How initial degrees of freedom may contribute to initial effective mass, i.e. effective mass of the universe proportional to (D.O.F.) to the 1/4th power by an ENORMOUS initial degrees of freedom value

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Abstract
Using a relationship between Hubbles 'parameter', Temperature, Energy and effective mass , From there obtain in 3+1 dimensions a relationship between effective mass, and the initial degrees of freedom, to the 1/4th power. We will discuss candidates for entry into this , assuming for a start that initial universe conditions are similar to a black hole, i.e. a nearly singular start to inflationary expansion,. This would necessitate a HUGE initial degrees of freedom value as outlined in our argument

1. First of all the Hubble parameter used, and then the tie into energy and degrees of freedom

This is the easiest part of the derivation, in some respects extremely simple minded. The inputs into the parameters selected though will be anything BUT simple

Begin first with[1] a Hubble parameter

$$H = 1.66\sqrt{g_*} \cdot \frac{T_{temperature}{}^2}{m_P} \tag{1}$$

Whereas we have, an assumed temperature dependence which we write as[2]

$$E_{system} = \frac{k_B}{2} \cdot T_{temperature} \tag{2}$$

Whereas we use the Sarkar scaling for scale factor, [2] of the form[2]

$$a(t) = a_{initial} \cdot t^{\gamma} \tag{3}$$

In the first iteration assuming these three equations there is an extremely simple relationship, as to Temperature and degrees of Freedom initially assumed. We will present it, and then right afterwards go to the more complex issue of effective mass

To do so, start with the simplest iteration as to temperature and degrees of freedom. And then from there go to mass issues

Assume that we have, then a relationship between mass and temperature as of a black hole, namely the Hawkings temperature[3][4]

$$T_{Hawkings} = \frac{\hbar c^3}{8\pi G k_B M} \tag{4}$$

Then the mass will scale as

$$M = \sqrt{\sqrt{g_*} \cdot \frac{1.66\hbar}{64\pi^2 m_P G^2 k_B^{\,2}}} \cdot \sqrt{\frac{t}{\gamma}} \approx \sqrt{N_{Gravitons}} \cdot m_{Planck} \qquad (5)$$

Having said, that will input in values for the time and that will be the remainder of this document

2. Input of time parameter into Equation (5) and what it signifies

What we are doing in line with the idea of using an initial black hole configuration is going to a graviton condensate model which would have from [5] the following configuration for a early universe configuration.

$$\begin{aligned} m &\approx \frac{M_P}{\sqrt{N_{gravitons}}} \\ M_{BH} &\approx \sqrt{N_{gravitons}} \cdot M_P \\ R_{BH} &\approx \sqrt{N_{gravitons}} \cdot l_P \\ S_{BH} &\approx k_B \cdot N_{gravitons} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{gravitons}}} \end{aligned} \qquad (6)$$

We would have the value of M so obtained be proportional in this situation to, say, if we were considering modeling the early universe as a "primordial " black hole as setting to first approximation, having

$$M = \sqrt{\sqrt{g_*} \cdot \frac{1.66\hbar}{64\pi^2 m_P G^2 k_B^{\,2}}} \cdot \sqrt{\frac{t}{\gamma}} \approx \sqrt{N_{Gravitons}} \cdot m_{Planck} \quad (7)$$

What this is saying is that we can have the following formula for initial gravitons, from a primordial black hole condensate

$$\backslash \quad N_{Gravitons} \approx \sqrt{g_*} \cdot \frac{1.66\hbar}{64\pi^2 \cdot (m_P)^3 G^2 k_B^{\,2}} \cdot \frac{t}{\gamma} \qquad (8)$$

We have a really weird situation here. Namely consider if we go to Planck units, and we want m in Eq(6) to be commensurate with regards to a massive graviton of about 10^ -65 grams, if so then using normalized Planck units we will have

$$k_B^{\,2} = G^2 = \hbar = m_P = t_P \to 1 \qquad (9)$$

Also use the following rescaling of the time , as we could scale it to be

$$t \to \vartheta \cdot t_P \Rightarrow \frac{\vartheta \cdot t_P}{\gamma} \approx o(1) \qquad (10)$$

Then

If Planck mass is about 10^-5 grams, and the mass of a heavy graviton is about 10^-65 grams, then

$$m \approx 10^{-60} m_P \Rightarrow N_{Gravitons} \approx 10^{120} \qquad (11)$$

This means that the mass, m, as stated would be that of about a massive graviton, or about 10-65 grams

Whereas the total mass, M. would be the actual value of the mass of the universe, provided that

$$\begin{aligned} M &= \sqrt{\sqrt{g_*} \cdot \frac{1.66\hbar}{64\pi^2 m_P G^2 k_B^2}} \cdot \sqrt{\frac{t}{\gamma}} \sqrt{N_{Gravitons}} \cdot m_{Planck} \\ &\xrightarrow[Planck-Units]{} \approx \sqrt[4]{g_*} \cdot \sqrt{\frac{1.66}{64\pi^2}} \cdot m_{Planck} \approx \sqrt{N_{Gravitons}} \cdot m_{Planck} \quad (12) \\ &\approx 10^{60} \cdot m_{Planck} \end{aligned}$$

If so then the strange situation we have would be resolvable if

$$\sqrt[4]{g_*} \cdot \sqrt{\frac{1.66}{64\pi^2}} \approx 10^{60} \qquad (13)$$

i.e. the initial degrees of freedom, would be a staggering value of about

$$g_* \approx 10^{240} \cdot \left(\frac{64\pi^2}{1.66}\right)^2 \approx 10^{240} \times 144791 \propto 10^{245} \quad (14)$$

This number is gigantic, and it is in line with the initial mass, M as specified being proportional to the mass of the universe today

On the face of it, this huge initial degrees of freedom argument looks contrived and insane. Where could it come from ? We will go back to a version of the multiverse argument and a nonsingular start to the universe which may explain where this gigantic degrees of freedom argument comes from.

3. Tying this in to an early multiverse model of the Universe as specified by the author Looking now at the Modification of the Penrose CCC (Cosmology)

We now outline the generalization for Penrose CCC(Cosmology) just before inflation which we state we are extending Penrose's suggestion of cyclic universes, black hole evaporation, and the embedding structure our universe is contained within, This multiverse has BHs and may resolve what appears to be an impossible dichotomy. The text following is largely from [6] and has serious relevance to the final part of the conclusion .That there are N universes undergoing Penrose 'infinite expansion' (Penrose) [7] contained in a mega universe structure. Furthermore, each of the N universes has black hole evaporation, with Hawking radiation from decaying black holes. If each of the N universes is defined by a partition function, called $\{\Xi_i\}_{i \equiv N}^{i \equiv 1}$, then there exist an information ensemble of mixed minimum information correlated about $10^7 - 10^8$ bits of information per partition function

in the set $\left.\{\Xi_i\}_{i \equiv N}^{i \equiv 1}\right|_{before}$, so minimum information is conserved between a set of partition functions per universe [6]

$$\left\{\Xi_i\right\}_{i\ \equiv N}^{i\ \equiv 1}\Big|_{before} \equiv \left\{\Xi_i\right\}_{i\ \equiv N}^{i\ \equiv 1}\Big|_{after} \qquad (14)$$

However, there is non-uniqueness of information put into partition function $\left\{\Xi_i\right\}_{i\ \equiv N}^{i\ \equiv 1}$ .Also

$$\left\{\Xi_i\right\}_{i\ \equiv 1}^{i\ \equiv N} \propto \left\{\int_0^\infty dE_i \cdot n(E_i) \cdot e^{-E_i}\right\}_{i\ \equiv 1}^{i\ \equiv N}. \qquad (15)$$

Each of E_i identified with Eq.(9) above, are with the iteration for N universes [6][7]],and (Penrose, 2006) [7] Then the following holds, by asserting the following claim to the universe, as a mixed state, with black holes playing a major part, i.e.

CLAIM 1

See the below[6] representation of mixing for assorted N partition function per CCC cycle [7]

$$\frac{1}{N}\cdot\sum_{j=1}^{N}\Xi_j\Big|_{j-before-nucleation-regime} \xrightarrow[vacuum-nucleation-tranfer]{} \Xi_i\Big|_{i-fixed-after-nucleation-regime} \quad (16)$$

For N number of universes, with each $\Xi_j\Big|_{j-before-nucleation-regime}$ for j = 1 to N being the partition function of each universe just before the blend into the RHS of Eq.(16) above for our present universe. Also, each independent universes as given by $\Xi_j\Big|_{j-before-nucleation-regime}$ is constructed by the absorption of one to ten million black holes taking in energy**. I.e. (Penrose)** [7]. Furthermore, the main point is done in in terms of general ergodic mixing [6][8]

Claim 2

$$\Xi_j\Big|_{j-before-nucleation-regime} \approx \sum_{k=1}^{Max}\tilde{\Xi}_k\Big|_{black-holes-jth-universe} \quad (17)$$

We argue that this treatment of a multiverse just before the creation of our present universe may allow for the enormous initial degrees of freedom argument given earlier [6][8]

4. **Do we have a 1-1 correspondence via this "cosmological constant" argument in magnitude with the mass of a massive graviton ?**

If so, by Novello [9]

$$m_g = \frac{\hbar\cdot\sqrt{\Lambda}}{c} \qquad (18)$$

In other documents the author has tried to come up with a treatment for the cosmological constant. What we are doing here is to come up with, via scaling arguments a value for the left hand side of Eq. (18)

Final point. Having this as a way to do the problem outlines how one could have an enormous entropy value. See this

5. Infinite quantum statistics as give by Jack Ng.

Jack Ng changes conventional statistics: he outlines how to get $S \approx N$, which with additional arguments we refine to be $S \approx < n >$ (where <n> is graviton density). Begin with a partition function [10]

$$Z_N \sim \left(\frac{1}{N!}\right) \cdot \left(\frac{V}{\lambda^3}\right)^N \tag{19}$$

This, according to Ng, leads to entropy of the limiting value of, if $S = (\log[Z_N])$

$$S \approx N \cdot (\log[V/N\lambda^3] + 5/2) \xrightarrow[Ng-\inf inite-Quantum-Statistics]{} N \cdot (\log[V/\lambda^3] + 5/2) \approx N \tag{20}$$

If so, and if a count of gravitons is leading to entropy we can have

$$\begin{aligned} & m \approx 10^{-60} m_P \Rightarrow N_{Gravitons} \approx 10^{120} \\ & \Rightarrow N_{Gravitons} \approx 10^{120} \approx S_{entropy} \end{aligned} \tag{21}$$

6. Conclusion. The following are equivalent

$$\begin{aligned} & m_{graviton} \approx 10^{-60} m_P \Rightarrow N_{Gravitons} \approx 10^{120} \\ & \Rightarrow N_{Gravitons} \approx 10^{120} \approx S_{entropy} \\ & \Leftrightarrow g_* \approx 10^{240} \cdot \left(\frac{64\pi^2}{1.66}\right)^2 \approx 10^{240} \times 144791 \propto 10^{245} \end{aligned} \tag{22}$$

In other words, the initial degrees of freedom in the Pre Planck regime is effectively infinite, or nearly so

This assumes a non – singular start to expansion of the Universe, and a multiverse input into that starting point[6]

Still though, with all that, we may be still seeing the sort of dynamics, initially, of the form given in [11] and that may be very useful in terms of classical-quantum bridges between effects in the early universe

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