Analysis of How High Frequency Gravitational Waves Could Commence from Early Universe

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Abstract

We will be reduplicating the Book "Dark Energy" by M. Li, X-D. Li, and Y. Wang, zero-point energy calculation with an unexpected "length' added to the 'width' of a graviton wavefunction just prior to the entrance of 'gravitons' to a small region of space-time prior to a nonsingular start to expansion of the Universe. In doing so, the initially large wavelength is in a 'multiverse' domain of space-time. The eventual exit of matter and energy from this nonsingular starting point will be where we form a cosmological constant, a density of dark energy , and the mass of gravitons prior to expansion into our present universe. The papers conclusion, after we set a mass m(graviton) per graviton is to access an initial frequency for Planckian to at latest the electroweak era of cosmology.

I. Begin first with the Zero-point energy calculation, as in [1] and its subsequent modification to obtain Dark Energy/ Cosmological constant.

As of the Zero-point energy calculation, we start off with the following as given by [1]

$$\begin{aligned}
&\frac{1}{2}\cdot\sum_i \omega_i \equiv V(volume)\cdot\int_0^{\hat{\lambda}}\sqrt{k^2+m^2}\,\frac{k^2dk}{4\pi^2}\approx\frac{\hat{\lambda}^4}{16\pi^2} \\
&\xrightarrow[\hat{\lambda}=M_{Planck}]{}\rho_{boson}\approx 2\times 10^{71}GeV^4\approx 10^{119}\cdot\left(\rho_{DE}=\frac{\Lambda}{8\pi G}\right)
\end{aligned} \tag{1}$$

In stating this we have to consider that $\rho_{DE}=\frac{\Lambda}{8\pi G}\approx\hbar\cdot\frac{(2\pi)^4}{\lambda_{DE}{}^4}$, so then that the equation we have to consider is a wavelength $\lambda_{DE}\approx 10^{30}\ell_{Planck}$ which is about 10^{30} times a Plank length radius of a space-time bubble which we discuss in [2] as a start point for a nonsingular expansion point for Cosmology, at the start of inflation with the space-time bubble of about a Plank length radius we have to consider is a wavelength $\lambda_{DE} \approx 10^{30}\,\ell_{Planck}$ which is about 10^{30} times a Plank length radius of a space-time bubble [8] as a nonsingular expansion point for Cosmology, at the start of inflation with the space-time bubble of about a Plank length radius in size. . Having said that , how do we get having the Penrose [11] multiverse condition in this problem[1], for

$$\lambda_{DE} \approx 10^{30}\,\ell_{Planck} \tag{1a}$$

before the near singularity, then the existence of

$$\rho_{DE} = \frac{\Lambda}{8\pi G} \approx \hbar \cdot \frac{(2\pi)^4}{\lambda_{DE}{}^4} \tag{1b}$$

Will be then, if we use the value of Eq. (1a) fully consistent with regards to a value in line with the DE density seen today, i.e. cutting the value of Eq. (1) by 10^120 . In order to obtain space-time for a wavelength approximately 10^{30} times ℓ_{Planck} a of the starting point which is of radii ℓ_{Planck} , as given in [2] we specify a generalization of Penrose Cyclic conformal cosmology, as given usually by the identification of a contribution to a partition function of our present universe which we call Ξ_j

$$\Xi_j\Big|_{j-before-nucleation-regime} \approx \sum_{k=1}^{Max} \tilde{\Xi}_k\Big|_{black-holes-jth-universe} \tag{2}$$

With each partition function per universe defined by $\left\{\Xi_i\right\}_{i\equiv 1}^{i\equiv N} \propto \left\{\int_0^{\infty} dE_i \cdot n(E_i) \cdot e^{-E_i}\right\}_{i\equiv 1}^{i\equiv N}$. As in [3] and we specify a formation of a nontrivial gravitational measure as a new big bang for each of the N universes as by $n(E_i)\cdot$ the density of states at a given energy E_i for partition function which [2] and [3] specify Then the main methodology in the Penrose proposal has been in utilizing Eq. (2) evaluating a change in the metric g_{ab} by a conformal mapping $\hat{\Omega}$ to [2]

$$\hat{g}_{ab} = \hat{\Omega}^2 g_{ab} \tag{3}$$

Penrose's suggestion has been to utilize the following [2]

$$\hat{\Omega} \xrightarrow[ccc]{} \hat{\Omega}^{-1} \tag{4}$$

We thereby bundle in a multiverse contribution to Eq. (2), Eq.(3) and Eq., (4) after the following averaging of N partition functions from prior universes for our present universe

$$\frac{1}{N} \cdot \sum_{j=1}^{N} \Xi_j\Big|_{j-before-nucleation-regime} \xrightarrow[vacuum-nucleation-tranfer]{} \Xi_i\Big|_{i-fixed-after-nucleation-regime} \tag{5}$$

We specify that while this is going on, we have a Pre Planckian space-time allowing for $\lambda_{DE} \approx 10^{30}\,\ell_{Planck}$, and then evolution to forming a graviton mass, in the Pre-Planckian state via $m_g = \frac{\hbar\sqrt{\Lambda}}{c}$ [4] , and having done this we can now discuss our conclusion which is how to obtain High Frequency Gravitational waves in relic conditions

II. Having specified a graviton mass, via a procedure to obtain a DE density value , how do we obtain relic high frequency Gravity waves?

Using [5] a scale factor $a(t) = a_{\min} t^{\gamma}$ we obtain the following relation,

$$
\begin{aligned}
&\left(1+z_{initial-era}\right) \equiv \frac{a_{today}}{a_{initial-era}} \approx \left(\frac{\omega_{Earth-orbit}}{\omega_{initial-era}}\right)^{-1} \\
&\Rightarrow \left(1+z_{initial-era}\right)\omega_{Earth-orbit} \approx 10^{25}\omega_{Earth-orbit} \approx \omega_{initial-era}
\end{aligned}
\qquad (6)
$$

We postulate that we specify an initial era frequency via dimensional analysis which is slightly modified by Maggiore for the speed of a graviton[6] whereas $c\left(light-speed\right) \approx \omega_{initial-era} \cdot \left(\lambda_{initial-post-bubble} = \ell_{Planck}\right)$

and that dimensional comparison with initially having a temperature built up so as $\Delta E \approx \hbar\omega_{initial-era}$ where

$T_{universe} \approx T_{Plank-temerature} = 1.22 \times 10^{19}$ **GeV** . If so then the initial temperature would be extremely high leading to a change in temperature from Pre Planckian conditions to Planck era leading to

$$\Delta E = \frac{d(\dim)}{2} \cdot k_B \cdot T_{universe} \qquad (7)$$

Where we would be assuming $\omega_{initial-era} \approx \dfrac{c}{\ell_{planck}} \leq 1.8549 \times 10^{43}\ Hz$ so then we would be looking at having

frequencies on Earth from gravitons of mass m(graviton) less than of equal to $\omega_{Earth-orbit} \leq 10^{-25}\omega_{initial-era}$
And this partly due to the transference of cosmological 'information' as given in [7] for a phantom bounce type of construction as well as the work done in [2]

Further point that since gravitons travel at nearly the speed of light [6], that gravitons are formed from the surface of a bubble of space-time up to the electroweak era that mass values of the order of 10^-65 grams (rest mass of relic gravitons) would increase due to extremely high velocity would lead to enormous $\Delta E \approx \hbar\omega_{initial-era}$ values per graviton, which would make the conflation of ultrahigh temperatures with gravitons traveling at nearly the speed of light as given in Eq. (7) compared with $\Delta E \approx \hbar\omega_{initial-era}$. Details of making sense out of this would by necessity await experimental confirmation and data sets**. Note we have further linkages to Casual structure and entropy in [8] with a more up to date version in [9]**

III. We should also notice what this avoids, mainly

The author also wishes to make reference as to a completely different take on Multiverse physics usually taken up whereas there is an extremely unlikely value given as to the existence of the probability of a multiverse state having a given value of Λ via Hartle-Hawking theory having a given probability of the square of the Hartle-Hawking wavefunction, i.e.,

$$P(probability) \sim \exp(-24\pi^2/\Lambda) = \exp(-S_A) \quad \textbf{(8)}$$

This probability would lead to a ridiculously large time value one would have to wait for any such occurrence happening in the multiverse [10] with Reference [10] claiming that there would be continuous tunnelling between different vacua (read different universes) with a time of a value almost infinitely larger than the age of the expected universe.

$$t \sim \exp(S_A) \sim 10^{10^{12}} \quad (9)$$

=What we have done is to avoid this absurdity as to our present construction. In essence, the String theorists as well as Hartle and Hawking have convinced themselves as to the extreme unlikelihood of any identified state in the multiverse which we view as a misuse of the existence of the cosmological constant. This probability would lead to a ridiculously large time value one would have to wait for any such occurrence happening in the multiverse that a vacua would have a cosmological constant with our known value in our universe of Λ

What we have done is to make certain that this mathematical absurdity is not what is calculated and that we have a saner procedure

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