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Probability of Obtaining the Planck Constant, in a Universe Modeled as a Giant Black Hole by Bose Einstein Condensates of Gravitons Using Hawking Argument and Scaling

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Abstract

We use the methodology of A. D. Linde to model the probability of obtaining a cosmological constant which is in turn affected by scaling arguments for a Bose Einstein gravitational condensate as given by Chavanis, in 2015. The net result, is that the scaling argument so provided allows for a gravitational constant commensurate with the size of the Universe, using arguments which appear to be simple but which give, if one has the conditions for modeling the Universe as a "black hole" virtually 100 % chance for the cosmological constant arising.

Keywords

Black Hole, Bose Einstein Condensate, Planck Constant, Massive Graviton, Hubble Parameter

1. First of All Look at the Argument by Chanvanis, 2015

If this is done, then the following Graviton condensate relationship as argued by the author before, should also be examined as far as experimental verification, especially if the initial configuration of the Universe right after the Pre Planck physics written out is amendable to black holes in the start of inflation [1]

$$m \approx \frac{M_P}{\sqrt{N_{\text{gravitons}}}}$$
$$M_{BH} \approx \sqrt{N_{\text{gravitons}}} \cdot M_P$$
$$R_{BH} \approx \sqrt{N_{\text{gravitons}}} \cdot l_P$$

$$\begin{aligned} S_{BH} &\approx k_B \cdot N_{\text{gravitons}} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{\text{gravitons}}}} \end{aligned} \tag{1}$$

We then will be looking at the relationship given by Novello [2] as given by

$$m_g = \frac{\hbar \cdot \sqrt{\Lambda}}{c} \tag{2}$$

Also the Hawking argument as to the probability of finding a universe with Λ being a given value [3] [4]

$$P(\Lambda) \sim \exp\left(-2S_E(\Lambda)\right) \approx \exp\left(\frac{3\pi M_P^2}{\Lambda}\right) \tag{3}$$

We get combining Equations (1)-(3) that

$$\begin{aligned} P(\Lambda) &\xrightarrow[\text{Eq(1),Eq.(2),Eq.(3)}]{} \exp\left(\frac{3\pi c^2 N_{\text{graviton}}}{\hbar^2}\right) \\ &\xrightarrow[\text{Eq(1),Eq.(2),Eq.(3)},\hbar=c\to 1]{} \exp\left(3\pi N_{\text{graviton}}\right) \end{aligned} \tag{4}$$

2. Now Putting in the Detail about the Universe Being Treated as a Giant Black Hole, of Sorts, According to Equations (1)-(3)

First sign in the mass m in Equation (1) as being the same as the mass of a graviton, in Equation (2).

We then would have

$$m \to m_g \approx \frac{M_P}{\sqrt{N_{\text{graviton}}}} \Rightarrow N_{\text{graviton}} \approx 10^{122} \tag{5}$$

In addition the radius of the "particle" would be of the form given by

$$R \to R_{\text{universe}} \approx \sqrt{N_{\text{graviton}}} \cdot \ell_P \approx 10^{61} \cdot \ell_P \tag{6}$$

Also the overall mass M would scale as

$$M \to M_{\text{universe}} \approx \sqrt{N_{\text{graviton}}} \cdot M_P \approx 10^{61} \cdot M_P \tag{7}$$

Whereas the entropy

$$S \to S_{\text{universe}}(\text{gravitons}) \approx k_B \cdot 10^{122} \xrightarrow[k_B \to 1]{} 10^{122} \tag{8}$$

And the final temperature

$$T \to T_{\text{universe}}(\text{gravitons}) \approx \frac{T_P}{\sqrt{N_{\text{graviton}}}} \approx 10^{-61} \cdot T_P \tag{9}$$

In this case, we have that the mass of the graviton, allowing for this scaling is given by [5] [6].

3. Consequences: We Have a Starting Point Determined by the Following

From [7] [8] we have

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

4. What to Keep in Mind in All of This. The Following Additional Scaling to Be Investigated as a Possible Invariant Term

$$
P = \text{Power} = F(\text{force}) \times v(\text{velocity}) \tag{11}
$$

Begin first with a simple expression for power of the form [9],

$$
P_{GW} \approx \frac{G M_{\text{mass}} \omega_{gw}^2}{c^2} \tag{12}
$$

We in a different article [10] have a scaling which went as

$$
\nu \xrightarrow{\text{Planck normalization}} 4\pi \times \left(\omega_{gw}\right)^{12} \times \frac{(\varsigma)^4}{\tilde{\beta}^2} \tag{13}
$$

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

$$
\nu \propto \left(\omega_{\text{Planck}}\right)^{12}, \tag{14}
$$

This enormous initial coefficient to the scale factor time coefficient, would be put in initially in the last part of Equation (10) which would subsequently, be invariant, namely from the beginning of inflation, to its near present day conditions, the following would be invariant, namely the start of initial conditions would derive from [11] and with changing coefficients the following would be approximately a constant

$$
\left.\frac{H^2}{\dot{\phi}} \approx 10^{-5}\right\}_{\text{initial conditions}} \xrightarrow{\text{Evolution to near present}} \left.\frac{H^2}{\dot{\phi}} \approx 10^{-5}\right\}_{\text{present conditions}} \tag{15}
$$

This would somehow have to be confirmed via data sets, but this is meant as a new invariance, combined with Equation (1) and the scaling arguments so presented.

This would be my next are of inquiry to try to show this as well as to inquire about possible connections to [12].

5. Consideration as to What HUP to Use as Far as Input into Left Side of Equation (15)

To answer this, we look at the following. Namely the crazy geometry in the Pre Planckian regime of space time.

Let us first recall the Shalyt-Margolin and Tregubovich [13]

$$\Delta t \geq \frac{\hbar}{\Delta E} + \gamma t_P^2 \frac{\Delta E}{\hbar} \Rightarrow (\Delta E)^2 - \frac{\hbar \Delta t}{\gamma t_P^2}(\Delta E)^1 + \frac{\hbar^2}{\gamma t_P^2} = 0$$
$$\Rightarrow \Delta E = \frac{\hbar \Delta t}{2\gamma t_P^2} \cdot \left(1 + \sqrt{1 - \frac{4\hbar^2}{\gamma t_P^2 \cdot \left(\frac{\hbar \Delta t}{2\gamma t_P^2} \right)^2}} \right) = \frac{\hbar \Delta t}{2\gamma t_P^2} \cdot \left(1 \pm \sqrt{1 - \frac{16\hbar^2 \gamma t_P^2}{(\hbar \Delta t)^2}} \right) \quad (16)$$

For sufficiently small γ.

$$\Delta E \approx \frac{\hbar \Delta t}{2\gamma t_P^2} \cdot \left(1 \pm \left(1 - \frac{8\hbar^2 \gamma t_P^2}{(\hbar \Delta t)^2} \right) \right)$$
$$\Rightarrow \Delta E \approx \text{either } \frac{\hbar \Delta t}{2\gamma t_P^2} \cdot \frac{8\hbar^2 \gamma t_P^2}{(\hbar \Delta t)^2} \text{ or } \frac{\hbar \Delta t}{2\gamma t_P^2} \cdot \left(2 - \frac{8\hbar^2 \gamma t_P^2}{(\hbar \Delta t)^2} \right) \quad (17)$$

would lead to a minimal relationship between change in E and change in time as

$$\Delta E \approx \frac{\hbar \Delta t}{2\gamma t_P^2} \cdot \frac{8\hbar^2 \gamma t_P^2}{(\hbar \Delta t)^2} \equiv \frac{4\hbar}{\Delta t} \quad (18)$$

Or

$$\Delta E \Delta t \approx 4\hbar \quad (19)$$

In doing so, we will refer to Equation (18) as the pre inflaton state of energy being delivered due to a non conserved interjection of energy into the new universe [14] [15] [16] [17] [18].

Doing so would be a way to have the frequency so alluded to given in [16] [17] [18] and this is what we conjecture as to the evolution of the change in energy if we have the inflaton included which would be in Planckian space-time

$$\left\langle (\delta g_{uv})^2 (\hat{T}_{uv})^2 \right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2}$$
$$\xrightarrow[uv \to tt]{} \left\langle (\delta g_{tt})^2 (\hat{T}_{tt})^2 \right\rangle \geq \frac{\hbar^2}{V_{\text{Volume}}^2} \quad (20)$$
$$\& \ \delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+$$

$$\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2}$$
$$\text{Unless } \delta g_{tt} \sim O(1) \quad (21)$$

$$\delta g_{tt} \sim a^2(t) \cdot \phi \ll 1 \quad (22)$$

This version of uncertainty would be for inclusion of energy once we are in the specific Planckian regime of space time and may be what is needed for sufficient energy imput from the fifth dimension, leading to a fifth force argument as given by [19] which may be from the work given by Wesson in [16]. This fifth force, in addition to fitting in the HUP in the Pre Planckian to Planckian physics regime would be encouraging us for an unbelievably high initial change in energy, as stated in Equation (21), whereas once we are in the Planckian regime of the present universe we would be using Equation (19) so as to specify a very high initial initial frequency, and this would be in tandeum with [16] being directly employed

$$\int p_\alpha \mathrm{d}x^\alpha = \pm \frac{h}{c}\cdot\frac{L}{\ell} = \pm \frac{h}{c}\cdot\sqrt{\frac{3}{\Lambda}}\frac{m_{\text{particle}}}{h} = \frac{r}{m_{pl}}\cdot\left(1-\log\left[\frac{r}{\varpi\cdot c}\right]\right) \Leftrightarrow r \approx \varepsilon^{+} \tag{23}$$

This is in tandem with the value of z, as to red shift showing up in [16] [17] [18] and it shows how to obtain a very small radial value in a different manner, namely in a tiny scale factor due to an enormous z red shift as given in [18].

Quote

Note this comes from a scale factor, if $z \sim 10^{55} \Leftrightarrow a_{\text{scale factor}} \sim 10^{-55}$, *i.e.* 55 orders of magnitude smaller than what would normally consider, but here note that the scale factor is not zero, so we do not have a space-time singularity.

End of quote.

6. Conclusions and Future Work to Consider

Equation (19) is likely the HUP to use in the formation of the frequency as stated in Equation (14), whereas the fifth force would likely play a role in Equation (21) whereas the application of the fifth force as in [19] would likely play a role in the breakthrough to the Planckian regime.

Note that the fifth force argument, is tied in directly with Equation (23) and also the regime of space time for which we have the intermediate regime for which we made the following approximations, as given.

Why is this important? We argue that the fifth force will be important as far as resolving this detail at the boundary between Pre Planckian physics to Planckian physics. Namely if we go to Equation (10)

$$\begin{aligned} &m_{\text{graviton}} \approx 10^{-60} m_P \Rightarrow N_{\text{Gravitons}} \approx 10^{120} \\ &\Rightarrow N_{\text{Gravitons}} \approx 10^{120} \approx S_{\text{entropy}} \\ &\Leftrightarrow g_* \approx 10^{240}\cdot\left(\frac{64\pi^2}{1.66}\right)^2 \approx 10^{240}\times 144791 \propto 10^{245} \end{aligned} \tag{24}$$

If we are using Planck Values, what we have is that the degrees of freedom, independent of assumed entropy values will commence to have an enormous value for *M*, and if we are using in Planck units that *E*, energy, is the same as mass, we are stating that our construction will be leading to for high degrees of freedom.

This is directly due, if we are assuming a non zero fifth force, due to an initial value of $t = \frac{r}{\varpi c}$ that the value of

$$\phi\left(\frac{r}{\varpi c}\right) = \sqrt{\frac{\nu}{4\pi G}}\ln\left(\sqrt{\frac{8\pi G V_0}{\nu(\nu-1)}}\cdot\left(\frac{r}{\varpi c}\right)\right) \tag{25}$$

That way of putting a fifth force in, would be at the point of transition between Equation (19) and Equation (21).

The details of the fifth force as to helping to obtain inputs into the Left hand side of Equation (15) need to be fully worked out as a way of confirming the data sets to include so as to obtain the BEC treatment, for graviton condensates to form an eventual very large pseudo black hole.

In addition we look forward to use of the graviton condensate argument confirming if possible.

In [20], page 17, the following is given as a NON relativistic geodestic equation for a "test particle"

$$\ddot{\vec{x}} = -\vec{\nabla}\Psi - \frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \tag{26}$$

The first term has a gravitational potential Ψ. The second term involves the fifth force. What we have assumed in this Pre Planck to Planck regime is that we are neglecting, in this Ψ. In a word for Pre Planck to Plank physics what we are assuming is

$$\ddot{\vec{x}} = -\vec{\nabla}\Psi - \frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \xrightarrow[\text{Pre Planck}]{} \ddot{\vec{x}} = -\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \tag{27}$$

This fifth force as far as helping to form the left hand side of Equation (14), and a choice of inputs into what HUP to use is crucial and needs to be filled in. Finally note this as to the break up of a mass m body.

We would have say if we have not just ONE giant BEC style black hole, of mass M say several bodies of, mass m each, in so we consider when we make the substitution according to Freeze as reported by Beckwith in [21] as to the eventual break up of the mass M object referred to in Equation (1) and gravitation as in Equation (14)

$$M \longrightarrow \text{several } \tilde{m} = \frac{8\pi R\left(\text{radius of } \tilde{m}\right)^3 \tilde{\rho}}{3} \tag{28}$$

Picking an optimal density as in this expression, Equation (28) would lead to the graviton release as postulated and part of the working assumptions of Equation (1). Whereas we would be doing all of this to work in more details as to the initial start and finish as to Equation (15).

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Conflicts of Interest

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

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