Journal of High Energy Physics, Gravitation and Cosmology, 2025, 11(2), 464-479
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Relic Black Holes and the Presence of Barbour's Shape Dynamics to Explain Different Pathways for a Change of Energy State at the Start of Inflation

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How to cite this paper: Beckwith, A.W. (2025) Relic Black Holes and the Presence of Barbour's Shape Dynamics to Explain Different Pathways for a Change of Energy State at the Start of Inflation. *Journal of High Energy Physics, Gravitation and Cosmology*, **11**, 464-479.
https://doi.org/10.4236/jhepgc.2025.112033

Received: February 9, 2025
Accepted: April 22, 2025
Published: April 25, 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. The formation of a cosmological constant is akin to use Torsion in order to obtain the cosmological constant, but in order to do so, we need a starting point as far as emergence of energy from the onset of the Big Bang. This paper is dedicated to that proposition, using Barbour shape formulation to obtain emergent energy values which are less disruptive to pre Planckian to Planckian physics than the usual paradigms. In particular, our emergent energy values are using Padmanabhan scalar field construction, combined with a modified HUP construction, which we then try to tie into black hole physics.

Keywords

Inflation, Gravitational Waves

1. Part 1. Preliminaries, Recounting the Parameters of Black Hole Physics Used in This Essay, as Well as the Importance of a Quantum Number *n*

Following [1]-[3] using the substitutions outlined so we can re-do the introduction of black hole physics in terms of a quantum number n. To begin this, first look at a reference to the BEC condensate given by [1]-[3] as to scaling.

I.e. the origins of the black holes have no hair theorem and a preview of what we will be trying to modify.

Our supposition has the no hair idea and starts off with a simple idea. 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

$$\frac{\mathrm{d}M}{\mathrm{d}t} = -\tilde{a}\cdot T^4 \tag{1}$$

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

$$T = \frac{\hbar c^3}{8\pi k_B G M} \tag{2}$$

This leads to, if indeed Equation (1) is observed

$$M^5(\text{loss}) = \left(\frac{-5}{64^2}\cdot\tilde{a}\right)\cdot\left(\frac{\hbar^4 c^{12}}{\pi^4 k_B^4 G^4}\right)\cdot t \tag{3}$$

as to how we can observe a violation of the black holes which have no hair idea, we will need to do parameterization of a mass *M*, for black holes, in terms of the following inputs. In order to do this, though we need to consider where the energy budget for black holes initially came from in the primordial Universe.

2. A Brief Explainer as to How Shape Dynamics, May Induce an Energy Flux for the Creation of Relic Black Holes, with an Initially Incorrect Value of the Cosmological Constant

In ([4], p. 265), Barbour uses shape dynamics to come up with a delta t expression in a way which we can rewrite as having the following input into formation of initial cosmological constant energy starting with [5]-[7] which we will use.

Namely, we will be working with [2] [4]-[7]

$$\begin{aligned} &\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t)\cdot\phi} \ll \hbar \\ &\Leftrightarrow S_{\text{initial}}\left(\text{with}\left[\delta g_{tt}\right]\right) = \left(\delta g_{tt}\right)^{-3} S_{\text{initial}}\left(\text{without}\left[\delta g_{tt}\right]\right) \gg S_{\text{initial}}\left(\text{without}\left[\delta g_{tt}\right]\right) \end{aligned} \tag{4}$$

i.e. the fluctuation $\delta g_{tt} \ll 1$ dramatically boosts 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 [1]-[3] [6] [7]

$$\delta g_{tt} \sim a^2(t)\cdot\phi \xrightarrow[\phi\sim\text{Very Large}]{} 1 \tag{5}$$

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 [6] [7]

$$m_{\text{graviton}} \geq \frac{2\hbar^2}{\left(\delta g_{tt}\right)^2 l_P^2}\cdot\frac{E-V}{\Delta T_{tt}^2} \tag{6}$$

This is in terms of an initial HUP which is defined by [4]-[7]

$$\begin{aligned} &\left\langle \left(\delta g_{uv}\right)^2 \left(\hat{T}_{uv}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2} \\ &\xrightarrow[uv\to tt]{} \left\langle \left(\delta g_{tt}\right)^2 \left(\hat{T}_{tt}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2} \\ &\& \, \delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+ \end{aligned} \tag{7}$$

Also if

$$T_{ii} = diag(\rho, -p, -p, -p) \tag{8}$$

Then

$$\Delta T_{tt} \sim \Delta\rho \sim \frac{\Delta E}{V^{(3)}} \tag{9}$$

This uses the following, *i.e.* to keep in mind in terms of visualizing the initial HUP

$$\begin{aligned} (\Delta l)_{ij} &= \frac{\delta g_{ij}}{g_{ij}} \cdot \frac{l}{2} \\ (\Delta p)_{ij} &= \Delta T_{ij} \cdot \delta t \cdot \Delta A \end{aligned} \tag{10}$$

If we use the following, from the Roberson-Walker metric [14]-[17]

$$\begin{aligned} g_{tt} &= 1 \\ g_{rr} &= \frac{-a^2(t)}{1 - k \cdot r^2} \\ g_{\theta\theta} &= -a^2(t) \cdot r^2 \\ g_{\phi\phi} &= -a^2(t) \cdot \sin^2\theta \cdot d\phi^2 \end{aligned} \tag{11}$$

Following Unruh [14] [15], write then, an uncertainty of metric tensor as, with the following inputs

$$a^2(t) \sim 10^{-110}, r \equiv l_P \sim 10^{-35} \text{ meters} \tag{12}$$

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

$$\begin{aligned} & V^{(4)} = \delta t \cdot \Delta A \cdot r \\ & \delta g_{tt} \cdot \Delta T_{tt} \cdot \delta t \cdot \Delta A \cdot \frac{r}{2} \geq \frac{\hbar}{2} \\ & \Leftrightarrow \delta g_{tt} \cdot \Delta T_{tt} \geq \frac{\hbar}{V^{(4)}} \end{aligned} \tag{13}$$

Here, we have that the lead-up of all of this, if we merely assume a massive energy flux is an enormous vacuum energy term.

Here, [1] [6]

$$K.E. \sim (E - V) \sim \dot{\phi}^2 \propto a^{-6} \tag{14}$$

Then [1] [6] [7]

$$\dot{\phi} \sim a^{-3} \Leftrightarrow \phi \approx t \cdot a^{-3} + H.O.T \tag{15}$$

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 inflation 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

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

Begin looking at material from page 483-485 of [8]

$$\left(\frac{\dot{a}}{a}\right)^3 - \frac{3}{2}\cdot\left(\frac{\dot{a}}{a}\right)^2 - 2\cdot\left(\frac{\ddot{a}}{a}\right)\cdot\left(\frac{\dot{a}}{a}\right) + \left[\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right] = 0 \tag{16}$$

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.

1) ***What if*** $\left(\frac{\ddot{a}}{a}\right)$ ***vanishingly small contribution.*** **(*low acceleration*)**

$$\left(\frac{\dot{a}}{a}\right)^3 - \frac{3}{2}\cdot\left(\frac{\dot{a}}{a}\right)^2 + \left[\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right] \cong 0 \tag{17}$$

Then, using the idea of a "repressed cubic" we will have the following solution for $\left(\frac{\dot{a}}{a}\right)$, namely [9]

$$\left(\frac{\dot{a}}{a}\right) = \text{Solution} = \xi \tag{18}$$

2) **Solutions for Equation (17), in reduced Cubic form for Equation (17)**

$$\xi = A+B, \frac{\sqrt{-3}}{2}\cdot(A-B) - \left(\frac{A+B}{2}\right), \frac{-\sqrt{-3}}{2}\cdot(A-B) - \left(\frac{A+B}{2}\right) \tag{19}$$

$$\begin{aligned} A &= \left(\left(\frac{-1}{128\pi G\cdot t^2} + \frac{\Lambda}{4}\right) + \sqrt{\frac{1}{4}\cdot\left(\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right)^2 + \frac{1}{8}}\right)^{1/3} \\ B &= -\left(\left(\frac{1}{128\pi G\cdot t^2} - \frac{\Lambda}{4}\right) + \sqrt{\frac{1}{4}\cdot\left(\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right)^2 + \frac{1}{8}}\right)^{1/3} \end{aligned} \tag{20}$$

Then using [9]

$$\Theta = \frac{1}{8}\cdot\left[2\cdot\left(\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right)^2 - 1\right] \tag{21}$$

$$\begin{aligned} &\Theta > 0 \Rightarrow \xi \ \text{ has, 1st real, 2nd imaginary, 3rd imaginary} \\ &\Theta = 0 \Rightarrow \xi \ \text{ has, 3 real roots, 2 of 3 roots equal} \\ &\Theta < 0 \Rightarrow \xi \ \text{ has, 3 real roots, all roots unequal} \end{aligned} \tag{22}$$

The situation to watch is when the time, *t*, is extremely small. Then one has 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

$$\begin{aligned} &\left[2\cdot\left(\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right)^2 - 1\right] \approx 0 \Leftrightarrow \left(\frac{-1}{64\pi G\cdot t^2} + \frac{\Lambda}{2}\right) \approx \frac{1}{\sqrt{2}} \\ &\Leftrightarrow \Lambda \approx \sqrt{2} + \frac{1}{32\pi G\cdot t^2} \end{aligned} \tag{23}$$

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

$$\Theta \le 0 \Leftrightarrow \Lambda \ge \sqrt{2} + \frac{1}{32\pi G \cdot t^2} \tag{24}$$

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 [10]

$$\begin{aligned} & a(t) = a_{\text{initial}} t^{\nu} \\ & \Rightarrow \phi = \ln\left(\sqrt{\frac{8\pi G V_0}{\nu \cdot (3\nu - 1)}} \cdot t \right)^{\sqrt{\frac{\nu}{16\pi G}}} \\ & \Rightarrow \dot{\phi} = \sqrt{\frac{\nu}{4\pi G}} \cdot t^{-1} \\ & \Rightarrow \frac{H^2}{\dot{\phi}} \approx \sqrt{\frac{4\pi G}{\nu}} \cdot t \cdot T^4 \cdot \frac{1.66^2 \cdot g_*}{m_P^2} \approx 10^{-5} \end{aligned} \tag{25}$$

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

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

First of all, rather than use the scalar field as given in Equation (8) and Equation (9) we use a different approach, as given by (19) and we also look at a different application of the shape function argument for incremental time. As pioneered by Barbour [4]

$$\delta t = \sqrt{\frac{\sum m_a \delta x_a \cdot \delta x_a}{2\left(E - V(\text{potential})\right)}} \tag{26}$$

In our case, our simplication is to rewrite this by using Equation (19)

$$\begin{aligned} \delta t = \sqrt{\frac{m_g \cdot (\delta x)^2}{2\left(E - V(\text{potential})\right)}} & \xrightarrow[\ell_p \to 1]{} \sqrt{\frac{m_g \cdot (\delta x)^2}{2\left(E - V(\text{potential})\right)}} \\ & \xrightarrow[\delta x \to \ell_p \to 1]{} \sqrt{\frac{m_g \cdot 8\pi G}{\alpha}} \cdot t \end{aligned} \tag{27}$$

Then in doing so, we will be obtained by the initial uncertainty principle as of Equation (4)

$$\begin{aligned} \Delta E & \xrightarrow[\delta x \to \ell_p \to 1]{} \sqrt{\frac{4\pi G \hbar^2}{t^2 \cdot m_g}} \cdot \frac{1}{\left(a_0 t^{\alpha}\right)^2 \cdot \ln\left(\sqrt{\frac{8\pi G V_0}{\alpha \cdot [3\alpha - 1]}} \cdot t \right)} \\ & \xrightarrow[t \to t_p \to 1]{} \sqrt{\frac{4\pi G \hbar^2}{m_g}} \cdot \frac{1}{\left(a_0\right)^2 \cdot \ln\left(\sqrt{\frac{8\pi G V_0}{\alpha \cdot [3\alpha - 1]}} \right)} \end{aligned} \tag{28}$$

Here, *i.e.* if the mass of a graviton is not zero, and if we have an initial potential $V_0 \neq \infty$ and $\alpha \neq \frac{1}{3}$ as well as time not set equal to zero as well as an initial scale factor not equal to zero, we will be able to obtain values which are not incommensurate as to formation of primordial black holes. And also Equation (27) can be compared against

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

$$\Delta t_{\text{time}}(\text{initial}) = \hbar / (\delta g_{tt} E_{\text{initial}}) = \frac{2\hbar}{\delta g_{tt} \cdot g_{*s}(\text{initial}) \cdot T_{\text{initial}}} \tag{29}$$

This would put a requirement upon a very large initial temperature T_{initial} and so then, if $S(\text{initial}) \sim n(\text{particle count}) \approx g_{*s}(\text{initial}) \cdot V_{\text{volume}} \cdot \left(\frac{2\pi^2}{45}\right) \cdot (T_{\text{initial}})^3$ [11]

$$S(\text{initial}) \sim n(\text{particle count}) \approx \frac{V_{\text{volume}}}{g_{*s}^2(\text{initial})} \cdot \left(\frac{2\pi^2}{45}\right) \cdot \left(\frac{\hbar}{\Delta t_{\text{initial}} \cdot \delta g_{tt}}\right)^3 \tag{30}$$

Having said that how do we obtain a quantum number, n, as to Black holes, and the phenomenon of Torsion? To come up with a finite value of the cosmological constant?

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

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

$$\begin{aligned} \sqrt{\Lambda} &= \frac{k_B E}{\hbar c S_{\text{entropy}}} \\ S_{\text{entropy}} &= k_B N_{\text{particles}} \end{aligned} \tag{31}$$

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

$$\begin{aligned} m &\approx \frac{M_P}{\sqrt{N_{\text{gravitons}}}} \\ M_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot M_P \\ R_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot l_P \\ S_{BH} &\approx k_B \cdot N_{\text{gravitons}} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{\text{gravitons}}}} \end{aligned} \tag{32}$$

This is promising but needs to utilize [12] in which we make use of the following. First a time step

$$\tau \approx \sqrt{GM\delta r} \tag{33}$$

By use of the HUP [13] we use Equation (34) for energy [12] for radiation of a particle pair from a black hole, via use of [12]

$$\left|E\right| \approx \left(\sqrt{GM\delta r}\right)^{-1}\hbar \tag{34}$$

Here we assert that the spatial variation goes as

$$\delta r \approx \ell_P \tag{35}$$

This is of a Plank length, whereas we assume in Equation (33) that the mass is a Planck sized black hole

$$M \approx \alpha M_P \tag{36}$$

If so, we transform Equation (34) to be of the form for a "particle" pair as given in Carlip [12]

$$\left|E\right| \approx \left(\sqrt{G\cdot\left(\alpha M_P\right)\cdot \ell_P}\right)^{-1}\hbar \tag{37}$$

We argue that for small black holes that we are talking about intense radiation from a Planck sized black hole, so we approximate Equation (37) as the mass of a relic black hole. Now using the following normalization of Planck units, *i.e.* [13] as

$$G = M_P = \hbar = k_B = \ell_P = c = 1 \tag{38}$$

And, also, the initial energy, E [14] [15]

$$E_{Bh} = -\frac{n_{\text{quantum}}}{2} \tag{39}$$

We then can use for a Black hole the scaling,

$$\left|E\right| \approx \left(\sqrt{G\cdot\left(\alpha M_P\right)\cdot \ell_P}\right)^{-1}\hbar \xrightarrow[G=M_P=\hbar=k_B=\ell_P=c=1]{} \left(1/M_{BH}\right)^{1/2} \approx \frac{n_{\text{quantum}}}{2} \tag{40}$$

We then reference Equation (32) to observe the following

$$\begin{aligned} &M_{BH} \approx \sqrt{N_{\text{gravitons}}}M_P \\ &\Rightarrow \left(1/M_{BH}\right)^{1/2} \approx \frac{n_{\text{quantum}}}{2} \approx \frac{1}{\left(N_{\text{gravitons}}\right)^{1/4}} \\ &\Rightarrow n_{\text{quantum}} \approx \frac{2}{\left(N_{\text{gravitons}}\right)^{1/4}} \end{aligned} \tag{41}$$

This is a stunning result, *i.e.* Equation (32) 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 the following **Table 1**.

Table 1 from [2] assumes Penrose recycling of the Universe as stated in that document.

Table 1. 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

Continued

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 [1]-[4]. To begin this look at [2], which is akin, as we discuss later to [16]

$$\rho_{\Lambda}c^2 = \int_0^{E_{\text{Plank}}/c} \frac{4\pi p^2 \mathrm{d}p}{(2\pi\hbar)^3}\cdot\left(\frac{1}{2}\cdot\sqrt{p^2c^2+m^2c^4}\right) \approx \frac{\left(3\times10^{19}\,\text{GeV}\right)^4}{(2\pi\hbar)^3} \xrightarrow[E_{\text{Plank}}/c\to10^{-30}]{} \frac{\left(2.5\times10^{-11}\,\text{GeV}\right)^4}{(2\pi\hbar)^3} \tag{42}$$

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 fact, by [2]

$$\frac{\Delta E}{c} = 10^{18}\,\text{GeV} - \frac{n_{\text{quantum}}}{2c} \approx 10^{-12}\,\text{GeV} \tag{43}$$

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 (42) 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 given in Equation (15) whereas what is done in Equation (42) by [1] [2] is restricted to a different venue which is reproduced below, namely cancellation of the following by Torsion [16]

$$\rho_{\Lambda}c^2 = \int_0^{E_{\text{Plank}}/c} \frac{4\pi p^2 \mathrm{d}p}{(2\pi\hbar)^3}\cdot\left(\frac{1}{2}\cdot\sqrt{p^2c^2+m^2c^4}\right) \approx \frac{\left(3\times10^{19}\,\text{GeV}\right)^4}{(2\pi\hbar)^3} \tag{44}$$

Furthermore, the claim in [2] is that there is no cosmological constant, *i.e.* that Torsion always cancelling Equation (44) 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

(44) above.

6. 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 [9] [17], we have the following, *i.e.*, we have a spin density term of [1] [9] [17]. And this will be what we input black hole physics into to form a spin density term from primordial black holes.

$$\sigma_{Pl} = n_{Pl}\hbar \approx 10^{71} \tag{45}$$

7. Now for the Statement of the Torsion Problem as Given in [1] [2] [9] [17]

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 [9] [17] as

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

8. What [9] Does as to Equation (46) 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 (46) reduces to

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right)\cdot[\rho] - \frac{\tilde{k}c^2}{\tilde{R}^2} \tag{47}$$

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 [9] [17]

$$\left(\frac{\dot{\tilde{R}}}{\tilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right)\cdot[\rho] + \frac{\Lambda_{0\text{bserved}}c^2}{3} - \frac{\tilde{k}c^2}{\tilde{R}^2} \tag{48}$$

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 (47) and Equation (48) 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.

9. Filling in the Details of the Equation (47) Collapse of the Cosmological Term, versus the Situation Given in Equation (48) via Numerical Values

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

$$\Lambda_{Pl} c^2 \approx 10^{87} \tag{49}$$

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

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right]+\frac{\Lambda c^2}{3}=0 \tag{50}$$

What we are arguing is that instead, one is seeing, instead [17]

$$\left(\frac{8\pi G}{3}\right)\cdot\left[-\frac{2\pi G\sigma^2}{3c^4}\right]+\frac{\Lambda_{Pl} c^2}{3}\approx 10^{-122}\times\left(\frac{\Lambda_{Pl} c^2}{3}\right) \tag{51}$$

Our timing as to Equation (50) is to unleash a Planck time interval t about 10^−43 seconds.

As to Equation (50) versus Equation (51), the creation of the torsion term is due to a presumed particle density of

$$n_{Pl} \approx 10^{98}\ \text{cm}^{-3} \tag{52}$$

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

10. Future Works to Be Commenced as to Derivational Tasks

We will assume for the moment that Equation (50) and Equation (51) share in common Equation (52).

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 (50) by Equation (52) is defined to be an ad hoc creation, as to [3]. 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.

11. Conclusion, Looking Directly at a Modification of the Black Holes Which Have No Hair Theorem, via the Inputs of This Document

In [18], we have the essential black holes that 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 [19] 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 [20].

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 [20].

I.e. using our equation 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

$$|N| \approx |N_{\text{gravitons}}| \approx \left(\frac{5t}{64^2 \pi^4}\right)^{2/5} \tag{53}$$

Due to using [3]

$$M \approx \sqrt{N} M_p \tag{54}$$

M here being linked to the mass of a BEC black hole, and also using Equation (3) for the loss of a black hole, over time.

Also use

$$|N_{\text{gravitons}}|^{5/2} \times \left(M_p \equiv 1\right)^{5/2} \approx \left(\frac{5t}{64^2 \pi^4}\right) \tag{55}$$

Then use the last equation of Equation (32) to obtain, a quantum number associated with a graviton just outside a BEC primordial black hole

$$n_{\text{graviton quantum number}} \equiv n_{\text{graviton}} \approx \left[\frac{2 \cdot 64^{1/10} \pi^{1/5}}{5^{1/20} \cdot t^{1/20}}\right] \approx \frac{2.16245415907}{t^{1/20}} \tag{56}$$

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.

If so then, and this is for primordial black holes, we then associate this graviton number, n for a graviton as linked to the following from [20], *i.e.* their Equation

(65) so we have for the radius of a BEC black hole as deformed by this quantum number n, a small change

$$\frac{\Delta R_n}{R_n} \equiv \frac{\sqrt{n^2+2}}{3n} \tag{57}$$

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 [20] an ADM mass variance of M so then there is, due to gravitons, a rough change in initial Planck sized black holes

$$\Delta R_n = \left(\frac{\sqrt{n^2+2}}{3n}\right)\cdot R_n \approx \left(\frac{\sqrt{n^2+2}}{3n}\right)\Bigg|_{n\equiv 2.16245415907} \times R_n \tag{58}$$

where $n \ge (1-\varepsilon)\cdot(M/M_p)^2$ and we can compare our value of R, as given in Equation (32) with [20] having a different scale for R, as given in their Equation (60).

Needless to say, graviton number n, as specified, due to the processes within the primordial black hole we assert would lead to a violation of the black holes have no hair theorem, of [19].

We assert that this value of n, so obtained, as to gravitons would be as to the Corda result on Equation (39) the following

$$\begin{aligned} n(\text{black holes}) &= N(\text{graviton number per black hole}) \\ &\times n(\text{quantum number per graviton}) \end{aligned} \tag{59}$$

The left hand side of Equation (59) would be fully commensurate with Equation (39) of Corda's black hole quantum number [16].

The right hand side of Equation (59) 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 [17].

12. Future Developments for Applications of a Primordial HUP? Linking This to a Theory of Complex Initial and Final Structures. Black Holes Brought up

From **Table 1** from Appendix 2, of [18] assuming Penrose recycling of the Universe as stated in that document.

The limits in section four may give structural complexity data relevant to the following development. As given, see **Table 1**, Appendix 2. This increase in complexity can be with work tied into the following for black hole physics [3] from Equation (1). References from [18]-[21] are to be generally reviewed as to inspiration as to what we say next. We will try to quantify all this in future research work to explain this in terms of the physics of phase transitions, in the universe and cyclic conformal cosmology.

13. 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 the start, we will pay attention to a datum in reference [3], namely a Horizon, like a Schwarzschild black hole construction with [22]

$$L_A = \sqrt{\frac{3}{\Lambda}} \tag{60}$$

In what [22] deems as a corpuscular gravity, one would have a "kinetic energy term" per graviton

$$\in_G \cong \frac{M_p}{\sqrt{\tilde{N}}} \tag{61}$$

And the mass of a black hole, scaling as [22]

$$M_{\text{black hole}} \cong \sqrt{\tilde{N}} M_p \approx \tilde{N} \in_G \tag{62}$$

This in [3] has the exact same functional forms as is given in Equation (41) so then we have $\tilde{N} = N$ and furthermore [22] also has

$$\in_G \cong \frac{M_p}{\sqrt{\tilde{N}}} \cong \frac{\hbar}{L_A} \approx \frac{M_p}{\sqrt{N}} \tag{63}$$

If so for Black holes, we have the following

$$\sqrt{\Lambda} \cong \frac{\sqrt{3} M_p}{\hbar \sqrt{N}} \tag{64}$$

Now as to what is given in [1] [2] as to Torsion, we have that as given in [18] 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 said 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 to say 10^{50} black holes of say of Planck mass, to work with an initial volume for the production of black holes set as

$$V_{\text{volume(initial)}} \sim V^{(4)} = \delta t \cdot \Delta A_{\text{surface area}} \cdot \left(r \leq l_{\text{Planck}}\right) \tag{65}$$

Then as to the follow up to NLED and signals from primordial processes [21]

$$\begin{aligned} \alpha_0 &= \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0 \\ \hat{\lambda}(\text{defined}) &= \Lambda c^2 / 3 \\ a_{\min} &= a_0 \cdot \left[\frac{\alpha_0}{2\hat{\lambda}(\text{defined})} \left(\sqrt{\alpha_0^2 + 32\hat{\lambda}(\text{defined}) \cdot \mu_0 \omega \cdot B_0^2} - \alpha_0 \right) \right]^{1/4} \end{aligned} \tag{66}$$

Where the following is possibly linkable to minimum frequencies linked to *E* and *M* fields, and possibly relic Gravitons [21]

$$B > \frac{1}{2 \cdot \sqrt{10\mu_0 \cdot \omega}} \tag{67}$$

We submit the following for future investigation, namely the *n* particle count is related directly to inputs into Equation (5) and that the quantum number as discussed is linkable to the discussion given in Equation (45) and Equation (46).

Furthermore, the frequency, as given in Equation (67) would be tied into Equation (14) via the *n* of that equation as well as specified by [22] on its page 111, where we have

$$\omega = g_{rr} c k \tag{68}$$

Here g_{rr} is nearly zero, 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 to obtain ideas as to data sets which would satisfy multi-messenger astronomy namely the discussion as given in Mohanty, [23] namely a temperature, with scale factor as given in page 261

$$T \sim \frac{1}{g^* a} \tag{69}$$

With temperature *T*, as proportional to quantum number *n* as specified.

Here, we also have to consider the issues about primordial black holes as raised in [24] which are still unanswered as well as [25] as raised by Ruffini *et al.* as well as [26] and [27] as well as review the information on fifth forces given in [2] and other such constructions.

Conflicts of Interest

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

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