Examination of initial time step in the neighborhood of a Planckian to Pre Planckian space-time

Andrew Walcott Beckwith

Physics Department, Chongqing University, College of Physics, Chongqing University Huxi Campus, No. 44 Daxuechen Nanlu, Shapinba District, Chongqing 401331, People's Republic of China

Rwill9955b@gmail.com; abeckwith@uh.edu

Abstract

Using the early universe Heisenberg Uncertainty principle derived by the author, the HUP and also $\frac{dE}{dt} = v \cdot \left(m \cdot a - F(x) \right)$ are utilized , where E is the energy, F is a force equation, and m is mass and a acceleration. From here, we will be utilizing all of the above to derive a minimum time step Δt . Which is pertinent to the Pre Planckian to Planckian space-time regime.

Key words **massive gravity, inflaton physics, Modified Heisenberg Uncertainty principle.**

I. Initial conditions involving inflaton physics

Here, we bring up [1], and look at if scale factor $a \approx a_{\min} t^{\gamma}$, then [1,2]

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

In particular [2] gives a nonzero initial scale factor which will prove subsequently important. Having said that

$$V \approx V_0 \cdot \exp\left\{ -\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t) \right\} = V_0 \cdot \left\{ \left(\frac{\gamma(3\gamma - 1)}{8\pi G V_0} \right)^{\sqrt{2}} \cdot \left(\frac{c}{t} \right)^{\sqrt{2}} \right\} \tag{2}$$

Our approximation is to use $t = r / c$, the modified HUP given by [3]

$$\Delta E \Delta t = \frac{\hbar}{\left[g_{tt} = 10^{-110} \phi_{\inf} \right]} \sim \# \xrightarrow[\Delta t \to t(Planck)]{} \Delta E \Delta t = \hbar \tag{3}$$

Then using the approximation of $\frac{dE}{dt} \sim \frac{\Delta E}{\Delta t}$, and $F \sim -\frac{\partial}{\partial r} V$, we have then the final expression for a minimum time step, in the next section while using [4]

$$\frac{dE}{dt} = v \cdot \left(m \cdot a - F(x) \right) \tag{4}$$

II. Looking at an interval of time, minimized.

What is in the above introduction will be compartmentalized to read as follows

$$(\Delta t) \propto \frac{\hbar}{a_{\min}} \cdot \frac{1}{\sqrt{\frac{\gamma}{4\pi G}}} \cdot \frac{l_P^{\frac{1+\sqrt{2}}{\sqrt{2}}}}{\left| \ln \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot \frac{r}{c} \right|^{1/2} \cdot \left\{ V_0 \cdot \left(\frac{\gamma(3\gamma - 1)}{8\pi G V_0} \right)^{1/2} \cdot (c)^{\sqrt{2}} \right\}^{1/2}} \tag{5}$$

Such an expression will have the constituent r expressions proportional to the Planck length, l_P

This interval of minimum time should be made consistent with regards to the following force constraint. We will go to the [5] reference, page 85, in order to look at a change in the stress energy tensor,

$$\begin{aligned}
&\Delta T^{00} = (-T^{0j}_{,j} + F^{(0)}) \cdot \Delta t \\
&F^{(0)} = force / fluid(unit - volume)
\end{aligned} \tag{6}$$

Using this, and stating that in the Pre Planckian regime of space-time due to [5], that $T^{0j}_{,j} \approx 0$, then if so, using [3] and [5]

$$
\begin{aligned}
& F^{(0)} = force / \ fluid(unit - volume) \\
& T^{0j}_{,j} \approx 0 \\
& \Rightarrow \Delta T^{00} = (F^{(0)}) \cdot \Delta t \\
& \Delta E = (F^{(0)}) \cdot \Delta V^{(4)} = \frac{1}{\Delta t \cdot a^2_{initial} \phi} \\
& \Rightarrow F^{(0)} = \frac{1}{\Delta V^{(3)} \left(\Delta t\right)^2 \cdot a^2_{initial} \phi} \\
& = force / \ fluid(unit - volume)
\end{aligned}
\tag{7}
$$

In other words the Pre Planckian expression for force, as given in the last equation of Eq. (7) will be

Expected to be congruent with respect to Eq. (5)

III. Conclusion. Since the initial scale factors cancel out, resolving the problem of consistency between Eq. (5) and Eq. (7) , is heavily dependent upon the initial state of the inflaton

The problem of if we can keep consistency between Eq. (5) and Eq. (7) depends upon if we have a non zero , or zero inflaton value in the initial conditions of pre Planckian physics.

In simple language, as given in our problem it is a matter of if

$$
\sqrt{\frac{8\pi G V_0}{\gamma \cdot \left(3\gamma - 1\right)}} \cdot \frac{r}{c} > 1 \tag{8}
$$

Here,

$$
\sqrt{\frac{8\pi G V_0}{\gamma \cdot \left(3\gamma - 1\right)}} \cdot \frac{r}{c} \sim \sqrt{\frac{8\pi G V_0}{\gamma \cdot \left(3\gamma - 1\right)}} \cdot \frac{l_P}{c} > 1 \tag{9}
$$

This puts major constraints upon the terms in the square root sign, and is a matter which has to be regularized in research modeling in the future.

In addition it would be advisable to keep fidelity with regards to initial conditions for which this is true [6,7,8]

$$
E = M = \left[S(entropy) \sim n(count - gravitons)\right] \cdot m_{graviton} \tag{10}
$$

Doing so, and keeping track of issues in [9,10,11,12] will help us keep our result in fidelity with experimental constraints. In addition when reviewing Eq. (9), we need to be mindful of what Corda brought up in [13] as well in his model of “gravity’s breath”

IV. . Acknowledgements

This work is supported in part by National Nature Science Foundation of China grant No. 11375279

Reference

[1] Padmanabhan, T., "understanding our universe, current status and open issues", pp 175-204, of 100 Years of Relativity, Space-Time Structure: Einstein and Beyond, Editor, A. Ashatekar, World Scientific Publishing Co. Pte.Ltd, Singapore, Republic of Singapore, 2005; http://arxiv.org/abs/gr-qc/0503107

[2] Camara, C.S., de Garcia Maia, M.R., Carvalho, J.C. and Lima, J.A.S. (2004) Nonsingular FRW Cosmology and Non Linear Dynamics. Arxiv astro-ph/0402311 Version 1, Feb 12.

[3] Beckwith, A. (2016) Gedanken Experiment for Refining the Unruh Metric Tensor Uncertainty Principle via Schwarzschild Geometry and Planckian Space-Time with Initial Nonzero Entropy and Applying the Riemannian-Penrose Inequality and Initial Kinetic Energy for a Lower Bound to Graviton Mass (Massive Gravity). *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 106-124. doi: 10.4236/jhepgc.2016.21012.

[4] Scott, R. " A first course in General relativity", Cambridge University Press, Cambridge England , 2009

[5] Scott, R, " A Student manual for A first course in General relativity", Cambridge University Press, Cambridge UK, 2016

[6] Ng, Y.J. (2008) Spacetime Foam: From Entropy and Holography to Infinite Statistics and Nonlocality. Entropy, 10, 441-461. http://dx.doi.org/10.3390/e10040441

[7] Lloyd, S, "A theory of quantum gravity based on quantum computation",

https://arxiv.org/abs/quant-ph/0501135

[8] Goldhaber, A. and Nieto, M. (2010) Photon and Graviton Mass Limits. Reviews of Modern Physics, 82, 939-979.

http://arxiv.org/abs/0809.1003http://dx.doi.org/10.1103/RevModPhys.82.939

[9] B. P. Abbott et al. (LIGO Scientific Collaboration and Virgo Collaboration) ***; "***Observation of Gravitational Waves from a Binary Black Hole Merger"**;** Phys. Rev. Lett. **116**, 061102 – Published 11 February 2016

[10] B. P. Abbott et al. (LIGO Scientific Collaboration and Virgo Collaboration)***; "***GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence", Phys. Rev. Lett. **116**, 241103 – Published 15 June 2016

[11] B. P. Abbott et al. "Tests of general relativity with GW150914", https://arxiv.org/pdf/1602.03841.pdf

[12] Corda, C. "Interferometric detection of gravitational waves: the definitive test for General Relativity", Int. J. Mod. Phys. D18:2275-2282,2009; https://arxiv.org/abs/0905.2502

[13] Corda, C. " Gravity's Primordial Breath, " Electronic Journal of Theoretical physics, EJTP 9, No. 26 (2012) 1–10; http://www.ejtp.com/articles/ejtpv9i26p1.pdf