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Constraints, in Pre-Planckian Space-Time via Padmabhan's $\Lambda_{\text{initial}} \cdot H_{\text{initial}}^{-2} \approx o(1)$ Approximation Leading to Initial Inflaton Constraints and Its Relation to Early Universe Graviton Production

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Abstract

We are looking at what if the initial cosmological constant is $\Lambda_{\text{initial}} \approx H_{\text{initial}}^2 \sim \gamma^2/t^2$ due to $a \sim a_{\min} t^{\gamma}$ if we furthermore use $\delta g_{tt} \sim a_{\min}^2 \cdot \phi_{\text{initial}}$ as the variation of the time component of the metric tensor g_{tt} in Pre-Planckian Space-time up to the Planckian space-time initial values. This assumes ϕ_{initial} as an initial inflaton value, as well as employing Non-Linear Electrodynamics to the scale factor in $a \sim a_{\min} t^{\gamma}$, and the upshot is an expression for ϕ_{initial} as an initial inflaton value/squared which supports Corda's assumptions in the Gravity's breath Electronic Journal of theoretical physics article. We close with an idea to be worked in further detail as to density matrices and how it may relate to gravitons traversing from a Pre-Planckian to Planckian space-time regime. We will write up an idea in far greater detail in a future publication.

Keywords

Inflaton Physics, Density Matrix Equation, Gravitons

1. Basic Idea, the Padmabhan Approximation of $\Lambda_{\text{initial}} \cdot H_{\text{initial}}^{-2} \approx o(1)$

To do this, we look at [1] which is of the form

$$\Lambda_{\text{initial}} \cdot H_{\text{initial}}^{-2} \approx o(1) \tag{1}$$

Our objective is to use Equation (1) with [2]

$$a \sim a_{\min} t^{\gamma} \tag{2}$$

and [2]

$$a \approx a_{\min} t^{\gamma} \Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t\right\} \Leftrightarrow V \approx V_0 \cdot \exp\left\{-\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t)\right\} \tag{3}$$

and [2] [3]

$$\phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t\right\} \tag{4}$$

and [3] [4] [5]

$$g_{tt} \sim \delta g_{tt} \approx a_{\min}^2 \phi \tag{5}$$

and [4]

$$\Delta E \Delta t \sim \left[\hbar \Big/ \left(\delta g_{tt} \sim a_{\min}^2 \cdot \phi_{\text{initial}}\right)\right] \tag{6}$$

The next step will be to utilize [6]

$$\Lambda L_{P^2} \approx \left(E / E_P\right)^6 \tag{7}$$

where [6]

$$E_P = \left(hc^5 / G\right)^{1/2} \approx 10^{19} \text{ GeV} \tag{8}$$

as well as use the Non-Linear Electrodynamic minimum value of the scale factor $a_{\min}$ [7] which is in the spirit of [8] and which is avoiding using [9].

2. Using the Section 1 Material to Isolate a Minimum Value of the Inflaton, beyond Equation (4)

From [4] we make the following approximation, *i.e.* simply put a relationship of the Lagrangian multiplier giving us the following: if

$$\lambda \sim \frac{1}{\kappa} \sqrt{\frac{-g}{\left(\delta g_{tt} \approx a_{\min}^2 \phi\right)}} \cdot \Lambda \tag{9}$$

If the following is true, *i.e.* in a Pre-Plankian to Planckian regime of space-time

$$\sqrt{\frac{-g}{\left(\delta g_{tt} \approx a_{\min}^2 \phi\right)}} \approx \text{Constant} \tag{10}$$

Here, −g is a constant, as assumed in [4] which means in the Pre-Planckian to Plackian regime we would have Equation (5) as a constant, so then we are looking at, if $\phi \equiv \phi_{\text{initial}}$, an energy density as given by Zeldovich, as talked about with [10] setting a minimum energy density given by

$$\rho_{\Lambda} \approx \frac{G\left(E/c^2\right)^2}{l} l^{-3} = \frac{GE^6}{c^8 \hbar^4} \tag{11}$$

And with the following substitution of

$$E \xrightarrow[\text{Pre-Planckian}\to\text{Planckian}]{} \Delta E \sim \frac{\hbar}{\Delta t\cdot\left(\delta g_{tt}\approx a_{\min}^{2}\phi_{\text{initial}}\right)} \tag{12}$$

Then to first order we would be looking at Equation (11) re written as leading to

$$\rho_{\Lambda} \sim \frac{G}{c^{8}\hbar^{4}}\cdot\left(\frac{\hbar}{\Delta t\cdot\left(\delta g_{tt}\approx a_{\min}^{2}\phi_{\text{initial}}\right)}\right)^{6} \tag{13}$$

And if Equation (1) holds, we would have by [1]

$$\begin{aligned}\Lambda_{\text{initial}} &\approx H_{\text{initial}}^{2}\sim \gamma^{2}/t^{2}\\ \Lambda_{\text{initial}}\cdot L_{p}^{2} &\approx 10^{-123}\end{aligned} \tag{14}$$

So

$$10^{-123}\sim \gamma^{2}L_{P}^{2}\cdot\left(\Delta E\cdot\delta g_{tt}\right)^{2}/\hbar^{2} \tag{15}$$

And if L_{P}^{2} is the square of Planck's length, after some algebra, and assuming $t \xrightarrow[\text{Pre-Planckian}\to\text{Planckian}]{} \Delta t$

$$\begin{aligned}a_{\min} &\sim \left(10^{-123/4}\right)\sim\left(\Delta E/E_{P}\right)^{3/2}\\ \&\phi_{\text{initial}}^{2} &\sim o\left(\sqrt{\Delta E\cdot\gamma\cdot L_{P}}/\hbar^{2}\right)\end{aligned} \tag{16}$$

We will examine the consequences of these assumptions as to what this says about the NLED approximation for the initial scale factor, as given in [7].

3. Conclusions: Examining the Contribution of the Inflaton

In [11] Corda gives a very lucid introduction as to the physics of the inflaton. We urge the readers to look at it as it refers to Equation (17), second line. In particular, it gives the template for the possible range of values for ΔE in Equation (16).

The take away is that we are assuming a relatively large initial entropy (based upon a count of massive gravitons) being recycled from one universe to the next, which would influence the behavior of the first line of Equation (16) and tie into the behavior of the 2nd line of the inflaton Equation (16) given above. The exact particulars of ΔE are being investigated.

Keep in mind the importance of the result from reference [12] below which forms the core of Equation (17) below

$$N_{e\text{-foldings}} = -\frac{8\pi}{m_{\text{Planck}}^{2}}\cdot\int_{\phi 1}^{\phi 2}\frac{V(\phi)}{\left(\dfrac{\partial V(\phi)}{\partial\phi}\right)}\mathrm{d}\phi \geq 65 \tag{17}$$

We have to adhere to this e fold business, and this will influence our choices as to how to model the inflaton.

Furthermore the constraints given in [13] [14] and [15] as to the influence of LIGO on our gravity models have to be looked into and not contravened.

This is a way of also showing if general relativity is the final theory of gravitation. *i.e.*, if massive gravity is confirmed, as given in [16], then GR is perhaps to be replaced by a scalar-tensor theory, as has been shown by Corda.

Finally is a re-do of what was brought up in [17] by Tang. In a density equation of stated with a relaxation procedure, between different physical states, Tank writes if m, and n are different quantum level states, then, if T_{mn} is the "Atomic coherence time"

$$\begin{gathered}
\frac{\mathrm{d}\rho_{mn}}{\mathrm{d}t} = -i\omega_{mn}\rho_{mn} - \frac{\rho_{mn}^{\text{theory}}(t) - \rho_{mn}}{T_{mn}} \\
\Leftrightarrow \rho_{mn}(t) = \rho_{mn}^{\text{theory}}(t) + \left[\rho_{mn}(0) - \rho_{mn}^{\text{theory}}(0)\right]\cdot\exp\left(-t/T_{mn}\right) \text{ if } m = n; \\
\text{AND} \\
\rho_{mn}(t) = \rho_{mn}(0)\exp\left(-i\omega_{mn}t + \frac{t}{T_{mn}}\right) \text{ if } m \neq n;
\end{gathered} \tag{18}$$

We will here, in our work assign $\rho_{mn}(t)$ the same sort of physical state which would in place have if $m = n;$ in which then the solution to this problem would be given by Equation (11). The idea would be as follows. If $m = n;$ model the density of states as having the flavor of gravitons preserving the essential quantum "state" $m = n$, and not changing if we go from the Pre-Planckian to Planckian state.

There would be then the matter of identifying $\rho_{mn}^{\text{theory}}(t)$, $\rho_{mn}(0)$ and the time T_{mn}, if $m = n$. In our review we would put T_{mn} likely as the Pre-Planckian to Planckian transition time.

Note that in the $m = n$ time if our "density of states" was referring to gravitons, keeping the same states as if $m = n$ is picked, that the second part of Equation (17) is in referral to quantum states of a graviton having a non-planar character which would not have a planar wave character.

In the case of $m \neq n$ we are then referring to changes in the states of presumed gravitons as information carriers, and the density equation, $\rho_{mn}(t)$ has in Eq. (17) as a wave with explicit damped by time evolution wave component times a planar wave component.

We presume here that the frequency term, ω_{mn} would be in the high gigahertz range.

In any case, the details of this sketchy idea should be from the Pre-Planckian to Planckian regime of space-time given far more structure in a future document.

We should note that the removal of initial singularities is due to Non-Linear Electrodynamics, as seen in [7], by Camara *et al.,* which is also in tandem with [18] [19] [20] which give also frequency specifications, which could also affect ω_{mn}, *i.e.* a tie in, with Gravitons, and Nonlinear Electrodynamics, which should be developed further.

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