Geddankerexperiment for initial temperature, particle count and entropy affected by initial D.O.F and fluctuations of metric tensor and the Riemannian Penrose inequality, with Applications

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This paper is to address using what a fluctuation of a metric tensor leads to, in pre Planckian physics, namely $\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2}$. If so then, we pick the conditions for an equality, with a small δg_{tt}, to come up with restraints initial temperature, particle count and entropy affected by initial degrees of freedom in early Universe cosmology. This leads to an open question as to the applicability of the Riemannian Penrose inequality, in early universe conditions , if the mass m, is a sum of prior universe gravitons, and if the area A is due to either a quantum bounce, or due to Non Linear Electrodynamics scale factor a not being zero. Note that the Riemannian Penrose inequality is for Black hole physics. Its application to our problem is solely due to a nonzero, but extremely small initial scale factor. If the initial scale factor goes to zero, then of course, this inequality no longer holds.

Keywords: Emergent time, heavy gravity, metric tensor perturbations, Riemannian Penrose inequality

1. Introduction . Finding

This article starts with updating what was done in [1] , which is symbolized by, if the scale factor is very small, metric variance [2,3]

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$$\left\langle (\delta g_{uv})^2 \left(\hat{T}_{uv}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{Volume}^2}$$
$$\xrightarrow[uv\to tt]{} \left\langle (\delta g_{tt})^2 \left(\hat{T}_{tt}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{Volume}^2} \tag{1}$$
$$\& \quad \delta g_{rr} \sim \delta g_{\theta\theta} \sim \delta g_{\phi\phi} \sim 0^+$$

In [4] this lead to

$$\delta t \Delta E \geq \frac{\hbar}{\delta g_{tt}} \neq \frac{\hbar}{2} \tag{2}$$
$$Unless \quad \delta g_{tt} \sim O(1)$$

We assume δg_{tt} is a small perturbation and look at $\delta t \Delta E = \frac{\hbar}{\delta g_{tt}}$ with

$$\Delta t_{time}(initial) = \hbar / \left(\delta g_{tt} E_{initial}\right) = \frac{2\hbar}{\delta g_{tt} \cdot g_{*s}(initial) \cdot T_{initial}} \tag{3}$$

This would put a requirement upon a very large initial temperature $T_{initial}$ and so then, if $S(initial) \sim n(particle-count) \approx g_{*s}(initial) \cdot V_{volume} \cdot \left(\frac{2\pi^2}{45}\right) \cdot \left(T_{initial}\right)^3$ [5]

$$S(initial) \sim n(particle-count) \approx \frac{V_{volume}}{g_{*s}{}^2(initial)} \cdot \left(\frac{2\pi^2}{45}\right) \cdot \left(\frac{\hbar}{\Delta t_{initial} \cdot \delta g_{tt}}\right)^3 \tag{4}$$

And if we can write as given in [2,3]

$$V_{volume(initial)} \sim V^{(4)} = \delta t \cdot \Delta A_{surface-area} \cdot \left(r \leq l_{Planck}\right) \tag{5}$$

The volume in the pre Planckian regime would be extremely small, i.e. if we are using the convention that Eq. (4) holds, then it argues for a very large g_s^* beyond the value of 102, as given in [5] . In any case, our boundary between the Pre Planckian regime and Planckian, as far as the use of Eq. (4) yields a preliminary value of , for a radii less than or equal to Planck Length , of non zero value, with

$$10^{20} \le S(initial) \sim n(particle-count)\Big|_{r \le l_P} \le 10^{37} \qquad (6)$$

This is also assuming a $\delta t_{initial} \approx \Delta t_{initial} \propto Plank-time$, i.e. at or smaller than the usual Planck time interval.

2. Counter pose hypothesis, by String Theory, for Eq. (6)

The author is aware of the String theory minimum length and minimum time which is different from the usual Planck lengths, but are avoiding these, mainly due to a change in the assumed entropy formulae to read as the square root of the above results, namely [6,7,8]

$$10^{10} \le S(initial)\Big|_{String-Theory} \sim \sqrt{n(particle-count)}\Big|_{r \le l_P} \le 10^{16} \qquad (7)$$

The above is still non zero, but it cannot be exactly posited as in the Pre Planckian regime of Space-time, since the minimum length may be larger than Planck Length, i.e. as of the sort given in [8]

3. Conclusions : Questions as to refining both Eq. (6) and Eq. (7) for more precise Entropy bounds , and does the Riemannian Penrose inequality hold ?

If from Giovannini [9] we can write

$$\delta g_{tt} \sim a^2(t) \cdot \phi << 1 \qquad (8)$$

Refining the inputs from Eq.(8) means more study as to the possibility of a nonzero minimum scale factor [10] , as well as the nature of ϕ as specified by Giovannini [9] . We hope that this can be done as to give quantifiable estimates and may link the nonzero initial entropy to either Loop quantum gravity “quantum bounce” considerations [11] and/or other models which may presage modification of the sort of initial singularities of the sort given in [12]. Furthermore if the nonzero scale factor is correct, it may give us opportunities as to fine tune the parameters given in [10] below. We next investigate the use of the Riemannian- Penrose inequality, especially if Eq. (8) holds , due to a nonzero initial value for scale factor. In doing so, we wish to state we are aware of the usual application of this inequality (for black holes). We could use it here due to either a quantum bounce, or a similar grid of space time avoiding the standard classical initial singularities of GR cosmology physics. To begin with, we wish to put in a condition which may permit a nonzero initial value for the scale factor.

$$\alpha_0 = \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0$$
$$\widehat{\lambda}(defined) = \Lambda c^2 / 3 \tag{9}$$

$$a_{\min} = a_0 \cdot \left[\frac{\alpha_0}{2\widehat{\lambda}(defined)} \left(\sqrt{\alpha_0^2 + 32\widehat{\lambda}(defined) \cdot \mu_0 \omega \cdot B_0^2} - \alpha_0 \right) \right]^{1/4}$$

Where the following is possibly linkable to minimum frequencies linked to E and M fields [10] , and possibly relic Gravitons

$$B > \frac{1}{2 \cdot \sqrt{10\mu_0 \cdot \omega}} \tag{10}$$

Finally is the question of applicability of the Riemann Penrose inequality which is [13] , p431, which is stated as

Riemann Penrose Inequality: Let (**M, g**) be a complete , asymptotically flat 3-manifold with Non negative-scalar curvature, and total mass m, whose outermost horizon Σ has total surface area A. Then

$$m_{total-mass} \geq \sqrt{\frac{A_{surface-Area}}{16\pi}} \tag{11}$$

And the equality holds, iff (**M, g**) is isometric to the spatial isometric spatial Schwartzshield manifold **M** of mass **m** outside their respective horizons.

Assume that the frequency, say using the frequency of Eq.(10), and $A \approx A_{\min}$ of Eq.(11) is employed. So then say we have

$$\omega \approx \omega_{initial} \sim \frac{1}{d_{\min}}$$
$$d_{\min} \sim A^{1/3} \propto a_{\min} \tag{12}$$

Assume that we also set the input frequency as to Eq. (10) as according to $10 < \zeta \leq 37$ i.e. does

$$\begin{aligned}&\left(m_{total-mass} \sim 10^{\zeta} \cdot m_{graviton}\right)^2 \propto a_{\min}^3 / 16\pi \\ &\Leftrightarrow \omega \approx \omega_{initial} \sim \frac{1}{d_{\min}} \sim \left(16\pi \times 10^{\zeta} \cdot m_{graviton}\right)^{-2/3}\end{aligned} \tag{13}$$

In doing this, this is a frequency input into Eq. (10) above where we are safely assuming a graviton mass of about [14]

$$\begin{aligned}&m_{total-mass} \sim 10^{37} \cdot m_{graviton} \\ &m_{graviton} \sim 10^{-62}\, grams\end{aligned} \tag{13}$$

Does the following make sense ? I.e. look at , when $10 < \zeta \le 37$

$$\begin{aligned}&\left(m_{total-mass} \sim 10^{\zeta} \cdot m_{graviton}\right)^2 \propto a_{\min}^3 / 16\pi \\ &\Leftrightarrow \omega \approx \omega_{initial} \sim \frac{1}{d_{\min}} \sim \left(16\pi \times 10^{\zeta} \cdot m_{graviton}\right)^{-2/3}\end{aligned} \tag{14}$$

We claim that if this is an initial frequency and that it is connected with relic graviton production, that the minimum frequency would be relevant to Eq. (10), and may play a part as to admissible B fields. Furthermore, , if $N = N_{graviton} \approx 10^{\zeta} \quad ; 10 < \zeta \le 37$, then [15] with

$$N = N_{graviton}\Big|_{r_H} = \frac{c^3}{G \cdot \hbar} \cdot \frac{1}{\Lambda} \approx \frac{1}{\Lambda} \tag{15}$$

Which in turn would lead to [16]

$$m_{graviton} = \frac{\hbar}{c} \cdot \sqrt{\frac{(2\Lambda)}{3}} \approx \sqrt{\frac{(2\Lambda)}{3}} \tag{16}$$

Doing so would put a different mass of a graviton into Eq. (13) with attendant consequences we may refer to at a later publication. See [17] for details.

References

1.T. G. Downes, G. J. Milburn, "Optimal Quantum Estimation for Gravitation ", gr-qc arXiv:1108.5220
2. W. G. Unruh; "Why study quantum theory?", **Canadian Journal of Physics,** 1986, Vol. 64, No. 2 : pp. 128-130; (doi: 10.1139/p86-019)
3. W. G. Unruh; "Erratum: Why study quantum gravity?", Can. J. Phys. 64, 128 (1986)

4. A. W. Beckwith, "Gedankenexperiment for Refining the Unruh Metric Tensor Uncertainty Principle Via Schwartzshield Geometry and Planckian Space-Time with Initial Non Zero Entropy"; will be an article published, with corrections in Ukranian journal of physics, and can be read in http://vixra.org/pdf/1509.0173v6.pdf

5. E. Kolb, M. Turner, *The Early Universe* ,Addison-Wesley Publishing Company, Redwood City, California, USA, 1990

6.J. Louis, T. Mohaupt, and S. Theisen , "String Theory: An Overview" http://www.aei.mpg.de/~theisen/LMT.pdf

7. M. Ammon, J. Ergmenger, *Gauge/ Gravity Duality, Foundations and Applications*, Cambridge University Press, Cambridge UK, 2015

8. K. Becker , M. Becker, J. H. Schwarz, *String Theory and M-Theory: A Modern Introduction 1st Edition* Cambridge University Press, Cambridge, UK, 2007

9. M. Giovannini, *A Primer on the Physics of the Cosmic Microwave Background* World Press Scientific, Hackensack, New Jersey, USA, 2008

10. C.S. Camara, M.R. de Garcia Maia, J.C. Carvalho, and J.A.S. Lima, " Nonsingular FRW cosmology and Non Linear dynamics", Arxiv astro-ph/0402311 version 1, Feb 12, 2004

11.C. Rovelli, and F. Vidotto, *Covariant Loop Quantum Gravity, An Elementary Introduction to Quantu Gravity and Spinfoam Theory* Cambridge University Press, Cambridge, UK, 2015

12. C. Will, "Was Einstein Right? A Centenary Assessment", pp 49-96, as part of document with Editors A. Ashtekar, B. Berger, J. Isenberg and M. Mac Callum *General Relativity and Gravitation, a Centennial Perspective,* Cambridge University Press, Cambridge, UK, 2015

13. G. Galloway, P. Miao, and R. Schoen, "Initial Data and the Einstein Constraints", pp 412-448, as part of ***General Relativity and Gravitation, A centennial Perspective*** with editors A. Ashtekar (Editor in Chief), B. Berger, J.Isenberg and M. MacCallum , Cambridge University Press, Cambridge, UK, 2015

14. A. Goldhaber, M. Nieto, "Photon and Graviton Mass Limits", Rev.Mod.Phys.82:939-979,2010, http://arxiv.org/abs/0809.1003

15. I. Haranas and I. Gkigkitzis, "The Mass of Graviton and Its Relation to the Number of Information according to the Holographic Principle", International Scholarly Research Notices, Volume 2014(2014),8 pages, http://www.hindawi.com/journals/isrn/2014/718251/

16. A. F. Ali, S. Das "Cosmology from Quantum Potential", Physics Letters B 741, (2015), 276-279

17. H. Wen, F.Y. Li, Z.Y. Fang, A. Beckwith; http://arxiv.org/abs/1403.7277