‘Functional time step’ Involving relic gravitons, GW, and NLED and Fifth Force arguments. Showing how Counting Gravitons, as Entropy is Crucial to Structure Formation in the Universe

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Abstract: We will reference entropy as a count of initial gravitons as part of a formulation leading to structure formation in the universe. To do this we use a linkage between gravitation and electrodynamics the author shared with Unnishkan at Rencontres De Moriond (2015). Then we find that a time step minimization procedure given by Peebles (1993) fine tunes an NLED contribution to time step as formulated by Camara et.al. (2004), which the author then links to gravity due to adopting the fifth force formalism of Fishbach et.al, in a (1988) Rencontres De Moriond 5^{th} force – Neutrino physics school. A talk by Fishbach in (2015) Rencontres De Moriond supports using Unnishkan’s linkage of classical gravity with magnetism in a way which the author extends to the problem of not only gravity, but gravitons .Then take a linkage between the number of gravitons, a minimum grid size, and the time evolution of Hubble’s parameter, to ascertain a minimum number of initial gravitons produced, which in turns of Ng’s infinite quantum statistics is a measure of entropy. .As to structure formation, we find that the stronger an early universe magnetic field is, the greater the likelihood of production of about 20 new domains of size 1/ *H*, with *H* early universe Hubble’s constant, per Planck time interval in evolution. The *H* so obtained is directly from gravitons, and entropy.

Keywords: Infinite Quantum Statistics; Gravitons; Hubble’s Parameter

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1. Introduction

We start off with a description of both the Fifth force hypothesis of Fishbach[1,2,3] as well as what Unnishkan brought up in Rencontres De Moriond[4,5] with one of the predictions dove tailing closely with use of Gravitons as produced by early universe phase transition behaviour, leading to how QM relates to a semi classical approximation for E and M and other physical processes. For the Fifth force used, we use the following from Fishbach [1], namely what is admittedly an oversimplified model , as

$$V(r) = -\frac{G_\infty \cdot m_i \cdot m_j}{r} \pm \frac{Q_i \cdot Q_j}{r} \cdot \exp(-r/\lambda) \tag{1}$$

This second term in the potential is going to have, here $Q_i \,\&\, Q_j$ fifth force charges we will outline as

$$\left| Q_i \cdot Q_j / G_\infty \cdot m_i \cdot m_j \right| \approx 10^{-1} - 10^{-3} \tag{2}$$

We have that Unnishkan shared in Rencontres Du Moriond [4,5] which is an extension of what he did in [5], i.e. looking at, if $i_1 \,\&\, i_2$ are currents in electricity and magnetism, and $i_{1g} \,\&\, i_{2g} = m_1 v_1 \,\&\, m_2 v_2$ are the 'Newtonian' 'gravity' equivalent expressions , with m_1 mass 1, m_2 mass 2, and v_1 and v_2 velocities of the particles in question so that the following, up to a point holds

$$\left[\frac{i_1 \cdot i_2}{r^2} = k \cdot \frac{(q_1 \cdot v_1)(q_2 v_2)}{r^2} \right]_{E\&M} \sim \left[\frac{G}{c^2} \cdot \frac{i_{1g} \cdot i_{2g}}{r^2} = \frac{G}{c^2} \cdot \frac{(m_1 \cdot v_1)(m_2 v_2)}{r^2} \right]_{Gravity} \tag{3}$$

and

$$\frac{dA}{dt} \equiv \frac{\Phi_N}{c^2} \cdot \frac{dv_i}{dt} \tag{4}$$

The above relationship with its focus upon interexchange relations between gravity and magnetism is in a word focused upon looking at , if A, the nominal vector potential used to define the magnetic field as in the Maxwell equation, the relationship we will be using at the beginning of the expansion of the universe, is a variation of the quantized Hall effect, i.e. from Barrett [6], the current I about a loop with regards to electronic energy U, of a loop with the A electromagnetic vector potential going through the loop is given by, if L is a unit spatial length, and we approximate the beginning of the universe as having some of the same characteristics as a quantized Hall effect, then, if n is a particle count of some sort, then

$$I(current) = (c/L) \cdot \frac{\partial U}{\partial A} \Leftrightarrow A = n \cdot \hbar \cdot c/e \cdot L \tag{5}$$

We will be taking the right hand side of the A field, in the above, and approximate Eq.(4) as given by

$$\frac{dA}{dt} \approx \frac{dn}{dt} \cdot \left(\hbar \cdot c / e \cdot L\right) \tag{6}$$

Then, we have an approximation for writing [4,5]

$$\begin{aligned} &\frac{dA}{dt} \approx \frac{dn}{dt} \cdot \left(\hbar \cdot c / e \cdot L\right) \equiv \frac{\Phi_N}{c^2} \cdot \frac{dv_i}{dt} \\ &\Leftrightarrow \Phi_N \approx \frac{dn}{dt} \cdot \left(\hbar \cdot c^3 / e \cdot L\right) / \left(\frac{dv_i}{dt}\right) \end{aligned} \tag{7}$$

Eq. (7) needs to be interpolated, up to a point. I.e. in this case, we will conflate the n, here as a 'graviton' count, initially, i.e. the number of early universe gravitons, then assume that $\frac{dv_i}{dt}$ is a net acceleration term which will be linked to the beginning of inflation, i.e. that we look then at Ng's 'infinite' quantum statistics [7] , with entropy given as , initially a count of gravitons, with $\mathbb{N}$ a generalized count. Then , if $\mathbb{N} \doteq n(particles)$, and we refer to the n of Eq. (5) to Eq. (7) as being the same as $\mathbb{N}$, keeping in mind some pitfalls of entropy in spacetime considerations as given in [8]

$$S \sim \mathbb{N} \approx \mathbb{N}_{Graviton-count}(\text{inf}) \tag{8}$$

We will elaborate upon this treatment of entropy in our derivations, as well as tie it in with some issues as to the uncertainty principle first elucidated in [9] in our minimization of energy and its tie in to presumed graviton physics. We should though link our work above to near singular physical spacetime and for that we will reference the next sub section

2.1. Entropy, its spatial configuration near a singularity and how we use this definition to work in effects of Non Linear Electrodynamics

The usual treatment of entropy, if there is the equivalent of a event horizon is, that (Padmanabhan) [10] with $r_{critical}$ to be set at the end of the article, with suggestions for future work. And L in Eq. (7) is of the order of magnitude proportional to L_P. i.e. also to be set at the end of this article, i.e. we will suggest a formal relationship between L and L_P . Here we leave this as to be a determined parameter

$$S(classical-entropy) = \frac{1}{4L_P^2} \cdot \left(4\pi r_{critial}^2\right) \Leftrightarrow Energy \equiv \frac{c^4}{2G} \cdot r_{critial} \tag{9}$$

If so, then we have that from first principles, (and here we also will set $\frac{dr_{critical}}{dt}$ formally at the end of the paper, with suggested updates as far as an investigation)

$$\frac{dn}{dt} \sim 2\pi L_P^{-1} r_{critical} \cdot \frac{dr_{critical}}{dt} \tag{10}$$

Then Eq. (7) is re written in terms of [4,5] adopted formulation as given by

$$\Phi_N \approx \frac{dn}{dt} \cdot \left(\hbar \cdot c^3 / e \cdot L\right) / \left(\frac{dv_i}{dt}\right) \propto 2\pi \frac{r_{critical}}{L_P} \cdot \frac{dr_{critical}}{dt} \cdot \left(\frac{dv_i}{dt}\right)^{-1} \left(\hbar \cdot c^3 / e \cdot L\right) \tag{11}$$

The following parameters will be identified, i.e. what is $\left(\frac{dv_i}{dt}\right)$, what is L, and what is $r_{critical}$. These values will be set toward the end of the manuscript, with the consequences of the choices made discussed in this document as suggested new areas of inquiry. However, Eq.(11) will be linkable to re writing Eq. (4) as

$$\frac{dA}{dt} \sim 2\pi \frac{r_{critical}}{L_P} \cdot \frac{dr_{critical}}{dt} \cdot \left(\hbar \cdot c^2 / e \cdot L\right) \tag{12}$$

If $\frac{dr_{critical}}{dt}$ is ALMOST time independent, as we will assert in the end of our paper, Eq.(12) will then lead to a primordial value of the magnitude of the A vector field as

$$A \sim t \cdot \left[2\pi \frac{r_{critical}}{L_P} \cdot \frac{dr_{critical}}{dt} \cdot \left(\hbar \cdot c^2 / e \cdot L\right)\right] + \text{H.O.T.} \tag{13}$$

If so, then the E field up to a point will be

$$\begin{aligned} E &\sim -\nabla\phi - c^{-1} \cdot \partial_t A \\ &\sim -c^{-1} \cdot \left[\frac{2\pi}{L_P} \cdot \frac{dr_{critical}}{dt} \cdot \left(\hbar \cdot c^2 / e \cdot L\right) \cdot \left(r_{critical} + t \cdot \frac{dr_{critical}}{dt}\right)\right] - \nabla\phi \end{aligned} \tag{14}$$

To reconstruct ϕ we have that we will use

$$\nabla \cdot A = -c^{-1} \cdot \frac{\partial \phi}{\partial t} \tag{15}$$

Then

$$\phi \sim -t^2 \cdot \left[\frac{\pi}{L_P} \cdot \frac{dr_{critical}}{dt} \cdot \left(\hbar \cdot c^2 / e \cdot L\right)\right] \tag{16}$$

If so, then in Eq.(14) becomes

$$E \sim -c^{-1} \cdot \left[\frac{2\pi}{L_P} \cdot \frac{dr_{critical}}{dt} \cdot \left(\hbar \cdot c^2 / e \cdot L\right) \cdot \left(r_{critical} + t \cdot \frac{dr_{critical}}{dt}\right)\right] \tag{17}$$

The density, then is read as

$$\rho = -\frac{1}{4\pi c^2}\cdot\frac{\partial^2\phi}{\partial t^2} \sim \frac{1}{2L_P}\cdot\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot c^2/e\cdot L\right) \tag{18}$$

The current we will work with, is also then linkable to, by order of magnitude similar to Eq.(18) of

$$J = \frac{1}{4\pi c}\cdot\frac{\partial^2 A}{\partial t^2} \sim \frac{2}{L_P}\cdot\left(\frac{dr_{critical}}{dt}\right)^2\cdot\left(\hbar\cdot c/e\cdot L\right) \tag{19}$$

Then we get an effective magnetic field, based upon the NLED approximation given by Corda et.al [12] of

$$\begin{aligned}
&\rho_\gamma = \frac{16}{3}\cdot c_1\cdot B^4 \sim \frac{1}{2L_P}\cdot\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot c^2/e\cdot L\right)\\
&\Leftrightarrow B^4 \sim \frac{3}{32L_P\cdot c_1}\cdot\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot c^2/e\cdot L\right)\\
&\Leftrightarrow B_{initial} \sim \left(\frac{3}{32L_P\cdot c_1}\cdot\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot c^2/e\cdot L\right)\right)^{1/4}
\end{aligned} \tag{20}$$

Then we can also talk about an effective charge of the form, given by applying Gauss's law to Eq.(18)

$$Q = \varepsilon_0\oint_S E\cdot n\cdot da = \int_V \rho_\gamma dV \sim \frac{2\pi r^3_{critical}}{3L_P}\cdot\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot c^2/e\cdot L\right) \tag{21}$$

This charge, Q, so presented, will be part of the effective 5th force [1,2,3] , as to linking E and M and gravity, of Eq. (1) which we will relate to our further derivational work done in this paper. Furthermore, the critical value of $r_{critical}$ which will be made explicit in this paper, as well as L, and $\frac{dr_{critical}}{dt}$ as well as

$$Energy \sim \rho_\gamma\cdot\left(r_{critial}{}^3\right) = \frac{16}{3}\cdot c_1\cdot\left(r_{critial}{}^3\right)\cdot B^4 \sim \frac{\left(r_{critial}{}^3\right)}{2L_P}\cdot\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot c^2/e\cdot L\right) \sim \frac{c^4}{2G}\cdot r \tag{22}$$

This will lead to an evaluation of $r_{critical}$ as

$$r_{critial} \sim L_p\cdot\left(\frac{c\cdot e\cdot L}{\sqrt{\frac{dr_{critical}}{dt}\cdot\left(\hbar\cdot G\right)}}\right) \propto L_p \tag{23}$$

The value of $\frac{dr_{critical}}{dt}$ ~ c (speed of light), and by Padmabhan [10], $G\hbar = L_P^2 c^3$, so then most likely then the following are equivalent and imply each other as given in the grouping called Eq.(24) below

$$
\begin{aligned}
& L \sim L_P \\
& \Phi_N \approx \frac{2\pi}{L_P} \cdot \left(\frac{dv_i}{dt} \right)^{-1} \left(\hbar \cdot c^4 / e \right) \\
& S(initial - entropy) = \frac{1}{L_P^2} \cdot \left(\pi L_P^2 \right) \sim n_{initial} \neq 0 \\
& \Leftrightarrow 3 < n_{initial} < 4(?) \\
& Q \sim \frac{2\pi L_P}{3} \cdot \left(\hbar \cdot c^3 / e \right) \neq 0 \\
& \Leftrightarrow r_{critial}^2 \sim n_{initial} \frac{L_P^2}{\pi} \sim L_P^2 \\
& \Leftrightarrow E_{initial} \equiv \frac{c^4}{2G} \cdot r_{critial} \sim \frac{c^4 L_P}{2G} \sqrt{\frac{n_{initial}}{\pi}}
\end{aligned}
\tag{24}
$$

These value of Eq. (24) will up to a point be used to identify fillers into Eq.(1) and Eq.(2) of this document. The fact that the initial entropy is not zero, and that the initial energy is not zero, will be used then, with additional work to postulate circumstances indicating conditions for Eq.(4) to be consistent with the existence of a graviton, and a massive graviton at that.

2.1.1. Gravitons, and all that which will lead to a count of Gravitons to be a measure of Entropy

Eq. (24), which has the influence of NLED in it, will be useful when ascertaining what would be a way to determine necessary and sufficient conditions for a massive graviton to exist. To do so, we will look first at Linde (Les Houches, 2013), whom wrote of the probability of creation of a closed universe as given by [11]

$$
\begin{aligned}
& P(probability) \sim \exp(-24\pi^2 / V(potential)) \\
& \Leftrightarrow V(potential) \sim Energy(Planck)
\end{aligned}
\tag{25}
$$

The potential energy, so identified in Eq.(25) is none other than the one used by Padmanbhan [10] in which the H so identified is the Hubble 'constant' parameter, which actually changes over time. In this case, the potential so identified in Eq.(25) is given by

$$
V \sim 3H^2 M_{Planck} \cdot \left(1 + \left(\dot{H} / 3H^2 \right) \right) \tag{26}
$$

Here, if N is an integer number for dimensionality of space-time , and

$$
\begin{aligned}
& H = \dot{a}(t) / a(t) \,\&\, a(t) \sim t^N \\
& \Leftrightarrow V \sim 2M_{Planck} \cdot N^2 / t^N
\end{aligned}
\tag{27}
$$

If so, then if we have V as proportional to an energy E, then we can by the Heisenberg uncertainty principle be looking at a minimum uncertainty principle situation of [9]

$$
\Delta E \Delta t = \hbar \tag{28}
$$

Then, if Δt = t (minimum), and $\Delta E = E_{initial} \equiv \frac{c^4}{2G} \cdot r_{critical} \sim \frac{c^4 L_P}{2G}\sqrt{\frac{n_{initial}}{\pi}}$

$$\Delta t = \left(\hbar / \frac{c^4 L_P}{2G}\sqrt{\frac{n_{initial}}{\pi}} \right) = t_{\min} \tag{29}$$

Now, by Valev,[13] at the start of inflation, and this is before massive red shifting the following are equivalent

$$\begin{aligned} m_{graviton} &\sim \frac{\hbar H}{c^2} \sim \frac{\hbar N}{c^2 t_{\min}} \sim \frac{2GN}{c^6 L_P^2 \sqrt{\frac{n_{initial}}{\pi}}} \sim 10^{-61}\, grams \\ \lambda_{graviton} &\sim \frac{c}{H} \sim \frac{c \cdot t_{\min}}{N} \sim \frac{10}{N} \cdot L_p \sim \frac{1.61}{N} \times 10^{-34}\, meters \\ f\,(frequency)_{graviton} &\sim \frac{1.8 \times 10^{36}}{N}\, Hertz \end{aligned} \tag{30}$$

Inflation would reduce the frequency by 26 orders or so of magnitude (massive red shifting) [14]

$$f\,(frequency)_{graviton}[after - \inf] \sim 10^{10}\, Hertz \tag{31}$$

The difference in red shifted frequencies (a huge 26 order of magnitude reduction in frequency) due to inflation would be in tandem with what we will be identifying as structure formation issues, which are highlighted below

2.1.2 Formation of structure due to NLED formalism

This paper has several routes as to identifying NLED phenomenon pertinent to cosmology structure formation. First we look at what Mukhanov [15] writes as far as structure formation. Mainly that there is a formulation of what is called self reproduction of inhomogeneity in terms of early universe conditions [15]. In this, the starting point is if one used the meme of chaotic inflation, i.e. inflation generated by a potential of the form as given by Guth [14] as well as Mukhanov [15]

$$V\left(potential\right) \sim \phi^2 \tag{32}$$

In this, Mukhanov [15] write that one can look at a scalar field at the end of (chaotic) inflation, with an amplitude given by, with ϕ_i for the initial value of the inflaton such that (where m will be determined by NLED inputs to be brought up later.)

$$\delta_{\phi}^{Max} \sim m \cdot \phi_i^2 \tag{33}$$

In terms of the initial inflaton, inhomogenities do not form if the initial inflaton is bounded [15] as given by

$$m^{-1} > \phi_i > m^{-1/2} \tag{34}$$

This leads to (low?) inhomogeneity in the space-time generated by inflation. Inflation is eternal [15] if. there is only the inequality

$$\phi_i > m^{-1/2} \tag{35}$$

2.1.3 NLED applied to Eq. (35) plus details of structure formation added

What we will do is to look at the following treatment of mass, and this will be our starting point. i.e. we will be looking at , if l_P is Planck length, and α >0, then

$$m \sim 10^{\alpha} \cdot l_p^3 \cdot \rho(density) \tag{36}$$

Then we can consider the following formulation of density given below.
If we do not wish to consider a rotating universe, then Camara et al, [16] has an expression as to density, with a B field contribution to density, and we also can used the Weinberg result [4]of scaling density with one over the fourth power of a scale factor, which we will remark upon in the general section, as well the Corda and Questa result of [12] for density of (note reference [12] is for a star, whereas [16] is for a universe). In addition, Corda, and others in [12] use quintessential density to falsify the null energy condition of a Penrose theorem cited in [6], Further details of what Penrose was trying to do as to this issue of GR, can be seen in [7], and to answer how to violate the null energy condition, one should go to [5] for quintessential density defined, with the constant in Eq.(4) greater than zero. Then in both the massive star and the early universe, the density result below is applicable [12].

$$\rho_\gamma = \frac{16}{3} \cdot c_1 \cdot B^4 \tag{37}$$

Keeping in mind what was said as to choices of what to do about density, and its relationship to Eq.(36) above, we then can reference what Mukhanov[15] says about structure formation as follows, namely look at how a Hubble parameter changes with respect to cosmic evolution. It changes with respect to H_{today} being the Hubble parameter in the recent era, and the scale factor a , with this scale factor being directly responsive to changes in density according to [17], i.e.

$$\rho \sim a^{-4} \tag{38}$$

In the next section, we will examine how [3] suggests how to vary the scale factor cited in Eq. (38), and we will in this section take note of what the scale factor cited in [37] does to the Hubble parameter given in Eq.(38) below, and then in the section afterwards review a possible reconciliation of what Eq.(36) and Eq.(37) say about defining early universe parameters. But to know why we are doing it, we should take into consideration what happens to the Hubble parameter, as given below

$$H \sim H_{today} \big/ a^{3/2} \tag{39}$$

According to [15] inhomogeneous patches of space time appear in a causal region of space time for which [15]

$$Causal - domain \sim H^{-1} \sim 1/\left(H_{today} \big/ a^{3/2}\right) \tag{40}$$

Furthermore, [15] states that about 20 such domains are created in a Hubble time interval $\Delta t_H \propto H^{-1}$ i.e. As a function of say 10^{α} times Planck time, for a domain size given by Eq.(40) above and that this requires then a clear statement as to how the scale factor changes, due to considerations given by [3] and reconciling the density expression given in Eq.(38) above**.**

2.1.3 Showing a non zero initial radius of the universe due to non linear space-time E&M

What we are asserting is. in [16] there exists a scaled parameter λ, and a parameter a_0 which is paired with α_0. For the sake of argument, we will set $a_0 \propto \sqrt{t_{Planck}}$, with $t_{Planck} \sim$ 10^ - 44 seconds. Also, Λ is a cosmological 'constant' parameter which is described later, as in quintessence , via reference [17], and is in [16] via:

$$\alpha_0 = \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0 \tag{41}$$

And

$$\lambda = \Lambda c^2 \big/ 3 \tag{42}$$

Then if , initially, Eq. (41) is large, due to a very large Λ the time, given in Eq.(53) of [15] is such that we can write , most likely, that even though there is an expanding and contracting universe, that the key time parameter may be set , due to very large Λ as

$$t_{\min} \approx t_0 \equiv t_{Planck} \sim 10^{-44} s \tag{43}$$

Whenever one sees the coefficient like the magnetic field, with the small 0 coefficient, for large values of Λ, this should be the initial coefficient at the beginning of space-time which helps us make sense of the non zero but tiny minimum scale factor[15]

$$a_{\min} = a_0 \cdot \left[\frac{\alpha_0}{2\lambda} \left(\sqrt{\alpha_0^2 + 32\lambda\mu_0\omega B_0^2} - \alpha_0 \right) \right]^{1/4} \tag{44}$$

The minimum time, as referenced in Eq.(43) most likely means, due to large Λ that Eq. (44) is of the order of about 10^{-55}, i.e. 33 orders of magnitude smaller than the square root of Planck time, in magnitude. We next will be justifying the relative size of Λ.

2.1.4 Showing How to obtain a varying Λ with a large initial value and its relationship to obtaining scale factor value for the early universe via NLED methods

Non withstanding the temperature variation in reference [17] for the cosmological Hubble parameter, we also can reference what is done in reference [15**]** namely

$$\Lambda(t) \sim \left(H_{\text{inflation}}\right)^2 \tag{45}$$

In short, what we obtain, via looking at due to [8], that Eq.(45) is also equivalent to

$$\Lambda_{Max} \sim c_2 \cdot T_{temperature}{}^{\tilde{\beta}} \tag{46}$$

Comparing Eq.(45) and Eq.(46) above, leads to the following constraints, i.e.

$$\left(\rho \sim a^{-4}\right)^{-1} \sim a^4 \sim \frac{16}{3} \cdot c_1^{-1} \cdot B^{-4} \sim a_0^4 \left[\frac{\alpha_0}{2\lambda} \left(\sqrt{\alpha_0^2 + 32\lambda\mu_0\omega B_0^2} - \alpha_0 \right) \right] \tag{47}$$

The above relationship will argue in favor of a large value for Eq.(46) and Eq.(47) B field and also the cosmological ‘constant’ parameterized in Eq. (45) and Eq.(46), i.e. once fully worked out, the allowed values of B, for initial conditions will be large but tightly constrained, and this in turn will allow for Eq. (49) having initially extremely small inhomogeneity behavior, in line with being proportional to the inverse of an allowed Hubble parameter based upon Eq. (49). Note that from [18] we have

$$\frac{\Delta H}{H} \sim \Omega_m^2 h^2 \Delta_{\Re} \sim 10^{-5} \tag{48}$$

Here, we have that if there is a flat universe, that according to Guth [19] and taking note of

$$H^2 = \frac{8\pi}{3} \cdot \rho \tag{49}$$

Roughly put, what we are predicting is, that if we use what Lloyd wrote, namely [20] as well as use the magnetic field relations to density brought up in Eq.(36). This is also in part related to the number of gravitons which could be expected as given by Peebles [21] , i.e. if one has a density related to energy via $\rho \propto \hbar \cdot \omega_{Graviton} \cdot V^{-1}(Volume) \Leftrightarrow \hbar \cdot \omega_{Graviton} \sim \rho \cdot V^{+1}(Volume)$. Then one can write, say by using the approximation given by Peebles [21]

$$\mathbb{N}_{graviton} = graviton\# \sim \left(\left(\exp\left[\hbar \cdot \omega_{graviton} / k_B T\right]\right) - 1\right)^{-1} \propto \left(\left(\exp\left[\rho \cdot V_{Volume} \cdot a_{initial}(t) / k_B\right]\right) - 1\right)^{-1} \tag{50}$$

If we have such a treatment of information as given by Lloyd [20], plus the above, we can estimate that there is a fluctuation due to early universe cosmology along the lines of, if we have a base line number for initial (expansion) value of the Hubble parameter, we call $H_{base-line}$ as a starting point for an expanding universe, and with $\#operations$, as given by Lloyd [20] as a function of entropy, initially. So then, in terms of what may be generated and show up in the CMBR we may see

$$\Delta H(thermal) \sim H_{base-line} \cdot (\#operations)^{1/4} \cdot 10^{-5} \cdot \sqrt{t / t_{Planck}} \tag{51}$$

The number of gravitons, as given by Eq. (49) is significant, since we have , if we look at say what constitutes a contribution from $\rho \cdot V_{Volume}$, and from there, given a value of $H_{base-line}$ according to the following procedure , if $H_{initial} \sim H_{baseline}$, and then define $H_{initial}$ as

$$H_{initial} \sim \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume} \cdot a_{initial}}} \cdot \left(\log\left[1 + \frac{1}{\mathbb{N}_{graviton}(initial)}\right]\right) \tag{52}$$

For the sake of simplicity, we will have, then that the following are equivalent, which leads to $\Delta H(thermal)$

$$\begin{aligned}
&H_{initial} \approx H_{base-line} \Rightarrow H_{base-line} \sim \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume} \cdot a_{initial}}} \cdot \left(\log\left[1 + \frac{1}{\mathbb{N}_{graviton}(initial)}\right]\right) \\
&\& \Delta H(thermal) \sim \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume} \cdot a_{initial}}} \cdot \left(\log\left[1 + \frac{1}{\mathbb{N}_{graviton}(initial)}\right]\right) \cdot (\#operations)^{1/4} \cdot 10^{-5} \cdot \sqrt{t / t_{Planck}} \\
&\& \#operations \sim \left(\mathbb{N}_{graviton}(initial)\right)^{4/3} \Rightarrow \\
&\Delta H(thermal) \sim \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume} \cdot a_{initial}}} \cdot \left(\log\left[1 + \frac{1}{\mathbb{N}_{graviton}(initial)}\right]\right) \cdot (\mathbb{N}_{graviton}(initial))^{1/3} \cdot 10^{-5} \cdot \sqrt{t / t_{Planck}}
\end{aligned} \tag{53}$$

The upshot of Eq. (53) is that if Eq. (47) is commensurate with a minimum value of the scale factor, i.e. so long $a_{initial} \neq 0$ due to [16]

$$a_{initial} \approx a_{\min} \sim a_0 \cdot \left[\frac{\alpha_0}{2\lambda}\left(\sqrt{\alpha_0^2 + 32\lambda\mu_0\omega B_0^2} - \alpha_0\right)\right]^{1/4} \propto \left[\frac{\alpha_0}{2\lambda}\left(\sqrt{\alpha_0^2 + 32\lambda\mu_0\omega B_0^2} - \alpha_0\right)\right]^{1/4} \tag{54}$$

Then the shift in the change in the Hubble parameter, in expansion to first order can be delineated as

$$\Delta H(thermal) \sim \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume}} \cdot \frac{\left(\log\left[1+\frac{1}{\mathbb{N}_{graviton}(initial)}\right]\right)}{\left[\frac{\alpha_0}{2\lambda}\left(\sqrt{\alpha_0^2+32\lambda\mu_0\omega B_0^2}-\alpha_0\right)\right]^{1/8}}} \cdot (\mathbb{N}_{graviton}(initial))^{1/3} \cdot 10^{-5} \cdot \sqrt{t/t_{Planck}} \qquad (55)$$

By necessity to get non pathological values of the change in $\Delta H(thermal)$, we need to have the following values

$$\begin{aligned} &\mathbb{N}_{graviton}(initial) \neq 0 \\ &\mathbb{N}_{graviton}(initial) \neq \infty \\ &B_0 \equiv B_{initial} \neq 0 \\ &B_0 \equiv B_{initial} \neq \infty \\ &\lambda \neq 0 \\ &\lambda \neq \infty \end{aligned} \qquad (56)$$

The initial volume would be at a minimum the cube of Planck's length, say 10^-33 centimeters, cubed, leading to an enormous value for Eq.(55), whereas we would be considering if we had an initial time step close to Planck time, and $0 < \mathbb{N}_{graviton}(initial) < 10^5$, and

$$\Delta H(thermal) \sim \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume}} \cdot \frac{\left(\left[\frac{1}{\mathbb{N}_{graviton}(initial)} - \frac{1}{2\mathbb{N}^2_{graviton}(initial)}\right]\right)}{\left[8\mu_0\omega B_0^2\right]^{1/8}}} \cdot (\mathbb{N}_{graviton}(initial))^{1/3} \cdot 10^{-5} + H.O.T \qquad (57)$$

This places an absolute requirement upon having the initial magnetic field not equal to zero, as well as having a non zero initial graviton production number, and also non zero initial volume. With both these requirements in place, if $m_{graviton} \sim \frac{\hbar H}{c^2} \sim 10^{-61} grams$, and we set in a Planck time interval

$$\begin{aligned} m_{graviton} &\sim \frac{\hbar H}{c^2} \sim 10^{-61} grams \\ &\sim \frac{\hbar}{c^2} \cdot \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume}} \cdot \frac{\left(\left[\frac{1}{\mathbb{N}_{graviton}(initial)} - \frac{1}{2\mathbb{N}^2_{graviton}(initial)}\right]\right)}{\left[8\mu_0\omega B_0^2\right]^{1/8}}} \cdot (\mathbb{N}_{graviton}(initial))^{1/3} \cdot 10^{-5} \end{aligned} \qquad (58)$$

These Eq.(57) and Eq.(58) are useful for linking structure formation to entropy, as will be mentioned next. The conclusions link structure formation to a count of gravitons, which is the subject matter of the conclusion.

4. Conclusions

We then get an inter relationship between $\mathbb{N}_{graviton}\left(initial\right)$, the initial Volume, and the initial magnetic field to consider. Moreover, what we have also shown, is that NLED. Appearing initially, that it is very probable that if one uses infinite quantum statistics as given by Ng [7]

$$\mathbb{N}_{graviton}\left(initial\right) \approx S\left(initial - entropy\right) \neq 0 \tag{59}$$

Note that in usual treatment of entropy, and entropy density we usually assume a fourth order dependence upon temperature for entropy density. Here we say that this entropy is most likely independent of Temperature , by Infinite quantum statistics, as given by Ng[7] . But we also will be talking about a necessary bound of quantum fluctuations which will be given below. I.e. consider if we have the following restrictions in fluctuations due to quantum effects which we give as follows.
What we will mention, is that co current with Eq.(57), Eq. (58) and Eq. (59) that there is a situation for which , as given by Mukhanov [15] there are conditions in which a quantum fluctuation would spoil initial homogeneity if there exist quantum fluctuations exceeding

$$\begin{aligned}
&\lambda_{Critical-value} \sim \left(\Delta H\right)^{-1} \exp(m_{graviton}^{-1}) \\
&\sim \sqrt{\frac{12 \cdot V_{Volume}}{8\pi k_B}} \cdot \frac{\left[8\mu_0 \omega B_0^2\right]^{1/8} (\mathbb{N}_{graviton}\left(initial\right))^{-1/3} \cdot 10^5}{\left[\frac{1}{\mathbb{N}_{graviton}\left(initial\right)} - \frac{1}{2\mathbb{N}^2_{graviton}\left(initial\right)}\right]} \\
&\cdot \exp\left(\frac{c^2}{\hbar} \cdot \sqrt{\frac{12 \cdot V_{Volume}}{8\pi k_B}} \cdot \frac{\left[8\mu_0 \omega B_0^2\right]^{1/8} (\mathbb{N}_{graviton}\left(initial\right))^{-1/3} \cdot 10^5}{\left[\frac{1}{\mathbb{N}_{graviton}\left(initial\right)} - \frac{1}{2\mathbb{N}^2_{graviton}\left(initial\right)}\right]}\right)
\end{aligned} \tag{60}$$

The quantum uncertainty in position which will be referred to is of the form

$$\Delta x \Delta p \equiv \lambda_{QM} \cdot m \cdot c \approx \hbar \Leftrightarrow \lambda_{QM-graviton} \approx \frac{\hbar}{m_{graviton} \cdot c} \sim c \cdot \sqrt{\frac{12 \cdot V_{Volume}}{8\pi k_B}} \cdot \frac{\left[8\mu_0 \omega B_0^2\right]^{1/8} (\mathbb{N}_{graviton}\left(initial\right))^{-1/3} \cdot 10^5}{\left[\frac{1}{\mathbb{N}_{graviton}\left(initial\right)} - \frac{1}{2\mathbb{N}^2_{graviton}\left(initial\right)}\right]} \tag{61}$$

When the wavelength function of Eq. (60) and Eq.(61) are about the same value, one has the destruction of inhomogeneity, in early universe conditions, which puts restrictions on the value of graviton mass, of presumed entropy, as given by Ng's infinite quantum statistics, and more. The details of such will be elaborated upon in further publications. Furthermore, it also puts constraints upon the magnetic fields which may be present in early universe conditions. In any case the expected mass of the graviton would be of the order of about 10 ^ - 62 grans, and the entropy would be here about

$$1 < \mathbb{N}_{graviton}\left(initial\right) \sim S_{\ initial} < 10^5 \tag{62}$$

The implications of Eq.(58) to Eq.(60) need to be considered and evaluated fully. We hope that in due time, Eq.(55) to Eq.(60) will allow for evaluating the apparent falsification of inflationary results first reported by [22] which was discussed at length in Rencontres De Moriond, Cosmology in both 2014 and 2015, which the author views as of paramount importance in constructing a gravitational astronomy initiative . As well as making sense of the Mukhanov based [15] criteria as to the formation of structure during the Dark ages, just before the turn on of the CMBR at z(redshift)~ 1100

$$Structure \propto 1 \Bigg/ \sqrt{\frac{8\pi k_B}{12 \cdot V_{Volume}}} \cdot \frac{\left(\left[\frac{1}{\mathbb{N}_{graviton}\left(initial\right)} - \frac{1}{2\mathbb{N}^2_{graviton}\left(initial\right)}\right]\right)}{\left[8\mu_0 \omega B_0^2\right]^{1/8}} \cdot (\mathbb{N}_{graviton}\left(initial\right))^{1/3} \cdot 10^{-5} \quad (63)$$

Eq. (63) has to be commensurate with the inverse of Eq. (57) which will take some serious work. We also state that Eq.(63) in itself may be enough to falsify the results of [22], in line with work presented in [23] which gave extremely specific magnetic field strengths for early universe cosmology.

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Conflicts of Interest

"The authors declare no conflict of interest".

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