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New Conservation Law and a Consideration as to When Forming a Cosmological Constant Term: Using Fifth Force for Frequency of BEC "Gravitons" and Cosmological Constant Formed before BEC Gravitons Form

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Abstract

We use scalar fields. The scalar field version which we are using is one from Padmanabhan, and the problem is that the scalar field in the Padmanabhan representation is initially only dependent on time. We also refer to a new assumed conservation law which will give new structure as to inflationary expansion and its immediate aftermath. That of the Hubble "constant" is divided by the "time derivative" of the scalar field in the inflation regime and then a long time afterwards. In doing so, we help define when the cosmological constant may form and what they says about the advent of dark energy.

Keywords

Inflaton, Fifth Force, Gravitational Waves, Gravitons, Hubble Parameter

1. Introduction

Our idea is to regularize inflation and its aftermath by a Hubble parameter divided by the derivative of a scalar field, as being about the same ratio in Planckian space time and then say in the time frame within a billion years of the present. The benefits of such an interpretation are to regularize how we obtain GW frequency. The way to do this assumes pre universe giant sized black holes broken up into tiny black holes by the uncounted millions [1].

This is useful in terms of determining conditions for which we have the formation of a cosmological constant [2].

In a word, it will be making sense of the following calculation, namely where we have [3].

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

This limiting value of Equation (1) would be by [1] necessary to reset the vacuum energy to be the cosmological constant.

In a word, the vacuum energy is reduced 10^{-120} times. First of all, we try to determine some initial conditions.

2. How We Will Obtain Scalar Field Behavior We Want. For Conditions for a Fifth Force

Using

$$a(t) = a_{\text{initial}} t^{\nu} \tag{2}$$

Which will lead to? [3] gives a temperature dependence for the Hubble parameter and [4] permits

$$\frac{H^2}{\dot{\phi}} \approx \sqrt{\frac{4\pi G}{\nu}} \cdot t \cdot T^4 \cdot \frac{1.66^2 \cdot g_*}{m_P^2} \approx 10^{-5} \tag{3}$$

The Equation (3) is part of a conservation law which is considered to be true in the initial expansion, Planck regime of space-time.

This of course makes uses of Equation (4) for the Hubble parameter, the Padmabhan value of the scalar field due to Equation (2) and this is all assuming a value of [3]

$$H = 1.66\sqrt{g_*} \cdot \frac{T^2_{\text{temperature}}}{m_P} \tag{4}$$

We will make the following calculation [5]

$$V_0 = \left(\frac{0.022}{\sqrt{qN_{\text{efolds}}}}\right)^4 = \frac{\nu(\nu-1)\lambda^2}{8\pi G m_P^2} \tag{5}$$

λ is a dimensionless parameter which we refer to later. From references [1] and [6] we set the Chameleon mechanism for fifth force as

$$F_{\text{5th-force}} = -\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \tag{6}$$

Equation (6) equals zero of we have a scalar field solely dependent upon time.

We use here in Pre Planckian conditions the substitution

$$t = \frac{r}{\varpi c} \tag{7}$$

What we need to do now is to get a way to calculate what the frequency would be in BEC units.

In terms of Planck Units [1] in Planckian space-time

$$\begin{aligned}
&\omega_{gw}^{6} \approx c^{7} \times \frac{\tilde{\beta}}{2m_P r} \cdot \sqrt{\frac{\nu}{\pi G}} \times \frac{1}{Gc \cdot \left(M_{\text{mass}}\right)^2 \left\langle r^2 \right\rangle^2} \\
&\Rightarrow \omega_{gw} \approx G, m_P, r \approx \ell_p \xrightarrow[\text{Planck normalization}]{} 1 \\
&M_{\text{mass}} \approx \varsigma \cdot m_P \xrightarrow[\text{Planck normalization}]{} \varsigma \\
&\left\langle r^2 \right\rangle^2 \approx \ell_p^4 \xrightarrow[\text{Planck normalization}]{} 1 \\
&\therefore \omega_{gw} \xrightarrow[\text{Planck normalization}]{} \left(\sqrt{\frac{\nu}{4\pi}} \times \frac{\tilde{\beta}}{\varsigma^2}\right)^{1/6}
\end{aligned} \tag{8}$$

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 Equation (2) 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 [1] [5] [7] [8] [9].

What this means is that coefficient ν in the initial genesis of GW which will be in Planckian space-time to be

$$\nu \xrightarrow[\text{Planck normalization}]{} 4\pi \times \left(\omega_{gw}\right)^{12} \times \frac{\varsigma^4}{\tilde{\beta}^2} \tag{9}$$

This is the frequency of the initial gravitational waves, and of the gravitons, NET.

3. Energy Values, and the Degrees of Freedom Initially

In an earlier paper, initial mass [1] [10] is written as a huge value, namely by [1]

$$\begin{aligned}
&M = \sqrt{\sqrt{g_*} \cdot \frac{1.66\hbar}{64\pi^2 m_P G^2 k_B^2}} \cdot \sqrt{\frac{t}{\gamma}} \sqrt{N_{\text{Gravitons}}} \cdot m_{\text{Planck}} \\
&\xrightarrow[\text{Planck Units}]{} \approx \sqrt[4]{g_*} \cdot \sqrt{\frac{1.66}{64\pi^2}} \cdot m_{\text{Planck}} \approx \sqrt{N_{\text{Gravitons}}} \cdot m_{\text{Planck}} \approx 10^{60} \cdot m_{\text{Planck}}
\end{aligned} \tag{10}$$

If this is done, then the Graviton condensate relationship as argued by the author before, should also be examined as far as experimental verification [1] [11] [12]. It would be optimal if we find that the Pre Planckian to Planckian physics regime would have a lot of black holes, as given in [1] [12]

$$\begin{aligned}
&m \approx \frac{M_P}{\sqrt{N_{\text{gravitons}}}} \\
&M_{BH} \approx \sqrt{N_{\text{gravitons}}} \cdot M_P \\
&R_{BH} \approx \sqrt{N_{\text{gravitons}}} \cdot l_P \\
&S_{BH} \approx k_B \cdot N_{\text{gravitons}} \\
&T_{BH} \approx \frac{T_P}{\sqrt{N_{\text{gravitons}}}}
\end{aligned} \tag{11}$$

Having a change in initial conditions from Pre Planckian physics to Planckian physics would be enough if we find that the term m in Equation (11) is actually the mass of a graviton.

If so, by Novello [13] we then scale mass m as given in Equation (11) to the mass of a graviton, as in Equation (12)

$$m_g = \frac{\hbar \cdot \sqrt{\Lambda}}{c} \tag{12}$$

4. Consequences. We Have a Starting Point Determined by the Following

From Equation (1) and Equation (2) of this manuscript we have the DNA for the working out of the coefficient of the scale factor, and this is in the end what we end up with [1].

If we are looking at Planck time, and assuming we have Plank frequency, this means in the Planck era

$$\nu \propto \left(\omega_{\text{Planck}}\right)^{12}, \tag{13}$$

This enormous initial coefficient to the scale factor time coefficient, would be put in initially in the last part of Equation (14) which would subsequently, be invariant, namely from the beginning of inflation, to its near present day conditions, the following would be invariant, so the following would be approximately a constant

$$\left.\frac{H^2}{\dot{\phi}} \approx 10^{-5}\right\}_{\text{initial conditions}} \xrightarrow{\text{Evolution to near present}} \left.\frac{H^2}{\dot{\phi}} \approx 10^{-5}\right\}_{\text{present conditions}} \tag{14}$$

This would somehow have to be confirmed via data sets but the coefficients in the initial conditions to final, in ratio would be similar, in ratio value, but the magnitude of the H term and the magnitude of the derivative of the scalar field would be vastly different. The energy value would be almost infinite, *i.e.* close to Planck energy in Plankian era. In Pre Planck era, we would have a different value of T, for temperature, but we would presume working with still working with

$$\Delta E \Delta t \approx 4\hbar \tag{15}$$

In doing so, keep in mind that [1].

If $z \approx 10^{55}$ then $a \approx 10^{-55}$ so we do not have a space-time singularity.

All these details need to be worked out and given more foundation in future research.

5. Linkage to GW and Their Importance as to GW Astronomy by Making an Analogy to Black Holes Explicit for GW Generation

We will for the sake of linkages to GW treat this problem as related to black holes, and gravitons and subsequent GW generation.

Assuming our BEC condensate argument leads to scaling as far as black hole production, we will make the following assumption, namely the following grouping leads to [1] just AFTER Planckian space-time

$$
\begin{aligned}
& M \rightarrow M_{\text{universe}} \approx \sqrt{N_{\text{graviton}}} \cdot M_P \approx 10^{61} \cdot M_P \\
& M \longrightarrow \text{several } \tilde{m} = \frac{8\pi R(\text{radius of } \tilde{m})^3 \tilde{\rho}}{3} \\
& \left.\frac{H^2}{\dot{\phi}} \approx 10^{-5}\right\}_{\text{initial conditions}} \xrightarrow{\text{Evolution to near present}} \left.\frac{H^2}{\dot{\phi}} \approx 10^{-5}\right\}_{\text{present conditions}}
\end{aligned} \tag{16}
$$

I estimate that this together leads to about 10^{20} to 10^{21} effective Planck mass s sized mini black holes in the beginning of the cosmos at the cosmos. Using that rule, we could assume 10^{122} gravitons, as actually being generated from primordial conditions with say of this number, say at most about 10^{21} Planck sized black holes being formed [1].

Then

$$
\begin{aligned}
& E_{\text{BEC Graviton}} \approx \frac{k_B T_{BH}}{2} \approx \frac{k_B \times 10^{-5} \times T_P}{2} \\
& \Rightarrow \omega_{\text{BEC Graviton}} \propto 10^{-5} \times 10^{43}\ \text{Hz} \approx 10^{38}\ \text{Hz} \\
& \Rightarrow \omega_{\text{BEC Graviton to CMBR}} \approx 10^{38} \times 10^{-3}\ \text{Hz}
\end{aligned} \tag{17}
$$

We could see Primordial black holes as about $z \approx 10^{25}$. Leading to present Gravitational wave signals from the primordial black holes today of about 1 Hertz, by massive red shifting.

However this would be in the Planckian regime. *I.e.* very high frequency in the Planckian regime. In our model, we are presuming that Black holes break down from very massive in the Pre Universe conditions to about Planck mass size in Planckian regime. We diagram this out in Table 1.

6. So Where Does That Factor of 10^{-30} Come from in Equation (1)? To See This, Note Equation (10) and That There Initially Would Be about 10^{60} Grams as to the Mass Given for the Mass of the Universe

Whereas we have 10^{40} black holes of mass about 10^{-5} grams, *i.e.* about the Planck

Table 1. From [1] 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 1.989×10^{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	Number (black holes) 10^{22} to about 10^{21},
Post Planck era black holes just before the CMBR formation	Mass (black hole) Up to 10^6 grams per black hole	Number (black holes) 10^{18} to at most 10^{20}

mass, about Planck length in the vicinity of a starting point for cosmological expansion. Just before the Planck regime, we could see energy values start to sharply rise. The critical energy would be 10^{-30} that of Planck energy and would be formed in the neighborhood of Pre Planckian space-time.

In other words, we are suggesting that before Planckian expansion that Equation (1) would be satisfied. And likely in conditions for which [14] [15] [16] [17] [18] will have to be considered. Therefore, cosmological constant formed before BEC gravitons form.

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Conflicts of Interest

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

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