}}\sqrt{\frac{\sqrt{8\pi}}{t}}\cdot\left[\frac{1}{\frac{\sqrt{8\pi}}{t}+i\cdot(t+r)} - \frac{1}{+\frac{\sqrt{8\pi}}{t}i\cdot(t-r)}\right] \tag{30}$$

With, say

$$\omega \approx \frac{\sqrt{8\pi}}{t} \tag{31}$$

And this in a setting where we have the dimensional reset of Planck Units

$$\hbar=\ell_P=G=t_P=k_B=1 \tag{32}$$

7. The Big Picture, Polarization of Signals from a Wormhole Mouth May Affect GW Astronomy Investigations

We will be referencing [22] and [23]. *I.e.* for [22] we have a rate of production from the worm hole mouth we can quantify as

$$\Gamma \approx \exp\left(\omega_{\text{signal}}/T_{\text{temperature}}\right) \tag{33}$$

Whereas we have from [23] a probability for "scalar" particle production from the wormhole given as

$$\Gamma \approx \exp\left(-E/T_{\text{temperature}}\right) \tag{34}$$

Whereas if we assume that there is a negative temperature in Equation (34) and say rewrite Equation (34) as obeying having

$$\left(\omega_{\text{signal}}/T_{\text{temperature}}\right) \approx \left(-E/T_{\text{temperature}}\right) \tag{35}$$

This is specifying a rate of particle production from the wormhole. And so then: If we refer to black holes, with extra dimension, n, of Planck sized mass, we have a lifetime of the value of about

$$\begin{aligned}&\tau \sim \frac{1}{M_*}\left(\frac{M_{BH}}{M_*}\right)^{\frac{n+3}{n+1}} \xrightarrow[M_{BH}\approx M_{\text{Planck}}]{} 10^{-26}\text{ seconds}\\ &M_* \approx \text{is the low energy scale,}\\ &\text{which could be as low as a few TeV,}\end{aligned} \tag{36}$$

The idea would be that there would be n additional dimensions, as given in Equation (38) which would then lay the door open to investigating [24] and [25] in terms of applications, with additional polarization states to be investigated, as to signals from the mouth of the wormhole. We will next then go into some predictions into first, the strength of the signals, the frequency range, and several characteristics as to the production rate of Planck sized black holes which conceivably could get evicted by use of Equation (36), in terms of what could be observed via instrumentation.

8. A First Order Guess as to the Rate of Production of Planck Sized Black Holes through a Wormhole, Using Equation (35)

In order to do this, we will be estimating that the temperature would be of the order of Planck temperature, *i.e.*, using ideas from [25] and [26]

$$\frac{\omega_p}{T_p} \equiv \frac{\sqrt{Gk_B^2}}{\hbar} \xrightarrow[\hbar=G=k_B=1]{} 1 \tag{37}$$

If so, then there would be to first order the following rate of production. Of Gravitons, associated with a White-Hole, black hole pair, with the white hole in the prior universe and the Black hole in the present universe, *i.e.* per white hole to black hole transition per unit of Planck time, as a production rate looking like

$$\Gamma_{\text{rate of production}} \approx e \approx 2\text{-}3 \tag{38}$$

9. Interpretation of Equation (38) in Lieu of Table 1

What we are seeing is that **Table 1**, is implicitly assuming millions of white hole (prior universe) to black hole (present universe) transitions, and ENORMOUS generation of gravitons as a wormhole transition. *I.e.* if so then, we can then relate this to our problem, via the cosmological transition as by the following argument.

The reason for using this table is because of the modification of Dark Energy and the cosmological constant [1]-[4] To begin this look at [2]

$$\begin{aligned} \rho_\Lambda c^2 &= \int_0^{E_{\text{Plank}}/c} \frac{4\pi p^2 \mathrm{d}p}{(2\pi\hbar)^3} \cdot \left(\frac{1}{2} \cdot \sqrt{p^2c^2 + m^2c^4} \right) \approx \frac{\left(3\times10^{19}\,\text{GeV}\right)^4}{(2\pi\hbar)^3} \\ &\xrightarrow[E_{\text{Plank}}/c \to 10^{-30}]{} \frac{\left(2.5\times10^{-11}\,\text{GeV}\right)^4}{(2\pi\hbar)^3} \end{aligned} \tag{39}$$

In [2], the first line is the vacuum energy which is completely cancelled in their formulation of application of Torsion. In our article we are arguing for the second line. In facto by [2] we can assume we are having DE created by the following

$$\frac{\Delta E}{c} = 10^{18}\,\text{GeV} - \frac{n_{\text{quantum}}}{2c} \approx 10^{-12}\,\text{GeV} \tag{40}$$

The term n (quantum) comes from a Corda expression as to energy level of relic black holes [7]. We argue that our application of [1] [2] will be commensurate with Equation (39) which uses the value given in [2] as to the following *i.e.* relic black holes will contribute to the generation of a cut off of the energy of the integral

$$\rho_\Lambda c^2 = \int_0^{E_{\text{Plank}}/c} \frac{4\pi p^2 \mathrm{d}p}{(2\pi\hbar)^3} \cdot \left(\frac{1}{2} \cdot \sqrt{p^2c^2 + m^2c^4} \right) \approx \frac{\left(3\times10^{19}\ \text{GeV}\right)^4}{(2\pi\hbar)^3} \tag{41}$$

Furthermore, the claim in [2] is that there is no cosmological constant, *i.e.* that Torsion always cancelling Equation (30) which we view is incommensurate with **Table 1** as of [2]. We claim that the influence of Torsion will aid in the decomposition of what is given in **Table 1** and will furthermore lead to the influx of primordial black holes which we claim is responsible for the behavior of Equation (30) above.

10. Stating What Black Hole Physics Will Be Useful for in Our Modeling of Dark Energy. *I.e.* Inputs into the Torsion Spin Density Term

In [2] [9] we have the following, *i.e.*, we have a spin density term of [1] [2] [9]. And this will be what we input black hole physics into as to forming a spin density term from primordial black holes. $\sigma_{Pl} = n_{Pl}\hbar \approx 10^{71}$ as given in Equation (7).

11. Now for the Statement of the Torsion Problem

Eventually in the case of an unpolarized spinning fluid in the immediate aftermath of the big bang, we would see a Roberson Walker universe given as, if σ is a torsion spin term added due to [1] [2] [9] as

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right) \cdot \left[\rho - \frac{2\pi G\sigma^2}{3c^4}\right] + \frac{\Lambda c^2}{3} - \frac{\tilde{k}c^2}{\tilde{R}^2} \tag{42}$$

12. What [9] Does as to Equation (42) versus What We Would Do and Why

In the case of [1] we would see σ be identified as due to torsion so that Equation (42) reduces to

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right) \cdot [\rho] - \frac{\tilde{k}c^2}{\tilde{R}^2} \tag{43}$$

The claim is made in [2] that this is due to spinning particles which remain invariant so the cosmological vacuum energy, or cosmological constant is always cancelled. Our approach instead will yield [1] [2] [9]

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right) \cdot [\rho] + \frac{\Lambda_{0\text{bserved}} c^2}{3} - \frac{\tilde{k}c^2}{\tilde{R}^2} \tag{44}$$

I.e. the observed cosmological constant $\Lambda_{0\text{bserved}}$ is 10^{-122} times smaller than the initial vacuum energy.

The main reason for the difference in the Equation (39) and Equation (41) is in the following observation.

Mainly that the reason for the existence of σ^2 is due to the dynamics of spinning black holes in the precursor to the big bang, to the Planckian regime, of space time, whereas in the aftermath of the big bang, we would have a vanishing of the torsion spin term. *i.e.* Table 1 dynamics in the aftermath of the Planckian regime of space time would largely eliminate the σ^2 term.

13. Filling in the Details of the Collapse of the Cosmological Term

First look at numbers provided by [17] as to inputs, *i.e.* these are very revealing

$$\Lambda_{Pl} c^2 \approx 10^{87} \tag{45}$$

This is the number for the vacuum energy and this enormous value is 10^{122} times larger than the observed cosmological constant. Torsion physics, as given by [17] is solely to remove this giant number. In order to remove it, the reference [1] [17] proceeds to make the following identification, namely

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right]+\frac{\Lambda c^2}{3}=0 \tag{46}$$

What we are arguing is that instead, one is seeing, instead [2]

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right]+\frac{\Lambda_{Pl} c^2}{3}\approx 10^{-122}\times\left(\frac{\Lambda_{Pl} c^2}{3}\right) \tag{47}$$

Our timing as to Equation (47) is to unleash a Planck time interval t about 10^{-43} seconds. As to Equation (46) versus Equation (47) the creation of the torsion term is due to a presumed particle density of

$$n_{Pl} \approx 10^{98}\ \text{cm}^{-3} \tag{48}$$

Finally, we have a spin density term of $\sigma_{Pl} = n_{Pl}\hbar \approx 10^{71}$ which is due to innumerable black holes initially.

14. Brief Recap of Tokamak Physics Obtaining Equation (11) Comparison with Grishchuk and Sachin Results. For Obtaining GW Generation Count

Russian physicists Grishchuk and Sachin [27] obtained the amplitude of a Gravitational wave (GW) in a plasma as proportional to the square of an electric field, and also the wavelength of a Gravitational wave. We call this h, and this is straight from Gurskchuk, in their original document. Also this is linked to power

$$A(\text{amplitude GW}) = h \sim \frac{G}{c^4}\cdot E^2\cdot\lambda_{GW}^2 . \tag{49}$$

This is compared with [27], and we diagram the situation out as follows [28] *i.e.* the E field is due to the presence of a current, I in a circular toroidal geometry.

Note that a simple model of how to provide a current in the Toroid is provided by a transformer core. This diagram is an example of how to induce the current *I*, used in the simple Ohms law derivation referred to in the first part of the text. Here, *E* is the electric field whereas λ_{Gw} is the gravitational wavelength for GW generated by the Tokamak in our model. In the original Griskchuk model, we would have very small strain values, which will comment upon but which require the following relationship between GW wavelength and resultant frequency. Note, if $\omega_{GW} \sim 10^6\ \text{Hz} \Rightarrow \lambda_{Gw} \sim 300\ \text{meters}$, so we will be assuming a baseline of the order of setting $\omega_{GW} \sim 10^9\ \text{Hz} \Rightarrow \lambda_{Gw} \sim 0.3\ \text{meters}$, as a baseline measurement for GW detection above the Tokamak.

15. Restating the Energy Density and Power Using the Formalism of Equation (49) Directly

$$W_E \cdot V_{\text{volume}} \sim \tilde{\alpha} \cdot \lambda_{GW}^2 \cdot \frac{\xi^{1/4} \tilde{\alpha}^2 T^2_{\text{Temp plasma fusion burning}}}{e_j^{\,2}} \tag{50}$$

The temperature for Plasma fusion burning, is then about between 30 to 100 KeV, as given by Wesson [29]. The corresponding power as given by Wesson is then for the Tokamak [29]

$$P_\Omega = E \cdot J \leq \frac{E}{\mu_0} \cdot \frac{B_\phi}{R} \tag{51}$$

This necessitates a brief parameter discussion which will be significantly augmented in a future follow up to this study.

16. Epsilon & Alpha Terms Represent in Paper (Plasma Confinement Factor & Geometric Factor of a Tokamak)

These may be explained as follows. *I.e.*

- **Epsilon (ε):**

This term is commonly used in models of plasma transport in tokamaks to represent the anomalous transport coefficient (χ) or the plasma confinement factor. It's related to how well the plasma's heat and particles are confined within the magnetic field.

- **Alpha (α):**

In tokamak studies, Alpha can be linked to geometric characteristics of the device. For example, the aspect ratio (R/a), where R is the major radius and a is the minor radius, can be represented by alpha. It can also refer to other geometric parameters like the radius of the plasma.

In essence: Epsilon (ε) typically relates to the efficiency of plasma confinement, while Alpha (α) often describes the tokamak's physical dimensions and shape.

We have these as to be defined rigorously in conjunction to a range of admissible values as to how to experimentally make our device in fidelity with the problem of GW detection about a Tokamak device. Which we will attempt to do in our next paper.

17. Having Said That, What Are the Applied Electric and Magnetic Fields Used with Respect to a Tokamak?

In a one second interval, if we use the input power as an experimentally supplied quantity, then the effective E field is

$$E_{\text{applied}} \sim \frac{\xi^{1/8} \cdot \tilde{\alpha}}{e_j} \times T_{\text{Tokamak temperature}} \tag{52}$$

What is found is, that if Equation (50) and Equation (51) hold. Then by Wesson [29], pp. 242-243, if $Z_{eff} \sim 1.5, q_a q_0 \sim 1.5, \left(R/\tilde{a}\right) \approx 3$ Then the temperature of a Tokamak, to good approximation would be between 30 to 100 KeV, and then one has [29]

$$B_{\phi}^{4/5} \sim 0.87 \cdot \left(\tilde{T} = T_{\text{Tokamak temperature}}\right) \tag{53}$$

Then the power for the Tokamak is

$$P_{\Omega}\Big|_{\text{Tokamak toroid}} \le \frac{\xi^{1/8} \cdot \tilde{\alpha}}{\mu_0 \cdot e_j \cdot R} \times \frac{\left(T_{\text{Tokamak temperature}}\right)^{9/4}}{0.87^{5/4}} \tag{54}$$

Then, per second, the author derived the following rate of production per second of a 10^{-34} eV graviton, as, brought up in Equation (11)

$$n\Big|_{\text{massive gravitons/second}} \propto \frac{3 \cdot \hbar \cdot e_j}{\mu_0 \cdot R^2 \cdot \xi^{1/8} \cdot \tilde{\alpha}} \times \frac{\left(T_{\text{Tokamak temperature}}\right)^{1/4}}{\lambda_{\text{Graviton}}^2 \cdot m_{\text{graviton}} \cdot c^2 \cdot 0.87^{5/4}}$$
$$\sim 1\big/\lambda_{\text{Graviton}}^2 \text{ scaling}$$

18. Wrapping It All up. Some Specific Inter Connections. For Future Work

I.e. We can state that Equation (11) is also tied into the quantum number n, as given in Equation (10) which in turn is linkable to N, as the black hole number, In addition, we have also stated that if we have multiple wormhole style connections between a black hole and a white hole with the white hole as given in the pre Planckian section of space time, and the black hole in the present era, that we should pay attention to what Equation (38) is saying is commensurate with **Table 1**. In short, lots of inter connections, and proof of Equation (11) by Tokamak physics may be extremely important.

This also means we can safely review the issues given in [27]-[37] with this in mind.

19. Future Project as to Explicitly Working in Prior Universe White Hole Linked to Present Universe Black Hole, via a Special Wormhole, for Each Wormhole Linking Prior to Present Universes

What we are doing is using the following wormhole connection, *i.e.*:

In doing this we should note that we are assuming as a future work that there would be black holes, in our initial configuration, plus a white hole in the immediate pre inflationary regime. Likely in a recycled universe. Reference [7] [17] is what we will start off with [7] [17] and its given metric as far as a black hole to white hole solution. *I.e.*

$$\mathrm{d}S^2 = -A(r,a)\mathrm{d}t^2 + B(r,a)^{-1}\mathrm{d}r^2 + g^2(r,a)\mathrm{d}\Omega^2 \quad (55)$$

We can perform a major simplification by setting, then

$$A(r,a) = B(r,a) = f(r,a) \quad (56)$$

In doing so, [7] gives us the following stress energy tensor values as give

$$\begin{aligned} T_t^t &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g' + 2fg''\right) - \frac{1}{g^2}\cdot\left(1 - fg'^2\right)\right) \\ T_r^r &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g'\right) - \frac{1}{g^2}\cdot\left(1 - fg'^2\right)\right) \\ T_\theta^\theta = T_\phi^\phi &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g' + fg''\right) + \frac{1}{2}\cdot\left(f''\right)\right) \end{aligned} \quad (57)$$

In doing this, we will chose the primed coordinate as representing a derivative with respect to *r*. Also in the case of black hole to white hole joining, we will be looking at a gluing surface as to the worm hole joining a black hole to white hole given as with regards to a gluing surface connecting a black hole to a white hole which we give as ξ. And $\tilde{\tilde{n}}$ is a quantum gravity index. Note that in [7] the authors often set it at 3, if so then for a black hole, to white hole to worm hole configuration they give

$$g(r,a) = \begin{cases} r^2 + a^2\left(1 - \dfrac{r^2}{\xi^2}\right)^{\tilde{\tilde{n}}}, & \text{when } (r \le \xi) \\ r^2, & \text{when } (r > \rho) \end{cases} \quad (58)$$

We then make the following connection to energy density in a black hole to white hole system, *i.e.*

$$\begin{aligned} &\rho_{\text{black hole white hole wormhole}} \equiv -T_r^r \\ &\approx \hbar\omega_{\text{black hole white hole wormhole}}\tilde{n}_{\text{black hole white hole wormhole}} \end{aligned} \quad (59)$$

This will lead to, if we use Planck units where we normalize *h* bar to being 1, of

$$\begin{aligned} &\tilde{n}_{\text{black hole white hole wormhole}} \\ &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g'\right) - \frac{1}{g^2}\cdot\left(1 - fg'^2\right)\right)\cdot\frac{1}{\omega_{\text{black hole white hole wormhole}}} \end{aligned} \quad (60)$$

If we are restricting ourselves to quantum geometry at the start of expansion of the universe, it means that say we can set these values to be compared to the inputs of quantum number *n* used to specify a quantum number *n*, and it furthermore if

$$a \approx \ell_P = \text{Planck length} \xrightarrow[\text{Planck normalization}]{} 1 \quad (61)$$

We get further restrictions as to the quantum number in Equation (60) when we compare it to where we had a value of *n* given in the first section of our document. Furthermore, it means that we can use this to model say, with additional work in a future project how a white hole (specified as in the prior universe. If we go back to **Table 1** of this document, there will be a join between the prior to present universes, where Equation (61) will be subsequently modified.

20. First Set of Conclusions, for This Document

First, the tokamak may enable a connection between the number of gravitons generated, from say early universe black holes to be formally worked out. *I.e.* this is tricky and will require a lot of work. Secondly, black holes generate gravitons and we have stated a relationship between gravitons and a quantum number n. Three, we are assuming that relic black holes have a quantum number as well. Four we have tried through **Table 1** to specify regimes between prior to our universe, to our present universe black holes, assuming a collapse and rebirth of a universe structure. Five, a wormhole connection between white holes, in the prior universe, to black holes in our present universe, as discussed in **Table 1**, is alluded to as a formal wormhole connection, *i.e.* this has to be formally worked out. Six, the rudiments of a wave function of the universe, as discussed by Kieffer are also discussed, and set up for further elaborations in future research. Main item to be considered is if we can get Pre Planck to Plank spacetime metrics understood as to explicitly understand the details of Section 17 fully. We also leave as a future investigation the items brought up in [38]-[40] as to their feasibility and application to this document.

21. Now for Applications of the Generalized HUP and Its Applications to Black Hole Physics

Heavy Gravity is the situation where a graviton has a small rest mass and is not a zero mass particle, and this existence of "heavy gravity" is important since eventually, gravitons having a small mass could possibly be observed via their macroscopic effects upon astrophysical events. See [41]-[50]. The second aspect of the inquiry of our manuscript will be to come up with a variant of the Heisenberg Uncertainty principle (HUP), in [43], with

$$\Delta x \Delta p \geq \frac{\hbar}{2} + \tilde{\gamma} \frac{\partial C}{\partial V} \tag{62}$$

As opposed to

$$\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2} \quad \text{Unless} \ \ \delta g_{tt} \sim O(1) \tag{63}$$

Which we claim in the Planckian regime will de evolve, as being effectively as being equivalent to

$$\Delta x \Delta p \geq \frac{\hbar}{\delta g_{tt}} \tag{64}$$

We will be comparing Equation (62) and Equation (63) as well as writing

$$\delta g_{tt} \sim a^2(t) \cdot \phi \ll 1 \tag{65}$$

In doing this, we adhere to the starting point of [46] [47]

$$\Delta l \cdot \Delta p \geq \frac{\hbar}{2} \tag{66}$$

We will be using the approximation given by Unruh,

$$\begin{aligned}(\Delta l)_{ij} &= \frac{\delta g_{ij}}{g_{ij}} \cdot \frac{l}{2} \\ (\Delta p)_{ij} &= \Delta T_{ij} \cdot \delta t \cdot \Delta A\end{aligned} \tag{67}$$

If we use the following, from the Roberson-Walker metric [46]-[49]

$$\begin{aligned}g_{tt} &= 1 \\ g_{rr} &= \frac{-a^2(t)}{1-k \cdot r^2} \\ g_{\theta\theta} &= -a^2(t) \cdot r^2 \\ g_{\phi\phi} &= -a^2(t) \cdot \sin^2\theta \cdot d\phi^2\end{aligned} \tag{68}$$

Before proceeding with inputs as to Equation (68) we wish to refer the reader to **Appendix A**, for a summary of what the GUP means, *i.e.* the Generalized Uncertainty principle.

Afterwards, let us fill in the assumed values as to the GUP, in the case of early universe nucleation.

Following Unruh [46] [47], write then, an uncertainty of metric tensor as, with the following inputs

$$a^2(t) \sim 10^{-110}, r \equiv l_P \sim 10^{-35} \text{ meters} \tag{69}$$

Then, if $\Delta T_{tt} \sim \Delta\rho$

$$\begin{aligned}&V^{(4)} = \delta t \cdot \Delta A \cdot r \\ &\delta g_{tt} \cdot \Delta T_{tt} \cdot \delta t \cdot \Delta A \cdot \frac{r}{2} \geq \frac{\hbar}{2} \\ &\Leftrightarrow \delta g_{tt} \cdot \Delta T_{tt} \geq \frac{\hbar}{V^{(4)}}\end{aligned} \tag{70}$$

This Equation (70) is such that we can extract, up to a point the HUP principle for uncertainty in time and energy, with one very large caveat added, namely if we use the fluid approximation of space-time [49] for the stress energy tensor as given in Equation (70).

$$T_{ii} = diag(\rho, -p, -p, -p) \tag{71}$$

Then

$$\Delta T_{tt} \sim \Delta\rho \sim \frac{\Delta E}{V^{(3)}} \tag{72}$$

Then,

$$\begin{aligned}&\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2} \\ &\text{Unless } \delta g_{tt} \sim O(1)\end{aligned} \tag{73}$$

How likely is $\delta g_{tt} \sim O(1)$? Not going to happen. Why? The homogeneity of the early universe will keep

$$\delta g_{tt} \neq g_{tt} = 1 \tag{74}$$

In fact, we have that from Giovannini [48], that if ϕ is a scalar function, and $a^2(t) \sim 10^{-110}$, then if

$$\delta g_{tt} \sim a^2(t) \cdot \phi \ll 1 \tag{75}$$

Then, there is no way that Equation (73) is going to come close to $\delta t \Delta E \geq \frac{\hbar}{2}$. *I.e.* it depends assuming time is for all purposes fixed at about Planck time to isolate V_0.

I.e. for the sake of argument, in the near Planckian regime, we can figure that Equation (75) will have as far as evaluation of the argument the following configuration, *i.e.* [47] [48]

$$a(t) \approx a_{\text{initial}} \cdot (t/t_P)^{\nu} \tag{76}$$

Given this we will be looking at, if we do the set up

$$\Delta x \Delta p \geq \frac{\hbar}{\delta g_{tt} = \left[a_{\text{initial}} \cdot (t/t_P)^{\nu}\right]^2 \left[\ln\left(\sqrt{\frac{8\pi G V_0}{\nu \cdot (3\nu - 1)}} \cdot t\right)^{\sqrt{\frac{\nu}{16\pi G}}}\right]} \tag{77}$$

Then eventually we obtain

$$V_0 \cong \left[\frac{\nu \cdot (3\nu - 1)}{8\pi}\right] \cdot \left[\exp\left(\frac{16\sqrt{\pi}}{\sqrt{\nu}} \cdot \frac{1}{a_{\min}^2 \cdot (t/t_p)^2}\right)\right] \cdot \left(\frac{1}{1 + 2\tilde{\gamma}\frac{\partial C}{\partial V}}\right)^2 \tag{78}$$

So then we are now doing an Evaluation of Equation (78) if we are near Planck time. Two limits:

1st, what if we have expansion of the scale factor initially at greater than the speed of light?

Set $\nu \approx 10^{88}$ and then we can obtain if we are just starting off inflation say $a_{\min}^2 \approx 10^{-44}$. Then

$$V_0 \cong \left[10^{176}\right] \cdot \left[\exp\left(16\sqrt{\pi}\right)\right] \cdot \left(\frac{1}{1 + 2\tilde{\gamma}\frac{\partial C}{\partial V}}\right)^2, \tag{79}$$

If we wish to have a Planck energy magnitude of the V_0 term, we will then be observing

$$V_0 \cong \left[10^{176}\right] \cdot \left[\exp\left(16\sqrt{\pi}\right)\right] \cdot \left(\frac{1}{1 + 2\tilde{\gamma}\frac{\partial C}{\partial V}}\right)^2, \xrightarrow[2\tilde{\gamma}\frac{\partial C}{\partial V} \approx \left[10^{88}\right]]{} o(1) \tag{80}$$

i.e. the system complexity will become effectively almost infinite, and this will be explained in the conclusion by use of

$$2\tilde{\gamma}\frac{\partial C}{\partial V}\approx\left[10^{88}\right]\Rightarrow V_0\cong o(1) \tag{81}$$

On the other hand, if there is a very small value for $2\tilde{\gamma}\frac{\partial C}{\partial V}$ we can see the following behavior for Equation (79), namely

$$2\tilde{\gamma}\frac{\partial C}{\partial V}\approx o(1)\Rightarrow V_0\cong\left[10^{176}\right] \tag{82}$$

i.e. low complexity in the measurement process will then imply an enormous initial inflaton potential energy.

2nd, now what if we have instead $\nu\approx 1$

$$V_0\cong\left[\frac{1}{4\pi}\right]\cdot\left[\exp\left(\frac{16\sqrt{\pi}}{a_{\min}^2\cdot\left(t/t_p\right)^2}\right)\right]\cdot\left(\frac{1}{1+2\tilde{\gamma}\frac{\partial C}{\partial V}}\right)^2 \tag{83}$$

The threshold if $2\tilde{\gamma}\frac{\partial C}{\partial V}\approx\left[10^{88}\right]$ *i.e.* a huge value for initial complexity would be effectively made insignificant in cutting down the initial inflaton lead to

$$\exp\left(\frac{16\sqrt{\pi}}{\sqrt{\nu}}\cdot\frac{1}{a_{\min}^2\cdot\left(t/t_p\right)^2}\right)\xrightarrow[a_{\min}^2\approx 10^{-88}]{}V_0\cong\exp\left(10^{88}\right) \tag{84}$$

I.e. we come to the seemingly counter Intuitive expression that the initial inflaton potential would still be infinite if we used Equation (83) in Equation (79).

22. First Major Implication of This Use of the HUP Is to Investigate, *i.e.* Role of Complexity in Bridge from Black Hole Numbers as Given in Table 1

There are three regimes of black hole numbers given in Table 1. From Pre Planckian, to Planckian and then to post Planckian physics regimes. This is all assuming CCC cosmology. To start to make sense of this, we need to examine how one could achieve the complexity as indicated by Table 1 in the Planckian era. To do this at a start, we will pay attention to a datum in reference [3] [4], namely a Horizon, like a Schwarzschild black hole construction with [50]

$$L_A=\sqrt{\frac{3}{\Lambda}} \tag{85}$$

In what [50] deems as a corpuscular gravity one would have a "kinetic energy term" per graviton

$$\epsilon_G\cong\frac{M_p}{\sqrt{\tilde{N}}} \tag{86}$$

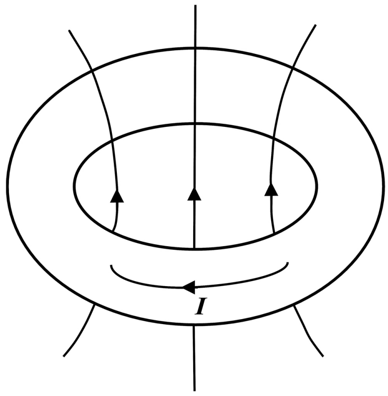

Figure 1. We outline the direction of Gravitational wave "flux". If the arrow in the middle of the Tokamak ring perpendicular to the direction of the current represents the z axis, we represent where to put the GW detection device as 5 meters above the Tokamak ring along the z axis. This diagram was initially from Wesson [29].

And the mass of a black hole, scaling as [50]

$$M_{\text{black hole}} \cong \sqrt{\tilde{N}} M_p \approx \tilde{N} \in_G \tag{87}$$

This in [3] [4] has the exact same functional forms as is given in Equation (2). So then we have $\tilde{N} = N$ and furthermore [50] also has

$$\in_G \cong \frac{M_p}{\sqrt{\tilde{N}}} \cong \frac{\hbar}{L_A} \approx \frac{M_p}{\sqrt{N}} \tag{88}$$

If so for Black holes, we have the following

$$\sqrt{\Lambda} \cong \frac{\sqrt{3} M_p}{\hbar \sqrt{N}} \tag{89}$$

Now as to what is given in [1] [2] as to Torsion, we have that as given in [51] that we can do some relevant dimensional scaling.

First look at numbers provided by [1] [2] as to inputs, *i.e.* these are very revealing, *i.e.* we go back to the arguments as to the beginning of the document, namely $\Lambda_{Pl} c^2 \approx 10^{87}$.

This is the number for the vacuum energy and this enormous value is 10^{122} times larger than the observed cosmological constant. Torsion physics, as given by [1] [2] is solely to remove this giant number.

Our timing is to unleash a Planck time interval t about 10^{-43} seconds. Also the creation of the torsion term is due to a presumed "graviton" particle density of $n_{Pl} \approx 10^{98}\ \text{cm}^{-3}$.

This particle density is directly relevant to the basic assumption of how to have relevant Gravitons initially created as to obtain the huge increase in complexity alluded to, in order to obtain the number of micro black holes in the Planckian era [1] [2].

***I.e.* assume that there are, then say initially up to 10^{98} gravitons, initially, and then from there, go to Table 1 to assume what number of micro sized black holes are available, *i.e.* Table 1 has say a figure of 10^{45} to at most 10^{50} micro**

sized black holes, presumably for 10^{98} gravitons being released, and this is meaning we have say 10^{50} black holes of say of Planck mass, to work with.

23. Linkage of This to Tokamaks, and What We Can Explicitly Look for Concerning Say Equation (84) and Temperature Scaling

Recall that the formula given of power for the Tokamak is stated to be

$$P_{\Omega}\Big|_{\text{Tokamak toroid}} \leq \frac{\xi^{1/8} \cdot \tilde{\alpha}}{\mu_0 \cdot e_j \cdot R} \times \frac{\left(T_{\text{Tokamak temperature}}\right)^{9/4}}{0.87^{5/4}}$$

Keep in mind that potential energy and Power are in a sense different concepts. However, Power is the rate at which energy is used or transferred, while energy is the capacity to do work.

A future idea would be to relate the power of a Tokamak to say the lead up to very stranger results as given in Equation (84) *i.e.* do the limiting values as discussed in the last sections make sense?

I believe that they actually DO make sense. And if we do the Tokamak experiments with due diligence, we will confirm the seemingly outlandish limiting values for Potential energy as a starting initiation of other experimental predictions made.

In addition would be verifying the scaling law due to power as to black holes and gravitons, namely due to all this to consider the following.

A black hole in a traditional sense has no frequency as we normally think of it, or a wave number because it is not a wave phenomenon, but the gravitational waves emitted by a black hole when it interacts with other massive objects can be described by a wave number, which is related to the wavelength of the gravitational wave it creates.

These details would be important to obtain ideas as to data sets which would satisfy multi messenger astronomy namely the discussion as given in Mohanty, [52] namely a temperature, with scale factor as given in his page 261

$$T \sim \frac{1}{g^{*} a} \tag{90}$$

i.e. find if there is a way to start verifying data sets which may link Equation (90) as may be important to multi messenger astronomy to simulation dynamics which show up in tokamaks. We then now appeal to Multiverse model dynamics in a generalization of the Penrose CCC. The consequences are a thermodynamic scaling which we claim allows Equation (90).

24. Looking Now at the Modification of the Penrose CCC (Cosmology)

This section requires a skimming from [53]-[60] as general information before the averaging procedure as outlined is comprehensible. I urge readers to look at all these publications first before diving into the details presented below.

We now outline the generalization for Penrose CCC (Cosmology) inflation which we state we are extending Penrose's suggestion of cyclic universes, black hole evaporation, and the embedding structure our universe is contained within, this multiverse has BHs and may resolve what appears to be an impossible dichotomy. The following is largely from [53] and has serious relevance to the final part of the conclusion. That there are N universes undergoing Penrose "infinite expansion" (Penrose) [54] contained in a mega universe structure. Furthermore, each of the N universes has black hole evaporation, which is with Hawking radiation from decaying black holes. If each of the N (counted) universes is defined by a partition function, called $\{\Xi_i\}_{i\equiv 1}^{i\equiv N}$, then there exist an information ensemble of mixed minimum information correlated about 10^7 - 10^8 bits of information per partition function in the set $\{\Xi_i\}_{i\equiv 1}^{i\equiv N}\Big|_{\text{before}}$, so minimum information is conserved between a set of partition functions per universe [53]

$$\{\Xi_i\}_{i\equiv 1}^{i\equiv N}\Big|_{\text{before}} \equiv \{\Xi_i\}_{i\equiv 1}^{i\equiv N}\Big|_{\text{after}} \tag{91}$$

However, there is non-uniqueness of information put into individual partition function $\{\Xi_i\}_{i\equiv 1}^{i\equiv N}$. Also Hawking radiation from black holes is collated via a strange attractor collection in the mega universe structure to form a new inflationary regime for each of the N universes represented.

Our idea is to use what is known as CCC cosmology [53] [54], which can be thought of as the following. First. Have a big bang (initial expansion) for the universe which is represented by $\{\Xi_i\}_{i\equiv 1}^{i\equiv N}$. Verification of this mega structure compression and expansion of information with stated non-uniqueness of information placed in each of the N universes favors ergodic mixing of initial values for each of N universes expanding from a singularity beginning. The n_f stated value, will be using (Ng, 2008) $S_{\text{entropy}} \sim n_f$ [53]. How to tie in this energy expression, as in Equation (12) will be to look at the formation of a nontrivial gravitational measure as a new big bang for each of the N (counted) universes as by $n(E_i)$ the density of states at energy E_i for partition function [53] [56].

$$\{\Xi_i\}_{i\equiv 1}^{i\equiv N} \propto \left\{ \int_0^\infty \mathrm{d}E_i \cdot n(E_i) \cdot \mathrm{e}^{-E_i} \right\}_{i\equiv 1}^{i\equiv N}. \tag{92}$$

Each of E identified with Equation (92) above, are with the iteration for N (universe counting index) universes [53] and [56]. Then the following holds, by asserting the following claim to the universe, as a mixed state, with black holes playing a major part, *i.e.*

<u>Claim 1</u>

See the below [53] representation <u>of mixing for assorted N (universe counting index) partition functions</u> per CCC cycle

$$\frac{1}{N} \cdot \sum_{j=1}^{N} \Xi_j \Big|_{j \text{ before nucleation regime}} \xrightarrow{\text{vacuum nucleation tranfer}} \Xi_i \Big|_{i \text{ fixed after nucleation regime}} \tag{93}$$

For N number of universes, with each $\Xi_j\Big|_{j \text{ before nucleation regime}}$ for $j = 1$ to N (universe counting index) being the partition function of each universe just before the blend into the RHS of Equation (93) above for our present universe. Also, each independent universe as given by $\Xi_j\big|_{j\text{ before nucleation regime}}$ is constructed *by the absorption of one to ten million black holes taking in energy. I.e.* (Penrose) [54]. Furthermore, the main point is done in [53] in terms of general ergodic mixing [57]-[59].

Claim 2

$$\Xi_j\big|_{j\text{ before nucleation regime}} \approx \sum_{k=1}^{Max} \Xi_k\big|_{\text{black holes } j\text{th universe}} \quad (94)$$

What is done in **Claims 1 and 2** is to come up as to how a multidimensional representation of black hole physics enables continual mixing of spacetime [53] [54], largely as a way to avoid the Anthropic principle [53], as to a preferred set of initial conditions. We also say that this averaging procedure makes the implementation of Equation (90) far more likely due to thermodynamic scaling.

Furthermore this sort of averaging, can be compared to the situation as given in [60].

Next, we will examine what happens if we wish to entertain the possibility of Electromagnetic fields in the early universe, after the feed in of the averaging procedure as alluded to in this document.

25. Linking Our Temperature as to Equation (90) to *E* and *M* Fields? In the Early Universe? How Does This Tie in with Tokamaks?

This would put a requirement upon a very large initial temperature T_{initial} and so then, if $S(\text{initial}) \sim n(\text{particle count}) \approx g_{*s}(\text{initial}) \cdot V_{\text{volume}} \cdot \left(\frac{2\pi^2}{45}\right) \cdot (T_{\text{initial}})^3$ [61].

Which would be correlated to a relic graviton count, *i.e.* in the following

$$S(\text{initial}) \sim n(\text{particle count}) \approx \frac{V_{\text{volume}}}{g_{*s}^2(\text{initial})} \cdot \left(\frac{2\pi^2}{45}\right) \cdot \left(\frac{\hbar}{\Delta t_{\text{initial}} \cdot \delta g_{tt}}\right)^3 \quad (95)$$

And if we can write as given in

$$V_{\text{volume(initial)}} \sim V^{(4)} = \delta t \cdot \Delta A_{\text{surface area}} \cdot (r \le l_{\text{Planck}}) \quad (96)$$

Then as to the follow up to NLED and signals from primordial processes [62]

$$\begin{aligned} \alpha_0 &= \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0 \\ \hat{\lambda}(\text{defined}) &= \Lambda c^2/3 \\ a_{\min} &= a_0 \cdot \left[\frac{\alpha_0}{2\hat{\lambda}(\text{defined})}\left(\sqrt{\alpha_0^2 + 32\hat{\lambda}(\text{defined}) \cdot \mu_0 \omega \cdot B_0^2} - \alpha_0\right)\right]^{1/4} \end{aligned} \quad (97)$$

where the following is possibly linkable to minimum frequencies linked to *E* and *M* fields, and possibly relic Gravitons [62]

$$B > \frac{1}{2 \cdot \sqrt{10\mu_0 \cdot \omega}} \quad (98)$$

i.e. the way to do this is to scale initial energy, and power as proportional to a temperature, and from there to make the following identification. *I.e.* Frequency, in Equation (98) would be proportional to energy AND power, and we would be examining if the Tokamak expression of POWER we referenced earlier, would be having a temperature component, which in the early universe would also scale as ENERGY and graviton production.

What would be stunning would be if Equation (98) as outlined is with specified frequency, would be true for early universe conditions AND also a Tokamak. That would be a game changer if true.

26. Now We Can Examine How These Predictions Would Scale to the Present Era from the Distant Past. *I.e.* Specific Reference to High Frequency Gravitational Waves

To do this section, please review [61] [62] as well as spending time with [63]-[69] for an overview as to what is involved. Before going to the following discussion

$$\begin{aligned}&\left(1+z_{\text{initial era}}\right)\equiv\frac{a_{\text{today}}}{a_{\text{initial era}}}\approx\left(\frac{\omega_{\text{Earth orbit}}}{\omega_{\text{initial era}}}\right)^{-1}\\&\Rightarrow\left(1+z_{\text{initial era}}\right)\omega_{\text{Earth orbit}}\approx10^{25}\,\omega_{\text{Earth orbit}}\approx\omega_{\text{initial era}}\end{aligned}\tag{99}$$

Equation (99) is crucial to what we do next. *I.e.* see involves.

Whereas we postulate that we specify an initial era frequency via use of simple dimensional analysis which is slightly modified by Maggiore for the speed of a graviton [63] whereas

$$c\left(\text{light speed}\right)\approx\omega_{\text{initial era}}\cdot\left(\lambda_{\text{initial post bubble}}=\ell_{\text{Planck}}\right)\tag{100}$$

and that dimensional comparison with initially having a temperature built up so as

$$\Delta E\approx\hbar\omega_{\text{initial era}}\tag{101}$$

where $T_{\text{universe}}\approx T_{\text{Plank temerature}}=1.22\times10^{19}\,\text{GeV}$. If so then the Planck era we would have that the temperature would be extremely high leading to a change in temperature from the Pre Planckian conditions to Planck era leading to

$$\Delta E=\frac{d\left(\dim\right)}{2}\cdot k_B\cdot T_{\text{universe}}\tag{102}$$

In doing so, be assuming

$$\omega_{\text{initial era}}\approx\frac{c}{\ell_{\text{planck}}}\leq1.8549\times10^{43}\,\text{Hz}\tag{103}$$

where $\omega_{\text{initial era}}\approx\frac{c}{\ell_{\text{planck}}}\leq1.8549\times10^{43}\,\text{Hz}$ would be assumed so then we would be looking at frequencies on Earth from gravitons of mass m (graviton) less than of equal to

$$\omega_{\text{Earth orbit}}\leq10^{-25}\,\omega_{\text{initial era}}\tag{104}$$

And this partly due to the transference of cosmological "information" as given in [53] for a phantom bounce type of construction.

Further point that since we have that gravitons travel at nearly the speed of light [64], that gravitons are formed from the surface of a bubble of space-time up to the electroweak era that mass values of the order of 10^{-65} grams (rest mass of relic gravitons) would increase due to extremely high velocity would lead to enormous $\Delta E \approx \hbar\omega_{\text{initial era}}$ values per graviton, which would make the conflation of ultrahigh temperatures with gravitons traveling at nearly the speed of light as given in Equation (104) as compared with $\Delta E \approx \hbar\omega_{\text{initial era}}$. We can in future work compare this with the Rosen [65] mini universe value as given below and also its links to a universe with a Schrodinger equation of a initial universe ground state mass of value of energy for a mini universe of(from a Schrodinger equation) with ground state mass of $m = \sqrt{\pi} M_{\text{Planck}}$ and an energy of

$$E_{\hat{n}} = \frac{-Gm^5}{2\pi^2\hbar^2\hat{n}^2} \tag{105}$$

Our preliminary supposition is that Equation (105) could represent the initial energy of a Pre Planckian Universe and that Equation (102) be the thermal energy dumped in due to the use of Cyclic Conformal cosmology (maybe in multiverse form) so that if there is a buildup of energy greater than Equation (105) due to thermal buildup of temperature due to fall of matter-energy, we have a release of Gravitons in great number which would commence as a domain wall broke down about in the Planckian era with a temperature of the magnitude of Planck Energy for a volume of radius of the order of Plank Length. This will be investigated in detailed future calculations. All this should be in fidelity, in experimental limits to [66], as well as looking at ideas about Quantum tunneling we may gain from [67] as to understand the transition from Pre Planckian to Planckian physics [68] [69].

And now for our final review of Tokamak dynamics, *i.e.*

27. Final Point of the Tokamak versus Primordial GW Business, *i.e.* See This Enhancing GW Strain Amplitude via Utilizing a Burning Plasma Drift Current

Before reading this, review [29] [70]-[73] in detail because this section is a brief introduction to a very complicated machine technology.

We begin first of all with the following discussion. *I.e.* FROM [29].

We will examine the would-be electric field, contributing to a small strain values similar in part to Ohms law. A generalized Ohm's law ties in well with **Figure 1** above

$$J = \sigma \cdot E \tag{106}$$

In order to obtain a suitable electric field, to be detected via 3DSR technology [70]-[73], we will use a generalized Ohm's law as given by Wesson [29] (page 146), where E and B are electric and magnetic fields, and v is velocity.

$$E = \sigma^{-1} J - v \times B \tag{107}$$

Note that the term in Equation (108) given as $v \times B$ deserves special commentary. If v is perpendicular to B as occurs in a simple equilibrium case, then of course, Equation (108) would be, simply put, Ohms law, and spatial equilibrium averaging would then lead to

$$E = \sigma^{-1}J - v \times B \xrightarrow[v \text{ perpendicular to } B]{} E = \sigma^{-1}J \tag{108}$$

What saves the contribution of Plasma burning as a contributing factor to the Tokamak generation of GW, with far larger strain values commencing is that one does not have the velocity of ions in Plasma perpendicular to B fields in the beginning of Tokamak generation. It is, fortunately for us, a non-equilibrium initial process, with thermal irregularities leading to both terms in Equation (109) contributing to the electric field values. We will be looking for an application for radial free electric fields being applied e.g., Wesson [29] (page 120)

$$n_j e_j \cdot \left(E_r + v_{\perp j} B\right) = -\frac{\mathrm{d}P_j}{\mathrm{d}r} \tag{109}$$

The way forward is to go to Wesson [29] (2011, page 120) and to look at the normal to surface induced electric field contribution of a Tokamak and we get this item

$$E_n = \frac{\mathrm{d}P_j}{\mathrm{d}x_n} \cdot \frac{1}{n_j \cdot e_j} - \left(v \times B\right)_n \tag{110}$$

If one has for v_R as the radial velocity of ions in the Tokamak from Tokamak center to its radial distance, *R*, from center, and B_θ as the direction of a magnetic field in the "face" of a Toroid containing the Plasma, in the angular θ direction from a minimal toroid radius of $R = a$, with $\theta = 0$, to $R = a + r$ with $\theta = \pi$, one has v_R for radial drift velocity of ions in the Tokamak, and B_θ having a net approximate value of: with B_θ not perpendicular to the ion velocity, so then [29]

$$\left(v \times B\right)_n \sim v_R \cdot B_\theta \tag{111}$$

Also, From Wesson [29] (page 167) the spatial change in pressure denoted

$$\frac{\mathrm{d}P_j}{\mathrm{d}x_n} = -B_\theta \cdot j_b \tag{112}$$

Here the drift current, using $\xi = a/R$, and drift current j_b for Plasma charges, *i.e.*

$$j_b \sim -\frac{\xi^{1/2}}{B_\theta} \cdot T_{Temp} \cdot \frac{\mathrm{d}n_{\text{drift}}}{\mathrm{d}r} \tag{113}$$

Figure 2 below introduces the role of the drift current, in terms of Tokamaks [29]

$$B_\theta^2 \cdot \left(j_b / n_j \cdot e_j\right)^2 \sim \frac{B_\theta^2}{e_j^2} \cdot \frac{\xi^{1/4}}{B_\theta^2} \cdot \left[\frac{1}{n_{\text{drift}}} \cdot \frac{\mathrm{d}n_{\text{drift}}}{\mathrm{d}r}\right]^2 \sim \frac{\xi^{1/4}}{e_j^2} \cdot \left[\frac{1}{n_{\text{drift}}} \cdot \frac{\mathrm{d}n_{\text{drift}}}{\mathrm{d}r}\right]^2 \tag{114}$$

Now, the behavior of the numerical density of ions, can be given as follows, namely growing in the radial direction, then [29]

$$n_{\text{drift}} = n_{\text{drift}}\big|_{\text{initial}} \cdot \exp\left[\tilde{\alpha} \cdot r\right] \tag{115}$$

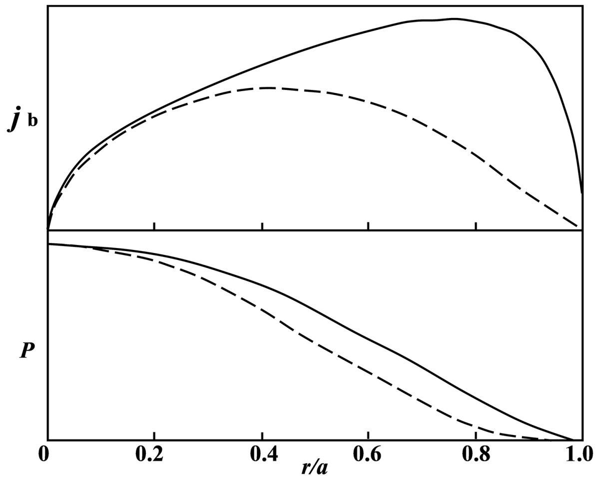

Figure 2. Typical bootstrap currents with a shift due to r/a where r is the radial direction of the Tokamak, and a is the inner radius of the Toroid This figure is reproduced from Wesson [29] Then one has.

This exponential behavior then will lead to the 2nd term in Equation (108) having in the center of the Tokamak, for an ignition temperature of $T_{Temp} \geq 10\ \text{KeV}$ a value of

$$h_{\text{2nd term}} \sim \frac{G}{c^4} \cdot B_\theta^2 \cdot \left(j_b / n_j \cdot e_j \right)^2 \cdot \lambda_{GW}^2 \sim \frac{G}{c^4} \cdot \frac{\xi^{1/4} \tilde{\alpha}^2 T_{Temp}^2}{e_j^2} \cdot \lambda_{GW}^2 \sim 10^{-25} \tag{116}$$

As shown in [29] there is a critical ignition temperature at its lowest point of the curve in the having $T_{Temp} \geq 30\ \text{KeV}$ as an optimum value of the Tokamak ignition temperature for $n_{ion} \sim 10^{20}\ \text{m}^{-3}$, with a still permissible temperature value of $T_{Temp}\big|_{\text{safe upper bound}} \approx 100\ \text{KeV}$ with a value of $n_{ion} \sim 10^{20}\ \text{m}^{-3}$, due to from page 11, [29] the relationship of Equation (117), where τ_E is a Tokamak confinement of plasma time of about 1 - 3 seconds, at least due to [29]. Then $n_{ion} \cdot \tau_E > 0.5 \times 10^{20}\ \text{m}^{-3} \cdot \text{sec}$. Also, if, $T_{Temp}\big|_{\text{safe upper bound}} \approx 100\ \text{KeV}$, then one could have at the Tokamak center, *i.e.* even the Hefei based Tokamak [29] [70]

$$h_{\text{2nd term}}\big|_{T_{Temp} \geq 100\ \text{KeV}} \sim \frac{G}{c^4} \cdot \frac{\xi^{1/4} \tilde{\alpha}^2 T_{Temp}^2}{e_j^2} \cdot \lambda_{GW}^2 \sim 10^{-25} - 10^{-26} \tag{117}$$

This would lead to, for a GW reading 5 meters above the Tokamak, then lead to for then the Tokamak [29]

$$\left[h_{\text{2nd term}}\big|_{T_{Temp} \geq 100\ \text{KeV}} \right]_{\text{5 meters above Tokamak}} \sim \frac{G}{c^4} \cdot \frac{\xi^{1/4} \tilde{\alpha}^2 T_{Temp}^2}{e_j^2} \cdot \lambda_{GW}^2 \sim 10^{-27} \tag{118}$$

Note that the support for up to 100 KeV for temperature can yield more stability in terms of thermal Plasma confinement IE **Restating the energy density and power using the formalism of Equation (119).**

I.E. **RECALL THE EARLIER GIVEN VALUE OF THE GRAVITATIONAL AMPLITUDE GIVEN** $A(\text{GW.amplitude}) \sim h \sim \frac{G \cdot W_E \cdot V_{\text{volume}}}{c^4 \cdot \tilde{a}}$ which is proportional to an applied *E* field of a plasma squared, times the square of the gravitational waves generated as seen in the $A(\text{amplitude GW}) = h \sim \frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2$.

Here are some basics:

Note that a simple model of how to provide a current in the Toroid is provided by a transformer core. This diagram is an example of how to induce the current I, used in the simple Ohms law derivation referred to in the first part of the text. Here, E is the electric field whereas λ_{Gw} is the gravitational wavelength for GW generated by the Tokamak in our model. In the original Griskchuk model, we would have very small strain values, which will comment upon but which require the following relationship between GW wavelength and resultant frequency. Note, if $\omega_{GW} \sim 10^6\ \text{Hz} \Rightarrow \lambda_{Gw} \sim 300\ \text{meters}$, so we will be assuming a baseline of the order of setting $\omega_{GW} \sim 10^9\ \text{Hz} \Rightarrow \lambda_{Gw} \sim 0.3\ \text{meters}$, as a baseline measurement for GW detection above the Tokamak.

Where WE USE

$$\begin{aligned} W_E &= \text{Average energy density}, \\ V_{\text{volume}} &= \text{Volume Toroid}, \\ \tilde{a} &= \text{inner radii}(\text{Toroid}) \end{aligned} \tag{119}$$

Directly WE OBTAIN $W_E \cdot V_{\text{volume}} \sim \tilde{\alpha} \cdot \lambda_{GW}^2 \cdot \frac{\xi^{1/4} \tilde{\alpha}^2 T^2_{\text{Temp plasma fusion burning}}}{e_j^2}$

The temperature for Plasma fusion burning, is then about between 30 to 100 KeV, as given by Wesson [10]. The corresponding power as given by Wesson is then for the Tokamak [10] AS GIVEN EARLIER AS $P_\Omega = E \cdot J \leq \frac{E}{\mu_0} \cdot \frac{B_\phi}{R}$. The tie HAPPENS IF WE ARE setting the E field as related to the B field, via E (electrostatic) ~$10^{12}\ \text{Vm}^{-1}$ as equivalent to a magnetic field $B \sim 10^4 T(Torr)$ as given by [72]. In a one second interval, if we use the input power as an experimentally supplied quantity, then the effective E field WAS GIVERN EARLIER AS BY THE FOLLOWING $E_{\text{applied}} \sim \frac{\xi^{1/8} \cdot \tilde{\alpha}}{e_j} \times T_{\text{Tokamak temperature}}$.

Further elaboration of this matter in the experimental detection of experimental data sets for massive gravity lies in the viability of the expression derived, WITH A STRAIN difference of 2 orders of magnitude. We state that our rough estimate is that we would see about the same strain values, in the initial starting point of the universe we would have, say h ~ decreasing to h ~ today. This is crucial for linking Tokamak behavior with the early universe.

I.e. a comparatively small change in strain amplitude. Contrast this with the e folding issues, of [71] whereas we would have a difference of 10^{26} in frequency magnitude, with 10^{10} Hz initially, for GW at start of big bang, decreasing to 10^{-16} Hz, due to inflation, and [72]. If we confirm that last statement observationally, we have confirmed the [71] e folding prediction and taken a huge step forward in observational cosmology. Eventually we could investigate, also, early universe polarization of gravity wavges. But that is the final part of our project.

ALL THIS HAS TO BE TIED IN WITH THE SCALING LAW GIVEN IN EQUATION (84) WHICH IS CRUCIAL FOR MAKING A CONNECTION. in addition the work done by Li *et al.* in [73] as to 3DSR technology being used for confirming theoretical modeling is really worth reading as far as machine technology and this endeavor.

28. Now Answering the Questions at the Start of the Document

Quote:

Q1: Near Equation (44), if the observed cosmological constant is 10^−122 less than the initial vacuum energy, where did the rest of this energy go?

Q2: Equation (49) Agw = should be $h^* G/c^4 \ldots$, not $h \sim G/c^4 \ldots$?

Q3: Equation (54) Power for tokamak, I recommend you include definitions for Epsilon (plasma confinement factor) & Alpha (geometric factor of tokamak, typically ~1.5).

Q4: Below Equation (67) in Unruh Temperature discussion, is the metric uncertainty in (69) derived from the HUP?

Q5: In section 20 Penrose CCC Models, you are arguing that the non-uniqueness of the information ensemble for each nucleation cycle leads to ergodic mixing, but doesn't ergodic mixing result in a loss of information memory? Thus unique vs non-unique?

Q6: On your Claim 2, that a multi-dimensional representation of BHs enables continual mixing of STs, do you have a reference for this notion, or is this an original insight?

Q7: New Equation (98) and below, how would it be possible to simulate early universe temperatures of $>10^{12}$ GeV with tokamak temperatures of <110 Kev? How do we step up/down or scale up/down from one case to the other?

I also made the following observations:

O1: I thought the claim 2 continual mixing of ST avoids invoking the Anthropic principle was an important insight. You reference your own work here but I'm wondering if this idea appears elsewhere?

O2: I think that the idea of using tokamak plasmas to simulate the early universe is a fascinating and wholly original idea. GW, based on Grishchuk & Sachin, but that's as far as I went.

NOW FOR SOME ANSWERS, TO THE QUESTIONS

ANSWER TO Q1: The entire business of where the energy went is answered in section 29. Of this document. It requires a long answer and I advise readers to go to Section 29. For an extended review of what is entailed cosmologically.

Answer to Q2: See section 23, As the formula is indeed correct but it also is an extended discussion.

Answer to Q3: This is in a nutshell the main topic of my NEXT paper. *I.e.* we introduce the idea, but doing full justice to it is indeed doing exactly what is suggested. *I.e.* it's a full paper in its own right.

Answer to Q4: The answer is YES. That is the entire POINT.

Answer to Q5: Ergodic mixing does indeed average out memory, but what is the real point is that thermodynamics which I argue is crucial for forming the initial Planck constant initially is due to invariant initial space-time geometry which does not change appreciably from cycle to cycle. This sort of averaging over a universe partition function is done in such a way as that the precursors of h bar, (Planck constant) do not vary from cycle to cycle, and Planck's constant is the big one. *I.e.* the entire foundation of the fundamental numbers as in the Planck units remains invariant from cycle to cycle, and from universe to universe.

Answer to Q6: I did this, this is MY take on the early universe. Done NOWHERE else.

Answer to Q7: Again the subject of my next paper but also section 29 gives a preview of the real reason/*I.e.* forming initial structure formation and re acceleration of the Universe is extremely energy intensive. *I.e.* to form what is in Section 29. A huge amount of energy is required.

So lets go to the Section 29.

29. How Could Anyone Get the Acceleration of the Universe Factored into Our Scale Factor?

We will proceed to isolate out an energy flux term which will be able to ascertain how to make sense of this enormous change in an inflaton environment, and here is what we are trying to avoid. *i.e.* a simple model will be presented, which we state gives the wrong value for a cosmological constant term *i.e.* in doing so, we will utilize the following namely.

Begin looking at material from page 483-485 of [74]

$$\left(\frac{\dot{a}}{a}\right)^3 - \frac{3}{2}\cdot\left(\frac{\dot{a}}{a}\right)^2 - 2\cdot\left(\frac{\ddot{a}}{a}\right)\cdot\left(\frac{\dot{a}}{a}\right) + \left[\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right] = 0 \tag{120}$$

Then, consider two cases of what to do with the ration of $\left(\frac{\dot{a}}{a}\right)$ and solve the above as a cubic equation.

30. What If $\left(\frac{\ddot{a}}{a}\right)$ ~Vanishingly Small Contribution. (Low Acceleration)

$$\left(\frac{\dot{a}}{a}\right)^3 - \frac{3}{2}\cdot\left(\frac{\dot{a}}{a}\right)^2 + \left[\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right] \cong 0 \tag{121}$$

Then, using the idea of a "repressed cubic" we will have the following solution for $\left(\frac{\dot{a}}{a}\right)$, namely [75]

$$\left(\frac{\dot{a}}{a}\right) = \text{Solution} = \xi \tag{122}$$

Solutions for Equations (121), in reduced Cubic form for Equations (121)

$$\xi = A+B, \frac{\sqrt{-3}}{2}\cdot(A-B)-\left(\frac{A+B}{2}\right), \frac{-\sqrt{-3}}{2}\cdot(A-B)-\left(\frac{A+B}{2}\right) \tag{123}$$

$$\begin{aligned} A &= \left(\left(\frac{-1}{128\pi G\cdot t^2}+\frac{\Lambda}{4}\right)+\sqrt{\frac{1}{4}\cdot\left(\frac{-1}{64\pi G\cdot t^2}+\frac{\Lambda}{2}\right)^2+\frac{1}{8}}\right)^{1/3} \\ B &= -\left(\left(\frac{1}{128\pi G\cdot t^2}-\frac{\Lambda}{4}\right)+\sqrt{\frac{1}{4}\cdot\left(\frac{-1}{64\pi G\cdot t^2}+\frac{\Lambda}{2}\right)^2+\frac{1}{8}}\right)^{1/3} \end{aligned} \tag{124}$$

Then using [9] [75]

$$\Theta = \frac{1}{8}\cdot\left[2\cdot\left(\frac{-1}{64\pi G\cdot t^2}+\frac{\Lambda}{2}\right)^2-1\right] \tag{125}$$

$$\begin{aligned} &\Theta > 0 \Rightarrow \xi \text{ has, 1st real, 2nd imaginary, 3rd imaginary} \\ &\Theta = 0 \Rightarrow \xi \text{ has, 3 real roots, 2 of 3 roots equal} \\ &\Theta < 0 \Rightarrow \xi \text{ has, 3 real roots, all roots unequal} \end{aligned} \tag{126}$$

The situation to watch is when the time, *t*, is extremely small. Then one is having to work with the situation where $\Theta > 0 \Rightarrow \xi$ has, 1st real, 2nd imaginary, 3rd imaginary. *I.e.* the situation is then dominated with one real root and two imaginary roots. The value of what happens to $\left(\frac{\dot{a}}{a}\right) = \text{Solution} = \xi$ is one which will be commented upon if there is one real root, and two imaginary. What would be a possible constraint upon would be if we had, for non-dimensionalized units

$$\begin{aligned} &\left[2\cdot\left(\frac{-1}{64\pi G\cdot t^2}+\frac{\Lambda}{2}\right)^2-1\right]\approx 0 \Leftrightarrow \left(\frac{-1}{64\pi G\cdot t^2}+\frac{\Lambda}{2}\right)\approx\frac{1}{\sqrt{2}} \\ &\Leftrightarrow \Lambda \approx \sqrt{2}+\frac{1}{32\pi G\cdot t^2} \end{aligned} \tag{127}$$

I.e. for the case that one uses non-dimensionalized units we would have, then

$$\Theta \le 0 \Leftrightarrow \Lambda \ge \sqrt{2}+\frac{1}{32\pi G\cdot t^2} \tag{128}$$

i.e. this means that if we have small *t* *i.e.* almost at the start of inflation, a HUGE vacuum energy. And this is what we want to avoid. *I.e.* how likely is this to happen, in the Pre Planckian regime? Not likely. In fact, the construction of Equation (24) almost completely voids out how to obtain a vacuum energy which is going to be avoided first by working with the following expression for scalar fields [76]

$$\begin{aligned} &a(t) = a_{\text{initial}} t^{\nu} \\ &\Rightarrow \phi = \ln\left(\sqrt{\frac{8\pi G V_0}{\nu\cdot(3\nu-1)}}\cdot t\right)^{\sqrt{\frac{\nu}{16\pi G}}} \\ &\Rightarrow \dot{\phi} = \sqrt{\frac{\nu}{4\pi G}}\cdot t^{-1} \\ &\Rightarrow \frac{H^2}{\dot{\phi}} \approx \sqrt{\frac{4\pi G}{\nu}}\cdot t\cdot T^4\cdot\frac{1.66^2\cdot g_*}{m_P^2}\approx 10^{-5} \end{aligned} \tag{129}$$

We will from here obtain a range of energy flux expressions which avoids the mess created by Equation (23).

31. How to Come up with an Alternate Initial Energy Expression Which May Avoid the Situation in Equation (23) (127)?

First of all, rather than use the scalar field as given in Equation (129) we use a different approach, as given by Equation (123) and we also look at a different application of the shape function argument for incremental time. As pioneered by Barbour [77]

$$\delta t = \sqrt{\frac{\sum m_a \delta x_a \cdot \delta x_a}{2\left(E - V\left(\text{potential}\right)\right)}} \tag{130}$$

In our case, our simplication is to re write this as by using Equation (123)

$$\begin{aligned} \delta t &= \sqrt{\frac{m_g \cdot (\delta x)^2}{2\left(E - V\left(\text{potential}\right)\right)}} \xrightarrow[\ell_p \to 1]{} \sqrt{\frac{m_g \cdot (\delta x)^2}{2\left(E - V\left(\text{potential}\right)\right)}} \\ &\xrightarrow[\delta x \to \ell_p \to 1]{} \sqrt{\frac{m_g \cdot 8\pi G}{\alpha}} \cdot t \end{aligned} \tag{131}$$

Then in doing so, we will be obtaining by the initial uncertainty principle as of Equation (132).

Namely we will be working with [77]-[79]

$$\begin{aligned} &\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t) \cdot \phi} \ll \hbar \\ &\Leftrightarrow S_{\text{initial}}\left(\text{with}\left[\delta g_{tt}\right]\right) = \left(\delta g_{tt}\right)^{-3} S_{\text{initial}}\left(\text{without}\left[\delta g_{tt}\right]\right) \\ &\quad \gg S_{\text{initial}}\left(\text{without}\left[\delta g_{tt}\right]\right) \end{aligned} \tag{132}$$

I.e. the fluctuation $\delta g_{tt} \ll 1$ dramatically boost initial entropy. Not what it would be if $\delta g_{tt} \approx 1$. The next question to ask would be how could one actually have

$$\delta g_{tt} \sim a^2(t) \cdot \phi \xrightarrow[\phi \sim \text{Very Large}]{} 1 \tag{133}$$

In short, we require an enormous "inflaton" style ϕ valued scalar function, and $a^2(t) \sim 10^{-110}$ How could ϕ be initially quite large? Within Planck time the following for mass holds, as a lower bound

$$m_{\text{graviton}} \geq \frac{2\hbar^2}{\left(\delta g_{tt}\right)^2 l_P^2} \cdot \frac{E - V}{\Delta T_{tt}^2} \tag{134}$$

$$\begin{aligned} \Delta E &\xrightarrow[\delta x \to \ell_p \to 1]{} \sqrt{\frac{4\pi G \hbar^2}{t^2 \cdot m_g}} \cdot \frac{1}{\left(a_0 t^\alpha\right)^2 \cdot \ln\left(\sqrt{\frac{8\pi G V_0}{\alpha \cdot [3\alpha - 1]}} \cdot t\right)} \\ &\xrightarrow[t \to t_p \to 1]{} \sqrt{\frac{4\pi G \hbar^2}{m_g}} \cdot \frac{1}{\left(a_0\right)^2 \cdot \ln\left(\sqrt{\frac{8\pi G V_0}{\alpha \cdot [3\alpha - 1]}}\right)} \end{aligned} \tag{135}$$

In so many words, a good deal of the excess energy is eaten up by Equation (135) and becomes drawn off, initially with the small residue the remaining cosmological constant.

32. Having Said This, What about Compression of the Initial States at the Start of Inflation? *I.e.* the Transition to Semi Classical States after Equation (135)? Entropy Generation via Ng's Infinite Quantum Statistics

This discussion is motivated to present a purely string theory approach and to see if its predictions may over lap with semi classical WDM (semi classical) treatments of cosmology. The contention being advanced is that if there is an over lap between these two methods that it may aid in obtaining experimentally falsifiable data sets for GW from relic conditions.

The author wishes to understand the linkage between dark matter and gravitons. If DM is composed of, as an example, KK gravitons, higher dimensional versions of the KK tower of graviton masses in dimensions above 4 dimensions contribute to a dark matter candidate. If how relic gravitational waves relate to relic gravitons"? To consider just that, the author will look at the "size" of the nucleation space, V (volume). When considering dark matter, DM. V (volume) for nucleation is HUGE. Graviton space V (volume) for nucleation is tiny, well inside inflation if initial gravitational waves are extremely high frequency, as would be the case with the model Giovannini, *et al.* (1995) [80] proposed. Therefore, the log factor drops OUT of entropy S if V chosen properly for both Equation (1) and Equation (2). Ng's result [81] begins with a modification of the entropy/partition function Ng used the following approximation of temperature and its variation with respect to a spatial parameter, starting with temperature $T \approx R_H^{-1}$ (R_H can be thought of as a representation of the region of space where the author takes statistics of the particles in question). Furthermore, assume that the volume of space to be analyzed is of the form $V \approx R_H^3$ and look at a preliminary numerical factor the author shall call $N \sim \left(R_H / l_P\right)^2$, where the denominator is Planck's length (on the order of 10^{-35} centimeters). The author also specifies a "wavelength" parameter $\lambda \approx T^{-1}$. So the value of $\lambda \approx T^{-1}$ and of R_H are approximately the same order of magnitude. Now this is how Jack Ng (2008) [81] changes conventional statistics: he outlines how to get $S \approx N$, which with additional arguments the author refines to be $S \approx \langle n \rangle$ (where $\langle n \rangle$ is graviton density). Begin with a partition function [81]

$$Z_N \sim \left(\frac{1}{N!}\right) \cdot \left(\frac{V}{\lambda^3}\right)^N \tag{136}$$

This, according to Ng, leads to entropy of the limiting value of, if $S = \left(\log\left[Z_N\right]\right)$

$$\begin{aligned} & S \approx N \cdot \left(\log\left[V / N\lambda^3\right] + 5/2\right) \\ & \xrightarrow[\text{Ng infinite Quantum Statistics}]{} N \cdot \left(\log\left[V/\lambda^3\right] + 5/2\right) \approx N \end{aligned} \tag{137}$$

But $V \approx R_H^3 \approx \lambda^3$, so unless N in Equation (137) above is about 1, S (entropy) would be <0, which is a contradiction. Now this is where Jack Ng introduces removing the $N!$ term in Equation (136) above, *i.e.*, inside the Log expression the author, following Ng (2008), [81] removes the expression of N in Equation (137) above. The modification of Ng's entropy expression [81] is in the region of space time for which the general temperature dependent entropy De Vega [82] expression breaks down. In particular, the evaluation of entropy the author does via the modified Ng argument above is in regions of space time where g before re heat is an unknown, and probably not measurable number of degrees of freedom The Kolb and Turner entropy expression (1991) [14] [82] has a temperature T related entropy density which leads to that the author is able to state total entropy as the entropy density time's space time volume V_4 with $g_{\text{re heat}} \approx 1000$, according to De Vega [82], while dropping to $g_{\text{electro weakt}} \approx 100$ in the electro weak era. This value of the space time degrees of freedom, according to de Vega has reached a low of $g_{\text{today}} \approx 2\text{-}3$ today. The author asserts that Equation (137) above occurs in a region of space time before $g_{\text{re heat}} \approx 1000$, so after re heating Equation (137) no longer holds, and the author instead can look at [2] [83]

$$S_{\text{total}} \equiv s_{\text{Density}} \cdot V_4 = \frac{2\pi^2}{45} \cdot g_{\bullet} \cdot T^3 \cdot V_4 \tag{138}$$

This permits a regime after the start of inflation to have say where we can try to talk about Gravitons being formed into semi classical treatment of Gravity as seen here.

33. Issues about Coherent State of Gravitons (Linking Gravitons with gw) after the Onset of Inflation

In the quantum theory of light (quantum electrodynamics) and other bosonic quantum field theories, coherent states were introduced by the work of Glauber (1963) [84]. We also reference [83] and [85] especially in lieu of String theory contributions to cosmology seen in [85]. Now, it is well appreciated that Gravitons are NOT similar to light. So what is appropriate for presenting gravitons as coherent states? Coherent states, to first approximation are retrievable as minimum uncertainty states. If one takes string theory as a reference, the minimum value of uncertainty becomes part of a minimum uncertainty which can be written as given by Venziano (1993) [86], where $l_S \cong 10^{\alpha} \cdot l_{\text{Planck}}$, with $\alpha > 0$, and $l_{\text{Planck}} \approx 10^{-33}$ centimeters

$$\Delta x > \frac{\hbar}{\Delta p} + \frac{l_S^2}{\hbar} \cdot [\Delta p] \tag{139}$$

To put it mildly, if the author is looking at a solution to minimize graviton position uncertainty, the author, will likely be out of luck if string theory is the only tool the author has for early universe conditions. Mainly, the momentum will not be small, and uncertainty in momentum will not be small either. Either way, most likely, $\Delta x > l_S \cong 10^{\alpha} \cdot l_{\text{Planck}}$ In addition, it is likely, as Klaus Kieffer (2008) [21] in his book "Quantum Gravity" (on page 290 of that book) that if gravitons are excitations of closed strings, then one will have to look for conditions for which a coherent state of gravitons, as stated by Mohaupt (2003) [87] occurs. What Mohaupt is referring to is a string theory way to re produce what Ford gave in 1995, *i.e.* conditions for how Gravitons in a squeezed vacuum state, the natural result of quantum creation in the early universe will introduce metric fluctuations. Ford's (1995) [88] treatment is to have a metric averaged retarded Green's function for a mass less field becoming a Gaussian. The condition of Gaussianity is how to obtain semi classical, minimal uncertainty wave states, in this case de rigor for coherent wave function states to form. Ford [88] uses gravitons in a so called "squeezed vacuum state" as a natural template for relic gravitons. *I.e.* the squeezed vacuum state (a **squeezed coherent state**) is any state such that the uncertainty principle is saturated. In QM coherence would be when $\Delta x \Delta p = \hbar/2$. In the case of string theory it would have to be

$$\Delta x \Delta p = \frac{\hbar}{2} + \frac{l_S^2}{2 \cdot \hbar} \cdot [\Delta p]^2 \tag{140}$$

Begin with noting *t* hat if one is not using string theory, the author, Beckwith, merely set the term $l_S \xrightarrow[\text{non string}]{} 0$, but that the author is still considering a variant of the example given by Glauber (1963) [18] [80] with string theory replacing Glaubler's stated (1963) example.

However, in string theory, the author, Beckwith observes 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 [89], 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

$$Z[r, \vartheta] = \exp\left[\frac{r}{2} \cdot \left(\left[\exp(-i\vartheta)\right] \cdot a^2 - \left[\exp(i\vartheta)\right] \cdot a^{+^2}\right)\right],$$

where combining the $Z[r, \vartheta]$ with

$$|\alpha\rangle = D(\alpha) \cdot |0\rangle \tag{141}$$

Equation (141) leads to a single mode squeezed coherent state, as they define it via

$$|\varsigma\rangle = Z[r, \vartheta]|\alpha\rangle = Z[r, \vartheta] D(\alpha) \cdot |0\rangle \xrightarrow[\alpha]{} Z[r, \vartheta] \cdot |0\rangle \tag{142}$$

The right hand side. of Equation (142) given above becomes a highly non classical operator, *i.e.* in the limit that the super position of states $|\varsigma\rangle \xrightarrow[\alpha]{} Z[r, \vartheta] \cdot |0\rangle$ 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 $|\varsigma\rangle \xrightarrow[\alpha]{} Z[r, \vartheta] \cdot |0\rangle$ 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) [90] [91] 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.*, (1989) [90]-[92] reference their version of a cosmological perturbation h_{nlm} via the following argument. How the author works with the argument will affect what is said about the necessity, or lack of, of squeezed states in early universe cosmology [90]-[92]. From Class. Quantum Gravity: 6 (1989), L161-L165, 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 $a(\eta)$

$$h_{nlm} \equiv \frac{l_{\text{Planck}}}{a(\eta)} \cdot \mu_{nlm}(\eta) \cdot G_{nlm}(x) \tag{143}$$

$$\mu''_{nlm}(\eta) + \left(n^2 - K - \frac{a''}{a}\right) \cdot \mu_{nlm}(\eta) \equiv 0 \tag{144}$$

If $y(\eta) = \frac{\mu(\eta)}{a(\eta)}$ is picked, and a Schrodinger equation is made out of the Lagrangian used to formulate the above Equation (144) above, with $\hat{P}_y = \frac{-i}{\partial y}$, and $M = a^3(\eta)$, $\Omega = \frac{\sqrt{n^2 - K^2}}{a(\eta)}$, $\breve{a} = [a(\eta)/l_{\text{Planck}}] \cdot \sigma$ and $F(\eta)$ an arbitrary function. $y' = \partial y / \partial \eta$. Also, the author is working with an example which has a finite volume $V_{\text{finite}} = \int \sqrt{^{(3)}g}\, \mathrm{d}^3 x$.

Then the Lagrangian for deriving Equation (144) 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 [90]-[92]

$$L = \frac{M \cdot y'^2}{2a(\eta)} - \frac{M^2 \cdot \Omega^2 a \cdot y^2}{2} + a \cdot F(\eta) \tag{145}$$

$$\frac{-1}{i} \cdot \frac{\partial \psi}{a \cdot \partial \eta} \equiv \hat{H}\psi \equiv \left[\frac{\hat{P}_y^2}{2M} + \frac{1}{2} \cdot M\Omega^2 \hat{y}^2 - \frac{1}{2} \cdot \varsigma \cdot \Omega\right] \cdot \psi \tag{146}$$

Then there are two possible solutions to the S.E. Grushchuk created in 1989 [90]-[92] one a non squeezed state, and another squeezed state. So in general the author works with

$$y(\eta) = \frac{\mu(\eta)}{a(\eta)} \equiv C(\eta) \cdot \exp(-B \cdot y) \tag{147}$$

The **non squeezed state** has a parameter $B\big|_{\eta} \xrightarrow[\eta\to\eta_b]{} B(\eta_b) \equiv \omega_b/2$ where η_b is an initial time, for which the Hamiltonian given in (147) in terms of raising/lowering operators is "diagonal", 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 (147) has, instead of $B(\eta_b) \equiv \omega_b/2$

$$B\big|_{\eta} \xrightarrow[\eta\neq\eta_b]{} B(\omega, \eta \neq \eta_b) \equiv \frac{i}{2} \cdot \frac{\left(\mu/a(\eta)\right)'}{\mu/a(\eta)} \equiv \frac{\omega}{2} \cdot \frac{\cosh r + \left[\exp(2i\vartheta)\right] \cdot \sinh r}{\cosh r - \left[\exp(2i\vartheta)\right] \cdot \sinh r} \quad (148)$$

Taking Grishchuck's formalism literally, a state for a graviton/GW is not affected by squeezing when the author is 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, $\eta \neq \eta_b \Rightarrow \omega \neq \omega_b \Rightarrow B(\omega, \eta \neq \eta_b) \equiv \frac{i}{2} \cdot \frac{\left(\mu/a(\eta)\right)'}{\mu/a(\eta)} \neq \frac{\omega_b}{2}$ 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 $t \approx t_{\text{Planck}} \propto 10^{-44}$ seconds.

The interested reader can access [93] [94] for further generalizations. Also, in the future, the references, [95] [96] and [97] will be judiciously explored as to formulate possible data sets, In particular paying attention to [97]. and Cordas hypothesis as to a gravity breath data set signature, from inflaton physics.

FTR, all this happens as a bridge between Torsion generation of the cosmological constant, and then the creation of GW, via Gravitons. We wish to do further investigations to confirm more of the details.

We wish to state that all this is supposing that there is a nonzero initial entropy for reasons given in **Appendix B**.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix A: A Treatment of GUP, *i.e.* Generalized Uncertainty Principles with Respect to the Early Universe and Gravitons

1) Introduction

The first matter of business will be to introduce a framework of the speed of gravitons in "heavy gravity". Heavy Gravity is the situation where a graviton has a small rest mass and is not a zero mass particle, and this existence of "heavy gravity" is important since eventually, as illustrated by Will [9] gravitons having a small mass could possibly be observed via their macroscopic effects upon astrophysical events. Secondly, our manuscript's inquiry also will involve an upper bound to the rest mass of a graviton. The second aspect of the inquiry of our manuscript will be to come up with a variant of the Heisenberg Uncertainty principle (HUP), involving a metric tensor, as well as the Stress energy tensor, which will in time allow us to establish a lower bound to the mass of a graviton, preferably at the start of cosmological evolution.

We reference what was done by Will in his living reviews of relativity article as to the "Confrontation between GR and experiment". Specifically we make use of his experimentally based formula of [9], with v_{graviton} the speed of a graviton, and m_{graviton} the rest mass of a graviton, and E_{graviton} in the inertial rest frame given as:

$$\left(\frac{v_{\text{graviton}}}{c}\right)^2 = 1 - \frac{m_{\text{graviton}}^2 c^4}{E_{\text{graviton}}^2} \tag{A1}$$

Furthermore, using [9], if the rest mass of a graviton is very small we can make a clear statement of

$$\begin{aligned} &\frac{v_{\text{graviton}}}{c} = 1 - 5\times10^{-17}\cdot\left(\frac{200\ \text{Mpc}}{D}\right)\cdot\left(\frac{\Delta t}{1\sec}\right) \\ &\doteq 1 - 5\times10^{-17}\cdot\left(\frac{200\ \text{Mpc}}{D}\right)\cdot\left(\frac{\Delta t = \Delta t_a - (1+z)\cdot\Delta t_b}{1\sec}\right) \\ &\Leftrightarrow \frac{2m_{\text{graviton}}c^2}{E_{\text{graviton}}} \approx 5\times10^{-17}\cdot\left(\frac{200\ \text{Mpc}}{D}\right)\cdot\left(\frac{\Delta t_a - (1+z)\cdot\Delta t_b}{1\sec}\right) \end{aligned} \tag{A2}$$

here, Δt_a is the difference in arrival time, and Δt_e is the difference in emission time/in the case of the early Universe, *i.e.* near the big bang, then if in the beginning of time, one has, if we assume that there is an average $E_{\text{graviton}} \approx \hbar\cdot\omega_{\text{graviton}}$, and

$$\begin{aligned} &\Delta t_a \sim 4.3\times10^{17}\sec \\ &\Delta t_e \sim 10^{-33}\sec \\ &z \sim 10^{50} \end{aligned} \tag{A3}$$

Then, $\left(\frac{\Delta t_a - (1+z)\cdot\Delta t_b}{1\sec}\right) \sim 1$ and if $D \sim 4.6\times10^{26}\ \text{meters} = \text{radii}(\text{universe})$, so one can set

$$\left(\frac{200\ \text{Mpc}}{D}\right) \sim 10^{-2} \tag{A4}$$

And if one sets the mass of a graviton [3] into Equation (A1), then we have in the present era, that if we look at primordial time generated gravitons, that if one uses the

$$\begin{aligned}&\Delta t_a \sim 4.3\times10^{17}\ \text{sec}\\&\Delta t_e \sim 10^{-33}\ \text{sec}\\&z \sim 10^{55}\end{aligned} \tag{A5}$$

Note that the above frequency, for the graviton is for the present era, but that it starts assuming genesis from an initial inflationary starting point which is not a space-time singularity.

Note this comes from a scale factor, if $z \sim 10^{55} \Leftrightarrow a_{\text{scale factor}} \sim 10^{-55}$, *i.e.* 55 orders of magnitude smaller than what would normally consider, but here note that the scale factor is not zero, so we do not have a space-time singularity.

We will next discuss the implications of this point in the next section, of a nonzero smallest scale factor. Secondly the fact we are working with a massive graviton, as given will be given some credence as to when we obtain a lower bound, as will come up in our derivation of modification of the values [3]

$$\begin{aligned}&\left\langle\left(\delta g_{uv}\right)^2\left(\hat{T}_{uv}\right)^2\right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2}\\&\xrightarrow[uv\to tt]{}\left\langle\left(\delta g_{tt}\right)^2\left(\hat{T}_{tt}\right)^2\right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2}\\&\&\ \delta g_{rr}\sim\delta g_{\theta\theta}\sim\delta g_{\phi\phi}\sim 0^+\end{aligned} \tag{A6}$$

2) Nonzero scale factor, initially and what this is telling us physically. Starting with a configuration from Unruh

Begin with the starting point of [45]-[47]

$$\Delta l\cdot\Delta p \geq \frac{\hbar}{2} \tag{A7}$$

We will be using the approximation given by Unruh [45]-[47],

$$\begin{aligned}&\left(\Delta l\right)_{ij} = \frac{\delta g_{ij}}{g_{ij}}\cdot\frac{l}{2}\\&\left(\Delta p\right)_{ij} = \Delta T_{ij}\cdot\delta t\cdot\Delta A\end{aligned} \tag{A8}$$

If we use the following, from the Roberson-Walker metric [48].

$$\begin{aligned}&g_{tt} = 1\\&g_{rr} = \frac{-a^2(t)}{1-k\cdot r^2}\\&g_{\theta\theta} = -a^2(t)\cdot r^2\\&g_{\phi\phi} = -a^2(t)\cdot\sin^2\theta\cdot d\phi^2\end{aligned} \tag{A9}$$

Following Unruh [46] [47], write then, an uncertainty of metric tensor as, with the following inputs

$$a^2(t)\sim 10^{-110},\ r\equiv l_P\sim 10^{-35}\ \text{meters} \tag{A10}$$

Then, the surviving version of Equation (A7) and Equation (A8) is, then, if

$$\Delta T_{tt} \sim \Delta\rho$$

$$\begin{aligned} & V^{(4)} = \delta t \cdot \Delta A \cdot r \\ & \delta g_{tt} \cdot \Delta T_{tt} \cdot \delta t \cdot \Delta A \cdot \frac{r}{2} \geq \frac{\hbar}{2} \\ & \Leftrightarrow \delta g_{tt} \cdot \Delta T_{tt} \geq \frac{\hbar}{V^{(4)}} \end{aligned} \tag{A11}$$

This Equation (A11) is such that we can extract, up to a point the HUP principle for uncertainty in time and energy, with one very large caveat added, namely if we use the fluid approximation of space-time [48] for the stress energy tensor as given in Equation (A12) below.

$$T_{ii} = diag\left(\rho, -p, -p, -p\right) \tag{A12}$$

Then

$$\Delta T_{tt} \sim \Delta\rho \sim \frac{\Delta E}{V^{(3)}} \tag{A13}$$

Then, Equation (A11) and Equation (A12) and Equation (A13) together yield

$$\begin{aligned} & \delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2} \\ & \text{Unless } \delta g_{tt} \sim O(1) \end{aligned} \tag{A14}$$

How likely is $\delta g_{tt} \sim O(1)$? Not going to happen. Why? The homogeneity of the early universe will keep

$$\delta g_{tt} \neq g_{tt} = 1 \tag{A15}$$

In fact, we have that from Giovannini [48], that if ϕ is a scalar function, and $a^2(t) \sim 10^{-110}$, then if

$$\delta g_{tt} \sim a^2(t) \cdot \phi \ll 1 \tag{A16}$$

Then, there is no way that Equation (A14) is going to come close to $\delta t \Delta E \geq \frac{\hbar}{2}$. Hence, the Mukhanov suggestion, is not feasible. Finally, we will discuss a lower bound to the mass of the graviton.

3) How we can justifying writing very small $\delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+$ values

To begin this process, we will break it down into the following co-ordinates.

In the $rr, \theta\theta$ and $\phi\phi$ coordinates, we will use the Fluid approximation, $T_{ii} = diag\left(\rho, -p, -p, -p\right)$ [61] with

$$\begin{aligned} & \delta g_{rr} T_{rr} \geq -\left|\frac{\hbar \cdot a^2(t) \cdot r^2}{V^{(4)}}\right| \xrightarrow[a \to 0]{} 0 \\ & \delta g_{\theta\theta} T_{\theta\theta} \geq -\left|\frac{\hbar \cdot a^2(t)}{V^{(4)}\left(1 - k \cdot r^2\right)}\right| \xrightarrow[a \to 0]{} 0 \\ & \delta g_{\phi\phi} T_{\phi\phi} \geq -\left|\frac{\hbar \cdot a^2(t) \cdot \sin^2\theta \cdot d\phi^2}{V^{(4)}}\right| \xrightarrow[a \to 0]{} 0 \end{aligned} \tag{A17}$$

If as an example, we have negative pressure, with T_{rr}, $T_{\theta\theta}$ and $T_{\phi\phi} < 0$, and

$p = -\rho$, then the only choice we have, then is to set $\delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+$, **since there is no way that** $p = -\rho$ is zero valued.

Having said this, the value of δg_{tt} being nonzero, will be part of how we will be looking at a lower bound to the graviton mass which is not zero.

4) Lower bound to the graviton mass using barbour's emergent time

In order to start this approximation, we will be using Barbour's value of emergent time [77] [94] restricted to the Plank spatial interval and massive gravitons, with a massive graviton [95]

$$(\delta t)^2_{\text{emergent}} = \frac{\sum_i m_i l_i \cdot l_i}{2\cdot(E-V)} \to \frac{m_{\text{gravtion}} l_P \cdot l_P}{2\cdot(E-V)} \quad \text{(A18)}$$

Initially, as postulated by Babour [77] [94], this set of masses, given in the emergent time structure could be for say the planetary masses of each contribution of the solar system. Our identification is to have an initial mass value, at the start of creation, for an individual graviton.

If $(\delta t)^2_{\text{emergent}} = \delta t^2$ in Equation (A11), using Equation (A11) and Equation (A18) we can arrive at the identification of

$$m_{\text{gravtion}} \geq \frac{2\hbar^2}{(\delta g_{tt})^2 l_P^2} \cdot \frac{E-V}{\Delta T_{tt}^2} \quad \text{(A19)}$$

This also involves [95]

Key to Equation (A19) will be identification of the kinetic energy which is written as $E-V$. This identification will be the key point raised in this manuscript. Note that [96] raises the distinct possibility of an initial state, just before the "big bang" of a kinetic energy dominated "pre inflationary" universe. *I.e.* in terms of an inflaton $\dot{\phi}^2 \gg (P.E \sim V)$ [61]. The key finding which is in [96] is, that, if the kinetic energy is dominated by the "inflaton" that

$$K.E. \sim (E-V) \sim \dot{\phi}^2 \propto a^{-6} \quad \text{(A20)}$$

This is done with the proviso that $w < -1$, in effect, what we are saying is that during the period of the "Planckian regime" we can seriously consider an initial density proportional to Kinetic energy, and call this K. E. as proportional to [61]

$$\rho_w \propto a^{-3(1-w)} \quad \text{(A21)}$$

If we are where we are in a very small Planckian regime of space-time, we could, write Equation (A21) as proportional to $g^* T^4$ [61], with g^* initial degrees of freedom, and T the initial temperature as just before the onset of inflation. The question to ask, then is, what is the value of the initial degrees of freedom?

Appendix B: Scenarios as to the Value of Entropy in the Beginning of Space-Time Nucleation

Review first [98] [99] before reading this discussion.

We will be looking at inputs from page 290 of [98] so that if

$E \sim M \sim \Delta T_{tt} \cdot \delta t_{\text{time}} \cdot \Delta A \cdot l_P$

$$S(\text{entropy}) = \ln Z + \frac{\left(E \sim \Delta T_{tt} \cdot \delta t \cdot \Delta A \cdot l_P\right)}{k_B T_{\text{temperature}}} \tag{B1}$$

And using Ng's infinite quantum statistics, we have to first approximation [99]

$$\begin{aligned} S(\text{entropy}) &\sim \ln Z + \frac{\left(\left(E \sim \Delta T_{tt}\right) \cdot \delta t \cdot \Delta A \cdot l_P\right)}{k_B T_{\text{temperature}}} \\ &\sim \ln Z + \frac{\hbar}{k_B T_{\text{temperature}} \delta g_{tt}} \\ &\xrightarrow[T_{\text{temperature}} \to \# \text{anything}]{} \left[S(\text{entropy}) \sim n_{\text{count}}\right] \end{aligned} \tag{B2}$$

This is due to a very small but non vanishing δg_{tt} with the partition functions covered by [99], and also due to [99] with n_{count} a non-zero number of initial "particle" or information states, about the Planck regime of space-time, so that the initial entropy is non zero.