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Does Vacuum Energy Allow for Computational "Bits" at the Start of Cosmological Evolution, and Their Possible Ties to Torsion Physics

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Abstract

Based on the notion that torsion cancels cosmological vacuum energy [1], we consider if relic black holes at the start of inflation may allow for the observed cosmological constant. If thermal energy used at the start of inflation creates conceptual issues, an energy term based on Corda's treatment of black holes may provide a solution, a leftover cosmological constant 10^{-121} times vacuum energy. Considerations as to how black-hole physics may contribute to torsion and the cosmological constant are considered in several numerical cases. Also we present entanglement entropy in the early universe with a shrinking scale factor [2] and show that consequences arise due to initial entangled for a time-dependent horizon radius in cosmology with flat space conditions for conformal time. This construction preserves a minimum nonzero vacuum energy, and, in doing so, keeps the computational bits for cosmological evolution. The bits are ascribed to initial torsion as we describe.

1 Introduction

We review torsion [1] and its cancelation of vacuum energy and the cosmological constant, namely

$$\left(\frac{\mathrm{d}}{\mathrm{d}a}\tau\right)^2 = \left[1 - \frac{\beta_1}{a^2} - \frac{\beta_2}{a^2}\right] \tag{1}$$

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. Therefore,

$$\left(\frac{\mathrm{d}}{\mathrm{d}a}\tau\right)^2 = \left[1 - \frac{l_{\mathrm{P}}^2}{a^2} - \frac{l_{\mathrm{P}}^4}{a^2}\right] \tag{2}$$

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, adding a torsion spin term [1],

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

Table 1: Total Black-Hole Mass and Count Assuming Penrose Recycling

End of prior universe time frame	Mass (black hole): super-massive end-of-time black hole 1.98910×10^{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) to have, say, 10^{10} gravitons/second released per black hole	Mass (black hole) 10 g to say 10^6 g per black hole	Number (black holes) due to repeated black-hole-pair formation. 10^{20} to at most 10^{25}

To fully analyze this, we make use of the following analysis of black holes. Table 1 [3] assumes Penrose recycling of the universe.

We consider how the Planckian regime of space–time may influence torsion directly.

2 Some Modifications of Eq. (3)

Following [1, 3], we use two substitutions for our problem.

$$\begin{aligned}\sqrt{\Lambda} &= \frac{k_B E}{\hbar c S_{\text{entropy}}} \\ S_{\text{entropy}} &= k_B N_{\text{particles}}\end{aligned} \tag{4}$$

We also reference the BEC condensate given by [1, 4] for scaling.

$$\begin{aligned}m &\approx \frac{M_{\text{P}}}{\sqrt{N_{\text{gravitons}}}} \\ M_{\text{BH}} &\approx \sqrt{N_{\text{gravitons}}} \cdot M_{\text{P}} \\ R_{\text{BH}} &\approx \sqrt{N_{\text{gravitons}}} \cdot l_{\text{P}} \\ S_{\text{BH}} &\approx k_B \cdot N_{\text{gravitons}} \\ T_{\text{BH}} &\approx \frac{T_{\text{P}}}{\sqrt{N_{\text{gravitons}}}}\end{aligned} \tag{5}$$

To begin this look at [1, 3, 4], which purports to show a global cancellation of a vacuum energy term and is akin, as we discuss later, to cancelling the following completely [4, 5].

$$\rho_\Lambda c^2 = \int_0^{E_{\text{Planck}}/c} \frac{4\pi p^2\,\mathrm{d}p}{(2\pi\hbar)^3} \cdot \left(\frac{1}{2} \cdot \sqrt{p^2c^2 + m^2c^4}\right) \approx \frac{(3 \times 10^{19}\,\text{GeV})^4}{(2\pi\hbar)^3} \xrightarrow[E_{\text{Planck}}/c \to 10^{-30}]{} \frac{(2.5 \times 10^{-11}\,\text{GeV})^4}{(2\pi\hbar)^3} \tag{6}$$

If so, then we will be looking at Eq. (3) to be recast as

$$\left(\frac{\dot{\widetilde{R}}}{\widetilde{R}}\right)^2 = \left(\frac{8\pi G}{3}\right) \cdot \left[\rho - \frac{2\pi G\sigma^2}{3c^4}\right] + \frac{k_B^2 E^2}{3\hbar^2 c^2 \cdot [k_B^2 N^2_{\text{particles}}]} - \frac{\widetilde{k}c^2}{\widetilde{R}^2} \tag{7}$$

Our analysis from here will delve into different candidate versions of energy E put into Eq. (7) as to what could be expected for the torsion term and its implications in cosmology. That is, keep in mind that Eq. (7) as configured in this situation is assuming in [1] that torsion completely cancels a cosmological constant.

3 What If Energy *E* in Eq. (7) Is Thermal?

We then will be looking at

$$\frac{k_B^2 c_1^2 T^2_{\text{Temperature}}}{12\hbar^2 c^2 \cdot [k_B^2 N^2_{\text{particles}}]} - \frac{16\pi G}{9} \cdot \frac{2\pi G\sigma^2}{c^4} \equiv \frac{\Lambda_{\text{observed}} c^2}{3}. \tag{8}$$

Assuming that $\Lambda_{\text{observed}} c^2$ is of the order of 10^{-35}, this yields

$$N^2_{\text{particles}} \approx \frac{\frac{12\hbar^2 c^2}{c_1^2 T^2_{\text{Temperature}}}}{\frac{16\pi G}{9} \cdot \frac{2\pi G\sigma^2}{c^4} + \frac{\Lambda_{\text{observed}} c^2}{3}}. \tag{9}$$

This becomes smaller and smaller with increasing initial temperature. Of course, this is not viable when applying Eq. (5), and the problem becomes a bit ridiculous with no torsion term: We would be then be looking at N going way past 10^{120}, beyond the observed or expected entropy of the universe.

This is not going to go over well; the only way to have a huge number of initial *particles*—say, initial black holes and gravitons from the black holes—would be if we assume Table 1 is for the initial Planckian regime with low temperature values. This is *not* what occurs.

4 Changing the Energy

By default, we will be looking then at changing the energy E to the Corda value of energy for a black hole, so then we will be looking at the following. Namely,

$$\frac{(\hbar\omega \cdot n_{\text{quantum number}})^2}{12\hbar^2 c^2 \cdot [k_B^2 N_{\text{particles}}^2]} - \frac{16\pi G}{9} \cdot \frac{2\pi G \sigma^2}{c^4} \equiv \frac{\Lambda_{\text{observed}} c^2}{3}. \tag{10}$$

In effect, based on Eq. (6), we would be stating

$$\frac{\Delta E}{c} = 10^{18}\,\text{GeV} - \frac{n_{\text{quantum number}}}{2c} \simeq 10^{-12}\,\text{GeV}. \tag{11}$$

But the term $n_{\text{quantum number}}$ comes from a Corda-derived expression for energy level of relic black holes [6] after Planckian space–time normalization.

$$E_{\text{Bh}} = -\frac{n_{\text{quantum number}}}{2} \tag{12}$$

Here, ω is presumably Planck frequency $\approx 6.62607015 \times 10^{-34}\,\frac{\text{J}}{\text{Hz}}$ (or J s) or 3×10^{42} Hz. We are presuming in doing so that this is a GW frequency for initial relic GW from this process.

5 Modeling Challenges, Future Investigations

First, what are the particle N term and the quantum n terms used in Eq. (10)? This needs to be explicitly worked out. Second, assume [1] the following values: Our timing for Eq. (10) is to unleash a Planck time interval t of about 10^{-43} s. Again in Eq. (10), the creation of the torsion term is due to a presumed particle density of

$$n_{\text{Planck}} \approx 10^{98}\,\text{cm}^{-3} \tag{13}$$

Finally, we have a spin density term of

$$\sigma_{\text{Planck}} = n_{\text{Planck}}\hbar \approx 10^{71}. \tag{14}$$

Would this spin density term be commensurate to Gravitons as a BEC condensate? This sort of detail must be worked out in future modeling of this problem. This work on torsion, while indeed relavatory, needs to be also considered in light of [7], which we present below.

Note that the punchline to all of this is contained in [2], which models the initial configuration of the universe after the onset of conditions in Table 1, like a giant black hole. Also, a change-in-entropy formula [8] reveals the interrelationship between energy, entropy, and temperature:

$$m \cdot c^2 = \Delta E = T_{\text{U}} \cdot \Delta S = \frac{\hbar \cdot a}{2\pi \cdot c \cdot k_{\text{B}}} \cdot \Delta S. \tag{15}$$

As a reviewer has asked about Eq. (15) and the interrelationship of a mass, m, and acceleration, the key point of this review is to examine if gravitons have a mass, m, in the beginning, and—if Eq. (15) is used–if the mass of a graviton is proportional to

$$m = \frac{\Delta E}{c^2} = \frac{T_{\mathrm{U}} \cdot \Delta S}{c^2} = \frac{\hbar \cdot a}{2\pi \cdot c^4 \cdot k_{\mathrm{B}}} \cdot \Delta S. \tag{16}$$

The mass of a graviton is stated in Eq. (16) to presume that the relationship given by Lee [8], for any mass, is given by Eq. (15) and Eq. (16). So, we can relate any presumed mass linked to gravitons to change in entropy. The acceleration comes from Eq. (15), Eq. (16), and, by thermodynamic reasoning, the generalized temperature [2, 7, 8].

$$T_{\mathrm{U}} = \frac{\hbar \cdot a}{2\pi \cdot c^2 \cdot k_{\mathrm{B}}} \tag{17}$$

If we assume, in the onset of expansion of the universe, that Eq. (17) holds, then we can review the application of Eq. (16) to graviton mass, m, as $m = \frac{\Delta E}{c^2} = \frac{T_{\mathrm{U}} \cdot \Delta S}{c^2}$. This yields acceleration, given by $a \simeq \frac{c^2}{\Delta x}$, as part of a definition of generalized temperature, given by Eq. (17).

Note that temperature is, in this presentation by Lee [8], presumably a constant initially, very hot, so then we are really in this presentation assuming that the acceleration, as given by $a \simeq \frac{c^2}{\Delta x}$, is a constant. So, in fact, we are actually reviewing, through Eq. (16), a direct relationship of mass as proportional to entropy:

$$m \sim \Delta S. \tag{18}$$

That is, the mass of a graviton is presumed to be proportional to entropy. In choosing Eq. (18), we are leading up to one of the themes of this document: If entropy is proportional to information—and note that later we will be relating entropy, as given, to a numerical count factor—then, in fact, this will lead to a rewrite of Eq. (18) to read as, if N_{count} is a numerical count proportional to the change in entropy,

$$m \sim \Delta S \sim N_{\mathrm{count}} \Rightarrow m_{\mathrm{graviton}} \sim \frac{\Delta S}{N_{\mathrm{count}}}. \tag{19}$$

This assumes, that we are evaluating Eq. (17) as a constant. That is, the temperature is fixed, which leads to the acceleration as a constant via the relationship $a \simeq \frac{c^2}{\Delta x}$ as a fixed acceleration factor. Presumably the Δx factor is on the order of a Planck length. This also involves considering [2] as well. Now how can we reconcile Eq. (19) with Eq. (5) of this manuscript [7]?

$$\begin{gathered} m \sim \Delta S \sim N_{\mathrm{count}} \Rightarrow m_{\mathrm{graviton}} \sim \frac{\Delta S}{N_{\mathrm{count}}} \\ m \approx \frac{M_{\mathrm{P}}}{\sqrt{N_{\mathrm{gravitons}}}} \Leftrightarrow m_{\mathrm{graviton}} = m \Rightarrow \frac{\Delta S}{N_{\mathrm{count}}} \approx \frac{M_{\mathrm{P}}}{\sqrt{N_{\mathrm{gravitons}}}} \end{gathered} \tag{20}$$

If so, then a counting algorithm, N_{count}, exists that may be different from the number of released gravitons from relic black holes of say Planck size:

$$\Delta S \approx \frac{M_{\mathrm{P}} N_{\text{count}}}{\sqrt{N_{\text{gravitons}}}} \propto \aleph \times (S_{\mathrm{BH}} \approx k_{\mathrm{B}} \cdot N_{\text{gravitons}}(\text{per black hole})) \tag{21}$$

$$M_{\mathrm{BH}} \approx \sqrt{N_{\text{gravitons}}} \cdot M_{\mathrm{P}}. \tag{22}$$

Here, we have then that then the *Number*, $\aleph$, is in reference to the number of black holes and is in tandem with Table 1 of this document. And, by the way, the purported radius (R_{initial}) for the initial configuration of the number of relic black holes is given by [7] with follow up comments from both [2] and [8] in attendance, is a minimum radii and has nothing to do with curvature. This formula has evidently confused referees. That is, if # refers to a computational-bits value which will show up in our manuscript, then our statement is that we have an initial radii of less than Planck Length.

$$R_{\text{initial}} \sim \frac{1}{\#} \ell_{Ng} < l_{\text{Planck}} \tag{23}$$

Then, if we make use of the Ng formula [7] with M being the mass of the total number of black holes initially created [2, 8],

$$\#\text{bits} \sim \left[\frac{E}{\hbar} \cdot \frac{l}{c}\right]^{\frac{3}{4}} \approx \left[\frac{Mc^2}{\hbar} \cdot \frac{l}{c}\right]^{\frac{3}{4}}. \tag{24}$$

The term that shows up in [7] is that we have *lub* Eq. (23) for total initial entropy. That is, if l in Eq. (24) is commensurate with initial configuration entropy of the universe as given by [2],

$$S_{\text{Entropy}} = \frac{0.3 r_{\mathrm{H}}^2}{a^2}. \tag{25}$$

The term $a_{\text{initial}} \sim 10^{-30}$ is a starting point, and the term $r_{\mathrm{H}} \propto R_{\text{initial}}$ may be feasible, but needs a lot of work for confirmation. Finally, we end up with the following to confirm [7]. If for a time-dependent horizon radius r_{H} in cosmology Eq. (25) holds, what does this say about Table 2 and [8, 9, 10]?

The tie in with Torsion is in Table 2, in the first era. It is also linked to determining $\aleph$ due to the influence of black-hole numbers in Table 1. Also from [7], this needs to be investigated.

$$\ln a + \frac{a^6}{6} + \frac{2 \cdot a^3}{3} = \sqrt{\frac{8\pi}{3}} \cdot \frac{t}{t_{\text{Planck}}} \tag{26}$$

Two time and scale factor values in tandem stand out particularly:

$$a \sim \frac{a_{\text{scale}}}{[a_{\text{Planck}} \sim 10^{-25}]} \equiv 1.344 \Leftrightarrow t \propto t_{\text{Planck}} \sim 5.4 \times 10^{-44}\,\text{s}. \tag{27}$$

This in turn may involve more of [9] and [10] once we get more derivational work, but the tie into Torsion physics awaits the confirmation and further development of the bits of *information* initially, which we claim is connected to Table 1.

Table 2: Dynamic Consequences and QM Applicability through Time

Time Interval	Dynamic consequences	QM/WdW applies?
Just before Electroweak era	Form from early E & M fields, and use Maxwell's equations as necessary to implement boundary conditions due to change from Octonionic geometry to flat space	NO
Electro-Weak Era	$\hbar$ kept constant due to Machian relations	YES
Post Electro-Weak Era to today	$\hbar$ kept constant due to Machian relations	YES, Wave function of the universe

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