

# Calculating $\delta g_{tt}$ at Boundary of Start of Planckian Physics Due to 1 Million Relic Black Holes

Andrew Walcott Beckwith

Physics Department, College of Physics, Chongqing University Huxi Campus, Chongqing, China

Email: Rwill9955b@gmail.com, abeckwith@uh.edu

**How to cite this paper:** Beckwith, A.W. (2017) Calculating  $\delta g_{tt}$  at Boundary of Start of Planckian Physics Due to 1 Million Relic Black Holes. *Journal of High Energy Physics, Gravitation and Cosmology*, 3, 29-33. <http://dx.doi.org/10.4236/jhepgc.2017.31005>

**Received:** October 20, 2016

**Accepted:** November 20, 2016

**Published:** November 24, 2016

Copyright © 2017 by author and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

We use the ideas of a million black holes, at the boundary of  $\delta g_{tt}$  contribution to the shift from Pre-Planckian to Planckian physics, as a summed up contribution from one million primordial black holes. *I.e.* this is assuming a quantum bounce. This is an extension of work done by the author as to explain the nature of a transition from  $\delta g_{tt}$  being tiny to when  $\delta g_{tt}$  becomes 1 in value. Taking this into account, this article is a way to delineate the physics, inherent in the transition from  $\Delta E \Delta t \geq \frac{\hbar}{\delta g_{tt}}$  to  $\Delta E \Delta t \geq \hbar$  which puts a premium upon the growth of the inflaton,

due to  $\delta g_{tt} \sim (a_{\min})^2 \cdot \phi$ , with  $a_{\min} \sim 10^{-55}$  but with  $\phi$  changing from  $\phi|_{\text{Pre-Planckian}} \approx 10^{-137} \xrightarrow{\text{2nd-order-phase-transition}} \phi|_{\text{Planckian}} \approx 10^{114}$ , an  $10^{255}$  increase in magnitude. This increase in magnitude may be the driver of subsequent inflation. When  $\Delta E \Delta t \geq \frac{\hbar}{\delta g_{tt}}$  we have a pre quantum, especially if the inequality becomes an equality,

and then the transition to  $\Delta E \Delta t \geq \hbar$  marks the start of quantum gravity, whereas our black hole entropy model used to obtain a non zero entropy contribution from 1 million primordial relic black holes, as referenced, comes from Dr. Sen in an October 10 Run Run Shaw lecture in Stonybrook University.

## Keywords

Massive Gravity, Inflaton Physics, Infinite Quantum Statistics, (Usual) Black Hole Entropy

## 1. Introduction

Dr. Sen, in 2016 [1] makes use of a simple black hole generation of entropy analogy which we write as, using Planck units for 3 + 1 dimensional geometry

$$S(\text{Entropy}) = \frac{k_B c^3 A_{\text{surface-area}}}{4\pi G \hbar} \equiv \frac{A_{\text{surface-area}}}{4\pi} \Big|_{\text{Planck-units}} \xrightarrow{3+1\text{Dimensions}} r^2 \approx \log N \quad (1)$$

$N$ , in this case, is a counting mechanism, for “particles” leaving the event horizon of a black hole and we will have more to say about an alleged counting mechanism later, while  $r$ , in this case, is a radial “distance” which is assuming a nonsingular treatment with  $r$ , in this case equivalent to an event horizon [2] [3]. We will though for the sake of a model, state that we are fixing say  $10^6$  (a million) relic black holes, at the boundary of Pre Planckian to Planckian physics. And that we are when doing that, making the following transformation, as given by [4]

$$\Delta E \Delta t \geq \frac{\hbar}{\delta g_{tt}} \Big|_{\text{Pre-Planckian}} \xrightarrow{\text{2nd-order-phase-transition}} \Delta E \Delta t \geq \hbar \Big|_{\text{Planckian}} \quad (2)$$

The idea of a 2<sup>nd</sup> order transition in cosmology can be looked up in [5] [6] [7] but in fact what we are examining is due to [3], namely if we are looking at the generation of gravitational waves/gravitons from decay of the following mass via

$$M(\text{black-hole}) \sim 10^{15} \cdot \left( \frac{t}{10^{-23} \text{ sec}} \right) g \xrightarrow{\text{Relic-conditions}} M < 10^{15} \text{ g} \quad (3)$$

$$\& \tau(\text{Black-hole-life-time}) \sim 10^{64} \cdot \left( \frac{M}{M_{\text{Sun}}} \right)^3 \text{ yr} \xrightarrow{M < 10^{15} \text{ g}} \tau < 10^{-23} \text{ sec}$$

Take about 1 million black holes behaving as given in Equation (3) and also assume, [8], *i.e.* a quantum bounce, with [8]

$$a_{\text{min}} \sim 10^{-55} \quad (4)$$

And we will be using in Equation (2)

$$\delta g_{tt} \sim (a_{\text{min}})^2 \cdot \phi \quad (5)$$

In addition, from [9] we will be using the following for the inflaton, if  $a(t) = a_0 t^\gamma$ , then

$$V(t) = V_0 \left( \frac{\gamma(3\gamma-1)}{8\pi G V_0} \right)^{1/\sqrt{2}} \frac{c^{\sqrt{2}}}{t^{\sqrt{2}}} = V_0 \left( \frac{\gamma(3\gamma-1)}{8\pi G V_0} \right)^{1/\sqrt{2}} \frac{c^2}{r^{\sqrt{2}}} \quad (6)$$

$$\phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln \left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma-1)}} \cdot t \right\} \quad (7)$$

Furthermore, Sciama, in 1982 [10] allows us to write the following, namely Sciama [10] in 1982 argued for the lifetime of a black hole, of mass  $M$ , that the following holds

$$t(\text{black-hole-lifetime}) \sim 10^{10} \cdot (M/10^{15} \text{ grams})^3 \text{ years} \sim 3.154 \times 10^{17} \cdot (M/10^{15} \text{ grams})^3 \text{ sec} \quad (8)$$

Here, if the time is about  $10^{-44}$  seconds (Planck time), then  $M \sim 10^{-7}$  grams. If so, then, according to [2], Calmert, *et al.* about 0.1% of the energy emitted, in the traditional 4 dimensional black hole (3 + 1 dimensions) would be gravitons. Then,  $M \sim 10^{-7}$  grams becomes linked to Gravitons according to

$$M(\text{primordial-B.H.}) \sim 10^{-7} \text{ grams} \Rightarrow M(\text{gravitons}) \sim 10^{-10} \text{ grams} \quad (9)$$

This would mean then 1 primordial black hole would produce, if the mass of a gra-

viton is  $10^{-62}$  grams [11]

$$\text{total} - M(\text{gravitons}) \sim 10^{-10} \text{ grams} \Rightarrow 10^{52} \text{ gravitons} \tag{10}$$

Or, for a million black holes about  $10^{58}$  gravitons and we would, do the following for change in energy, namely write, from [2], and using [4]

$$\begin{aligned} \frac{dE}{dt} &\doteq \frac{\Delta E}{\Delta t} \approx (\# \text{Black-Holes}) \cdot M(\text{Black-Holes}) \cdot \omega_{\text{gravitons}}^2 \cdot r_H^2 \\ \Leftrightarrow \Delta E \Delta t &\approx (\Delta t)^2 \cdot (\# \text{Black-Holes}) \cdot M(\text{Black-Holes}) \cdot \omega_{\text{gravitons}}^2 \cdot r_H^2 \sim \frac{\hbar}{\delta g_{tt}} \end{aligned} \tag{11}$$

Furthermore, we will be assuming, using for Graviton production, that  $r_H^2 \sim r^2 \propto l_{\text{Planck}}^2$ , *i.e.* the Planck length is approximately the same as the event Horizon of the Black hole, that then we will use Equation (1) directly with the result that for 3 + 1 dimensions, we are using if we use Planck length, that

$$r_H^2 \sim r^2 \propto l_{\text{Planck}}^2 \propto S_{\text{Black-Hole}} \tag{12}$$

For the remainder of this document we will be working with

$$\delta g_{tt} \sim 1/(\Delta t)^2 \cdot [(\# \text{Black-Holes}) \cdot M(\text{Black-Holes}) \cdot \omega_{\text{gravitons}}^2 \cdot S_{\text{Black-Hole}}] \tag{13}$$

We will be working with Equation (13) to isolate out what we can extract from this, in terms of early universe conditions. The approximation for Gravitons and entropy is based upon, Ng, namely we will, as a start, incorporate Ng’s infinite quantum statistics idea, of entropy being equivalent to a count of particles, *i.e.* by [12]

$$S(\text{entropy}) \sim \# \text{gravitons} \tag{14}$$

All this will be elaborated upon in the main analysis leading to the change in inflaton values, next.

## 2. Isolation of the Value of the Inflaton, Using Equation (13), Equation (14)

Given the above, we can write, if we do the math, that we need to do a basic re normalization via Planck units of the above in terms of  $k_B = t_{\text{Planck}} = \hbar = c = m_{\text{Planck}} = 1$ , if so then we have that we rewrite Equation (13) via

$$\begin{aligned} (\Delta t)^2 &\sim t_{\text{Planck}}^2 = 1 \\ \& \ M(\text{Black-Holes}) &\sim 10^{-7} \text{ g} \approx 10^{-2} m_{\text{Planck}} \approx 10^{-2} \end{aligned} \tag{15}$$

Then if  $(a_{\text{min}})^2 \sim 10^{-110}$  we can rewrite the Equation (13). To read as follows. If the mass of a graviton is  $10^{-62}$  g, and the value of Planck mass is about  $10^{-5}$  g with Planck mass renormalized by Planck scaling to be 1, then in the Planck rescaling we have

$$m_{\text{graviton}} \sim 10^{-57} \tag{16}$$

Now if the frequency, initially was of the order of

$$\omega_{\text{gravitons}} \Big|_{\text{initially}} \sim 10^{40} \text{ Hz} \tag{17}$$

We get, then that

$$\begin{aligned} \delta g_{tt} \Big|_{\text{Boundary(Pre-Planck, Planck)}} &\sim 10^{-251} \xrightarrow{\text{2nd-order-phase-transition}} 1 \\ \phi \Big|_{\text{Boundary(Pre-Planck, Planck)}} &\sim 10^{-141} \xrightarrow{\text{2nd-order-phase-transition}} 10^{114} \end{aligned} \tag{18}$$

*i.e.* the inflaton, nearly zero, in the Pre-Planckian regime, becomes enormously large, right after the phase transition, and we are assuming that the scale factor,  $(a_{\min})^2 \sim 10^{-110}$  is invariant, in Equation (18). If so then there is a  $10^{255}$  increase in the inflaton, according to Equation (18).

### 3. Conclusion: Is the Increase of $10^{255}$ for the Inflaton, a Driver of Inflation?

No one knows. It is a seminal question, but Equation (2) is a good imbedding of inflation. *i.e.* if one uses the Penrose Cyclic conformal cosmology as given in [4] in that references page 111 to page 112, we may be able to ascertain a description of our problem as one where the dramatic  $10^{255}$  increase in the inflaton, according to Equation (17), maybe due to the influx of new matter-energy as given in [4]. Further details are to be checked as to [13]-[18]. In particular, does this help us find relic gravitational waves? Check Corda's choices as to gravity, and its foundations in [17]. We can examine if [13] is satisfied, by considering the initial conditions given in Freeze's article which leads to the 63 orders of  $e$  fold expansion, in inflation. References [14] [15] [16] give experimental constraints as to gravitation by LIGO which we need to consider, and of course [18] is a way of reformulating the issue of if there is a vacuum energy involved which can be mathematically calculated.

The final question to ask, is about the  $N$  in the right hand side of Equation (1). It can be viewed, as say the number of operations, for the Universe. *i.e.* in this sense is a counter point to the [19] of Seth Lloyd which has a power relationship of the entropy being  $3/4^{\text{th}}$  the power of the computational bits. *i.e.* our suggestion is that perhaps there are many more  $N$  computations than was supposed in Seth Lloyds [19] reference.

### Acknowledgements

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

### References

- [1] Sen, A. (2016) An Introduction to String Theory. 10 October 2016, Stonybrook University at the Run Run Shaw Distinguished Lecture Series, 5:40 PM.
- [2] Calmert, X, Carr, B. and Winstanley, E. (2014) Quantum Black Holes. Springer Briefs in Physics, Springer Verlag, Heidelberg. <https://doi.org/10.1007/978-3-642-38939-9>
- [3] Shultz, R. (2009) A First Course in General Relativity. 2nd Edition. Cambridge University Press, Cambridge, UK.
- [4] Beckwith, A. (2016) Gedanken Experiment for Refining the Unruh Metric Tensor Uncertainty Principle via Schwarzschild Geometry and Planckian Space-Time with Initial Non-zero 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. <https://doi.org/10.4236/jhepgc.2016.21012>
- [5] Stanley, H.E. (1971) Introduction to Phase Transitions and Critical Phenomena. Oxford University Press, Oxford, United Kingdom.
- [6] Layzer, D. (1991) Cosmogogenesis: The Development of Order in the Universe. Oxford University Press, Oxford, United Kingdom.

- [7] Ivancevic, V.G. and Ivancevic, T.T. (2008) Complex Nonlinearity. Springer, Berlin, 176-177.
- [8] Camara, C.S., de Garcia Maia, M.R., Carvalho, J.C. and Lima, J.A.S. (2004) Nonsingular FRW Cosmology and Non Linear Dynamics. Version 1, 12 February 2004. Arxiv astro-ph/0402311
- [9] Padmanabhan, T. (2005) Understanding Our Universe, Current Status and Open Issues. In: Ashatekar, A., Ed., *100 Years of Relativity, Space-Time Structure. Einstein and Beyond*, World Scientific Publishing Co. Pte. Ltd., Singapore, 175-204. <http://arxiv.org/abs/gr-qc/0503107>
- [10] Sciama, D. (1982) Black Hole Explosions. In: Terzian, Y. and Bilson, E.M., Eds., *Cosmology and Astrophysics: Essays in Honor of Thomas Gold*, Cornell University Press, Ithaca, 83-98.
- [11] Goldhaber, A. and Nieto, M. (2010) Photon and Graviton Mass Limits. *Reviews of Modern Physics*, **82**, 939-979. <https://arxiv.org/abs/0809.1003>  
<https://doi.org/10.1103/revmodphys.82.939>
- [12] Ng, Y.J. (2008) Spacetime Foam: From Entropy and Holography to Infinite Statistics and Nonlocality. *Entropy*, **10**, 441-461. <https://doi.org/10.3390/e10040441>
- [13] Freese, K. (1992) Natural Inflation. In: Nath, P. and Recucroft, S., Eds., *Particles, Strings, and Cosmology*, World Scientific Publishing Company, Singapore, 408-428.
- [14] Abbott, B., *et al.* (2016) Observation of Gravitational Waves from a Binary Black Hole Merger. LIGO Scientific Collaboration and Virgo Collaboration. *Physical Review Letters*, **116**, Article ID: 061102. <https://doi.org/10.1103/physrevlett.116.061102>
- [15] Abbott, B., *et al.* (2016) GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence. LIGO Scientific Collaboration and Virgo Collaboration. *Physical Review Letters*, **116**, Article ID: 241103. <https://doi.org/10.1103/physrevlett.116.241103>
- [16] Abbott, B., *et al.* (2016) Tests of General Relativity with GW150914. *Physical Review Letters*, **116**, Article ID: 221101. <https://arxiv.org/pdf/1602.03841.pdf>  
<https://doi.org/10.1103/physrevlett.116.221101>
- [17] Corda, C. (2009) Interferometric Detection of Gravitational Waves: The Definitive Test for General Relativity. *International Journal of Modern Physics D*, **18**, 2275-2282. <https://arxiv.org/abs/0905.2502>  
<https://doi.org/10.1142/S0218271809015904>
- [18] Beckwith, A. (2016) Non Linear Electrodynamics Contributing to a Minimum Vacuum Energy ("Cosmological Constant") Allowed in Early Universe Cosmology. *Journal of High Energy Physics, Gravitation and Cosmology*, **2**, 25-32. <https://doi.org/10.4236/jhepgc.2016.21003>
- [19] Lloyd, S. (2002) Computational Capacity of the Universe. *Physical Review Letters*, **88**, Article ID: 237901. <https://arxiv.org/abs/quant-ph/0110141>  
<https://doi.org/10.1103/physrevlett.88.237901>

**Submit or recommend next manuscript to SCIRP and we will provide best service for you:**

Accepting pre-submission inquiries through Email, Facebook, LinkedIn, Twitter, etc.

A wide selection of journals (inclusive of 9 subjects, more than 200 journals)

Providing 24-hour high-quality service

User-friendly online submission system

Fair and swift peer-review system

Efficient typesetting and proofreading procedure

Display of the result of downloads and visits, as well as the number of cited articles

Maximum dissemination of your research work

Submit your manuscript at: <http://papersubmission.scirp.org/>

Or contact [jhepgc@scirp.org](mailto:jhepgc@scirp.org)