Gedankerexperiment, assuming nonsingular quantum bounce Friedman Equations leading to a causal discontinuity between Pre Planckian to Planckian physics Space-Time regime.

A. B. Beckwith†

Physics Department, Chongqing University,
Chongqing 40014, PRC
†*E-mail:* abeckwith@uh.edu, *rwill9955b@gmail.com*

This paper is to address using what a fluctuation of a metric tensor leads to, in pre Planckian physics, namely. If so then, we pick the conditions for an equality, with a small δg_{tt} , to come up with restraints which are in line with modifications of the Friedman equation in a quantum bounce, with removal of the Penrose theorem initial singularity. In line with super negative pressure being applied, so as to understand what we can present as far as H = 0 (quantum bounce) in terms of density of the Universe. And also considering what to expect when $P = w\Delta\rho \sim (-1+\varepsilon^{+})\Delta\rho$. I.e. we have a negative energy density in Pre Planckian space-time. This leads to a causal discontinuity between Pre Planckian to Planckian space-time due to the sign of the inflaton changing from minus to positive, for reasons brought up in this manuscript. i.e. looking at Eq. (9) , Eq. (10) and Eq. (11) of this document, with explanations as to what is going on physically.

Keywords: Emergent time , metric tensor perturbations, HUP , negative energy density

1. Introduction .

We will here, in Equations 9 and 10 and 11 of the following document, outline the point of the document. I.e. a change in inflaton field, from a 'negative' to a 'positive' field contribution, leading to a counter intuitive result, namely that there would be a causal barrier when the inflaton field would vanish in the denominator of the derived energy density expression , about at the boundary between Pre Planckian to Planckian space-time physics. The rest of the paper will be to explain the reasons for this startling model and its possible implications.

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2. Setting up the template for the vanishing of the inflaton in the boundary between Pre Planckian Space-time to Planckian Space-time

We use Freeze et.al. Phantom bounce [1] plus Padmahan's inflaton value [2] in the case of $a(t) \sim a_{starting-po\mathrm{int}} \cdot t^{\alpha}$ in order to come up with a criteria as to initial mass. As given by [1] we have at a non singular bounce model of Cosmology a modified Friedman Equation of the form

$$H^2 = \frac{8\pi}{3M_{Planck}^2} \cdot \left(\rho - \frac{\rho^2}{2|\sigma|} \right) \tag{1}$$

Which when this is set equal to zero, at the time of a quantum bounce for a non singular universe, with

$$3 \cdot \left(1 + \frac{p}{\rho}\right) \cdot \frac{\rho^2}{|\sigma|} - \frac{\rho^2}{|\sigma|} - \left(1 + \frac{3p}{\rho}\right) \cdot \rho = 3 \cdot \left(1 + \frac{p}{\rho}\right) \cdot \rho \tag{2}$$

This Eq.(2) will have a modification of the density along the lines of $\rho \to \Delta\rho$

We also will be examining the influence of [3]

$$\frac{\Delta\rho}{\Delta t} \sim (visc) \times \left(H_{\mathrm{int}}{}^2\right) \times a^4 \tag{3}$$

With here as given by [4]

$$\begin{aligned} \Delta\rho &\sim (visc) \times \left(H_{\mathrm{int}}{}^2\right) \times a^4 \times \frac{2\hbar}{\delta g_{tt} k_B T_{initial}} \\ &\sim (visc) \times \left(H_{\mathrm{int}}{}^2\right) \times a_{init}^2 \times \frac{2\hbar}{\phi_{\mathrm{inf}} k_B T_{initial}} \end{aligned} \tag{4}$$

Our task will be to be looking at what this becomes with Eq. (4) put into Eq. (2) when $\rho \to \Delta\rho$

The term for pressure we will be using is, then from [5]

$$P = w\Delta\rho \sim (-1+\varepsilon^{+})\Delta\rho \tag{5}$$

Then, we will be looking at Eq. (2) written as

$$3\cdot\left(1+(-1+\varepsilon^{+})\right)\cdot\frac{\Delta\rho^{2}}{|\sigma|}-\frac{\Delta\rho^{2}}{|\sigma|}-\left(1+3(-1+\varepsilon^{+})\right)\cdot\Delta\rho = 3\cdot\left(1+(-1+\varepsilon^{+})\right)\cdot\Delta\rho \tag{6}$$

Leading to

$$\Delta\rho\cdot\left(1-\frac{1}{3\cdot\varepsilon^{+}}\right) = |\sigma|\cdot\left(1+\frac{\left(2-3\cdot\varepsilon^{+}\right)}{\left(3\cdot\varepsilon^{+}\right)}\right) \tag{7}$$

Or then, if we use [2]

$$\begin{aligned} & a \approx a_{\min} t^{\gamma} \\ & \Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot t\right\} \end{aligned} \tag{8}$$

We get in the regime of Pre Planckian physics, the situation that we would have

$$\begin{aligned} \Delta\rho &\approx -2|\sigma| \approx (visc)\times\left(H_{\text{int}}{}^{2}\right)\times a_{init}^{2}\times\frac{2\hbar}{\phi_{\text{inf}} k_{B} T_{initial}} \\ &\approx (visc)\times\left(H_{\text{int}}{}^{2}\right)\times a_{init}^{2}\times\frac{2\hbar}{\phi_{\text{inf}} k_{B} T_{initial}} \\ &\approx -(visc)\times\left(H_{\text{int}}{}^{2}\right)\times a_{init}^{2}\times\frac{2\hbar}{\left|\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot t_{\min}\right\}\right| k_{B} T_{initial}} \end{aligned} \tag{9}$$

In the regime of boundary between Pre Plankian to Planckian physics, we would have, instead

$$\Delta\rho \approx -2|\sigma| \approx (visc)\times\left(H_{\text{int}}{}^{2}\right)\times a_{init}^{2}\times\frac{2\hbar}{\left(\phi_{\text{inf}}+\delta^{+}\right)\cdot k_{B}\cdot\left(T_{\Pr e-Planck\to Planck}\right)}$$
$$\approx (visc)\times\left(H_{\text{int}}{}^{2}\right)\times a_{init}^{2}$$
$$\times\frac{2\hbar}{\left|\sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot\left(\left(t_{\min}+\varepsilon^{+}\right)\le t_{Plank}\right)\right\}\right|k_{B}\cdot\left(T_{\Pr e-Planck\to Planck}\right)} \tag{10}$$

What will be examined, in this document will be what we will be considering i.e. when the bracket in the ln expression approaches zero, namely

$$\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot\left(\left(t_{\min}\right)<t_{Plank}\right)<\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot\left(\left(t_{\min}+\varepsilon^{+}\right)\le t_{Plank}\right)$$
$$<\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot\left(t_{Plank}\right) \tag{11}$$
$$\&\sqrt{\frac{8\pi G V_{0}}{\gamma\cdot(3\gamma-1)}}\cdot\left(\left(t_{\min}+\varepsilon^{+}\right)\le t_{Plank}\right)\approx 1$$

The terms Visc, a_{init}^{2} and $H_{\text{int}}{}^{2}$ will be considered to be invariant in the area of the surface of the spherical (?) regime for where we have our analysis as to what this causal discontinuity implies, and why. This will be an addition to [4] and its analysis of space-time dynamics.

3. Causal discontinuity and what it may be implying.

In reference [5] we have a condition for which there is an extraordinarily rapid change in the value of the derivative of the inflation, namely, an argument for which we have

$$\dot{\phi}^{2} >> V_{SUSY} \tag{12}$$

If we use Eq. (8), we have that this is then

$$\dot{\phi}^2 \approx \frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}\cdot\frac{1}{\left(\ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot t\right\}\right)^2} \gg V_{SUSY}$$
$$iff\ \sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot t \approx 1\pm\varepsilon \tag{13}$$

In so many words, we believe that the dynamics of Eq. (11) as it applies to Eq. (9) and Eq. (10) fit this bill and also add, perforce a way as to confirm the existence of such behavior. And it puts also an inter-relationship between V_0 and V_{SUSY} as well, i.e. often they would be within an order of magnitude of each other and this when the generalized inflaton potential would be given as due to [2]

$$a \approx a_{\min} t^{\gamma}$$
$$\Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}}\cdot\ln\left\{\sqrt{\frac{8\pi G V_0}{\gamma\cdot(3\gamma-1)}}\cdot t\right\} \tag{14}$$
$$\Leftrightarrow V \approx V_0\cdot\exp\left\{-\sqrt{\frac{16\pi G}{\gamma}}\cdot\phi(t)\right\}$$

The point is, that the conditions for a Causal barrier would fit right into the SUSY potential being much smaller, than the square of the time derivative of the inflaton, and this would in its own way confirm the essence of [5] And we discuss that in the next section, section 4, which is below.

4. Examination of the Causal structure, as implied by Fay Dowker, and what we are saying replaces it.

With the initial Hubble parameter, in this situation a constant value in the Pre Planckian regime of space-time, instead of the usual

$$H_{Hubble} = \dot{a}/a \tag{15}$$

Also, $visc$ in Eq. (1) is for a viscous "fluid" approximation in a non-singular regime of space-time namely, that we have initially due to[4] and the proportionality of energy to Boltzman's constant times temperature [4]

$$\Delta t_{initial} \sim \frac{\hbar}{\delta g_{tt} E_{initial}} \sim \frac{2\hbar}{\delta g_{tt} k_B T_{initial}} \tag{16}$$

At about this time interval, and beyond, we are examining a_{init}^2 as given by[6] and also, the minimum scale factor has a factor of Λ which we interpret as todays value of the cosmological constant. B is the early cosmological B field , the Frequency of the order of 10 ^ 40 Hz, and $a_{\min} \sim a_{initial} \sim 10^{-55}$

$$\begin{aligned}
&\alpha_0 = \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0 \\
&\quad \hat{\lambda}(defined) = \Lambda c^2 / 3 \\
&a_{\min} = a_0 \cdot \left[\frac{\alpha_0}{2\hat{\lambda}(defined)} \left(\sqrt{\alpha_0^2 + 32\hat{\lambda}(defined) \cdot \mu_0 \omega \cdot B_0^2} - \alpha_0 \right) \right]^{1/4}
\end{aligned} \tag{17}$$

To get to the bottom of what this is implying as far as causal structure and how we modify it, we will be examining what Dowker brought up in [7], namely that she is assuming that there is no breakage as to what the causal interpolation of space time dynamics, to which we say, stuff and nonsense. However, we would be looking to preserve enough information exchange between physical domains in the prior to the present universe, as to preserve the operational continuity of physical law. As will be discussed in the conclusion.

5. Conclusion, i.e. examination of the following information exchange from a prior to the present universe, in light of the incredibly rapid transition implied by reference [5] so as to reconcile transfer of Information bits for $\hbar_{initial}\left[t_{initial} \le t_{Planck}\right]$ as far as initial values of the Plancks constant are concerned

The key point is that we wish to determine what is a minimum amount of information bits/attendant entropy values needed for transmission of

$\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$ .. If we specify a mass of about 10^{-60} grams per graviton, then to get at least one photon, and if we use photons as a way of 'encapsulating' $\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$, then to first order, we need about 10^{12} gravitons / entropy units (each graviton, in the beginning being designated as one 'carrier container' of information for one unit of $\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$. If as an example, as calculated by Beckwith [8] (2009) that there were about 10^{21} gravitons introduced during the onset of inflation , this means a minimum copy of about one billion $\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$ information packets being introduced from a prior universe, to our present universe, i.e. more than enough to insure introducing enough copies of $\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$ to insure continuity of physical processes.

The dynamics of $\dot{\phi}^2 >> V_{SUSY}$ actually give us a clue as to how this is possible. I.e. to use , due to the brevity of time interval, the equivalent of quantum teleportation between both sides of the causal barrier, to insure continuity of physical processes, along the lines of [9] . Note that we are doing this even while maintaining fidelity with respect to [10]

In other words, only enough information between both sides of the causal barrier would be swapped as to insure the continuity of physical processes, and this would be commensurate with an inquiry as to issues we will bring up next.

In order to have a positive inflaton, we would need to satisfy [4] having

$$\phi > 0 \quad iff \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot \delta t > 1 \tag{18}$$

This Eq. (18) has to be taken in light of preserving also, $\dot{\phi}^2 >> V_{SUSY}$, as given in Eq. (12)

This also is the same condition for which we would have to have visc, i.e. the viscosity of the initial spherical starting point for expansion, nonzero as well as reviewing the issues as of [11,12,13,14,15]

Whereas how we do it may allow for the Corda references, [12, 14] to be experimentally investigated. Finally the Abbot articles of [13,15] must be adhered to

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