Journal of High Energy Physics, Gravitation and Cosmology, 2025, 11(2), 518-543
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Relic Black Holes, in Terms of a Quantum Number *n* & Torsion Leading to Relic GW and How a Tokamak May Permit after Effects of Relic GW Frequencies Being Duplicated

Andrew Walcott Beckwith

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

How to cite this paper: Beckwith, A.W. (2025) Relic Black Holes, in Terms of a Quantum Number *n* & Torsion Leading to Relic GW and How a Tokamak May Permit after Effects of Relic GW Frequencies Being Duplicated. *Journal of High Energy Physics, Gravitation and Cosmology*, **11**, 518-543.
https://doi.org/10.4236/jhepgc.2025.112036

Received: March 7, 2025
Accepted: April 25, 2025
Published: April 28, 2025

Abstract

Our idea for black holes is using Torsion to form a cosmological constant. Planck sized black holes allow for a spin density term canceling Torsion. And we conclude with a generalized uncertainty principle which is then linked to a black hole versus white hole, linked by a worm-hole problem, The spin-offs as the connection to multi-messenger astronomy will be enumerated in the last part of this document. And we can compare the resultant GW generation as could be measured by Lisa from these. In doing so, we review its simulated connections to a Tokamak simulation.

Keywords

Relic Black Holes, Torsion in Cosmology, Cosmological Constant and Torsion, Black Hole and White Hole Linkage

1. Statement of Purpose of This Document

The author has in prior work given the idea that a decay of millions of Planck sized BHs 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 complemented 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 for using Tokamaks?

First of all, there is the question of what sort of polarization would be produced in initial processes. Secondly, if we were able to ascertain 10^{10} Hertz gravitational waves, via our laboratory arrangements and if we were later able to confirm, say the existence of 10^{-16} Hz GW frequencies via LISA in the present era, this would be stunning proof of the Big Bang hypothesis, and so we summarize what this inquiry may answer. **So what is our inquiry good for?**

1) Determination of the fidelity of the e-fold value of 60 in the Big Bang;

2) Issues of initial GW polarization which may be configured at the start of the Big Bang;

3) Determination of the relative stability of the production of the GW signal (*i.e.* if we had a Tokamak running and the resulting GW amplitude and the characteristics of the signal are stable, over a "long time interval" does this imply stability of the eLISA signal? Over time and space?)

4) Likelihood of noise and Stochastic fluctuations in a produced GW signal.

If A, B, C and D were determined as to the Tokamak, and GW, we may be able to infer what to look for and to model when examined directly, what a LISA GW signal set of characteristics may be inferring as to early universe conditions. Having said that, let us go to the Tokamak information

2. Comparison with Grishchuk and Sachin Results. For Obtaining GW Generation Count

Russian physicists Grishchuk and Sachin [8] obtained the amplitude of a Gravitational wave (GW) in a plasma as

$A(\text{amplitude GW}) = h \sim \frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2$. This is compared with [9], and we diagram the situation as follows [3] [10].

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 be commented 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. Furthermore,

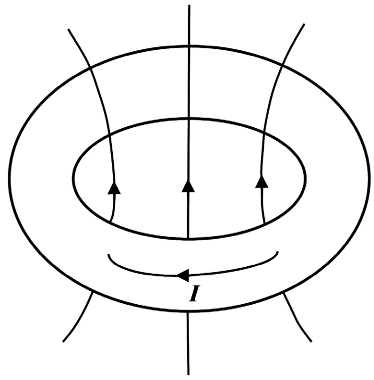

Figure 1. Flux directions of gravitational waves relative to tokamak configuration.

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 [10].

$$A(\text{GW amplitude}) \sim h \sim \frac{G \cdot W_E \cdot V_{\text{volume}}}{c^4 \cdot \tilde{a}} \tag{1}$$

Where

$$\begin{aligned} W_E &= \text{Average energy density,} \\ V_{\text{volume}} &= \text{Volume Toroid,} \\ \tilde{a} &= \text{inner radii}(\text{Toroid}) \end{aligned} \tag{1a}$$

Equation (2) above is due to the 1st term of a two-part composition of the strain, with the 2nd term of the strain value significantly larger than the first term and due to the ignition of the Plasma in the Tokamak. The first term of strain is largely due to what was calculated by Grishkuk [8] *et al.* The second term is due to Plasma fusion burning. This plasma fusion burning contribution is due to non equilibrium contributions to Plasma ignition, which will be elaborated on in this document. Note that the first term in the strain derivation is due to the electric field within a Toroid, not Plasma fusion burning, and we will first of all discuss how to obtain the requisite strain, for the electric field contribution to the current, inside a Tokamak, making use of Ohms law. See [9] for additional details.

3. Derivation of Strain Generated by an Electric Field, and Small Strain Values

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

$$J = \sigma \cdot E \tag{2}$$

In order to obtain a suitable electric field, to be detected via 3DSR technology [11] [12], we will use a generalized Ohm's law as given by Wesson [3] (page 146), where E and B are electric and magnetic fields, and v is velocity.

$$E = \sigma^{-1} J - v \times B \tag{3}$$

Note that the term in Equation (4) 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 (4) would be, simply put, Ohms law, and spatial equilibrium averaging would then lead to

$$E = \sigma^{-1} J - v \times B \xrightarrow[v \text{ perpendicular to } B]{} E = \sigma^{-1} J \tag{4}$$

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 at the beginning of Tokamak generation. It is, fortunately for us, a non equilibrium initial process, with thermal irregularities leading to both terms in Equation (5) contributing to the electric field values. We will be looking for an application for radial free electric fields being applied e.g., Wesson [10] (page 120)

$$n_j e_j \cdot \left(E_r + v_{\perp j} B \right) = -\frac{\mathrm{d}P_j}{\mathrm{d}r} \tag{5}$$

Here, n_j = ion density, jth species, e_j = ion charge, jth species, E_r = radial electric field, $v_{\perp j}$ = perpendicular velocity, of jth species, B = magnetic field, and P_j = pressure, jth species. The results of Equation (3) and Equation (4) are

$$\frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2 \sim \frac{G}{c^4} \cdot \left[\frac{Const}{R} \right]^2 \cdot \lambda_{GW}^2 + \frac{G}{c^4} \cdot \left[\frac{J_b}{n \cdot e} + v_R \right]^2 \cdot \lambda_{GW}^2 = 1^{\text{st}} + 2^{\text{nd}} \tag{6}$$

Here, the 1st term is due to $\nabla \times E = 0$, and the 2nd term is due to $E_n = \frac{\mathrm{d}P_j}{\mathrm{d}x_n} \cdot \frac{1}{n_j \cdot e_j} - (v \times B)_n$ with the 1st term generating $h \sim 10^{-38}\text{-}10^{-30}$ in terms of GW amplitude strain 5 meters above the Tokamak, whereas the 2nd term has an $h \sim 10^{-26}$ in terms of GW amplitude above the Tokamak. The article has contributions from amplitude from the 1st and 2nd terms separately. The second part will be tabulated separately from the first contribution assuming a minimum temperature of $T = Temp \sim 10\ \text{KeV}$ as from Wesson [10]. We should also consider the issues in [9], [11], and [12].

4. GW *h* Strain Values When the First Term of Equation (4) Is Used

We now look at what we can expect with the simple Ohm's law calculation for strain values. As it is, the effort leads to non-usable GW amplitude values of up to $h \sim 10^{-38}\text{-}10^{-30}$ for GW wave amplitudes 5 meters above a Tokamak, and $h \sim 10^{-36}\text{-}10^{-28}$ in the center of a Tokamak. *I.e.* this would be using Ohm's law and these are sample values of the Tokamak generated GW amplitude, using the first term of Equation (4) and obtaining the following value [8] with

$$h_{\text{First term}} \sim \frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2 \sim \frac{G}{c^4} \cdot \left[\frac{J}{\sigma} \right]^2 \cdot \lambda_{GW}^2 \tag{7}$$

We summarize the results of such in our first table as given for when $\omega_{GW} \sim 10^9\ \text{Hz} \Rightarrow \lambda_{Gw} \sim 0.3\ \text{meters}$ and with conductivity

$\sigma(\text{tokamak plasma}) \sim 10 \cdot m^2/\text{sec}$ and with the following provisions as to initial values. What we observe are a range of Tokamak values which are, even in the case of ITER (not yet built) beyond the reach of any technological detection devices which are conceivable in the coming decade. This table and its results, assuming fixed conductivity values $\sigma(\text{tokamak plasma}) \sim 10 \cdot m^2/\text{sec}$ as well as $\lambda_{Gw} \sim 0.3\,\text{meters}$ is why the author, results as to the 2nd term of Equation (4) which leads to even when considering the results for the Chinese Tokamak in Hefei to have [13]

$$h_{\text{Second term}} \sim \frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2 \sim \frac{G}{c^4} \cdot \left[\frac{J_b}{n \cdot e} + v_R\right]^2 \cdot \lambda_{GW}^2 \tag{8}$$

or values 10,000 larger than the results in ITER due to Equation (6).

Note that we are setting $\lambda_{Gw} \sim 0.3\,\text{meters}$, $\sigma(\text{tokamak plasma}) \sim 10 \cdot m^2/\text{sec}$, using Equation (6) above for Amplitude of GW. What makes it mandatory to go the 2nd term of Equation (4) is that even in the case of ITER, 5 meters above the Tokamak ring, the GW amplitude is 1/10,000 the size of any reasonable GW detection device, and including the new 3DSR technology (Li *et al.*, 2009) [11] [12]. Hence, we need to come up with a better estimate, which is what the value of the 2nd term of Equation (5) is in its formulation.

5. Enhancing GW Strain Amplitude via Utilizing a Burning Plasma Drift Current: Equation (4)

The way forward is to go to Wesson, [3] [10] (2011, page 120) and to look at the normal to surface induced electric field contribution

$$E_n = \frac{\mathrm{d}P_j}{\mathrm{d}x_n} \cdot \frac{1}{n_j \cdot e_j} - (v \times B)_n \tag{9}$$

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 [10]

$$(v \times B)_n \sim v_R \cdot B_\theta \tag{10}$$

Also, From Wesson [3] (page 167) the spatial change in pressure denoted

$$\frac{\mathrm{d}P_j}{\mathrm{d}x_n} = -B_\theta \cdot j_b \tag{11}$$

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

$$j_b \sim -\frac{\xi^{1/2}}{B_\theta} \cdot T_{Temp} \cdot \frac{\mathrm{d}n_{\text{drift}}}{\mathrm{d}r} \tag{12}$$

Figure 2 introduces the role of the drift current, in terms of Tokamaks [10]

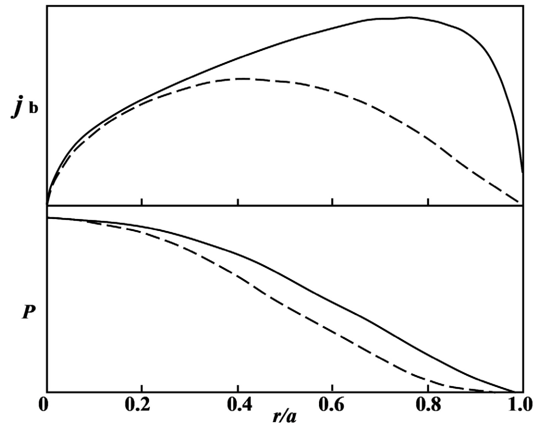

Figure 2. Bootstrap currents and pressure distribution in tokamak radial direction.

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 [10]. Then one has

$$B_{\theta}^{2}\cdot\left(j_{b}/n_{j}\cdot e_{j}\right)^{2}\sim\frac{B_{\theta}^{2}}{e_{j}^{2}}\cdot\frac{\xi^{1/4}}{B_{\theta}^{2}}\cdot\left[\frac{1}{n_{\text{drift}}}\cdot\frac{\mathrm{d}n_{\text{drift}}}{\mathrm{d}r}\right]^{2}\sim\frac{\xi^{1/4}}{e_{j}^{2}}\cdot\left[\frac{1}{n_{\text{drift}}}\cdot\frac{\mathrm{d}n_{\text{drift}}}{\mathrm{d}r}\right]^{2}\tag{13}$$

Now, the behavior of the numerical density of ions, can be given as follows, namely growing in the radial direction, then [3]

$$n_{\text{drift}}=n_{\text{drift}}\big|_{\text{initial}}\cdot\exp\left[\tilde{\alpha}\cdot r\right]\tag{14}$$

This exponential behavior then will lead to the 2nd term in Equation (4) having in the center of the Tokamak, for an ignition temperature of $T_{Temp}\geq 10\text{ KeV}$ a value of

$$h_{\text{2nd term}}\sim\frac{G}{c^{4}}\cdot B_{\theta}^{2}\cdot\left(j_{b}/n_{j}\cdot e_{j}\right)^{2}\cdot\lambda_{GW}^{2}\sim\frac{G}{c^{4}}\cdot\frac{\xi^{1/4}\tilde{\alpha}^{2}T_{Temp}^{2}}{e_{j}^{2}}\cdot\lambda_{GW}^{2}\sim 10^{-25}\tag{15}$$

6. Restating the Energy Density and Power Using the Formalism of Equation (1) Directly

$$W_{E}\cdot V_{\text{volume}}\sim\tilde{\alpha}\cdot\lambda_{GW}^{2}\cdot\frac{\xi^{1/4}\tilde{\alpha}^{2}T_{\text{Temp plasma fusion burning}}^{2}}{e_{j}^{2}}\tag{16}$$

The temperature for Plasma fusion burning, is then between 30 to 100 KeV, as given by Wesson [10]. The corresponding power as given by Wesson is then for the Tokamak [10]

$$P_{\Omega}=E\cdot J\leq\frac{E}{\mu_{0}}\cdot\frac{B_{\phi}}{R}\tag{17}$$

The tie-in with Equation (16) by Equation (18) can be seen by first of all setting the E field as related to the B field, via E (electrostatic) $\sim 10^{12}\text{ V}\cdot\text{m}^{-1}$ as equivalent to a magnetic field $B\sim 10^{4}\text{ T}$ (Torr) as given by [9]. In a one-second interval, if we use the input power as an experimentally supplied quantity, then the effective E field is

$$E_{\text{applied}} \sim \frac{\xi^{1/8} \cdot \tilde{\alpha}}{e_j} \times T_{\text{Tokamak temperature}} \tag{18}$$

What is found is, that if Equation (17) and Equation (18) hold. Then by Wesson [10], pp. 242-243, if $Z_{eff} \sim 1.5$, $q_a q_0 \sim 1.5$, $R/\tilde{a} \approx 3$. Then the temperature of a Tokamak, to good approximation would be between 30 to 100 KeV, and then one has [10]

$$B_{\phi}^{4/5} \sim 0.87 \cdot \left(\tilde{T} = T_{\text{Tokamak temperature}}\right) \tag{19}$$

Then the power for the Tokamak is

$$P_{\Omega}\Big|_{\text{Tokamak toroid}} \leq \frac{\xi^{1/8} \cdot \tilde{\alpha}}{\mu_0 \cdot e_j \cdot R} \times \frac{\left(T_{\text{Tokamak temperature}}\right)^{9/4}}{0.87^{5/4}} \tag{20}$$

Then, per second, the author derived the following rate of production per second of a 10^{-34} eV graviton, as, if $\tilde{a} = R/3$

$$n\Big|_{\text{massive gravitons/second}} \propto \frac{3 \cdot \hbar \cdot e_j}{\mu_0 \cdot R^2 \cdot \xi^{1/8} \cdot \tilde{\alpha}} \times \frac{\left(T_{\text{Tokamak temperature}}\right)^{1/4}}{\lambda_{\text{Graviton}}^2 \cdot m_{\text{graviton}} \cdot c^2 \cdot 0.87^{5/4}} \\ \sim 1/\lambda_{\text{Graviton}}^2 \text{ scaling} \tag{21}$$

This graviton density business is what we will try to recover in our relic GW arguments from Torsion and we will try to make a linkage to Equation (21) with Gravitons produced via relic conditions.

To do this review Graviton production via torsion.

7. Where Torsion May Allow for Understanding a Quantum Number *n*?

Following [11]-[13] we do the introduction of black hole physics in terms of a quantum number *n*.

$$\sqrt{\Lambda} = \frac{k_B E}{\hbar c S_{\text{entropy}}} \\ S_{\text{entropy}} = k_B N_{\text{particles}} \tag{22}$$

And then a BEC condensate given by [11] [13] as to

$$\begin{aligned} m &\approx \frac{M_P}{\sqrt{N_{\text{gravitons}}}} \\ M_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot M_P \\ R_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot l_P \\ S_{BH} &\approx k_B \cdot N_{\text{gravitons}} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{\text{gravitons}}}} \end{aligned} \tag{23}$$

This is promising but needs to utilize [14] in which we make use of the following. First a time step

$$\tau \approx \sqrt{GM\delta r} \tag{24}$$

By use of the HUP, we use Equation (25) for energy [14] for radiation of a particle pair from a black hole,

$$|E| \approx \left(\sqrt{GM\delta r}\right)^{-1} \hbar \tag{25}$$

Here we assert that the spatial variation goes as

$$\delta r \approx \ell_P \tag{26}$$

This is of a Plank length, whereas we assume in Equation (25) that the mass is a Planck sized black hole

$$M \approx \alpha M_P \tag{27}$$

If so, we transform Equation (22) to be of the form for a "particle" pair as given in Carlip [14]

$$|E| \approx \left(\sqrt{G \cdot (\alpha M_P) \cdot \ell_P}\right)^{-1} \hbar \tag{28}$$

We argue that for small black holes, that we are talking about intense radiation from a Planck sized black hole, so we approximate Equation (28) as the mass of a relic black hole. Now using the following normalization of Planck units, as

$$G = M_P = \hbar = k_B = \ell_P = c = 1 \tag{29}$$

And, also, the initial energy, E [15]

$$E_{Bh} = -\frac{n_{\text{quantum}}}{2} \tag{30}$$

We then can use for a Black hole the scaling,

$$\begin{aligned} &|E| \approx \left(\sqrt{G \cdot (\alpha M_P) \cdot \ell_P}\right)^{-1} \hbar \\ &\xrightarrow[G=M_P=\hbar=k_B=\ell_P=c=1]{} \left(1/M_{BH}\right)^{1/2} \approx \frac{n_{\text{quantum}}}{2} \end{aligned} \tag{31}$$

We then reference Equation (23) to observe the following,

$$\begin{aligned} &M_{BH} \approx \sqrt{N_{\text{gravitons}}} M_P \\ &\Rightarrow \left(1/M_{BH}\right)^{1/2} \approx \frac{n_{\text{quantum}}}{2} \approx \frac{1}{\left(N_{\text{gravitons}}\right)^{1/4}} \\ &\Rightarrow n_{\text{quantum}} \approx \frac{2}{\left(N_{\text{gravitons}}\right)^{1/4}} \end{aligned} \tag{32}$$

This is a stunning result. *i.e.* Equation (23) 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**.

Table 1 from [12] assumes Penrose recycling of the Universe as stated in that document.

Table 1. Distribution of black holes, prior universe to present 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
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}

The reason for using this table is because of the modification of Dark Energy and the cosmological constant [11] [12]. To begin this look at [11] which is akin, as we discuss later to [12]

$$\rho_{\Lambda}c^{2}=\int_{0}^{E_{\text{Plank}}/c}\frac{4\pi p^{2}\mathrm{d}p}{(2\pi\hbar)^{3}}\cdot\left(\frac{1}{2}\cdot\sqrt{p^{2}c^{2}+m^{2}c^{4}}\right)\approx\frac{\left(3\times10^{19}\,\text{GeV}\right)^{4}}{(2\pi\hbar)^{3}}$$
$$\xrightarrow[E_{\text{Plank}}/c\to10^{-30}]{}\frac{\left(2.5\times10^{-11}\,\text{GeV}\right)^{4}}{(2\pi\hbar)^{3}} \qquad (33)$$

In [12], the first line is the vacuum energy which is completely cancelled in their formulation of the application of Torsion. In our article, we are arguing for the second line. In fact by [12]

$$\frac{\Delta E}{c}=10^{18}\,\text{GeV}-\frac{n_{\text{quantum}}}{2c}\approx10^{-12}\,\text{GeV} \qquad (34)$$

The term n (quantum) comes from a Corda expression as to energy level of relic black holes [15].

We argue that our application of [11] [12] will be commensurate with Equation (35) which uses the value given in [12] as to the following. *i.e.* relic black holes will contribute to the generation of a cut-off of the energy of the integral given in Equation (35) whereas what is done in Equation (35) by [11] [12] is restricted to a different venue which is reproduced below, namely cancellation of the following by Torsion

$$\rho_{\Lambda}c^{2}=\int_{0}^{E_{\text{Plank}}/c}\frac{4\pi p^{2}\mathrm{d}p}{(2\pi\hbar)^{3}}\cdot\left(\frac{1}{2}\cdot\sqrt{p^{2}c^{2}+m^{2}c^{4}}\right)\approx\frac{\left(3\times10^{19}\,\text{GeV}\right)^{4}}{(2\pi\hbar)^{3}} \qquad (35)$$

Furthermore, the claim in [12] is that there is no cosmological constant, *i.e.* that Torsion always cancelling Equation (17) which we view is incommensurate with

Table 1 as of [12]. 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 (17) above.

8. 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 [11] we have the following, *i.e.*, we have a spin density term of [11] [12]. And this will be what we input black hole physics into to form a spin density term from primordial black holes.

$$\sigma_{Pl} = n_{Pl}\hbar \approx 10^{71} \tag{36}$$

9. Now for the Statement of the Torsion Problem as Given in [11] [12]

The author is very much aware as to quack science as to purported torsion physics presentations and wishes to state that the torsion problem is not linked to anything other than disruption as to the initial configuration of the expansion of the universe and cosmology, more in the spirit of [11] and is nothing else. Hence, in saying this we wish to delve into what was given in [11] with a subsequent follow-up and modification:

To do this, note that in [11] the vacuum energy density is stated to be

$$\rho_{vac} = \Lambda_{eff} c^4 / 8\pi G \tag{37}$$

Whereas the application is given in terms of an antisymmetric field strength $S_{\alpha\beta\gamma}$ [11].

In [12] due to the Einstein Cartan action, in terms of an SL (2, C) gauge theory, we write from [11]

$$L = -R/(16\pi G) + S_{\alpha\beta\gamma} S^{\alpha\beta\gamma} / 2\pi G \tag{38}$$

R here is with regards to Ricci scalar and Tensor notation and $S_{\alpha\beta\gamma}$ is related to a conserved current closing in on the SL (2, C) algebra as given by

$$J^{\mu} = J^{\mu} + 1/(16\pi G)\, \varepsilon^{\mu\alpha\beta\gamma} S_{\alpha\beta\gamma} \tag{39}$$

This is where we define

$$S_{\alpha\beta\gamma} = c_{\alpha} \times f_{\beta\gamma} \tag{40}$$

where c_{α} is the structure constant for the group SL (2, C), and

$$f_{\beta\gamma} \cdot \overline{g} = F_{\beta\gamma} \tag{41}$$

Where

$$\overline{g} = (g_1, g_2, g_3) \tag{43}$$

Is for tangent vectors to the gauge generators of SL (2, C), and also for Gauge fields A_{γ}

$$F_{\beta\gamma} = \partial_\beta A_\gamma - \partial_\gamma A_\beta + \left[A_\beta, A_\gamma \right] \quad (44)$$

And that there is furthermore the restriction that

$$\partial_\rho \left(\varepsilon^{\rho\alpha\beta\gamma} S_{\alpha\beta\gamma} \right) = 0 \quad (45)$$

Finally in the case of massless particles with torsion present, we have a space time metric

$$\mathrm{d}s^2 = \mathrm{d}\tau^2 + a^2(\tau)\mathrm{d}^2\Omega_3 \quad (46)$$

where $\mathrm{d}^2\Omega_3$ is the metric of S^3.

Then the Einstein field equations reduce to in this torsion application, (no mass to particles) as

$$(\mathrm{d}a/\mathrm{d}\tau)^2 = \left[1 - \left(r_{\min}^4 / a^4 \right) \right] \quad (47)$$

With, if S is the so called spin scalar and identified as the basic $\hbar$ unit of spin

$$r_{\min}^4 = 3G^2 S^2 / 8c^4 \quad (48)$$

10. How to Modify Equation (47) in the Presence of Matter via Yang Mills Fields $F_{\mu\nu}^{\beta}$

First of all, this involves a change of Equation (39) (20) to read

$$L = -R/(16\pi G) + S_{\alpha\beta\gamma} S^{\alpha\beta\gamma} / 2\pi G + \left(1/4g^2\right) F_{\mu\nu}^{\beta} F_{\beta}^{\mu\nu} \quad (49)$$

And eventually we have a re-do of Equation (47) to read as

$$(\mathrm{d}a/\mathrm{d}\tau)^2 = \left[1 - \left(\beta_1 / a^2 \right) - \left(\beta_2 / a^4 \right) \right] \quad (50)$$

If $g = \hbar c$ we have $\beta_1 = r_{\min}^2, \beta_2 = r_{\min}^4$, and the minimum radius is identified with a Planck Radius so then

$$(\mathrm{d}a/\mathrm{d}\tau)^2 = \left[1 - \left(\left(\beta_1 = \ell_P^2 \right) / a^2 \right) - \left(\left(\beta_2 = \ell_P^4 \right) / a^4 \right) \right] \quad (51)$$

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 [16] as

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}} \right)^2 = \left(\frac{8\pi G}{3} \right) \cdot \left[\rho - \frac{2\pi G \sigma^2}{3c^4} \right] + \frac{\Lambda c^2}{3} - \frac{\tilde{k} c^2}{\tilde{R}^2} \quad (52)$$

11. What [11] Does as to Equation (52) versus What We Would Do and Why

In the case of [11], we would see σ be identified as due to torsion so that Equation (52) reduces to

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}} \right)^2 = \left(\frac{8\pi G}{3} \right) \cdot [\rho] - \frac{\tilde{k} c^2}{\tilde{R}^2} \quad (53)$$

The claim is made in [12] 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 [12]

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right)\cdot[\rho] + \frac{\Lambda_{0\text{bserved}}c^2}{3} - \frac{\tilde{k}c^2}{\tilde{R}^2} \tag{54}$$

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 Equation (53) and Equation (54) 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.

12. Filling in the Details of the Equation (53) Collapse of the Cosmological Term, versus the Situation Given in Equation (54) via Numerical Values

First look at numbers provided by [16] as to inputs, *i.e.* these are very revealing

$$\Lambda_{Pl}c^2 \approx 10^{87} \tag{56}$$

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 [11] [12] is solely to remove this giant number.

In order to remove it, the reference [11] proceeds to make the following identification, namely

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right] + \frac{\Lambda c^2}{3} = 0 \tag{57}$$

What we are arguing is that instead, one is seeing, instead [12]

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right] + \frac{\Lambda_{Pl}c^2}{3} \approx 10^{-122} \times \left(\frac{\Lambda_{Pl}c^2}{3}\right) \tag{58}$$

Our timing as to Equation (56) is to unleash a Planck time interval t about 10^{-43} seconds.

As to Equation (57) versus Equation (58), the creation of the torsion term is due to a presumed particle density of

$$n_{Pl} \approx 10^{98}\ \text{cm}^{-3} \tag{59}$$

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

13. Future Works to Be Commenced as to Derivational Tasks

We will assume for the moment that Equation (56) and Equation (57) share in common Equation (59).

It appears to be trivial, a mere round off, but I can assure you the difference is anything but trivial. And this is where **Table 1** really plays a role in terms of why there is a torsion term to begin with, *i.e.* will make the following determination, *i.e.*

The term of "spin density" in Equation (56) by Equation (59) is defined to be an ad hoc creation, as to [13]. No description as to its origins is really offered

1st

We state that in the future a task will be to derive in a coherent fashion the following, *i.e.* the term of $\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right]$ arising as a result of the dynamics of **Table 1**, as given in the manuscript.

2nd,

We state that the term $\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right]$ is due to initial micro black holes, as to the creation of a Cosmological term.

In the case of Pre Planckian space-time the idea is to do the following [16], *i.e.* if we have an inflaton field [11] [12]

$$\begin{aligned}
&\left|\mathrm{d}p_\alpha \mathrm{d}x^\alpha\right| \approx \frac{L}{l}\cdot\frac{h}{c}\cdot\left[\frac{\mathrm{d}l}{l}\right]^2 \\
&\xrightarrow[\alpha=0]{}\left|\mathrm{d}p_0\mathrm{d}x^0\right| \simeq \left|\Delta E\Delta t\right| \approx \left(h/a_{init}^2\phi(t)\right) \\
&\Rightarrow \frac{L}{l}\cdot\frac{h}{c}\cdot\left[\frac{\mathrm{d}l}{l}\right]^2 \approx \left(h/a_{init}^2\phi(t_{init})\right)
\end{aligned} \tag{60}$$

Making use of all this leads to making sense of the quantum number *n* as given by reference to black holes, [15] $E_{Bh} = -\frac{n_{\text{quantum}}}{2}$.

3rd

The conclusion of [11] states that Equation (60) would remain invariant for the life of the evolution of the universe. We make no such assumption. We assume that, as will be followed up later Equation (58) (38) is due to relic black holes with the suppression of the initially gigantic cosmological vacuum energy.

The details of what follows after this initial period of inflation remain a task to be completed in full generality but we are still assuming as a given the following inputs [13]

$$\begin{aligned}
&a(t) = a_{\text{initial}}t^\nu \\
&\Rightarrow \phi = \ln\left(\sqrt{\frac{8\pi G V_0}{\nu\cdot(3\nu-1)}}\cdot t\right)^{\sqrt{\frac{\nu}{16\pi G}}} \\
&\Rightarrow \dot{\phi} = \sqrt{\frac{\nu}{4\pi G}}\cdot t^{-1} \\
&\Rightarrow \frac{H^2}{\dot{\phi}} \approx \sqrt{\frac{4\pi G}{\nu}}\cdot t\cdot T^4\cdot\frac{1.66^2\cdot g_*}{m_P^2} \approx 10^{-5}
\end{aligned} \tag{61}$$

1st CONCLUSION, how meeting conditions for applying Torsion to obtain the cosmological constant and DE modifies black hole physics in the early universe.

First of all, it puts a premium upon our **Table 1** as given and is shown in [12]. Secondly it means utilization of Equation (36) which takes into account the black hole energy equation given by Corda in [15] and it also means that the spin density term as given in Equation (38) is freely utilized.

We refer to black hole creation as given by torsion this way as a correction to [11] largely due to the insufficiency of black hole theory.

Quote

Black holes of masses sufficiency smaller than a solar mass cannot be formed by gravitational collapse of a star; such miniholes can only form in the early stages of the universe, from fluctuations in the very dense primordial matter.

End of quote

Our torsion argument is directly due to this acknowledgment and is due to the sterility of much theoretical thinking, as well as the tremendously important Equation (32) which is due to Corda [15].

Corda himself [15] has alluded to a path forward in such treatment of how black holes can be modeled which leads to Equation (60).

In addition, we outlined the stunning result as given as of Equation (34) as far as a more than an inverse relationship between graviton number, per generated black hole (presumably primordial) and a quantum number n, attached to a black hole as due to [15]. What we see is that if we have small black holes, with BEC characteristics with small number of gravitons, per primordial black hole, that the quantum number n climbs dramatically. We need to obtain the complete dynamics of this relationship as it pertains to how very small black holes have high quantum number n, which we presume is commensurate with initially high temperatures.

The details of this development as well as its tie into the dynamics of **Table 1** as given and Torsion have to be fine tuned.

More work needs to be done so we can turn early universe gravitational generation and black hole physics into an empirical science.

2nd CONCLUSION, looking directly at a modification of the Black holes has no hair theorem, via the inputs of this document.

In [17] we have the essential black holes have no hair theorem which can be seen roughly as

Quote

The idea is that beyond mass, charge and spin, black holes don't have distinguishing features, no hairstyle, cut or color to tell them apart.

End of quote

How do we get about this? Note that in [18] there is a pseudo extension which we can chalk up to Hawking; but in order to apply a more direct treatment we go to what is given in [30].

i.e. we go to formula 65 of that reference. This will give a variation of the radius of a black hole, over the radius, according to a quantum number n AGAIN. Before we get there we will do some initial work up to that quantum number, n as used in formula 65 of reference [19].

i.e. using our Equation (14) for N and also the Planck scale normalization as given by

$\hbar = k_B = c = G = M_p = \ell_p = 1$, and if we take $\tilde{a}$ approximately scaled to 1 as well we have that if

$$|N| \approx |N_{\text{gravitons}}| \approx \left(\frac{5t}{64^2 \pi^4}\right)^{2/5} \tag{62}$$

Due to using [13]

$$M \approx \sqrt{N} M_p \tag{63}$$

M here being linked to the mass of a BEC black hole, and also using the following for the loss of a black hole, over time *i.e.* [14].

That we begin with the model as to how a black hole mass, M, could lose a loss of its essence. Here, M is a mass, T is temperature, and $\tilde{a}$ is a proportionality term, *i.e.* what we reference in the primordial era

$$\frac{\mathrm{d}M}{\mathrm{d}t} = -\tilde{a} \cdot T^4 \tag{64}$$

In terms of having T as temperature related to black hole mass we use

$$T = \frac{\hbar c^3}{8\pi k_B G M} \tag{65}$$

This leads to, if indeed Equation (64) is observed

$$M^5(\text{loss}) = \left(\frac{-5}{64^2} \cdot \tilde{a}\right) \cdot \left(\frac{\hbar^4 c^{12}}{\pi^4 k_B^4 G^4}\right) \cdot t \tag{66}$$

Also use

$$|N_{\text{gravitons}}|^{5/2} \times (M_p \equiv 1)^{5/2} \approx \left(\frac{5t}{64^2 \pi^4}\right) \tag{67}$$

Then use the last equation of Equation (14) to obtain, a quantum number associated with a graviton just outside a BEC primordial black hole

$$n_{\text{graviton quantum number}} \equiv n_{\text{graviton}} \approx \left[\frac{2 \cdot 64^{1/10} \pi^{1/5}}{5^{1/20} \cdot t^{1/20}}\right] \approx \frac{2.16245415907}{t^{1/20}} \tag{68}$$

Assuming Planck scale time, or close to it, and renormalization to have Planck time as set to 1.

This means then that the quantum number, n associated with a graviton with respect to a Planck sized black hole would be close to 2, initially.

We assert that this value of n, so obtained, as to gravitons would be as to the Corda result on Equation (12) (32) the following

$$\begin{aligned} n(\text{black holes}) = N&(\text{graviton number per black hole}) \\ &\times n(\text{quantum number per graviton}) \end{aligned} \tag{69}$$

The left hand side of Equation (69) would be fully commensurate with Equation (12) of Corda's black hole quantum number [15].

The right hand side of Equation (69) would be commensurate with n being for a quantum number per graviton associated per black hole.

If there are a lot of gravitons, associated with a primordial black hole, this would commence with a very high initial quantum number, n (black holes) associated Cordas great result, as of [15].

Note that in future works, I told the onlookers that the original idea of my talk was to consider a black hole joined to a White Hole and to consider the generation of quantum number n, in the throat of a connecting worm hole between the black hole and white hole. This also is akin to [20].

14. Part 4. Looking at a Worm Hole Connecting a Black Hole and a White Hole, and the Possibility of a Quantum Number *n* Emerging

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 [21] is what we will start off with [21] and its given metric as far as a black hole to white hole solution.

Namely

$$\mathrm{d}S^2 = -A(r,a)\mathrm{d}t^2 + B(r,a)^{-1}\mathrm{d}r^2 + g^2(r,a)\mathrm{d}\Omega^2 \tag{70}$$

We can perform a major simplification by setting, then

$$A(r,a) = B(r,a) = f(r,a) \tag{71}$$

In doing so, [21] gives us the following stress energy tensor values as give

$$\begin{aligned}
T_t^t &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g' + 2fg''\right) - \frac{1}{g^2}\cdot\left(1 - fg'^2\right)\right)\\
T_r^r &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g'\right) - \frac{1}{g^2}\cdot\left(1 - fg'^2\right)\right)\\
T_\theta^\theta = T_\phi^\phi &= \frac{1}{8\pi}\cdot\left(\frac{1}{g}\cdot\left(f'g' + fg''\right) + \frac{1}{2}\cdot\left(f''\right)\right)
\end{aligned} \tag{72}$$

In doing this, we will choose 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 [21] the authors often set it at 3, if so then for a black hole, to white hole to worm hole configuration they give

$$g(r,a) = \begin{cases} r^2 + a^2\left(1 - \dfrac{r^2}{\xi^2}\right)^{\tilde{\tilde{n}}}, & \text{when } (r \le \xi) \\ r^2, & \text{when } (r > \rho) \end{cases} \tag{73}$$

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

$$\rho_{\text{black hole white hole wormhole}} \equiv -T_r^r \approx \hbar \omega_{\text{black hole white hole wormhole}} \tilde{n}_{\text{black hole white hole wormhole}} \tag{74}$$

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

$$\tilde{n}_{\text{black hole white hole wormhole}} = \frac{1}{8\pi} \cdot \left(\frac{1}{g} \cdot \left(f'g' \right) - \frac{1}{g^2} \cdot \left(1 - fg'^2 \right) \right) \cdot \frac{1}{\omega_{\text{black hole white hole wormhole}}} \tag{75}$$

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 furthermore if

$$a \approx \ell_P = \text{Planck length} \xrightarrow[\text{Planck normalization}]{} 1 \tag{76}$$

We get further restrictions as to the quantum number in Equation (75) 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.

15. And Now for a Grand Slam, *i.e.* the Connection We Have Been Waiting for, *i.e.* Quantum *n*, Primordial Black Holes. And Light Spectrum Issues

Key to doing this is to take into consideration. *i.e.* this is the point where we can take up the following [16] [22]-[24]

$$\begin{aligned} &\left\langle \left(\delta g_{uv}\right)^2 \left(\hat{T}_{uv}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2} \\ &\xrightarrow[uv \to tt]{} \left\langle \left(\delta g_{tt}\right)^2 \left(\hat{T}_{tt}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2} \\ &\& \ \delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+ \end{aligned} \tag{77}$$

We assume δg_{tt} is a small perturbation and look at $\delta t \Delta E = \frac{\hbar}{\delta g_{tt}}$ with

$$\Delta t_{\text{time}}\left(\text{initial}\right) = \hbar / \left(\delta g_{tt} E_{\text{initial}}\right) = \frac{2\hbar}{\delta g_{tt} \cdot g_{*s}\left(\text{initial}\right) \cdot T_{\text{initial}}} \tag{78}$$

This would put a requirement upon a very large initial temperature T_{initial} and so then, if $S\left(\text{initial}\right) \sim n\left(\text{particle count}\right) \approx g_{*s}\left(\text{initial}\right) \cdot V_{\text{volume}} \cdot \left(\frac{2\pi^2}{45}\right) \cdot \left(T_{\text{initial}}\right)^3$ [25]

$$S\left(\text{initial}\right) \sim n\left(\text{particle count}\right) \approx \frac{V_{\text{volume}}}{g_{*s}^2\left(\text{initial}\right)} \cdot \left(\frac{2\pi^2}{45}\right) \cdot \left(\frac{\hbar}{\Delta t_{\text{initial}} \cdot \delta g_{tt}}\right)^3 \tag{79}$$

And if we can write as given in

$$V_{\text{volume(initial)}} \sim V^{(4)} = \delta t \cdot \Delta A_{\text{surface area}} \cdot \left(r \leq l_{\text{Planck}}\right) \tag{80}$$

Then as to the follow up to NLED and signals from primordial processes [26] [24]

$$\alpha_0 = \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0$$
$$\hat{\lambda}(\text{defined}) = \Lambda c^2/3$$
$$a_{\min} = a_0 \cdot \left[\frac{\alpha_0}{2\hat{\lambda}(\text{defined})} \left(\sqrt{\alpha_0^2 + 32\hat{\lambda}(\text{defined}) \cdot \mu_0 \omega \cdot B_0^2} - \alpha_0 \right) \right]^{1/4} \tag{81}$$

Where the following is possibly linkable to minimum frequencies linked to E and M fields, and possibly relic Gravitons [26] [27]

$$B > \frac{1}{2 \cdot \sqrt{10\mu_0 \cdot \omega}} \tag{82}$$

Furthermore, the frequency, as given in Equation (82) (105) would be tied into Equation (34) via the n of that equation as well as specified by [28] on its page 111, where we have

$$\omega = g_{rr} ck \tag{83}$$

Here g_{rr} is nearly zero, as given in Equation (100), and the entire frequency in terms of k, as a wave number as given as this construction would have this consideration, namely.

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 as to obtain ideas as to data sets which would satisfy multi messenger astronomy namely the discussion as given in Mohanty, [29] namely a temperature, with scale factor as given in his page 261

$$T \sim \frac{1}{g^* a} \tag{84}$$

With temperature T, as proportional to quantum number n as specified, whereas k as in Equation (83) may be tied into the details of Equation (99) of our manuscript.

Once our ideas of a candidate magnetic field are clarified, *i.e.* we can then examine some of the ideas of [29] which can make a connection analytically to muli messenger Astrophysics explicit [30] *i.e.* for the record consider what is brought up in [17] which we also assert can be linked to Tokamaks, *i.e.* Compare this with tokamak conclusions.

16. GW Generation Due to the Thermal Output of Plasma Burning, and Linkage to the Initial GW Strain and Frequency Problem versus Values of Strain and Frequency of GW Today, from the Initial Pre Big Bang

Further elaboration of this matter in the experimental detection of experimental data sets for massive gravity lies in the viability of the expression derived, namely

Equation (19) $h \sim 10^{-27}$ for a GW detected 5 meters above a Tokamak represents the decrease in strain, by a factor of about 100, from details which are further elaborated upon in [18], whereas in the center of the Tokamak, we would have, say, $h_{\text{2nd term}} \sim 10^{-26}$ - 10^{-27} . *I.e.* a 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 $h \sim 10^{-25}$ decreasing to $h \sim 10^{-26}$ - 10^{-27} today. *I.e.* a comparatively small change in strain amplitude. Contrast this with the e-folding issues, of [18] 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. If we confirm that last statement observationally, we have confirmed the [19] e-folding prediction and taken a huge step forward in observational cosmology. Eventually we could investigate, also, early universe polarization of GW.

17. What Can We Say about the Stability of a Plasma Generated Signal Creating GW?

Among other things to consider, if we do Tokamak generation of GW simulations right as to GW generation we will be able to enhance the likelihood [19] [31]-[33] of having a stable signal (if that is what the Tokamak predicts), or an unstable signal (if that is what the Tokamak predicts) of the LISA data sets. Not necessarily in a fool proof way, but it would be a baseline to review and to refer back to. Another item to consider. Not just as to the type of GW polarizations, and stability of the signal, but also a way to infer through trial and error the duration of the phenomenon creating very early universe GW generation. This is in outlook similar to the opportunities. The author also refers readers to Monitz, as well as [34] for the old wavefunction of the universe problem. This all involves using the following frequency relationship

$$\begin{aligned} &\left(1+z_{\text{initial era}}\right) \equiv \frac{a_{\text{today}}}{a_{\text{initial era}}} \approx \left(\frac{\omega_{\text{Earth orbit}}}{\omega_{\text{initial era}}}\right)^{-1} \\ &\Rightarrow \left(1+z_{\text{initial era}}\right)\omega_{\text{Earth orbit}} \approx 10^{25}\,\omega_{\text{Earth orbit}} \approx \omega_{\text{initial era}} \end{aligned} \tag{85}$$

And a goal eventually of determining if the following are applicable to GW astronomy, *i.e.* [35] where on page 239 for a quantum cosmology similar to a "dust universe" we are given by Kieffer that

$$\langle E \rangle_{\kappa=n,\lambda} = \frac{(\kappa=n)+1/2}{\lambda} \xrightarrow[\lambda \approx 1/\hbar\omega]{} \hbar\omega \cdot \left((\kappa=n)+1/2\right) \tag{86}$$

i.e. to make the bridge with a tokamak we should review the geometry and issues in [36]-[41] as well as Equation (21).

18. Could the Tokamak Actually Get Data Sets as to Confirm This, at Least in Outline? *I.e.* a Challenge to the Black Holes Have No Hair Problem?

Assuming Planck scale time, or close to it, and renormalization to have Planck time as set to 1

This means from [21], *i.e.* their so-called Equation (65), so we have for the radius of a BEC black hole as deformed by this quantum number n, a small change

$$\frac{\Delta R_n}{R_n} \equiv \frac{\sqrt{n^2+2}}{3n} \tag{87}$$

If we use the value of n = 2.16245415907 for a graviton "quantum number" at about normalized Planck time, scaled to about 1, and we have according to [21]

$$\Delta R_n = \left(\frac{\sqrt{n^2+2}}{3n}\right)\cdot R_n \approx \left.\left(\frac{\sqrt{n^2+2}}{3n}\right)\right|_{n\equiv 2.16245415907} \times R_n \tag{88}$$

where $n \geq (1-\varepsilon)\cdot(M/M_p)^2$ and we can compare our value of R, as given in Equation (23) with [21] having a different scale for R, as given in their Equation (60).

19. Final Long Term Goal, If Done Correctly Making Full Use of Our Tokamak to Early Universe Comparison to Give Data Sets to Understand Quantization and Early Universe Wave Functions

In order to do this we need to reference all of the material as given in references [35] [42]-[57].

Using [42] a statement as to quantization for a would be GR term comes straight from

$$\Psi_{\text{Later}} = \int \sum_H \mathrm{e}^{(iI_H/\hbar)(t,t^0)} \Psi_{\text{Earlier}}(t^0)\,\mathrm{d}t^0 \tag{89}$$

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

$$\Psi_{\text{Later}} = \int \sum_H \mathrm{e}^{(iI_H/\hbar)(t,t^0)} \Psi_{\text{Earlier}}(t^0)\,\mathrm{d}t^0 \xrightarrow[H\to 1]{} \int \mathrm{e}^{(iI_{H\,FIXED}/\hbar)(t,t^0)} \Psi_{\text{Earlier}}(t^0)\,\mathrm{d}t^0 \tag{90}$$

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

$$\mathrm{e}^{(iI_{H\,FIXED}/\hbar)(t,t^0)} = \exp\left[\frac{i}{\hbar}\cdot\frac{c^4}{16\pi G}\cdot\int_{\mathrm{M}} \mathrm{d}t\cdot\mathrm{d}^3 r\sqrt{-g}\cdot(\Re - 2\Lambda)\right] \tag{91}$$

We will use the following, namely, if Λ is a constant, do the following for the Ricci scalar [47] [48]

$$\Re = \frac{2}{r^2} \tag{92}$$

If so then we can write the following, namely: Equation (91) becomes, if we have an invariant Cosmological constant, so we write $\Lambda \xrightarrow[\text{all time}]{} \Lambda_0$ everywhere, then

$$\mathrm{e}^{(iI_{H\,FIXED}/\hbar)(t,t^0)} = \exp\left[\frac{i}{\hbar}\cdot\frac{c^4\cdot\pi\cdot t^0}{16G}\cdot\left(r - r^3\Lambda_0\right)\right] \tag{93}$$

Then, we have that Equation (89) is re written to be

$$\Psi_{\text{Later}} = \int \sum_H \mathrm{e}^{(iI_H/\hbar)(t,t^0)} \Psi_{\text{Earlier}}(t^0)\mathrm{d}t^0 \xrightarrow[\text{at wormhole}]{} \int \exp\left[\frac{i}{\hbar}\cdot\frac{c^4\cdot\pi\cdot t^0}{16G}\cdot\left(r - r^3\Lambda_0\right)\right]\Psi_{\text{Earlier}}(t^0)\mathrm{d}t^0 \tag{94}$$

20. Examining the Behavior of the Earlier Wavefunction in Equation (94)

[43] states a Hartle-Hawking wavefunction which we will adapt for the earlier wavefunction as stated in Equation (94) so as to read as follows

$$\Psi_{\text{Earlier}}(t^0) \approx \Psi_{HH} \propto \exp\left(\frac{-\pi}{2GH^2}\cdot\left(1-\sinh(Ht)\right)^{3/2}\right) \tag{95}$$

Here, making use of Sarkar [3], we set, if say g_* is the degree of freedom allowed [9]

$$H = 1.66\sqrt{g_*}T_{temp}^2 / M_{\text{Planck}} \tag{96}$$

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 Equation (94) gives us while we use Equation (95) and Equation (96), with H approximately constant.

21. Methods Used in Calculating Equation (94), with Interpretation of the Results

We will be considering how to express Equation (94). And in doing this we will be looking at having a constant value for Equation (96). If so, then

$$\Psi_{\text{Later}} = \int \exp\left[\frac{i}{\hbar}\cdot\frac{c^4\cdot\pi\cdot t^0}{16G}\cdot\left(r-r^3\Lambda_0\right)\right]\exp\left(\frac{-\pi}{2GH^2}\cdot\left(1-\sinh(Ht)\right)^{3/2}\right)\mathrm{d}t^0 \tag{97}$$

Then using numerical integration, [50]-[52] on page 751 of this [52] citation

$$\begin{aligned}
&\Psi_{\text{Later}} \xrightarrow[t_M \to \varepsilon^+]{} \int_0^{t_M} \mathrm{e}^{i\cdot(\tilde{\alpha}1)\cdot t - (\tilde{\alpha}2)\cdot(1-\sinh(Ht))^{3/2}}\mathrm{d}t \\
&\approx \frac{t_M}{2}\cdot\left(\mathrm{e}^{i\cdot(\tilde{\alpha}1)\cdot t_M - (\tilde{\alpha}2)\cdot(1-\sinh(H\cdot t_M))^{3/2}} - 1\right) \\
&\tilde{\alpha}1 = \left[\frac{c^4\cdot\pi}{16G\hbar}\cdot\left(r-r^3\Lambda_0\right)\right],\ \tilde{\alpha}2 = \frac{\pi}{2GH^2}
\end{aligned} \tag{98}$$

Notice the terms for the H factor, and from here we will be making our prediction.

If the energy, E, has the following breakdown

$$\begin{aligned}
&H = 1.66\sqrt{g_*}T_{temp}^2 / M_{\text{Planck}} \\
&\Rightarrow E \approx k_B T_{Temp} \approx \hbar\cdot\omega_{\text{signal}} \\
&\Rightarrow \omega_{\text{signal}} \approx \frac{k_B\cdot\sqrt{M_{\text{Planck}}H}}{\hbar\cdot\sqrt{1.66\sqrt{g_*}}}
\end{aligned} \tag{99}$$

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 [35]. *I.e.* in this case we will write having

$$\Delta\omega_{\text{signal}}\Delta t \approx 1 \tag{100}$$

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

$$\Delta t \approx \frac{\hbar\sqrt{1.66\sqrt{g_*}}}{k_B \cdot \sqrt{M_{\text{Planck}} H}} \tag{101}$$

If Equation (101) is of a value somewhat close to t, in terms of general initial time, we can write

$$\psi_{\tilde{n},\lambda}(t,r) \equiv \frac{1}{\sqrt{2\pi}} \cdot \frac{\tilde{n}! \cdot (2\lambda)^{\tilde{n}+1/2}}{\sqrt{(2\tilde{n})!}} \cdot \left[\frac{1}{(\lambda + i \cdot t + i \cdot r)^{\tilde{n}+1}} - \frac{1}{(\lambda + i \cdot t - i \cdot r)^{\tilde{n}+1}} \right] \tag{102}$$

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

$$\lambda \approx \sqrt{\frac{8\pi G}{V_{\text{volume}} \hbar^2 t^2}} \xrightarrow[G=\hbar=\ell_{\text{Planck}}=k_B=1]{} \sqrt{\frac{8\pi}{t^2}} \equiv \frac{\sqrt{8\pi}}{t} \tag{103}$$

Then a preliminary emergent space-time wave function would take the form of

$$\psi_{\tilde{n},\lambda}(\Delta t,r) \equiv \frac{1}{\sqrt{2\pi}} \cdot \frac{\tilde{n}! \cdot \left(2 \cdot \sqrt{8\pi} \cdot (\Delta t)^{-1}\right)^{\tilde{n}+1/2}}{\sqrt{(2\tilde{n})!}} \cdot \left[\frac{1}{\left(\sqrt{8\pi} \cdot (\Delta t)^{-1} + i \cdot \Delta t + i \cdot r\right)^{\tilde{n}+1}} - \frac{1}{\left(\sqrt{8\pi} \cdot (\Delta t)^{-1} + i \cdot \Delta t - i \cdot r\right)^{\tilde{n}+1}} \right] \tag{104}$$

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

What we wish to do in our procedure is to come up with data sets which may be able to take the real version of the above wave function, also, make accessible the [57] reference data sets, if wormholes exist from a prior to the present universe, which contributes to the Big Bang.

Conflicts of Interest

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

References

[1] Beckwith, A. (2021) A Solution of the Cosmological Constant and DE Using Breakup of Primordial Black Holes, via a Criteria Brought Up by Dr. Freeze which Initiates DE as Linked to Inflation. Preprints.

[2] Gladyshev, V. and Fomin, I. (2019) The Early Universe as a Source of Gravitational Waves. https://www.intechopen.com/books/progress-in-relativity/the-early-universe-as-a-source-of-gravitational-waves

[3] Fukuyama, T. and Morikawa, M. (2007) Relativistic Bose-Einstein Condensation Model for Dark Matter and Dark Energy. In: Aschenbach, B., Burwitz, V., Hasinger, G. and Leibundgut, B., Eds., *ESO Astrophysics Symposia*, Springer, 95-97. https://doi.org/10.1007/978-3-540-74713-0_21

[4] Freese, K., Brown, M.G. and Kinney, W.H. (2011) The Phantom Bounce: A New Proposal for an Oscillating Cosmology. In: Mersini-Houghton, L. and Vaas, R., Eds., *The Arrows of Time*, Springer, 149-156. https://doi.org/10.1007/978-3-642-23259-6_7

[5] Maggiore, M. (2008) Gravitational Waves, Volume 1, Theory and Experiment. Oxford University Press.

[6] Rahvar, S. (2017) Cosmic Initial Conditions for a Habitable Universe. *Monthly Notices of the Royal Astronomical Society*, **470**, 3095-3102. https://doi.org/10.1093/mnras/stx1448

[7] Li, F., Wen, H., Fang, Z., Li, D. and Zhang, T. (2020) Electromagnetic Response to High-Frequency Gravitational Waves Having Additional Polarization States: Distinguishing and Probing Tensor-Mode, Vector-Mode and Scalar-Mode Gravitons. *The European Physical Journal C*, **80**, Article No. 879. https://doi.org/10.1140/epjc/s10052-020-08429-2

[8] Grishchuk, L.P. and Sazchin, M.V. (1975) Excitation and Detection of Standing Gravitational Waves. *Journal of Experimental and Theoretical Physics*, **68**, 1569-1582.

[9] Li, F., Tang, M., Luo, J. and Li, Y. (2000) Electrodynamical Response of a High-Energy Photon Flux to a Gravitational Wave. *Physical Review D*, **62**, Article 044018. https://doi.org/10.1103/physrevd.62.044018

[10] Wesson, J. (2011) Tokamaks. 4th Edition, Oxford Science Publications.

[11] de Sabbata, V. and Sivaram, C. (1991) Torsion, Quantum Effects and the Problem of Cosmological Constant. In: Zichichi, A., de Sabbata, V. and Sánchez, N., Eds., *Gravitation and Modern Cosmology*, Springer, 19-36. https://doi.org/10.1007/978-1-4899-0620-5_4

[12] Beckwith, A.W. (2024) How Torsion as Presented by De Sabbata and Sivaram in Erice 1990 Argument as Modified May Permit Cosmological Constant, and Baseline as to Dark Energy. *Journal of High Energy Physics, Gravitation and Cosmology*, **10**, 138-148. https://doi.org/10.4236/jhepgc.2024.101012

[13] Padmanabhan, T. (2006) An Invitation to Astrophysics. World Scientific, 384. https://doi.org/10.1142/6010

[14] Chavanis, P. (2014) Self-Gravitating Bose-Einstein Condensates. In: Calmet, X., Ed., *Fundamental Theories of Physics*, Springer International Publishing, 151-194. https://doi.org/10.1007/978-3-319-10852-0_6

[15] Carlip, S. (n.d.) Black Hole Thermodynamics and Statistical Mechanics. In: Papantonopoulos, E., Ed., *Lecture Notes in Physics*, Springer, 89-123. https://doi.org/10.1007/978-3-540-88460-6_3

[16] Downes, T.G. and Milburn, G.J. (2020) Optimal Quantum Estimation for Gravitation. arXiv:1108.5220

[17] Kuroyanagi, S., Ringeval, C. and Takahashi, T. (2013) Early Universe Tomography with CMB and Gravitational Waves. *Physical Review D*, **87**, Article 083502. https://doi.org/10.1103/physrevd.87.083502

[18] Beckwith, A.W. (2017) Part 2: Review of Tokamak Physics as a Way to Construct a Device Optimal for Graviton Detection and Generation within a Confined Small Spatial Volume, as Opposed to Dyson's "Infinite Astrophysical Volume" Calculations.

Journal of High Energy Physics, Gravitation and Cosmology, **3**, 138-155. https://doi.org/10.4236/jhepgc.2017.31015

[19] Chongchitnan, S. (2016) Inflation Model Building with an Accurate Measure of E-Folding. arXiv:1605.04871v2 https://arxiv.org/pdf/1605.04871.pdf

[20] Corda and Christian (2023) Black Hole Spectra from Vaz's Quantum Gravitational Collapse. Fortschritte der Physik-Progress of Physics, 11 p. arXiv:2305.02184 https://arxiv.org/abs/2305.02184

[21] Casadio, R. and Micu, O. (2024) Quantum Matter Core of Black Holes (and Quantum Hair). In: Malafarina, D. and Joshi, P.S., Eds., *Springer Series in Astrophysics and Cosmology*, Springer, 53-84. https://doi.org/10.1007/978-981-97-1172-7_2

[22] Feng, Z., Ling, Y., Wu, X. and Jiang, Q. (2024) New Black-to-White Hole Solutions with Improved Geometry and Energy Conditions. *Science China Physics, Mechanics & Astronomy*, **67**, Article No. 270412. https://doi.org/10.1007/s11433-023-2373-0

[23] Unruh, W.G. (1986) Why Study Quantum Theory? *Canadian Journal of Physics*, **64**, 128-130. https://doi.org/10.1139/p86-019

[24] Unruh, W.G. (1986) Erratum: Why Study Quantum Theory? *Canadian Journal of Physics*, **64**, 1453-1453. https://doi.org/10.1139/p86-257

[25] Casadio, R. and Giusti, A. (2021) Classicalizing Gravity. In: Saridakis, E.N., *et al*., Eds., *Modified Gravity and Cosmology*, Springer International Publishing, 405-418. https://doi.org/10.1007/978-3-030-83715-0_27

[26] Beckwith, A.W. (2018) Structure Formation and Non Linear Electrodynamics with Attendant Changes in Gravitational Potential and Its Relationship to the 3 Body Problem. *Journal of High Energy Physics, Gravitation and Cosmology*, **4**, 779-786. https://doi.org/10.4236/jhepgc.2018.44043

[27] Camara, C.S., de Garcia Maia, M.R., Carvalho, J.C. and Lima, J.A.S. (2004) Nonsingular FRW Cosmology and Nonlinear Electrodynamics. *Physical Review D*, **69**, Article 123504. https://doi.org/10.1103/physrevd.69.123504

[28] Dieter, L. and Vleeshouwers, S. (2019) Black Hole Information and Thermodynamics. In: *Springer Briefs in Physics*, Springer Verlag.

[29] Mohanty, S. (2020) Astroparticle Physics and Cosmology, Perspectives in the Multimessenger Era. Springer Nature. https://doi.org/10.1007/978-3-030-56201-4

[30] Bartos, I. and Kowalski, M. (2017) Multimessenger Astronomy. IOP Publishing. https://doi.org/10.1088/978-0-7503-1369-8

[31] Cornish, N. and Robson, T. (2017) Galactic Binary Science with the New LISA Design. *Journal of Physics: Conference Series*, **840**, Article 012024. https://doi.org/10.1088/1742-6596/840/1/012024

[32] The Elisa Consortium (2013) The Gravitational Universe. arXiv:1305.5720

[33] Astier, P., Guy, J., Regnault, N., Pain, R., Aubourg, E., Balam, D., *et al.* (2006) The Supernova Legacy Survey: Measurement of Ω_M, Ω_Λ and W from the First Year Data Set. *Astronomy & Astrophysics*, **447**, 31-48. https://doi.org/10.1051/0004-6361:20054185

[34] Monitz, P.V. (2010) Quantum Cosmology-The Supersymmetric Perspective-Vol. 1, Fundamentals. In: Citro, R., Hänggi, P., Hartmann, B., *et al*., Eds., *Lecture Notes in Physics*, Springer Nature.

[35] Kieffer, K. (2012) Quantum Gravity. 3rd Edition, Oxford University Press.

[36] Maldacena, J., Milekhin, A. and Popov, F. (2020) Traversable Wormholes in Four

Dimensions. arXiv:1807.04726. https://arxiv.org/abs/1807.04726

[37] The LIGO Scientific Collaboration & The Virgo Collaboration (2009) An Upper Limit on the Stochastic Gravitational-Wave Background of Cosmological Origin. *Nature*, **460**, 990-994. https://doi.org/10.1038/nature08278

[38] Li, M., Li, X., Wang, S. and Wang, Y. (2015) Dark Energy. In: *Peking University World Scientific Advance Physics Series*, Vol. 1, World Scientific.

[39] Maartens, R. (2004) Brane-World Gravity. *Living Reviews in Relativity*, **7**, Article No. 7. https://doi.org/10.12942/lrr-2004-7

[40] Dubovsky, S., *et al.* (2009) Signatures of a Graviton Mass in the Cosmic Microwave Background. arXiv:0907.1658. http://arxiv.org/abs/0907.1658

[41] Kolb, E. and Turner, M. (1990) The Early Universe. Addison-Wesley Publishing Company.

[42] Weber, J. (2004) General Relativity and Gravitational Waves. Dover Publications, Incorporated.

[43] Lu, H.Q., Fang, W., Huang, Z.G. and Ji, P.Y. (2008) The Consistent Result of Cosmological Constant from Quantum Cosmology and Inflation with Born-Infeld Scalar Field. *The European Physical Journal C*, **55**, 329-335. https://doi.org/10.1140/epjc/s10052-008-0564-z

[44] Sarkar and Utpal (2008) Particle and Astroparticle Physics. Taylor & Francis Group.

[45] Popov, A.A. and Sushkov, S.V. (2001) Vacuum Polarization of a Scalar Field in Wormhole Spacetimes. *Physical Review D*, **63**, Article 044017. https://doi.org/10.1103/physrevd.63.044017

[46] DeBenedictis, A. and Das, A. (2001) On a General Class of Wormhole Geometries. *Classical and Quantum Gravity*, **18**, 1187-1204. https://doi.org/10.1088/0264-9381/18/7/304

[47] Einstein, A. and Rosen, N. (1935) The Particle Problem in the General Theory of Relativity. *Physical Review*, **48**, 73-77. https://doi.org/10.1103/physrev.48.73

[48] Visser, M. (2002) The Quantum Physics of Chronology Protection. arXiv:gr-qc/0204022 https://arxiv.org/abs/gr-qc/0204022

[49] Lightman, A., Press, W., Price, R. and Teukolsky, S. (1975) Problem Book in Relativity and Gravitation. Princeton University Press.

[50] Kolb, E. and Turner, M. (1990) The Early Universe. Addison-Wesley Publishing Company.

[51] McCracken, D.D. and Dorn, W.S. (1977) Numerical Methods and Fortran Programming with Application in Engineering and Science. Publishing House Mir, 584 p.

[52] Philip, J.D. and Rabinowitz, P. (2007) Methods of Numerical Integration. 2nd Edition, Dover Publishers.

[53] Zwillinger, D. (2003) CRC Standard Mathematical Tables and Formulae. 31st Edition, Chapman and Hall/CRC.

[54] Barrow and John, D. (2002) The Constants of Nature, from Alpha to Omega—The Numbers that Encode the Deepest Secrets of the Universe. Pantheon Books.

[55] Planck and Max (1899) Über irreversible strahlungsvorgänge. Sitzungsberichte der königlich preußischen akademie der wissenschaften zu berlin (in German). **5**, 440-480. Pp. 478-480 Contain the First Appearance of the Planck Base Units Other than the Planck Charge, and of Planck's Constant, which Planck denoted by B. A and F in This Paper Correspond to K and G in Modern Usage.

[56] Aldaya, V., Barceló, C. and Jaramillo, J.L. (2011) Spanish Relativity Meeting (ERE 2010): Gravity as a Crossroad in Physics. *Journal of Physics*: *Conference Series*, **314**, Article 011001. https://doi.org/10.1088/1742-6596/314/1/011001

[57] Gecim, G. and Sucu, Y. (2020) Quantum Gravity Correction to Hawking Radiation of the 2 + 1-Dimensional Wormhole. *Advances in High Energy Physics*, **2020**, Article 7516789. https://doi.org/10.1155/2020/7516789