Detailing Minimum parameters as far as red shift, frequency, strain, and wavelength of Gravity Waves / gravitons, and possible impact upon GW astronomy

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Abstract

This document will briefly outline some of the issues pertinent to early inflation and how it affects both strain readings for a GW detector, GW wave lengths, the number of gravitons which may be collected per phase space, among other issues. Different inflation models will also be briefly alluded to.explain in part what may be happening, as far as rates of alternations of wavelengths of GW 's from their genesis in terms of pre inflation to inflationary generation. We also mention a standard as far as GW measurement and how the 'metric' of measurement varies between the different models To summarize we state that the best chances for relic GW measurements are $\Omega_{GW} \sim 10^{6}$ are in the $1Hz < f < 10\ GHz$ range. This according to the pre big bang models, and the QIM model.

Introduction

The linkage to SO(4) gauge theory and gravitons was brought up by [1] Kuchiev, M. Yu, and we think it leads to a kink-anti kink pair tie in for attendant gravitons. Note that Kuchiev [1] writes that "Conventional non-Abelian SO(4) gauge theory is able to describe gravity provided the gauge field possesses a s polarized vacuum state. In this vacuum the instantons and anti-instantons have a preferred direction of orientation.", and furthermore "Gravitons appear as the mode describing propagation of the gauge field which strongly interacts with the oriented instantons" Furthermore, as given by Andrić, Jonke and Jurman,[2] what is called an *n*-soliton solution is shown to have an equivalence "semiclassical solutions corresponding to

1. Modeling of entropy, generally, as kink-anti-kinks pairs with $\breve{N}$ the number of the kink-anti-kink pairs. This number, $\breve{N}$ is, initially in tandem with entropy production, brought up by Beckwith [3]

2. The tie in with entropy and gravitons is this: The two structures are related to each other in terms of kinks and anti-kinks. It is asserted that how they form and break up is due to the same phenomenon: a large insertion of vacuum energy leads to a breakup of both entropy levels and gravitons. When a second-order phase transition occurs, there is a burst of relic gravitons. Similarly, there is an initial breakup of net entropy levels, and after a second-order phase transition, another rapid increase in entropy.

The supposition we are making here is that the value of N is proportional to a numerical graviton density we refer to as <n> [4],[5]., provided that there is a bias toward HFGW, which would mandate a very small value for $V \sim volume \sim \lambda^3$ .Furthermore, structure formation arguments, given by Perkins [6] give ample evidence that if we use an energy scale, m, over a Planck mass value M_{Planck}, as well as contributions from field amplitude ϕ, and using the contribution of scale factor behavior $\frac{\dot{a}}{a} \equiv H \approx -m \cdot \frac{\phi}{3 \cdot \dot{\phi}}$, where we assume $\ddot{\phi} \cong 0$ due to inflation

$$\frac{\Delta\rho}{\rho} \sim H\Delta t \sim \frac{H^2}{\dot{\phi}} \sim \left(\frac{m}{M_{Planck}}\right) \times \left(\frac{\phi}{M_{Planck}}\right) \sim 10^{-5} \tag{1}$$

At the very onset of inflation, $\phi << M_{Planck}$, and if m (assuming $\hbar = c = 1$) is due to inputs from a prior universe, we have a wide range of parameter space as to ascertain where $\Delta S \approx \Delta N_{gravitons} \neq 10^{88}$ comes from and plays a role as to the development of entropy in cosmological evolution 'information'. If $S_{initial} \sim 10^{5}$ is transferred from a prior universe to our own universe at the onset of inflation,, at times less than Planck time $t_P \sim 10^{-44}$ seconds, that enough information **MAY** exit for the preservation of the prior universe's cosmological constants, i.e. $\hbar, G, \alpha$ (fine structure constant) and the like. We do not have a reference for this and this supposition is being presented for the first time. Times after time $t \approx t_{Planck} \sim 10^{-44}$ seconds are not less important. But the 'constant's memory' is already imprinted in the universe..Confirmation of this hypothesis depends upon models of how much 'information' $\hbar, G, \alpha$ actually require to be set in place, at the onset of our universe's inflation, a topic which we currently have no experimental way of testing at this current time.

Furthermore, finding out if or not it is either a drop in viscosity [7],[8] when $\left|\frac{\eta}{s} \approx \varepsilon^{+}\right| << \frac{1}{4\pi}$, or a major increase in entropy density may tell us how much information is , indeed, transferred from a prior universe to our present. If it is $s \to \infty$, the moment after the pre big bang configuration , likely then there will be a high degree of 'information' from a prior universe exchanged to our present universe. If on the other hand, $\eta \to 0^{+}$ due to restriction of 'information from four dimensional 'geometry' to a variable fifth dimension then it is likely that significant data compression has occurred. As indicated by Hawkings theorem, infinite density is its usual modus operandi, for a singularity, and this assumption may have to be revisited. Natário, .[9] (2006) has more details on the different type of singularities involved. The supposition is that the value of N is proportional to a numerical DM density referred to as <n> $\Big|_{Dark-matter}$.

HFGW would play a role if $V \approx R_H^3 \approx \lambda^3$ has each λ of the order of being within an order of magnitude of the Planck length value, as implied by Beckwith (2009) [10] . examined, and linked to modeling gravity as an effective theory, as well as giving credence to how to avoid dS/dt = ∞ at S=0 . If so, then one can look at the research results of Mathur [11] (2007). This is part of what has been developed in the case of massless radiation, where for D space-time dimensions, and E, the general energy is

$$S \sim E^{(D-1/D)} \tag{4}$$

This suggests that entropy scaling is proportional to a power of the vacuum energy, i.e., entropy ~ vacuum energy, if $E \sim E_{total}$ is interpreted as a total net energy proportional to vacuum energy, as given below**.** Conventional brane theory actually enables this instanton structure analysis, as can be seen in the following. This is adapted from a lecture given at the ICGC-07 conference by Beckwith [12]

$$\frac{\Lambda_{Max} V_4}{8 \cdot \pi \cdot G} \sim T^{00} V_4 \equiv \rho \cdot V_4 = E_{total} \tag{5}$$

The approximation we are making, in this treatment initially is that $E_{total} \propto V(\phi)$ where we are looking at a potential energy term.[13] What we are paying attention to, here is the datum that for an exponential potential (effective potential energy)

$$V(\phi) = g \cdot \phi^{\alpha} \tag{6}$$

De facto, what we come up with pre, and post Planckian space time regimes, when looking at consistency of the emergent structure is the following. Namely,[14]

$$V(\varphi) \propto \phi^{|\alpha|} \qquad \text{for } t < t_{PLanck} \tag{7a}$$

Also, we would have $$V(\varphi) \propto 1/\phi^{|\alpha|} \quad \text{for } t >> t_{PLanck} \tag{7b}$$

The switch between Eq. (7a) and Eq. (7b) is not justified analytically. I.e. it breaks down. Beckwith et al (2011) designated this as the boundary of a causal discontinuity. Now according to Weinberg [13] , if

$\in = \dfrac{\lambda^2}{16\pi G}, H = 1/\in t$ so that one has a scale factor behaving as

$$a(t) \propto t^{1/\in} \tag{8}$$

Then, if

$$|V(\phi)| << (4\pi G)^{-2} \tag{9}$$

there are no quantum gravity effects worth speaking of. I.e., if one uses an exponential potential a scalar field could take the value of , when there is a drop in a field from ϕ_1 to ϕ_2 for flat space geometry and times t_1 to t_2 [14]

$$\phi(t) = \frac{1}{\lambda} \ln\left[\frac{8\pi Gg \in^2 t^2}{3}\right] \tag{10}$$

Then the scale factors, from Planckian time scale as [14]

$$\frac{a(t_2)}{a(t_1)} = \left(\frac{t_2}{t_1}\right)^{1/\in} = \exp\left[\frac{(\phi_2 - \phi_1)\lambda}{2\in}\right] \tag{11}$$

The more $\dfrac{a(t_2)}{a(t_1)} >> 1$, then the less likely there is a tie in with quantum gravity. Note those that the way this potential is defined is for a flat , Roberson-Walker geometry, and that if and when $t_1 < t_{Planck}$ then what is done in Eq. (11) no longer applies, and that one is no longer having any connection with even an octonionic Gravity regime.

NOTE TO TAME THE INCOMMESURATE METRICS, USE FOR ALL MODELS, THE APPROXIMATION given below is used as a START

$$h_0^2 \Omega_{GW} \sim 10^{-6} \tag{11a}$$

Next, after we tabulate results with this measurement standard, we will commence to note the difference and the variances from using $h_0^2 \Omega_{GW} \sim 10^{-6}$ as a unified measurement which will be in the different models discussed right afterwwards

Wavelength, sensitivity and other such constructions from Maggiore, with our adaptations and comments

We will next gfive several of our basic considerations as to early universe geometry which we think are appropriate as to Maggiore 's [15] treatment of both wavelength, strain , and Ω_{GW} among other things. As far as early universe geometry and what we may be able to observe, such considerations are make or break as to the role of early universe geometry and the generation of GW at the start of the universe.

To begin with , we will look at Maggiore's [15] Ω_{GW} forumulation, his ideas of strain, and what we did with observations as from L. Crowell [16] which may tie in with the ten to the tenth power increase as to wave length from pre Planckian physics to 1-10 GHz early inflationary GW frequencies. The idea will be to look at how the ten to the tenth stretch out of generated wave length may tie in with early universe models. We will from there proceed to look at , and speculate how the presented conclusions factor in with information exchange between different universes.

We begin with the following table . The idea will be to , if one has $h_0 = .51 \pm .14$, as a degree of measurement uncertainty begin as to understand what may be affecting an expansion of the wave lengths of pre Planckian GW / gravitions which are then increased up to ten orders of magnitude This will have major consequences as far as not only information flow from a prior to present universe, but also fine tuning the degree of GW variance

Table 1 : Managing GW generation from Pre Planckian physics

$h_C \leq 2.82 \times 10^{-33}$	$f_{GW} \sim 10^{12}\, Hertz$	$\lambda_{GW} \sim 10^{-4}\, meters$
$h_C \leq 2.82 \times 10^{-32}$	$f_{GW} \sim 10^{11}\, Hertz$	$\lambda_{GW} \sim 10^{-3}\, meters$
$h_C \leq 2.82 \times 10^{-31}$	$f_{GW} \sim 10^{10}\, Hertz$	$\lambda_{GW} \sim 10^{-2}\, meters$
$h_C \leq 2.82 \times 10^{-30}$	$f_{GW} \sim 10^{9}\, Hertz$	$\lambda_{GW} \sim 10^{-1}\, meters$
$h_C \leq 2.82 \times 10^{-29}$	$f_{GW} \sim 10^{8}\, Hertz$	$\lambda_{GW} \sim 10^{0}\, meters$
$h_C \leq 2.82 \times 10^{-28}$	$f_{GW} \sim 10^{7}\, Hertz$	$\lambda_{GW} \sim 10^{1}\, meters$
$h_C \leq 2.82 \times 10^{-27}$	$f_{GW} \sim 10^{6}\, Hertz$	$\lambda_{GW} \sim 10^{2}\, meters$
$h_C \leq 2.82 \times 10^{-26}$	$f_{GW} \sim 10^{5}\, Hertz$	$\lambda_{GW} \sim 10^{0}\, kilometer$
$h_C \leq 2.82 \times 10^{-25}$	$f_{GW} \sim 10^{4}\, Hertz$	$\lambda_{GW} \sim 10^{1}\, kilometer$
$h_C \leq 2.82 \times 10^{-24}$	$f_{GW} \sim 10^{3}\, Hertz$	$\lambda_{GW} \sim 10^{2}\, kilometer$
$h_C \leq 2.82 \times 10^{-23}$	$f_{GW} \sim 10^{2}\, Hertz$	$\lambda_{GW} \sim 10^{3}\, kilometer$

What we are expecting, as given to us by L. Crowell, is that initial waves, synthesized in the initial part of the Planckian regime would have about $\lambda_{GW} \sim 10^{-14}\, meters$ for $f_{GW} \sim 10^{22}\, Hertz$ which would turn into $\lambda_{GW} \sim 10^{-1}\, meters$, for $f_{GW} \sim 10^{9}\, Hertz$ **,** and sensitivity of $h_C \leq 2.82 \times 10^{-30}$ **.** This is assuming that $h_0^2 \Omega_{GW} \sim 10^{-6}$, using Maggiories[15] $h_0^2 \Omega_{GW}$ analytical expression.

It is important to note in all of this, that when we discuss the different models that the $h_0^2 \Omega_{GW} \sim 10^{-6}$ is the first measurement metric which is drastically altered. h_C which is mentioned in **Eq. (11c)** should be also noted to be an upper bound. In reality , only the 2nd and 3rd colums in table 1 above escape being seriously off and very different. , since the interactions of gravitational waves / gravitions with quark – gluon plasmas and even neutrinos would serve to deform by at least an order of magnitude h_C . So for table 1, the first column is meant to be an upper bound which, even if using **Eq. (11c)** may be off by an order of magnitude.

More seriously, the number of gravitons per unit volume of phase space as estimated, is heavily dependent upon $h_0^2 \Omega_{GW} \sim 10^{-6}$. If that is changed, which shows up in the models discussed right afterwards, the degree of fidelity with **Eq. (11b)** drops. I.e. it makes for serious problems as to comparing and identifying the appropriate

Table 2: Managing GW count from Planckian physics/unit-phase-space

$\lambda_{GW} \sim 10^{-4}\, meters \Rightarrow n_f \propto 10^{-6}\, graviton/unit-phase-space$;
$\lambda_{GW} \sim 10^{-3}\, meters \Rightarrow n_f \propto 10^{-2}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{-2}\, meters \Rightarrow n_f \propto 10^{2}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{-1}\, meters \Rightarrow n_f \propto 10^{6}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{0}\, meters \Rightarrow n_f \propto 10^{10}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{1}\, meters \Rightarrow n_f \propto 10^{14}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{2}\, meters \Rightarrow n_f \propto 10^{18}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{0}\, kilometer \Rightarrow n_f \propto 10^{22}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{1}\, kilometer \Rightarrow n_f \propto 10^{26}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{2}\, kilometer \Rightarrow n_f \propto 10^{30}\, graviton/unit-phase-space$
$\lambda_{GW} \sim 10^{3}\, kilometer \Rightarrow n_f \propto 10^{34}\, graviton/unit-phase-space$

The particle per phase state count will be given as, if $h_0^2 \Omega_{GW} \sim 10^{-6}$ [15]

$$n_f \sim h_0^2 \Omega_{GW} \cdot \frac{10^{37}}{3.6} \cdot \left[\frac{1000 Hz}{f}\right]^4 \tag{11b}$$

Secondly we have that:a detector strain peritinent to device physics is given by [15]

$$h_C \le \left(2.82 \times 10^{-21}\right) \cdot \left(\frac{1 Hz}{f}\right) \tag{11c}$$

These values of strain, the numerical count, and also of n_f give a bit count and entropy which will lead to possible limits as to how much information is transferred. Note that per unit space, if we have an entropy count of , after the start of inflation with having the following , namely at the beginning of relic inflation $\lambda_{GW} \sim 10^{-1}\, meters \Rightarrow n_f \propto 10^{6}\, graviton/unit-phase-space$ for $f_{GW} \sim 10^{9}\, Hertz$ This is to have, say a starting point in pre inflationary physics of $f_{GW} \sim 10^{22}\, Hertz$ when $\lambda_{GW} \sim 10^{-14}\, meters$, i.e. a change of $\sim 10^{13}$ orders of magnitude in about 10^{-25} seconds, or less.

Establishing GW astronomy in terms of a choice between models

A change of $\sim 10^{13}$ orders of magnitude in about 10^{-25} seconds, or less in terms of one of the variants of inflation . As has been stated else where [17] , [18]in a publication under development, there are several models which may be affecting this change of magnitude. The following is a summary of what may be involved:

A) The relic GWs in the pre-big-bang model.

Here, the relic GWs have a broad peak bandwidth from 1 Hz to 10 GHz [19] (5). We can refer to other such publications for equivalent information [20] In this spectral region the upper limit of energy density of relic

GWs is almost a constant $\Omega_{gW} \sim 6.9\times10^{-6}$, but it will rapidly decline in the region from 1 Hz to 10^{-3} Hz. Thus direct detection of the relic GWs should be focused in intermediate and high-frequency bands. Amplitude upper limits of relic GWs range from $h \sim 10^{-23}$ at frequencies around 100 Hz to $h \sim 10^{-30}$ at frequencies around 2.9 GHz. This means that frequencies around 100 Hz and frequencies around 2.9 GHz would be two key detection windowsIf the relic GWs in the pre-big-bang model (or other similar models such as the cyclic model of the universe (41) [21] can be detectable, then its contribution to contemporary cosmological perspectives would be substantial

B) The relic GWs in the quintessential inflationary model (QIM).

The peak and maximal signal of relic GWs in the QIM are localized in the GHz band (21, 22), and the strength of relic GWs in both the QIM and the pre-big-bang model in the GHz band have almost the same magnitude (e.g., $h \sim 10^{-30}$ at 2.9GHz). But the peak bandwidth of the QIM (from 1GHz to 10GHz) (21) is less than that of the pre-big-bang model (from 1Hz to 10GHz) [19](5)

C) The relic GWs in the cosmic string model.

Unlike relic GWs in the pre-big-bang model and in the QIM, the peak energy density Ω_{gw} of relic GWs in the cosmic string model is in the low-frequency region of $\sim 10^{-7}$ Hz to 10^{-1} Hz, and the upper limit of Ω_{gw} may be $\sim 4\times10^{-6}$ at frequencies around 10^{-6} Hz . When $\nu < 10^{-7}$ Hz, the energy density decays quickly. Therefore, LISA and ASTROD will have sufficient sensitivity to detect low-frequency relic GWs in the region of $\sim 10^{-7}$ Hz$< \nu < 10^{-3}$ Hz predicted by the model [19], [22], [23] (5, 10, 11). Moreover, the energy density of relic GWs is an almost constant $\Omega_{gw} \sim 10^{-8}$ from 10^{-1} Hz to 10^{10} Hz, and the relic GWs at frequencies around 100 Hz should be detectable by advanced LIGO, but the amplitude upper limit of relic GWs in the GHz band may be only $h \sim 10^{-31}$ to 10^{-32}, which cannot be directly detected by current technologies.

D) The relic GWs in the ekpyrotic scenario

Relic GWs in the ekpyrotic scenario [21] and in the pre-big-bang [22],[23]model have some common and similar features. The initial state of universe described by both is a large, cold, nearly empty universe, and there is no beginning of time in both, and they are faced with the difficult problem of making the transition between the pre- and post-big bang phase. However, the difference of physical behavior of relic GWs in both is obvious. First, the peak energy density of relic GWs in the ekpyrotic scenario is $\Omega_{gw} \sim 10^{-15}$, and it is localized in frequencies around 10^{7} Hz to 10^{8} Hz. Therefore the peak of Ω_{gw} in the former is less than corresponding value in the latter.

E) The relic GWs in the ordinary inflationary model

Also, for ordinary inflation [24] the energy density of relic GWs holds constant ($\Omega_{gW} \sim 10^{-14}$) in a broad bandwidth from 10^{-16} Hz to 10^{10} Hz, but the upper limit of the energy density is less than that in the pre-big-bang model from 10^{-3} Hz to 10^{10} Hz, in the cosmic string model from 10^{-7} Hz to 10^{10} Hz, and in the QIM from 10^{-1} Hz to 10^{10} Hz. For example, this model predicts $h_{max} \sim 10^{-27}$ at 100 Hz, $h_{max} \sim 10^{-33}$ at 100 MHz and $h_{max} \sim 10^{-35}$ at 2.9 GHz.

To summarize, what we expect is that appropriate sensititivities plus predictions as to frequencies may confirm or falsify each of these five inflationary candidates, and perhaps lead to completely new model insights. We hope that we can turn GW research into an actual experimental science.

Note that in the following table , we assume that Ω_{GW} are essentially unmeasurable in the relic GW sense for the classic GR model.

TABLE 3: Variance of the Ω_{GW} parameters as given by the above mentioned cosmology models.

Relic pre big bang	QIM	Cosmic String model	Ekpyrotic
$\Omega_{GW} \sim 6.9\times 10^{-6}$ $when \quad f \geq 10^{-1}\,Hz$ $\Omega_{GW} << 10^{-6}$ $when \quad f < 10^{-1}\,Hz$	$\Omega_{GW} \sim 10^{-6}$ $1GH < f < 10GH$	$\Omega_{GW} \sim 4\times 10^{-6}$ $f \propto 10^{-6}\,Hz$ $\Omega_{GW} \sim 0$ $otherwise$	$\Omega_{GW} \sim 10^{-15}$ $10^{7}\,Hz < f < 10^{8}\,Hz$ $\Omega_{GW} \sim 0$ $otherwise$

The best targets of opportunity, for viewing $\Omega_{GW} \sim 10^{6}$ are in the $1Hz < f < 10\ GHz$ range, with another possible target of opportunity in the $f \propto 10^{-6}\,Hz$ range. Other than that, it may be next to impossible to obtain relic GW signatures . Now that we have said it, it is time to consider the next issue.

Having said that, it is now time to consider what is also vital. I.e. finding if information from a prior universe may be transmitted to our own universe. This is assuming that there is a way to obtain measurements commensurate with the Relic pre big bang, or the QIM model.

Minimum amount of information needed to initiate placing values of fundamental cosmological parameters

A.K. Avessian's [25] article (2009) about alleged time variation of Planck's constant from the early universe depends heavily upon initial starting points for $\hbar(t)$, as given below, where we pick :

$$\hbar(t) \equiv \hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]\cdot \exp\left[-H_{macro}\cdot\left(\Delta t \sim t_{Planck}\right)\right] \tag{12}$$

The idea is that we are assuming a granular , discrete nature of space time. Futhermore, after a time we will state as $t \sim t_{Planck}$ there is a transition to a present value of space time,. It is easy to, in this situation, to get an inter relationship of what $\hbar(t)$ is with respect to the other physical parameters , i.e. having the values of α written as $\alpha(t) = e^2/\hbar(t)\cdot c$, as well as note how little the fine structure constant actually varies . Note that if we assume an unchanging Planck's mass $m_{Planck} = \sqrt{\hbar(t)c/G(t)} \sim 1.2\times 10^{19}\,GeV$, this means that G has a time variance, too. This leads to us asking what can be done to get a starting value of $\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$ recycled from a prior universe, to our present universe value. What is the initial value, and how does one insure its existence? We obtain a minimum value as far as 'information' via appealing to Hogans [26] (2002) argument with entropy stated as

$$S_{\max} = \pi/H^2 \tag{13}$$

, and this can be compared with A.K. Avessian's article [25] (2009) value of, where we pick $\Lambda \sim 1$

$$H_{macro} \equiv \Lambda \cdot \left[H_{Hubble} = H \right] \quad (14)$$

I.e. a choice as to how $\hbar(t)$ has an initial value, and entropy as scale valued by $S_{\max} = \pi / H^2$ gives us a ball park estimate as to compressed values of $\hbar_{initial}\left[t_{initial} \leq t_{Planck}\right]$ which would be transferred from a prior universe, to todays universe. If $S_{\max} = \pi / H^2 \sim 10^5$, this would mean an incredibly small value for the INITIAL H parameter, i.e. in pre inflation, we would have practically NO increase in expansion, just before the introduction vacuum energy, or emergent field energy from a prior universe, to our present universe.

Unanswered questions, and what this suggests for future research endeavors

As far.back as 1982, Linde, [27]when analyzing a potential of the form

$$V(\phi) = \frac{m^2 \phi^2}{2} + \lambda \phi^4 + V(0) \quad (15)$$

This is when the 'mass' has the form, (here M is the bare mass term of the field ϕ in de Sitter space, which does not take into account quantum fluctuations)

$$m^2(t) = M^2 + \frac{3\lambda H^3}{4\pi} \cdot (t - t_0) \quad (16)$$

Specified non linearity of $< \phi^2 >$ at a time from the big bang, of the form

$$\Delta t_1 \approx \frac{3H}{2M} \quad (17)$$

The question raised repeatedly in whether or not i) if higher dimensions are necessary, and whether or not ii) mass gravitons are playing a role as far as the introduction of DE speed up of cosmological expansion may lead to an improvement over what was specified for density fluctuations and structure formation (the galaxy hierarchy problem) of density fluctuations given as

$$\frac{\delta\rho}{\rho} \sim 10^{-4} \Leftrightarrow \lambda \leq 10^{-10} \quad (18)$$

Eq (16) is for four space, a defining moment as to what sort of model would lead to density fluctuations. It totally fails as to give useful information as to the galaxy hierarchy problem , above. Furthermore is considering the spectral index problem, where the spectral index is [27]

$$n_S - 1 \cong -\frac{3}{8\pi} \cdot \left(\frac{V_\phi}{V} \right)^2 + \frac{1}{4\pi} \cdot \left(\frac{V_{\phi\phi}}{V} \right)^2 \quad (19)$$

Usual experimental values of density fluctuations experimentally are $\frac{\delta\rho}{\rho} \sim 10^{-5}$, instead of $\frac{\delta\rho}{\rho} \sim 10^{-4}$, and this is assuming that λ is small. In addition, Linde[27] (1982) had $\frac{d}{d\phi^2} V = m^2 \leq \frac{H}{40} = \frac{1}{40} \cdot \frac{\dot{a}}{a}$ inside a false vacuum bubble. If something other than the Klein Gordon relationship $\frac{\dot{a}}{a} \Rightarrow \ddot{\phi} + 3H\dot{\phi} + m^2 \varphi = 0$ occurs, then different models of how density fluctuation may have to be devised. A popular model of density fluctuations with regards to the horizon is[27]

$$\left(\frac{\delta\rho}{\rho} \right)_{Horizon} \cong \frac{k^{3/2} |\delta_k|}{\sqrt{2\pi}} \propto \frac{k^{(3/2)+3\alpha-3/2}}{\sqrt{2\pi}} \approx \left(1/\sqrt{2\pi}\right) \cdot k^{3\alpha} \quad (20)$$

, where $-.1 < \alpha < 0.2$, and $\alpha \equiv 0 \Leftrightarrow n_s \equiv 1$ and to first order, $k \cong Ha$. The values, typically of [28] $n_s \neq 1$ If working with $H^2 = \left(\frac{\dot{a}}{a}\right)^2 = \left[\left(\frac{\rho}{3M_4^2} + \frac{\rho^2}{36M_{Planck}^2}\right) + \frac{C}{a^4}\right]$, and with a density value [28], [29] $\rho \equiv \rho_0 \cdot \left(\frac{a_0}{a}\right)^3 - \left[\frac{m_g c^6}{8\pi G\hbar^2}\right] \cdot \left(\frac{a^4}{14} + \frac{2a^2}{5} - \frac{1}{2}\right)$ where $m_g \approx 10^{-65}$ grams, and $\alpha < 0.2$ is picked to avoid over production of black holes, a complex picture emerges. Furthermore, if $\alpha < 0.2$ and $\alpha \neq 0$

$$\left(\frac{\delta\rho}{\rho}\right)_{Horizon} \cong \left(1/\sqrt{2\pi}\right) \cdot k^{3\alpha} \sim \frac{H^2}{\dot{\phi}} \propto 10^{-4} - 10^{-5} \qquad (21)$$

The above equation gives inter relationships between the time evolution of a pop up inflaton field ϕ, and a Hubble expansion parameter H , and a wave length parameter $\lambda = (2\pi/k) \cdot a(t)$ for a mode given as δ_k . What should be considered is the inter relation ship of the constituent components of Eq. (19) and $\lambda \leq H^{-1}$. What the author thinks is of import is to look at whether equation below also holds.[27]

$$\left(\frac{\delta\rho}{\rho}\right) \cong Ak^{\left(\frac{n_S - 1}{2}\right)} \propto 10^{-4} - 10^{-5} \qquad (22)$$

To first order, variations of $\alpha < 0.2$ and $\alpha \neq 0$, should be compared with admissible values of $([n_S - 1]/2)$ which would closely correspond to $\alpha \neq 0$ and $0 < \alpha << 0.2$.

What we hope is that if we can determine what are the appropriate conditions for plotting sensitivities for strain, and frequency, for GW astronomy, that in due time we will be able to give inputs into Eq. (22) above to understand structure formation in the early universe. A proper understanding of Eq. (22) is also important if we wish to understand how GW and neutrinos may interact with each other, which could be part of what is happening in, as an example, low Lithium stars, as brought up by Beckwith in Erice , nuclear physics 2009 [30]

Conclusions, as to how to look at early universe topology and later flat space

Resolution of which add more detail to a wave function of the universe we can approximate in early pre inflationary conditions as $\Psi \sim [R/R_{eq}]^{3/2}$ [31] . I.e. spatial varation due to inflation is not in itself sufficient to understand how space time geometry evolved in the early universe. Our discussion has, in fact outlined $\Omega_{GW} \sim 10^6$ as in the $1Hz < f < 10\ GHz$ range for either the QIM and / or the pre big bang models as the best chance of obtaining signatures of GW physics in relic GW conditions.

It is clear that gravitational wave density is faint, even if we make the approximation that $H \equiv \frac{\dot{a}}{a} \cong \frac{m\phi}{\sqrt{6}}$ as stated by Linde (2008) [32], where we are following $\dot{\phi} = -m\sqrt{2/3}$ in evolution, so we have to use different procedures to come up with relic gravitational wave detection schemes to get quantifiable experimental measurements so we can start predicting relic gravitational waves. This is especially true if we make use of the following formula for gravitational radiation, as given by L.Kofman [33] (2008), with $M = V^{1/4}$ as the energy scale, with a stated initial inflationary potential V. This leads to an initial approximation of the emission frequency, using present-day gravitational wave detectors.

$$f \cong \frac{(M = V^{1/4})}{10^7 GeV} Hz \qquad (24)$$

What we would like to do for future development of entropy would be to consider a way to ascertain if or not the following is really true, and to quantify it by an improvement of a supposition advanced by Kiefer, Polarski, and Starobinsky [33]as of (2000) . I.e. the author, Beckwith , has in this document presented a general question of how to avoid having **dS/dt = ∞ at S=0,**

1, Removes any chance that early universe nucleation is a quantum based emergent field phenomena

2. Goldstone gravitons would arise in the beginning due to a violation of Lorentz invariance. I.e. we have a causal break , and merely having the above condition does not qualify for a Lorentz invariance breakdown

Kiefer, Polarski, and Starobinsky as of (2000) [34] presented the idea of presenting the evolution of relic entropy via the evolution of phase spaces, with Γ/Γ_0 being the ratio of 'final (future)' / 'initial' phase space volume, for k modes of secondary GW background.

$$S(k) = \ln \frac{\Gamma}{\Gamma_0} \tag{25}$$

If the phase spaces can be quantified, as a starting point of say $l_{\min-length-string} \equiv 10^{\alpha} \cdot l_{Planck}$, with l_{Planck} being part of how to form the 'dimensions' of Γ_0, and $l_{\min-length-string}$ part of how to form the dimensions of Γ, and 10^{α} being, for a given $\alpha > 0$, and in certain cases $\alpha >> 0$, then avoiding having **dS/dt = ∞ at S=0** will be straight forward Determining the run up as to avoiding infinite change of entropy/ early universe GW production and an infinite, unphysical spurt of gravitons at the onset of inflation is part and parcel of turning GW astronomy into an empirical science.What we intend to do, is to use Eq. (11) as part of making sense of the two tables, and also the point of Eq.(11)'s break down as an aid to distinguishing between the five models brought up in this document, plus the possibility that there is a multi verse to be investigated.

The entropy so outlined in eq. (25) with a graviton count, along the lines of what was brought up by Beckwith [34] for a relationship of entropy with particle count may be a way to obtain relic GW traces, provided we obtain conditions for turning GW physics into GW astro physics.

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