Using Gravo-Electric and Gravo-Magnetic Fields as a way to compute Minimum allowed initial Frequency, at start of Universe

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Abstract

Staring off with the Usual Energy Density for Electro-Magnetic fields, we adopt Padmanbhan's Gravo – Electric and Gravo Magnetic field formulation to come up with an initial frequency, at the start of the universe, and then using work done by the author, take the inverse of this frequency as a way to initiate a practical time step, which will then be related to earlier work the Author did. The miminum time step iteratively relates to a "cosmological constant" initial value, and a range of initial GW frequencies which for a scale factor $a\left(t_{initial}\right) \sim 10^{-30}$ which would correspond to GW of about 10^36 Hertz, red shifted to 10^4 Hertz in the modern era. If the scale factor were of the order of 10^-55, the GW waves initially would be as high as 10^42 Hertz which would be red shifted to 10^10 Hertz, for relic GW. All this assumes that the graviton rest mass remains invariant about 10^-62 grams in the aftermath of the creation of the universe.

Key words: cosmological vacuum energy. energy density ,initial time step.

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1 Introduction

We first of all cite there exists formalism of Berry[1] as to the formation of a shortest time step consistent to FRW space-time metrics. Then we will compare the results to the derived minimum time step derivation which is consistent with Non linear Electrodynamics NLED. In doing so we will isolate what is a range of values for the vacuum energy, and "cosmological constant" dependent upon Nonlinear Electrodynamics NLED [2] inputs.

Berry's results [1] are that for a standard flat space FRW cosmology, with positive cosmological 'constant'

$$t \sim \frac{2}{\sqrt{3\Lambda}} \cdot \operatorname{arcsinh}\left[a(t) \cdot \sqrt{\frac{\Lambda}{8\pi G\rho}} \right] \tag{1}$$

We will compare this answer with a minimum time step consistent with Non linear Electrodynamics NLED and use it to obtain a Non linearl Electrodynamics NLED bound on the Λ cosmological constant term.

We will be in our problem be using the inverse relationship between frequency , and time, as a way to parameterize the cosmological "constant" in this equation. The scale factor, a(t) as given above will be parametrized by NLED inputs as given by [2], whereas frequency will be one over Eq. (1), and the density function, will come from [2]. The Frequency will be from formulation given in [3], page 278-279.

2. First the Inputs into a minimum time step, which will be the inverse of frequency

What we are doing is to take the results of Padmanbhan [3] as given for Gravo – Electric and Gravo Magnetic fields, which give licence to use the very typical electromagnetic energy density expression [4]

$$u_{E-M}(energy-density) = \frac{1}{2} \cdot \left[\varepsilon_0 E^2 + \frac{B^2}{\mu_0} \right] \tag{2}$$

The Gravo-Electric, and Gravo-Magnetic fields, as given in [2], are leading to, if **S** is the total angular momentum of a source the following expression for energy density. What we do, is to use a dimensional scaling argument based upon calling the energy as equivalent to Plank's constant times frequency, and then take the expression for [1] as to time, and set it so it is the smallest allowed physical measurement of time, as one over the frequency. I.e. taking one over Eq. (1) from [1] will yield an admissible smallest unit construction of frequency, and we use this to ascertain, via this document a range of values for the Planck's constant. The short course is that we get an overshoot of at most 10^10 over todays Planck's constant, which is way better than the usual 10^120 overshoot used by Field theoretic methods. The trick we use which is discussed in this document later is to take what is called $S \sim L_z \sim m_z \hbar$ and set this at the lowest admissible value. It is a sleigh of hand meant to introduce the emergence of space-time as a quantum phenomena. I.e. one of the topics of further research would be ascertain why the quantum number $m_z = 1$, right now it is a fortuitous guess and has only convenience in it as used.

$$
\begin{aligned}
&u_{E-M}(energy-density) = \frac{1}{2}\cdot\left[\varepsilon_0 E^2 + \frac{B^2}{\mu_0}\right] \\
&= \frac{G^2}{|r|^4}\cdot\left(\varepsilon_0 M^2 + \frac{\left(S^2 + 3\left(\vec{S}\cdot r\right)^2\right)}{\mu_0 c^2 |r|^2}\right) \\
&if \\
&E(gravo-electric) = -\frac{G\cdot M}{|r|^2}\cdot\vec{r} \\
&B(gravo-magnetic) = \frac{2G}{c^2|r|^3}\left(\vec{S} - 3\left(\vec{S}\cdot r\right)\ \vec{r}\right)
\end{aligned} \tag{3}
$$

Then if we make the identification of net energy as if

$$
E(gravo-Electric-Magnetic) \sim \hbar\omega_{source} \tag{4}
$$

The net initial Gravo-Electric frequency would then be, if the Eq. (4) is identified as

$$
\begin{aligned}
&\frac{V(initially)\cdot u_{E-M}(energy-density)}{\hbar} \\
&= \frac{G^2 V(initially)}{|r|^4\hbar}\cdot\left(\varepsilon_0 M^2 + \frac{\left(S^2 + 3\left(\vec{S}\cdot r\right)^2\right)}{\mu_0 c^2|r|^2}\right) \sim \omega_{source}
\end{aligned} \tag{5}
$$

Then, we would be making the identification with Eq. (1) via the following

$$
\begin{aligned}
&1\Big/\left\{\frac{G^2 V(initially)}{|r|^4\hbar}\cdot\left(\varepsilon_0 M^2 + \frac{\left(S^2 + 3\left(\vec{S}\cdot r\right)^2\right)}{\mu_0 c^2|r|^2}\right)\right\} \\
&\sim t \sim \frac{2}{\sqrt{3\Lambda}}\cdot\operatorname{arcsinh}\left[a(t)\cdot\sqrt{\frac{\Lambda}{8\pi G\rho}}\right]
\end{aligned} \tag{6}
$$

$a(t)$, and ρ will come from inputs from [2] as well as the Gravo-Electric and Gravo Magnetic inputs from Eq. (3) above. The Volume , initially, V(initially), will be set as ~ r^3 which will make further cancellation doable and not a problem to execute.

3. Putting in values of $a(t)$, and ρ will come from inputs from [1,2]

i.e. we are looking at what happens if an electron moves at a velocity of v, with

$$|v| = |E/B| \tag{7}$$

Implying if c is the speed of light, and $\tilde{\beta} > 0$, then the magnitude of the electric field should be given by

$$|E| = c \cdot 10^{-\tilde{\beta}} |B| \tag{8}$$

i.e. in [2] we look at a generalized density .

$$\rho = \frac{1}{2\mu_0} \cdot B^2 \cdot \left(1 - 8 \cdot \mu_0 \cdot \omega \cdot B^2\right) \tag{9}$$

This has a positive value only if input (E and M ?) frequency ω is such that.

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

In this situation we will be setting $B \equiv B_0$ What we are asserting is, that the very process of an existent E and M field, also,sets a non zero initial radii to the universe. i.e. in [3] there exists a scaled parameter λ, and a parameter a_0 which is paired with

$$\alpha_0 = \sqrt{\frac{4\pi G}{3\mu_0 c}} B_0 \tag{11}$$

$$\lambda = \Lambda c^2 / 3 \tag{12}$$

Then if , initially, Eq. (12) is large, due to a initial vacuum energy parameter Λ the time, given in Eq.(53) of [2] is such that we can write , most likely, that 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

$$a_{\min} = a_0 \cdot \left[\frac{\alpha_0}{2\lambda} \left(\sqrt{\alpha_0^2 + 32\lambda\mu_0\omega B_0^2} - \alpha_0 \right) \right]^{1/4} \tag{13}$$

The above scale factor should be such that the value of Eq. (13) should be in its smallest , i.e. 480,000 times proportionately larger than a Planck length of $l_{Planck} \sim 1.6162 \times 10^{-35} meters$, i.e. scale $a_0 \propto 10^{-29}$

Then, we will have that

$$\left[\frac{\alpha_0}{2\lambda} \left(\sqrt{\alpha_0^2 + 32\lambda\mu_0\omega B_0^2} - \alpha_0 \right) \right] \geq 1 \tag{14}$$

$$\Rightarrow \frac{\alpha_0^2}{2\lambda}\left(\sqrt{1+32\frac{\lambda\mu_0\omega B_0^2}{\alpha_0^2}}-1\right)\geq 1$$
$$\Rightarrow 8\mu_0\omega B_0^2 \geq 1 \qquad (15)$$

Eq.(18) puts a strong constraint upon the frequency and magnetic field strength, whereas Eq. (12) gives a strong set of values as to allowed E, so as to have, then

$$E^2 \geq c^2 \cdot 10^{-2\tilde{\beta}} / 8\mu_0\omega \qquad (16)$$

Which will then be linked to a graviton mass via calculation of the upper bound to the Cosmological constant due to [5,6]

$$m_g^2 = \frac{\tilde{\kappa}\cdot\Lambda_{\max}\cdot c^4}{48\cdot h\cdot\pi\cdot G} \qquad (17)$$

i.e the time step is then independent upon elementary arguments as to massive graviton mass.

3. Minimum time according to the FRW metric allows for a NLED bound to Λ

The easiest case to consider is, if the Λ is not overly large, and the initial scale factor $a(t)$ is small. Then we have by [6]

$$t \sim \frac{2}{\sqrt{3\Lambda}}\cdot\left(a(t)\cdot\sqrt{\frac{\Lambda}{8\pi G\rho}}-\frac{a^3(t)}{2.3}\left(\frac{\Lambda}{8\pi G\rho}\right)^{3/2}+HOT\right) \qquad (18)$$

Then we are looking at applying Eq. (6) to the above, and we find

$$\frac{\Lambda}{8\pi G\rho} \approx 2.3\cdot a(t)^2\cdot\left\{1-\sqrt{\frac{3}{4}}\cdot\frac{a(t)^{-1}\sqrt{8\pi G\rho}\cdot\frac{|r|}{\hbar}}{\varepsilon_0 M^2+s^2+3\cdot(\vec{s}\cdot r)^2}\right\} \qquad (19)$$

Here, $a(t_{initial}) \sim 10^{-30}$ is very small, and we will next put in the value of the frequency, density function according to NLED, and other parameters, as well to make out estimates. M above is a mass factor, and what is says is that the greater the mass is, presumably at the start of inflation, the more the ratio of cosmological 'constant versus density in $\frac{\Lambda}{8\pi G\rho}$ depends upon just the scale factor, with the density given by Eq. (9). In addition, the term S, above, in Eq. (19) is a way to specify the source angular momentum. I.e. if the radii is at the beginning of the universe, with a small S value, then at the very most we are looking at

$$\frac{\Lambda}{8\pi G\rho} \approx 2.3 \cdot a(t)^2 \cdot \left\{ 1 - \sqrt{\frac{3}{4}} \cdot \frac{a(t)^{-1}\sqrt{8\pi G\rho} \cdot \frac{|r|}{\hbar}}{\varepsilon_0 M^2 + s^2 + 3\cdot\left(\vec{s}\cdot r\right)^2} \right\}$$

$$\xrightarrow[S\to small(Value), r\to(planck-length)]{} 2.3 \cdot a(t)^2 \cdot \left\{ 1 - \sqrt{\frac{3}{4}} \cdot \frac{a(t)^{-1}\sqrt{8\pi G\rho} \cdot \frac{|r|}{\hbar}}{\varepsilon_0 M^2} \right\} \tag{20}$$

$$\Leftrightarrow \left.\frac{\Lambda}{8\pi G\rho}\right|_{Early-universe} \propto 2.3 \cdot a(t)^2 \cdot \left\{ 1 - \sqrt{\frac{3}{4}} \cdot \frac{a(t)^{-1}\sqrt{8\pi G\rho} \cdot \frac{|r|}{\hbar}}{\varepsilon_0 M^2} \right\}$$

We will be next examining inputs into the density function, as given in Eq. (6) which depend critically upon a Gravo Magnetic field which in turn is also linked to S which is assumed to be small valued. The use of Eq. (6) in Eq.(20) allows us to state that NLED plays a crucial role in the bound of Plancks Λ

4. Putting in the NLED behavior of Eq. (6) into Eq. (20) via the Gravo-Magnetic field B of Eq.(3)

$$\rho\left[NLED\right] \propto \frac{2G^2}{\mu_0 c^4 |r|^6} \cdot \left(s^2 + 3\cdot\left(\vec{s}\cdot r\right)^2\right) \cdot \left\{ 1 - 8\mu_0\omega \cdot \left[\frac{4G^2}{c^4 |r|^6} \cdot \left(s^2 + 3\cdot\left(\vec{s}\cdot r\right)^2\right) \right] \right\} \tag{21}$$

The crucial input into this is the term S which is the total angular momentum of the source term. What we are assuming, using both [1] and [2] is that this source term is small, but non vanishing , which is equivalent to saying it is representing a non singular initial starting point for the universe, but one which is also with total angular momentum. Now here is a suggestion as to a simple model for the S term [7]

$$S \sim L_z \sim m_z \hbar \tag{22}$$

If so then, Eq. (21) will read as

$$\rho\left[NLED\right] \propto \frac{8G^2}{\mu_0 c^4 |r|^6} \cdot \left(m^2_{z-quantum,number}\hbar^2\right) \cdot \left\{ 1 - 8\mu_0\omega \cdot \left[\frac{16G^2}{c^4 |r|^6} \cdot \left(m^2_{z-quantum,number}\hbar^2\right) \right] \right\} \tag{23}$$
$$S \sim L_z \sim m_z \hbar$$

A priorit, until we know more, the numerical input into Eq.(23) will be set equal to 1, so our guess is that

$$\rho\left[NLED\right] \propto \frac{8G^2}{\mu_0 c^4 \left|r\right|^6}\cdot\left(\hbar^2\right)\cdot\left\{1-8\mu_0\omega\cdot\left[\frac{16G^2}{c^4\left|r\right|^6}\cdot\left(\hbar^2\right)\right]\right\} \tag{24}$$

$$S \sim L_z \sim \hbar$$

This puts restrictions upon the admissible frequency, but that is not unheard of, and that will be in line with putting Eq. (23) and/or Eq. (24) into

$$\Lambda\Big|_{Early-universe} \sim 2.3\cdot a(t)^2\cdot 8\pi G\rho\cdot\left\{1-\sqrt{\frac{3}{4}\cdot\frac{a(t)^{-1}\sqrt{8\pi G\rho}\cdot\frac{|r|}{\hbar}}{\varepsilon_0 M^2}}\right\} \sim 2.3\cdot a(t)^2\cdot 8\pi G\rho \tag{25}$$

Then the early universe Plancksl contant would be defined through the density function as given by Eq. (23) and Eq. (24)

M in this case would be many times larger than the electromagnetic density as given by Eq(23) or Eq.(24) and so then the mass of a graviton would then be after modifying the result from [5,6]

$$m_g^2 = \frac{\tilde{\kappa}\cdot\Lambda_{\max}\cdot c^4}{48\cdot h\cdot\pi\cdot G} \sim \frac{\tilde{\kappa}\cdot c^4\, 2.3\cdot a(t)^2\rho}{6\cdot h\cdot G} \tag{26}$$

And with the assumed density of the Gravo-magnetic field put in, this would reduce to

$$m_g^2 \sim \frac{\tilde{\kappa}\cdot c^4\, 2.3\cdot a(t)^2\rho}{6\cdot h\cdot G} \sim \frac{\tilde{\kappa}\cdot c^4\, 2.3\cdot a(t)^2}{3}\frac{4G}{\mu_0 c^4\left|r\right|^6}\cdot\left(\hbar\right)\cdot\left\{1-8\mu_0\omega\cdot\left[\frac{16G^2}{c^4\left|r\right|^6}\cdot\left(\hbar^2\right)\right]\right\} \tag{27}$$

The radii would be assumed to be of greater than Planck Length. The scale factor would be ~ 10^-30 to 10^-55. The frequency chosen, here, so that the square of the graviton mass would be ~ (10^-62 grams)^2

The modius operandi of Eq.(27) is in locating a range of frequencies for which the mass of a graviton will not exceed 10^-62 grams. If the scale factor goes in as low as 10^ -55 it indicates an initial frequency which could be as high as 10^42 Hz, which would then be red shifted by inflation to about 10^10 Hertz

For this paper, the scale factor is assumed to be on the order of $a\left(t_{initial}\right) \sim 10^{-30}$ which is in line with a radii a few orders of magnitude above the Plank Length, as far as a bubble of initial space-time not collapsing to the initial singularity. The initial frequency would then be about 10^36 Hertz, which would be refer to present day frequency of about 10^4 Hertz, as far as Primordial GW.

Re-examining relic gravitational wave models as to what relic Gravitational waves could tell us about the origins of the early universe. As given in an earlier paper by the Author

Quoting from [6] we write the following. We reproduce this, because of the centrality of Eq. (27) which is basic. It is very noticeable that in [6] we have that the following quote is particularly relevant to consider, in lieu of our results

Quote

"***Thus, if advanced projects on the detection of GWs will improve their sensitivity allowing to perform a GWs astronomy (this is due because signals from GWs are quite weak) [1], one will only have to look the interferometer response functions to understand if General Relativity is the definitive theory of gravity. In fact, if only the two response functions (2) and (19) will be present, we will conclude that General Relativity is definitive. If the response function (22) will be present too, we will conclude that massless Scalar - Tensor Gravity is the correct theory of gravitation. Finally, if a longitudinal response function will be present, i.e. Eq. (25) for a wave propagating parallel to one interferometer arm, or its generalization to angular dependences, we will learn that the correct theory of gravity will be massive Scalar - Tensor Gravity which is equivalent to f(R) theories. In any case, such response functions will represent the definitive test for General Relativity. This is because General Relativity is the only gravity theory which admits only the two response functions (2) and (19) [4, 7, 17, 18]. Such response functions correspond to the two "canonical" polarizations h+ and h×. Thus, if a third polarization will be present, a third response function will be detected by GWs interferometers and this fact will rule out General Relativity like the definitive theory of gravity***"

End of quote

We argue that a third polarization in Gravitational waves from the early universe may be detected, if there is proof positive that in the pre Planckian regime that the Corda conjecture [8] as given below, namely if the following analysis is part of our take on relic gravitational waves, is supported by the kinetic energy being larger than the potential energy, namely what if

Quote, from [6]

"The case of massless Scalar-Tensor Gravity has been discussed in [4, 12] with a "bouncing photons analysis" similar to the previous one . In this case, the line-element in the TT gauge can be extended with one more polarization, labelled with Φ (t + z), i.e. …"

End of quote: This ends our recap of the section given in [6] which we think is important.

What we are arguing for is that the choice of the vacuum energy as given by Eq. (27) may give conclusive proof as to satisfy the Corda conjecture and his supposition as to the existence of an additional polarization [8]. We will, in the future try to extend our results so as to determine if Eq. (27) either falsifies or supports the existence of a 3rd polarization. Which will be a way to determine the final disposition of GR as THE theory of Cosmology, or open up the possibility of alternate theories. It is an issue which we think will require extreme diligence. While ending our query as to the possible existence of a third polarization we should mention what would be the supreme benefit of our upcoming analysis of Eq. (27), namely how to avoid the conflating of dust , with gravitational waves, i.e. the tragic Bicep 2 mistake [6,9,10,11, 12][11, 12, 13,14]

4. How to avoid the Bicep 2 fiasco.

The main agenda would be in utilization of Eq. (27) to help nail down a range of admissible frequencies which would be to avoid [11, 12, 13, 14] conflating the frequencies of collected Gravitational wave signals from relic cosmological conditions (or would be signals) with those connected with Dust generated

Gravitational wave signals, especially from dust conflated with Galaxy formation in the early universe. More than anything else, we need to find, likely narrow(?) Frequency ranges, which would be commensurate with Eq. (27), and to use advanced detector technology. Of course such a search would be hard. But it also would be a way, with due diligence as to answer questions raised by the Author in [15]. In doing so, the relative flatness of the early universe and its departure from curved space conditions would be a great way to answer the suppositions raised in [9, 10] as well.

5. Conclusion:

. The previously done work by the author as to graviton production invoking nonlinear electrodynamics in cosmology was re-introduced for the purpose as to density functions which are used to create an upper bound to the largest initial time step, in cosmological evolution.

We utilize work by Padmanbhan, as a way to introduce Gravo Electrical and Gravo magnetic fields as a way to link the formation of Gravitons, with initial frequencies, and up to a point we do think we have achieved our goal. The main driver of initial conditions being, counter intuitively a magnetic "field" with an angular momentum component. This is stated generally as was in Padmanabhan's text [3], and it is combined with the work in [2] as to argue for an intial non singular starting point for cosmological evolution.

One of the topics of further investigation would be a rigorous argument in favor of both $S \sim L_z \sim m_z \hbar$ and more importantly would be to ascertain why the quantum number $m_z = 1$, right now it is a fortuitous guess and has only convenience in it as used. It needs rigorous proof.

Eq.(20) argues for an NLED influenced cosmological "vacuum energy", i.e. what we observe, initially is that the above, using $a\left(t_{initial}\right) \sim 10^{-30}$ that at most the value of Λ would be greater than the present value of the cosmological constant, perhaps by $10^{10} - 10^{20}$, arguing that some form of quintessence is argued for. But this value of Eq. (20) is far lower than the 10^{120} overshoot, obtained by traditional QFT methods. [7].

Eq. (27) is also important. It neatly allows for an investigation as to [13] flatness issues as well as gives credence to what is raised in [9, 10] as far as the existence, of an additional GW polarization.

Acknowledgements

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