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Using Model of a UniverseSimilar to a Black Hole, Ask If We Have to Have Initial Space-Time Singularities, If We Are Looking at Initial Time Step and Entropy Assuming Existence of Primordial Black Holes

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Abstract

Based on the idea of cyclic conformal cosmology, we formulate entropy and quantum number n, and then utilize the minimum uncertainty principle, where Delta E times Delta t equals h-bar, to actualize a prototype delta t time stop in the breakup of supermassive black holes into countless Planck mass-sized black holes.

This helps to link entropy, time step, and primordial conditions and define when the cosmological constant may form and the initial inflationary expansion "speed." All this is used to obtain a model of if a singularity initially is needed.

Key words:Inflation, Fifth force, Gravitational waves, Gravitons, Hubble parameter

I. We wish to state the problem. We use BEC for gravitons and black holes. Does this hinder or help answer if we need a singularity for the "beginning " of our universe ?

In a word what we do is to try to determine if we can by a construction with BEC answer if we need to have a singular start to the universe. The first stop is to establish BEC, as given by [1] [2] with a universe as a giant black hole. Establish BEC as then relevant to primordial black holes, and then use the primordial black holes. The final question is as on the necessity of a cosmic singularity, which references [3] and has some commonality with [4]

II. First of all model the universe as acting like a giant black hole.

We then would haveby [1] and [2]

$$m \rightarrow m_g \approx \frac{M_P}{\sqrt{N_{graviton}}} \Rightarrow N_{graviton} \approx 10^{122} \quad (1)($$

In addition, the radius of the universe as a giant black hole "particle" would be of the form given by

$$R \rightarrow R_{universe} \approx \sqrt{N_{graviton}} \cdot l_P \approx 10^{61} \cdot l_P \quad (2)$$

Also the overall mass M would scale as

$$M \rightarrow M_{universe} \approx \sqrt{N_{graviton}} \cdot M_P \approx 10^{61} \cdot M_P \quad (3)$$

Whereas the entropy

$$S \rightarrow S_{universe}(gravitons) \approx k_B \cdot 10^{122} \xrightarrow[k_B \rightarrow 1]{} 10^{122} \quad (4)$$

And the final temperature

$$T \rightarrow T_{universe}(gravitons) \approx \frac{T_P}{\sqrt{N_{graviton}}} \approx 10^{-61} \cdot T_P \quad (5)$$

In this case, we have that the mass of the graviton, allowing for this scaling is given by [1] [5]

$$m_g = \frac{\hbar \cdot \sqrt{\Lambda}}{c} \quad (6)$$

This is using the following approximation given for BECs by [1] [2]

$$
\begin{aligned}
m &\approx \frac{M_P}{\sqrt{N_{gravitons}}} \\
M_{BH} &\approx \sqrt{N_{gravitons}} \cdot M_P \\
R_{BH} &\approx \sqrt{N_{gravitons}} \cdot l_P \\
S_{BH} &\approx k_B \cdot N_{gravitons} \\
T_{BH} &\approx \frac{T_P}{\sqrt{N_{gravitons}}}
\end{aligned}
\quad (7)
$$

This treatment of graviton mass, as given by Eq. (6) and Eq. (7) sets us up to ask how one could have formed the parameter Λ

To begin with, we consider, that the expansion [6] [7] [8]

we have that for a scale factor expansion of the universe, that

$$a(t) = a_0 \left\{ \frac{1}{2\Omega_\Lambda} \cdot \left[\cosh\left(\sqrt{3\Lambda} t \right) - 1 \right] \right\}^{1/3} \xrightarrow[t \to Large]{} \exp\left(\sqrt{\frac{\Lambda}{3}} t \right) (8)$$

Roughly speaking we will by running backwards ascertain if an initial value of scale factor can actually go to zero and what would stop that from happening.

Our plan of action is as follows. First, we will be considering the situation given if the Universe is to first order, after expansion defined by Eq (8). Then we extrapolate backwards after obtaining the large radii value of the universe, with BEC scaling. After which, and which will be the rest of the document, we consider what happens if we iterate backwards from today to the onset of the cosmic dawn.

We run up against which will be thoroughly studied is that although by the work of Penrose, it is definite that black holes have classic singularities, that the same may not be true as to the starting point of the early universe. This is the situation which we are going to review at length [3]

III. First the template as to the recycling of black holes.

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 1.98910^+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	Mass (black hole)	Number (black holes)

formation Assuming start of merging of micro black hole pairs	10^-5 to 10^-4 grams (an order of magnitude of the Planck mass value)	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 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

Here, Eq. (1) will be by [1] [7] associated with the following scalar field of

$$
\begin{aligned}
& a(t) = a_{initial} t^{\nu} \\
& \Rightarrow \phi = \ln\left(\sqrt{\frac{8\pi G V_0}{\nu \cdot (3\nu - 1)}} \cdot t \right)^{\sqrt{\frac{\nu}{16\pi G}}} \\
& \Rightarrow \dot{\phi} = \sqrt{\frac{\nu}{4\pi G}} \cdot t^{-1} \\
& \Rightarrow \frac{H^2}{\dot{\phi}} \approx \sqrt{\frac{4\pi G}{\nu}} \cdot t \ \cdot T^4 \cdot \frac{(1.66)^2 \cdot g_*}{m_P^2} \approx 10^{-5}
\end{aligned} \quad (9)
$$

This would lead to an expansion parameter, a Hubble constant parameter as given in [9]
This of course makes uses of [9]

$$
H = 1.66\sqrt{g_*} \cdot \frac{T_{temperature}^{\ 2}}{m_P} \quad (10)
$$

Now for the sake of primordial black holes of an early universe, after we establish the ground rules for modeling by BEC formulation cosmological conditions, we look at what can be said about primordial (early universe) black holes.

IV. Formulation of entropy per primordial black hole, using the model of BEC condensates

Our idea is based upon looking at if primordial black holes generate GW, and what this tells us \

We will be using the ideas given in when we have the Gravitational wave frequency specified by [5] with r in the following equation of the order of Planck length, more or less[1].

$$
\begin{aligned}
&\omega_{gw}^{6} \approx c^{7} \times \frac{\tilde{\beta}}{2m_{P} r} \cdot \sqrt{\frac{\nu}{\pi G}} \times \frac{1}{Gc \cdot \left(M_{mass}\right)^{2} \left\langle r^{2} \right\rangle^{2}} \\
&\Rightarrow \omega_{gw} \approx \left(\sqrt{\frac{\nu}{4\pi G}} \times \frac{\tilde{\beta} c^{6}}{G \cdot \left(M_{mass}\right)^{2} m_{P} r \cdot \left\langle r^{2} \right\rangle^{2}} \right)^{1/6}
\end{aligned}
\quad (11)
$$

The idea of a fifth force contribution makes its way via the argument given in [1] to the effect that the power of a signal of GW generation in the primordial GW sense would be given by

$$
\begin{aligned}
&P_{GW} \approx \frac{Gc \cdot \left(M_{mass}\right)^{2} \omega_{gw}^{6} \left\langle r^{2} \right\rangle^{2}}{c^{6}} \\
&\approx c \times \left| F_{5th-force} \right| = \left| -c \times \frac{\tilde{\beta} \left(\vec{\nabla} \phi \right)}{m_{P}} \right| \approx c \times \frac{\tilde{\beta}}{2m_{P} r} \cdot \sqrt{\frac{\nu}{\pi G}}
\end{aligned}
\quad (12)
$$

Having said that we are now ready to discuss the role of individual black holes. In order to do this, we use [1] namely.

$$
t = \frac{r}{\varpi c} \quad (13)
$$

The term of ϖ is a dimensionless value less than or at most equal to the value 1, and never negative.

If so, then Eq. (5) will yield a radial force component which we will write as[1]

$$
F_{5th-force} = -\frac{\tilde{\beta} \left(\vec{\nabla} \phi \right)}{m_{P}} \approx -\frac{\tilde{\beta}}{2m_{P} r} \cdot \sqrt{\frac{\nu}{\pi G}} \quad (14)
$$

And then the BEC condensate given by[1][6], can if we do not use the entire universe as a black hole, and then specify say instead primordial black holes, we can have masses of say massive gravitons leaving the primordial black holes written as having an effective mass of

$$m \approx \frac{m_g}{\sqrt{1-\left(\frac{v_g}{c}\right)^2}} \approx \frac{M_P}{\sqrt{N_{gravitons}}} \approx 10^{-10}\, grams \quad (15)$$

If this is done the effect would have been 10^5 gravitons per Planck mass black hole, and if the primordial black holes went up to 1 gram, we would then see an upper bound of say per primordial black hole of effective graviton mass defined due to Eq.(9) leading to the following number of effective gravitons per Planck sized black hole on the order of

$$\therefore N_{gravitons} \approx 10^{10} \quad (16)$$

The next step will be to , after we have some conditions as to primordial black holes go to potential quantum effects, as seen below associated with primordial black holes

V. Considerations as to entropy, number of gravitons, and quantum numbers n, affiliated with each primordial black hole

Now having done this and let us assume we work with a Plank mass black hole, we make the following approximation of the quantum number, entropy and energy of a Planck sized black hole being given by Mukhanov [10] with a boson model of a black hole,

$$S_{BH} = \frac{A(area)}{4} \approx k_B \cdot N_{effective-graviton} \propto (n_{quantum} - 1)\ln 2 \quad (19)$$

Here, for a Planck mass sized black hole, we will set an entropy per black hole approximately as

$$N_{effective-graviton}\Big|_{Planck-mass-black-hole} \approx 10^5 \quad (20)$$

If so then, we have if we do Plank normalization of $\hbar = k_B = c = 1$, then Eq. (19) and Eq. (20) yield a quantum number of for a Planck mass sized black hole of

$$\begin{aligned} &N_{effective-graviton} \propto (n_{quantum} - 1)\ln 2 \\ &\Rightarrow n_{quantum} \approx 1 + \frac{N_{effective-graviton}}{\ln 2} \approx 1 + \frac{10^5}{\ln 2} \end{aligned} \quad (21)$$

We do not assume fractional quantum numbers per black hole, so we take the round off of Eq. (21) to a whole number.

VI. Using this quantum number n, per black hole to tie in with Dr. Corda's outstanding work on Black holes.

Also then we will be assuming then using these Planck units that approximately we use the Corda result of per black hole of bound state energy as given by [11]

$$E_{Bh} = -\frac{n_{quantum}}{2} \quad (22)$$

If we say that this is for black hole, as induced by the Penrose model and Figure 1, due to [1] we can write a minimum uncertainty of

$$\begin{aligned}
&\left(\Delta E \approx \left| E_{Bh} = -\frac{n_{quantum}}{2} \right| \right) \times \Delta t \approx 1 \\
&\Rightarrow \Delta t \approx \frac{2}{\left| E_{Bh} = -\frac{n_{quantum}}{2} \right|} \approx 10^{-5}
\end{aligned} \quad (23)$$

I.e. we would have for a Planck sized black hole, initial time step of 10^-5 times Planck time, which is incredible, whereas we would have entropy of 10^5, Per Planck sized black hole

This would be right due to the black hole figures given in Table 1, which are commensurate with [1].

VII. And now the question of the Cosmological constant, i.e. where could it be formed?

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 Eq. (1) for scale factor given as [1]

$$\nu \xrightarrow[Planck-normalization]{} 4\pi \times \left(\omega_{gw}\right)^{12} \times \frac{\left(\varsigma\right)^{4}}{\beta\%} \quad (24)$$

This is all defined in [1] in an article written by the author for Intech, for our convenience

Consider first the relationship between vacuum energy and the cosmological constant. Namely $\rho_{\Lambda} \approx \mathrm{h} k_{\max}^{4}$ where we have that [12]

$$\rho_{\Lambda} \approx \hbar k_{\max}^{4} \approx (10^{18} GeV)^{4} \xrightarrow[reduced]{} (10^{-12} GeV)^{4} \quad (25)$$

Where we define the mass of a graviton and then we can also use the following

This is useful in terms of determining conditions for a cosmological constant[1] [12]

$$\rho_{\Lambda} c^{2} = \int_{0}^{E_{Plank}/c} \frac{4\pi p^{2} dp}{(2\pi\hbar)^{3}} \cdot \left(\frac{1}{2} \cdot \sqrt{p^{2}c^{2} + m^{2}c^{4}} \right) \approx \frac{\left(3\times10^{19} GeV\right)^{4}}{(2\pi\hbar)^{3}}$$

. (26)\

$$\xrightarrow[E_{Plank}/c \to 10\wedge-30]{} \frac{\left(2.5\times10^{-11} GeV\right)^{4}}{(2\pi\hbar)^{3}}$$

This means shifting the energy level of the Eq. (19) downward by 10^-30, i.e.the top value energy becomes a down scale of Planck energy times 10^-30.\

VIII. How we change the energy in Eq. (26). Reference black hole energy values as given by Dr. Corda, as subtracted from the rest energy of a Planck sized black hole for Eq. (26)

Now what is the energy in the integration pertinent to Eq. (20) coming from?

i.e. what we will rewrite the top end of the integration is, as follows, for a Planck mass sized black hole

$$\frac{\Delta E}{c} = 10^{18} GeV - \frac{n_{quantum}}{2c} \; ; \; 10^{-12} GeV \quad (27)$$

i.e.the cosmological constant energy range would be established near the area of Primordial black holes
This limiting value of Eq. (25) and Eq. (27) for calculation of Eq. (26) would be by [1] necessary to reset the vacuum energy to be the cosmological constant due to the use of Corda's energy value in the vicinity of the Primordial Planck mass sized black holes.[11]

x. Now for examination if we have due to the existence of this minimum energy step as given in Eq. (22) and Eq. (26) a singularity.

Assuming Planck length as a minimum separation distance between two primordial black holes, their quick recombination may be analyzed. A huge downward red shift appears then from 10^25HZ to about 1HZ in an Earth-bound detector system. By using this, the behavior of primordial back holes in the formulation of entropy and an initial time step as well as the relationship of time and entropy in the context of cyclic conformal cosmology are formulated. There are initial time step of 10^-5 times Planck time and the entropy of 10^5, This is what we get in terms of frequency.

So how does this tie in with this idea?

Quote

What is cosmological singularity?

According to the Big Bang Theory, cosmological singularity is that point in the history of the universe in which the entire universe is squeezed into at least one point of infinite density, infinite temperature, infinite curvature.
End of quote

Do we have infinite density, infinite curvature, and infinite energy anywhere?

Go back to table 1. Assume that we have a delta energy, effective, per emergence, contributing to the formation of a cosmological constant. This means then we have Delta E being 2.5 times 10^-11 GeV: Plank energy in terms of GeV is 1.22 times 10 ^ 19 GeV; A downscaling of say 10^-30 per black hole contributing to a cosmological constant. There is 10^40 or so Planck sized black holes assumed of about Planck mass, initially formed. This leads to a net energy budget initially of for 10^40 Planck mass Black holes with

$$\Delta E_{form-\cos-const} \approx 10^{40} \times 10^{-11} GeV \approx 10^{29} GeV \quad (21)$$

If so this is 10^10 times bigger than a Planck mass, meaning we would have a delta time given by

$$\begin{aligned} &\Delta E_{form-\cos-const} \Delta t \approx \hbar \\ &\Rightarrow \Delta t \approx 10^{-10} t_{Planck} \equiv 10^{-10} \end{aligned} \qquad (22)$$

In a word, does this lead to infinite energy at the start? A singularity?

Note that while 10^10 times Planck energy is a LARGE number, equal to 10^29 GeV, this does NOT mean that the energy budget used at the formation of a cosmological constant for 10^40 black holes, using our assumption is even close to the presumed energy of the universe.

The Penrose singularity theorem is for Black holes, we are here referring to 10^40 mini black holes, and so it is unlikely using this reasoning there needs to be an initial cosmological singularity.

Furthermore by [12] [13] [14] we lead up to the matter of black hole uniqueness theorems [15] [16] which in terms of primordial black holes, HOLDS. However, for reasons which will be explained in future work we state that what we are considering makes it highly unlikely that such uniqueness theorems would apply to the near singularity as explained for the onset of conditions permitting our present document to be utilized. The flavor of what we are doing has some potential overlap with [17] using the idea of holography, dark energy, and the cosmological constant problem.

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