Gedankenexperiment for energy, and scale factor , based upon the assumption of Quintessence and idea of quantum bounce in order to isolate admissible Frequency for Gravitational waves in the beginning of cosmological evolution

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Abstract. We initially look at a non singular universe representation of time, and .of comparing a general formula of a cosmological Potential energy as given by Padmanbhan, with Weinberg's Quintessence Potential energy . Isolating a given time component which may serve as an introduction. We then compare this to when $\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t)\cdot\phi}$, and seeing what the time component then allows as far as available initial energy , the scale factor $a(t)$ and ϕ, then finally admissible frequency, for Pre Planckian process generated Gravitational waves

1. Introduction, setting up for calculation of using the results of initial time step value, initial energy as due to $\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t)\cdot\phi}$

We follow what to expect from $\Delta T_{tt} \sim \Delta\rho \sim \frac{\Delta E}{V^{(3)}}$ as given in [1, 2] for

$$\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t)\cdot\phi} \tag{1}$$

as a way to quantify energy density when we have what is coming from Weinberg [3] on initial energy density and then from there to say something about initial time step and also potential energy as given Padmanbhan [4] . Doing so will isolate out values of the Potential energy, as in [3] which will then be compared to [4]'s potential energy value, which in turn gets a value of time, which we will set by first considering the following evolution equation. From [3]

$$\ddot{\phi} + 3H\dot{\phi} + \partial_{\phi} V(\phi) = 0 \tag{2}$$

Then, look at $V(\phi)$ from [3] as having the value of, if M is related to mass, with α a variable parameter

$$V(\phi) = M^{4+\alpha} / \phi^{\alpha} \tag{3}$$

So, then the ϕ is given by [3]

$$\phi = \left(\frac{\alpha \cdot (\alpha+2)^2 \cdot M^{4+\alpha} \cdot t^2}{6+\alpha} \right)^{\frac{1}{\alpha+2}} \tag{3}$$

And also look at Padmanabhan's generalized inflaton potential [4], of comparing Eq.(2) with Eq.(4) below

$$V = \frac{3H^2}{8\pi G} \cdot \left(1 + \frac{\dot{H}}{3H^2} \right) \tag{4}$$

We have the Hubble parameter, if before Planck time, during Plank time $\dot{H} = \pm \delta H$

$$\begin{aligned} & H = H_{initial} e^{\pm \delta t} \Leftrightarrow \dot{H} = \pm \delta H, \\ & \dot{H} = +\delta H \quad if \quad Before \quad Planckian \quad time \\ & \dot{H} = -\delta H \quad if \quad Planckian \quad time \quad zone \end{aligned} \tag{5}$$

Then, we could get the following variance in time, $\tilde{t} \sim \Delta t$

$$\begin{aligned} & \phi = \left(\frac{\alpha \cdot (\alpha+2)^2 \cdot M^{4+\alpha} \cdot t^2}{6+\alpha} \right)^{\frac{1}{\alpha+2}} \approx \left(\frac{8\pi G M^{4+\alpha}}{(\pm\delta - 3H) \cdot H} \right)^{\frac{1}{\alpha}} \\ & \Leftrightarrow \tilde{t} = \left(\frac{M^{\left(\frac{4+\alpha}{2\alpha}\right) \cdot (2-\alpha)}}{H_{initial} \exp(\pm \delta \cdot t)} \right) \cdot \left(\frac{6+\alpha}{\alpha \cdot (2+\alpha)^2} \right)^{\frac{1}{\alpha+2}} \cdot \left(\frac{8\pi G}{\left(\pm\delta - 3 \cdot H_{initial} \exp(\pm\delta \cdot t)\right)} \right)^{\frac{1}{\alpha}} \end{aligned} \tag{6}$$

2. Finding how to use this value of $\tilde{t} \sim \Delta t$ in order to estimate a relic GW frequency

If so, then, up to a point, in the Pre Plankian regime of space time, according to the signs on Eq.(5) and Eq.(6) and [1,2] for the change in

$$\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t) \cdot \phi} \tag{7}$$

Set then, in early universe conditions, let us set, if we are considering gravitons, that we will set, say that the expression below would be for pre Planckian times, with t < 10^ -44 seconds. . The upshot would be that there would be a GW frequency, in many cases, as a result of pre Planckian physics of greater than or equal 10 ^ 32 Hz, which would be red shifted down to about 10 ^ 10 Hz, i.e. a 22 order of magnitude drop, in the present era. This is assuming $a^2(initial) \sim 10^{-110}$, as well as we are assuming N ~ 10^ 37, as seen in [1,2]

$$\delta t \Delta E = \frac{\hbar}{\delta g_{tt}} \equiv \frac{\hbar}{a^2(t)\cdot\phi} = \delta t \cdot N_{gravitons}\cdot\hbar\cdot\omega_{graviton}$$

$$\Leftrightarrow \omega_{graviton-initial} \approx \frac{1}{N_{gravitons}\cdot a^2(t)\cdot\phi}$$

$$\approx \frac{1}{N_{gravitons}\cdot a^2(t)}\cdot\frac{\left(\frac{6+\alpha}{\alpha\cdot(2+\alpha)^2}\right)^{\frac{-1}{\alpha+2}}\cdot\left(\frac{8\pi G}{\left(\pm\delta-3\cdot H_{initial}\exp(\pm\delta\cdot t)\right)}\right)^{\frac{-1}{\alpha}}}{\left(\frac{M^{\left(\frac{4+\alpha}{2\alpha}\right)\cdot(2-\alpha)}}{H_{initial}\exp(\pm\delta\cdot t)}\right)}. \tag{8}$$

The M as given in this would correspond to the Mass value of the universe, which is roughly 3×10^{55} g (where g is for grams.). [5] .

3. Marked difference in behaviour of time, as given in Eq.(6) says something about the importance, of Pre Planckian estimate for relic Graviton production

Note that time in Eq.(6) remains finite but very small, as it came out less than 10 to the minus 44 power seconds, less than Planck time, with the parameter α usually larger than 2. Time, in Eq. (6) as estimate is actually negative, unless we have that we chose in Eq. (5) the Pre Planckian option, which is saying that likely Planck time may not be the earliest sub division of time as we know it. This last point above will be important in our future research. As well as entropy production models due to discussions in [6,7,8,9] in terms of entropy generation in the Pre Planckian era.

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