Torsion, quantum gravity and prior universe contribution to black hole physics, and its gravitational wave signatures after nucleation of the present universe

Andrew Walcott Beckwith

Physics department, Chongqing University, People's Republic of China

Email: Rwill9955b@gmail.com

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Snail mail address

48 Julia Circle, East Setauket, NY, USA, zip 11733

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We consider if a generalized HUP set greater than or equal to Planck's constant divided by the square of a scale factor as well as an inflation field, yield the result that Delta E times Delta t is embedded in a 5 dimensional field which is within a deterministic structure. Our proof ends with Delta t as of Planck time yielding an enormous potential energy**, Second, we tie this energy to black hole physics and the early universe. i.e ,**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

I. Introduction. The basic uncertainty principle used for a very large initial energy,

In this document we are revisiting the following statement made earlier [1] [2] we make the assumptions. As given

Using the following we assume a fluid approximation of the early universe with

$$T_{ii} = diag(\rho, -p, -p, -p) \qquad (1)$$

Then

$$\Delta T_{tt} \sim \Delta \rho \sim \frac{\Delta E}{V^{(3)}} \qquad (2)$$

Then, Eq. (1) and Eq. (2) together yield

$$\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2}$$
$$Unless \quad \delta g_{tt} \sim O(1) \qquad (3)$$

What we are going to do is to, in the initial variation of the GUP is to look hard at the initial idea given in Eq.(3) is to make the following treatment at the start of expansion of the Universe[1][2]**[3]**

$$\delta g_{tt} \sim a^2(t) \cdot \phi << 1$$ Goes to become effectively almost ZERO. (4)

If this is effectively almost zero, the effect would be to embedd Quantum mechanics within a 5 dimensional structure

Before proceeding we should state that the inflaton field so used in Eq. (3) and Eq. (4) satisfies the following [2] [3][4]

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

In the spirit of use of the inflaton field what we will propose is that [3][4]

$$\phi = \ln\left(\sqrt{\frac{8\pi G V_0}{\nu \cdot (3\nu - 1)}} \cdot t\right)^{\sqrt{\frac{\nu}{16\pi G}}} \approx \sqrt{\frac{\nu}{16\pi G}} \cdot \left(\sqrt{\frac{8\pi G V_0}{\nu \cdot (3\nu - 1)}} \cdot t - 1\right) \qquad (6)$$

i.e. assume that if the initial time step is near Planck time which is normalized to 1 that

$$V_0 \approx initial - energy \qquad (7)$$

In addition we will go to Wesson [5] and to make the following adjustments
i.e. Wesson's treatment of embedding of the HUP in deterministic structure [5]

$$\left|dp_{\alpha}dx^{\alpha}\right| \approx \frac{L}{l}\cdot\frac{h}{c}\cdot\left[\frac{dl}{l}\right]^{2} \qquad (8)$$

Where we will define l and L as follows

First, define L in terms of the cosmological "constant" by [5]

$$\Lambda = \frac{1}{3L^{2}} \qquad (9)$$

Also

$$dS_{5-d}^{2} = \frac{L^{2}}{l^{2}}dS_{4-d}^{2} - \frac{L^{4}}{l^{4}}dl^{2} \qquad (10)$$

Also 5 dimensional wave number is defined via [5]

$$K_{l} = 1/l \qquad (11)$$

In the case of Pre Planckian space-time the idea is to do the following [5]

$$\begin{aligned}
&\left|dp_{\alpha}dx^{\alpha}\right| \approx \frac{L}{l}\cdot\frac{h}{c}\cdot\left[\frac{dl}{l}\right]^{2} \\
&\xrightarrow[\alpha=0]{} \left|dp_{0}dx^{0}\right| \simeq \left|\Delta E\Delta t\right| \approx \left(h/a_{init}{}^{2}\phi(t)\right) \qquad (12) \\
&\Rightarrow \frac{L}{l}\cdot\frac{h}{c}\cdot\left[\frac{dl}{l}\right]^{2} \approx \left(h/a_{init}{}^{2}\phi(t_{init})\right)
\end{aligned}$$

Making use of all this leads to[3][4]

$$\int_{l_1}^{l_2} dl/l^{3/2} \approx \frac{(l_2-l_1)}{l^{3/2}(c)} \approx \frac{(3\Lambda)^{1/4}}{a_{init}\cdot\left(\frac{\nu}{16\pi G}\right)^{1/4}\cdot\left(\sqrt{\frac{8\pi G V_0}{\nu\cdot(3\nu-1)}}\cdot t-1\right)^{1/2}} \qquad (13)$$

I. Extracting time initial from Eq. (13) and what if time is equal to Planck time? Extract V_0

Our approximation is to set G = 1 = h (Planck units) with Planck time normalized to 1. Then

$$t = t_{planck} \rightarrow 1 = \sqrt{\frac{\nu(3\nu-1)}{8\pi V_0}} + \sqrt{\frac{2\cdot(3\nu-1)}{V_0}}\cdot\frac{a_{init}{}^{2}\cdot(l_2-l_1)^{2}}{l^{3}(c)\cdot(3\Lambda)^{1/2}} \qquad (14)$$

Then we have that at Planck time, normalized to 1 we look at in four dimensions the following approximation.

$$V_0 = \left(\sqrt{\frac{\nu(3\nu-1)}{8\pi}} + \sqrt{2\cdot(3\nu-1)} \cdot \frac{a_{init}{}^2 \cdot (l_2 - l_1)^2}{l^3 (c) \cdot (3\Lambda)^{1/2}} \right)^2 \approx \Delta E \quad (15)$$

This concludes having a linkage as to [6] in terms of a huge energy flux into the early universe Having said this, what can we now say about graviton mass, in the early universe ?

II. Recap of torsion, starting with a table of early universe black holes.

Consider a table 1 for the early universe, i.e. as

Table 1 from [6][[7] assuming Penrose recycling of the Universe as stated in that document.

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 Eq. (1) and Eq. (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

As to Table 1, we obtain, due to the quantum number n, per black hole the following

The Table 1 data will be connected to the following given consideration of spin density , as to Planck sized black holes which ties directly into our torsion treatment of the cosmological constant. Having said this, its now time to go to Torsion for application of this to tie it into the cosmological constant problem and black holes To do this review how **Torsion may allow for understanding a quantum number n? And Primordial black holes and the cosmological constant**

Following [6][7] we do the introduction of black hole physics in terms of a quantum number n.

$$\sqrt{\Lambda} = \frac{k_B E}{\hbar c S_{entropy}} \qquad (16)$$
$$S_{entropy} = k_B N_{particles}$$

And then a BEC condensate given by [6][7][8] [9] as to

$$\begin{aligned} m &\approx \frac{M_P}{\sqrt{N_{gravitons}}} \\ M_{BH} &\approx \sqrt{N_{gravitons}} \cdot M_P \\ R_{BH} &\approx \sqrt{N_{gravitons}} \cdot l_P \\ S_{BH} &\approx k_B \cdot N_{gravitons} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{gravitons}}} \end{aligned} \qquad (17)$$

Let us now assume this scaling while going next to Torsion. And Black holes

Note now in terms of torsion, that the Friedman equation can be written as the following 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 [6][7][10]as

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right)\cdot\left[\rho - \frac{2\pi G\sigma^2}{3c^4}\right] + \frac{\Lambda c^2}{3} - \frac{\tilde{k}c^2}{\tilde{R}^2} \qquad (18)$$

Here the term $\tilde{k}$ is a measure of if one has positive, negative, or zero curvature. In all of this, the values of $\tilde{k}$ are usually linked to questions of if we have an open or closed universe . It has three possible values: 1 for a closed positive curvature universe (like a sphere), 0 for a flat Euclidian Universe, and 0 for an open negative – curvature universe . Question. What [6][7][10] does as to Eq. (69) versus what we would do and why? In the case of [6][7][10] we would see σ be identified as due to torsion so that we obtain

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right)\cdot[\rho] - \frac{\tilde{k}c^2}{\tilde{R}^2} \qquad (19)$$

The claim is made in [6][7][10] 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 a different result due to the following argument

In order to put in this scaling, we usually can refer to a Friedman equation as

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right)\cdot[\rho] + \frac{\Lambda_{0bserved}c^2}{3} - \frac{\tilde{k}c^2}{\tilde{R}^2} \qquad (20)$$

I.e. the observed cosmological constant $\Lambda_{0bserved}$ is 10^-122 times smaller than the initial vacuum energy .The main reason for the difference in the Eq. (18) and Eq. (20) 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. the Table 1 dynamics in the aftermath of the Planckian regime of space time would largely eliminate the σ^2 term

III. Filling in the details of the collapse of the cosmological term, versus the situation given in Eq. (20) via numerical values

First look at numbers provided by [6][7][10] as to inputs, i.e. these are very revealing

$$\Lambda_{Pl}c^2 \approx 10^{87} \qquad (21)$$

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 [6][7][10] is solely to remove this giant number . In order to remove it, the reference [6][7][10] proceeds to make the following identification, namely

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right] + \frac{\Lambda c^2}{3} = 0 \qquad (22)$$

What we are arguing is that instead, one is seeing, instead

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^{2}}{3c^{4}}\right]+\frac{\Lambda_{Pl}c^{2}}{3}\approx 10^{-122}\times\left(\frac{\Lambda_{Pl}c^{2}}{3}\right) \quad (23)$$

Our timing as to Eq. (23) is to unleash a Planck time interval t about 10^-43 seconds. As to Eq. (22) versus Eq. (23) the creation of the torsion term is due to a presumed particle density of

$$n_{Pl}\approx 10^{98}\,cm^{-3} \quad (24)$$

Finally, we have a spin density term of $\sigma_{Pl}=n_{Pl}\hbar\approx 10^{71}$ which is due to innumerable black holes initially. This treatment of torsion and the spin density term, i.e. of black holes, with a particle density term of Eq. (24) is due solely to the HUP employed, as to arguments given in the first part of the paper. And gives substance to the Table 1 estimates

Why I find this very interesting are the questions raised in[11][12] i.e. what is special about the Plank mass as an example. We submit that a through examination of Torsion may allow an answer to this issue in terms of early universe cosmology

As a final point to consider, what sort of Penrose cyclic argument is used for the prior to present universe, as employed by Table 1 ? We argue it allows for the treatment of the cosmological problem, as seen here

What this means in terms of phenomenology, is as follows , i.e. if we look at the section given by [10] as elaborated upon in the fifth force argument as given we can say the following

First of all is the old standby namely in the onset of inflation, there would be a huge speed of inflationary expansion with the coefficient of scale factor given as [6][7][10] . i.e. this is looking at the coefficient showing up in $a(t)\approx a_0 t^{\nu}$ scale factor expansion, that if we go to Eq. (25)

$$\nu \xrightarrow[Planck-normalization]{} 4\pi\times\left(\omega_{gw}\right)^{12}\times\frac{\left(\varsigma\right)^{4}}{\tilde{\beta}^{2}} \quad (25)$$

For mass greater than Planck mass, namely $M_{mass}\approx\zeta m_p$, with m_p for Planck Mass. We refer to [10] , in that this is for the mass of a physical system, i.e. M_{mass} of an object which in its physical configuration is generating gravitational waves, ω_{gw} and we find that in the Planckian regime, $\tilde{\beta}$ is a coefficient connected to a fifth force argument due to reasoning from [10]

This leads to the following i.e. in [10] which is reproduced here , In addition after approximating $\left\langle r^2\right\rangle^2\approx\ell_p^4$, ie Planck length to the fourth power and $r\left\langle r^2\right\rangle^2\approx\ell_p^5$

We find then we have at the immediate beginning of inflation, an almost Planck frequency value of 1.855 times 10^43 Hertz, we would need ν be 10^502 which would be factored into the scale factor value for the term ν. This would mean for the fifth force argument that we would have an almost infinitely quick expansion in the neighborhood of Planck length for the start of inflation

We find then we have at the immediate beginning of inflation, an almost Planck frequency value of 1.855 times 10^43 Hertz, we would need ν be 10^502 which would be factored into the coefficient of time which shows up in a scale factor argument and the scale factor value for the term ν. This would mean for the fifth force argument that we would have an almost infinitely quick expansion in the neighborhood of Planck length for the start of inflation.

If so, by Novello [13] we then have a bridge to the cosmological constant as given by

$$m_g = \frac{\hbar \cdot \sqrt{\Lambda}}{c} \tag{26}$$

Consider first the relationship between vacuum energy and the cosmological constant. Namely $\rho_\Lambda \approx \hbar k_{\max}^4$ where we have that

$$\rho_\Lambda \approx \hbar k_{\max}^4 \approx (10^{18}\,GeV)^4 \xrightarrow[reduced]{} (10^{-12}\,GeV)^4 \tag{27}$$

Where we define the mass of a graviton as in the numerator given by Eq. (26), and then we can also use the following. This is useful in terms of determining conditions for a cosmological constant [6][7][10][14]

$$\begin{aligned} \rho_\Lambda c^2 &= \int_0^{E_{Plank}/c} \frac{4\pi p^2 dp}{(2\pi\hbar)^3} \cdot \left(\frac{1}{2} \cdot \sqrt{p^2c^2 + m^2c^4} \right) \approx \frac{\left(3\times10^{19}\,GeV\right)^4}{(2\pi\hbar)^3} \\ &\xrightarrow[E_{Plank}/c \to 10\text{^}{-30}]{} \frac{\left(2.5\times10^{-11}\,GeV\right)^4}{(2\pi\hbar)^3} \end{aligned} \tag{28}$$

This means shifting the energy level of the Eq. (27) and Eq. (28) downward by 10^-30, i.e. the top value energy becomes a down scale of Planck energy times 10^-30.

Gravitons are used as the back bone of how to reduce Eq. (28) to the vacuum energy of today
In addition there is one line of reasoning, which I believe bears mentioning i.e. what would be a way to determine necessary and sufficient conditions for a massive graviton to exist. To do so, we will look first at [15] Linde (Les Houches, 2013), whom wrote of the probability of creation of a closed universe as given by

$$P(probability) \sim \exp(-24\pi^2 / V(potential))$$
$$\Leftrightarrow V(potential) \sim Energy(Planck) \qquad (29)$$

IV. How to link this idea as to disternable GW in experimental gravitation. We start with a basic assumption as given below

The potential energy, so identified in Eq.(29) is none other than the one used by Padmanbhan [3] in which the H so identified is the Hubble 'constant' parameter, which actually changes over time. In this case, the potential so identified in Eq.(29) is given by

$$V \sim 3H^2 M_{Planck} \cdot \left(1 + \left(\dot{H} / 3H^2\right)\right) \qquad (30)$$

Here, if N is an integer number for dimensionality of space-time, and [3]

$$H = \dot{a}(t) \big/ a(t) \;\&\; a(t) \sim t^N$$
$$\Leftrightarrow V \sim 2M_{Planck} \cdot N^2 \big/ t^N \qquad (31)$$

Applying the HUP uncertainty principle be looking at a minimum uncertainty principle situation of time. If so, then if we have V as proportional to an energy E, then we can by the Heisenberg uncertainty principle

$$\Delta E \Delta t = \hbar \qquad (32)$$

Then, if Δt = t (minimum), and ΔE = $E_{initial} \equiv \frac{c^4}{2G} \cdot r_{critial} \sim \frac{c^4 L_P}{2G}\sqrt{\frac{n_{initial}}{\pi}}$

$$\Delta t = \left(\hbar / \frac{c^4 L_P}{2G}\sqrt{\frac{n_{initial}}{\pi}}\right) = t_{\min} \qquad (33)$$

Now, by Valev,[16] at the start of inflation, and this is before massive red shifting

$$m_{graviton} \sim \frac{\hbar H}{c^2} \sim \frac{\hbar N}{c^2 t_{\min}} \sim \frac{2GN}{c^6 L_P^2 \sqrt{\frac{n_{initial}}{\pi}}} \sim 10^{-61}\, grams$$
$$\lambda_{graviton} \sim \frac{c}{H} \sim \frac{c \cdot t_{\min}}{N} \sim \frac{10}{N} \cdot L_p \sim \frac{1.61}{N} \times 10^{-34}\, meters$$
$$f(frequency)_{graviton} \sim \frac{1.8 \times 10^{36}}{N} Hertz \qquad (34)$$

Inflation would reduce the frequency by 26 orders or so of magnitude (massive red shifting) [16]

$$f(frequency)_{graviton}[after-\inf] \sim 10^{10}\,Hertz \quad (35)$$

Conceivably discernible if we are careful as to data sets and analysis in terms of primordial Planckian physics conditions.

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