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Does the Transition to Planckian Space Time Physics Allow Octonionic Gravity Conditions to Form?

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Abstract

We are in this document asking if Octonionic gravity [1] is relevant near the Planck scale. Furthermore, we ask if gravitational waves would be generated during the initial phase, of the universe when an increase in degrees of freedom that have in setting is used. We demonstrate how a Gaussian mapping, combined with a strange attractor will enable quantum gravity to form. The key development would be in using a strange attractor [2]. In addition, the supposition R. Penrose made: is presented with a more traditional cosmological constant, not varying over time? Does the Penrose model directly allow us to form a much simpler Entropy expression? However, in doing so, we make note of how a quartic phase transition initially may impose a level of precision in parameters impossible to verify with present experimental equipment.

Keywords

High-Frequency Gravitational Waves (HFGW), Symmetry, Causal Discontinuity

1. Introduction

This paper examines geometric changes that occurred in the very earliest phase of the universe, leading to values for δ_0, and explores how we might gain insight through gravitational wave research. The Planck epoch has gravity wave background radiation containing the imprint of the very earliest events.

1.1. What We Will Propose Is the Following, *i.e.* Reference Applications of Appendix A

That the degrees of freedom increase, with an increase in temperature, is what we expect to happen during a transition to a Rindler Geometry flat space regime of space time.

Further elaboration of properties of a mutually unbiased basis (MUB), [2] in **Appendix B** with one set of mutually unbiased basis at the start of cosmological evolution as by Equation (16) below, in **Appendix C**, [3], there is a way to quantify two different types of entropy, which are linked to each other by MUB. The first is Renyi entropy [4]. The second is in [5], is a particle count version of entropy, $S \sim \langle n \rangle$, with S an entropy per phase space volume, and $\langle n \rangle$ an emergent field contribution of particles per phase space volume. This will be built up using formalism in **Appendix C**. The topological transition is due to a change in basis/geometry from the regime of Renyi entropy to entropy in a particle count version of entropy, *i.e.* $S \sim \langle n \rangle$.

$$a(t) = \frac{\cosh\left(\sqrt{\Lambda/3}\cdot t\right)}{\sqrt{\Lambda/3}} \tag{1}$$

to a flat space FRW equation of the form [6]

$$\left(\frac{\dot{a}}{a}\right)^2 + \frac{1}{a^2} = \frac{\Lambda}{3} \tag{2}$$

which is so one forms a 1-dimensional Schrodinger equation [6] [7] [8]

$$\left(\frac{\partial^2}{\partial a^2} - \frac{9\pi^2}{4G^2}\cdot\left[a^2 - \frac{\Lambda}{3}\cdot a^4\right]\right)\Psi = 0 \tag{3}$$

with $\tilde{a}_0$ a turning point to potential [5] [6] [7]

$$U(a) = \frac{9\pi^2}{4G^2}\cdot\left[a^2 - \frac{\Lambda}{3}\cdot a^4\right]. \tag{4}$$

What we are doing afterwards is refinement as to this initial statement of the problem in terms of giving further definition of the term $\rho_{\text{vacuum}} = \left[\frac{\Lambda}{8\pi G}\right]$. We will model inputs into the initial value of Λ as high energy fluctuations, and see if they contribute to examination of non commutative geometry before the inflationary era. This $\rho_{\text{vacuum}} = \left[\frac{\Lambda}{8\pi G}\right]$ may enable tying vacuum expectation value (VeV) behavior with (**Figure 1**).

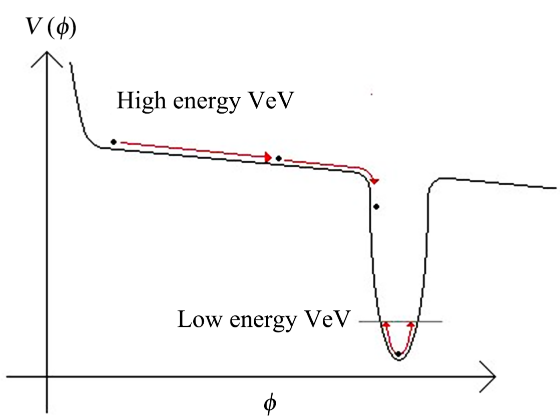

Figure 1. As supplied by L. Crowell, in correspondence to A. W. Beckwith, October 24, 2010 [8].

As by L. Crowell [8], delineate the VeV issue by considering an initially huge VeV, due to initial inflationary geometry. As stated by L. Crowell [9]:

"*The standard inflationary cosmology involves a scalar field φ which obeys a standard wave equation. The potential is this function which I diagram "above". The scalar field starts at the left and rolls down the slope until it reaches a value of φ where the potential is V(φ) ~φ^2. The enormous VeV at the start is about 14 orders of magnitude smaller than the Planck energy density ~(1/L_p)^4 on the long slope. The field then enters the quadratic region, where a lot of that large VeV energy is thermalized, with a tiny bit left that is the VeV and CC of the observable universe. The universe during this roll down the long small slope has a large cosmological constant, actually variable λ = λ(φ, ∂φ), which forces the exponential expansion. There are about 60-efolds of the universe through that period. Then at the low energy VeV the much smaller CC gives the universe with the configuration we see today.*"

One of the ways to relate an energy density to cosmological parameters and a vacuum energy density using a relation as given by (5), as given by Poplawski [10]:

$$\rho_{\Lambda} = H\lambda_{QCD} \tag{5}$$

where if λ_{QCD} is at least 200 MeV and is similar to the QCD scale parameter of the SU(3) gauge coupling constant, and H a Hubble parameter. Here we consider that if there is a relationship between Equation (5) above and $\rho_{\text{vacuum}} = \left[\frac{\Lambda}{8\pi G}\right]$ then the formation of inputs into our vacuum expectation values $V \approx \frac{3\langle H\rangle^4}{16\pi^2}$, and also equating $V \approx \frac{3\langle H\rangle^4}{16\pi^2}$ with $V(\varphi) \sim \varphi^2$ would be consistent with an inflaton treatment of initial inflation. We have

$$\rho_{\text{vacuum}} = \left[\frac{\Lambda}{8\pi G}\right] \approx \rho_{\Lambda} \approx H\lambda_{QCD} \Leftrightarrow V \approx \frac{3\langle H\rangle^4}{16\pi^2} \approx V_{\text{inf}} \propto \phi^2 \tag{6}$$

Different models for the Hubble parameter, H exist, and can be directly linked to how one forms the inflaton. The authors presently explore what happens to the relations as given in Equation (6) before, during, and after inflation. Table 1 below is how to obtain inflation.

1.2. First, Thermal Input into the New Universe. In Terms of Initial Vacuum Energy

We first consider the construction given in [11]. Then we look at the cosmological vacuum energy given in [12] in four and five dimensions

$$\left|\Lambda_{5\text{-dim}}\right| \approx c_1 / T^{\alpha} \tag{7}$$

in contrast with the more traditional four-dimensional version, minus the minus sign of the brane world theory as given by Park [12] [13]

$$\Lambda_{4\text{-dim}} \approx c_2 T^{\beta} \tag{8}$$

Table 1. Cosmological Λ in 5 and 4 dimensions [12] [13].

Time $0 \le t \ll t_P$	Time $0 \le t < t_P$	Time $t \ge t_P$
$\lvert\Lambda_5\rvert$ undefined, $T \approx \varepsilon^+ \to T \approx 10^{32}\ \text{K}$ $\Lambda_{4\text{-dim}} \approx$ almost ∞	$\lvert\Lambda_5\rvert \approx \varepsilon^+$, $\Lambda_{4\text{-dim}} \approx$ extremely large $10^{32}\ \text{K} > T > 10^{12}\ \text{K}$	$\lvert\Lambda_5\rvert \approx \Lambda_{4\text{-dim}}$, T much smaller than $T \approx 10^{12}\ \text{K}$

The difference between what Barvinsky [13], and Park [13] [14] is:

$$\Lambda_{4\text{-dim}} \propto c_2 \cdot T^{\beta} \xrightarrow[\text{graviton production as time}>t(\text{Planck})]{} 360 \cdot m_P^2 \ll c_2 \cdot \left[T \approx 10^{32}\ \text{K}\right]^{\beta} \tag{9}$$

Right after the gravitons are released, one still sees a drop-off of temperature contributions to the cosmological constant. Then [12]

$$\frac{\Lambda_{4\text{-dim}}}{\lvert\Lambda_{5\text{-dim}}\rvert} - 1 \approx \frac{1}{n} \tag{10}$$

If we examine $\lvert\Lambda_{5\text{-dim}}\rvert \sim c_2 T^{-\beta}$

We assume a discontinuity in pre Planckian regime, for scale factors [12].

$$\left[\frac{a\left(t^* + \delta t\right)}{a\left(t^*\right)}\right] - 1 < (\text{value}) \approx \varepsilon^+ \ll 1 \tag{11}$$

Starting with [15] [16]

$$E_{\text{thermal}} \approx \frac{k_B \cdot T_{\text{temperature}}}{2} \propto \Omega_0 \breve{T} \approx \tilde{\beta} \tag{12}$$

The assumption is that there is an initial entropy, as temperature $T \in \left[0^+, 10^{19}\ \text{GeV}\right]$ arrives. Then by [15] [16] where ϕ is a acalar field, largely like the inflaton. This state's entropy increases, as we have ϕ get very small, which may be a mechanism for the speed up of expansion of the Universe say about redshift value 1 to zero (today)

$$\Delta S = \left[\frac{\hbar}{T_{temp}}\right] \cdot \left[2k^2 + \frac{1}{\eta^2} \cdot m_{\text{Planck}}^2 \cdot \left[\frac{12}{4\pi\phi^2}\right]\right]^{1/2} \approx n_{\text{particle count}} \tag{13}$$

The way to introduce the expansion of the degrees of freedom from nearly zero to having $\boldsymbol{N(T) \sim 10^3}$ is to define the classical and quantum regimes of gravity as to minimize the point of the bifurcation diagram affected by quantum processes [5] by a Gauss mapping [15] [16]

$$x_{i+1} = \exp\left(-\tilde{\alpha} \cdot x_i^2\right) + \tilde{\beta} \tag{14}$$

Change of temperature, as given, is [15] [16]

$$\frac{\Delta\tilde{\beta}}{dist} \cong \left(5k_B \Delta T_{temp}/2\right) \cdot \frac{\bar{N}}{dist} \approx qE_{\text{Net Electric Field}} \approx \text{change in degrees of freedom} \tag{15}$$

We would regard this as being the regime in which we see a thermal increase in temperature, up to the Planckian physics regime. If so, then we can look at what is the feeding in mechanism from the **end of a universe, or universes**, and inputs into Equation (14) and Equation (15).

1.3. Extending Penrose's Cyclic Universes, Black Hole Evaporation

Beckwith strongly suspects that there are no fewer than N universes undergoing Penrose "infinite expansion" [16] [17] and all these are contained in a mega universe structure. Furthermore, each of the N universes has black hole evaporation, with the Hawking radiation from decaying black holes. If each of the N universes is defined by a partition function, we can call $\{\Xi_i\}_{i\equiv N}^{i\equiv 1}$, then there exist an information minimum ensemble of mixed minimum information roughly correlated as about 10^7 - 10^8 bits of information per partition function in the set $\{\Xi_i\}_{i\equiv N}^{i\equiv 1}$, so minimum information is conserved between a set of partition functions per universe [16] [17]

$$\left.\{\Xi_i\}_{i\equiv N}^{i\equiv 1}\right|_{\text{before}} \approx \left.\{\Xi_i\}_{i\equiv N}^{i\equiv 1}\right|_{\text{after}} \tag{15}$$

However, that there is nonuniqueness of information put into each partition function $\{\Xi_i\}_{i\equiv N}^{i\equiv 1}$. Furthermore Hawking radiation from the black holes is collated via a strange attractor collection in the mega universe structure to form a new big bang for each of the N universes as represented by $\{\Xi_i\}_{i\equiv N}^{i\equiv 1}$. Verification of this mega structure compression and expansion of information uses Ergodic mixing treatments of initial values for each of N universes expanding from a singularity beginning. The n_f value will be used to algorithm of [18].

$S_{\text{entropy}} \approx n_f$. How to tie in this energy expression, as in Equation (16) will be to look at the formation of a non trivial gravitational measure which we can state as a new big bang for each of the N universes as by [9], and $n(E_i)$ the density of states at a given energy E_i for a partition function [9] [10] [19]

$$\{\Xi_i\}_{i\equiv 1}^{i\equiv N} \propto \left\{\int_0^\infty \mathrm{d}E_i \cdot n(E_i)\cdot \mathrm{e}^{-E_i}\right\}_{i\equiv 1}^{i\equiv N} \tag{16}$$

Each of the terms E_i would be identified with Equation (16) above [16] [17],

$$\frac{1}{N}\cdot\sum_{j=1}^{N}\left.\Xi_j\right|_{j\text{ before nucleation regime}} \xrightarrow{\text{vacuum nucleation tranfer}} \left.\Xi_i\right|_{i\text{ fixed after nucleation regime}} \tag{17}$$

For N number of universes, with each $\left.\Xi_j\right|_{j\text{ before nucleation regime}}$ for $j = 1$ to N being the partition function of each universe just before the blend into the RHS of Equation (12) above for our present universe. Also, in the end [16] [17]

$$\left.\Xi_j\right|_{j\text{ before nucleation regime}} \approx \sum_{k=1}^{Max}\left.\tilde{\Xi}_k\right|_{\text{black holes } j\text{th universe}}. \tag{18}$$

1.4. Analysis of the Action of These Two Mappings on the Formation of Quantum Gravity

In particular, in the regime where there is a buildup of temperature, [1] Equation (19)

$$\begin{aligned}\oint\left[x_j, p_i\right]\mathrm{d}x_k &\approx -\oint p_i\left[x_j, \mathrm{d}x_k\right] = -\tilde{\beta}\cdot\ell_{\text{Planck}}\cdot T_{j,k,l}\oint p_k \mathrm{d}x_l \\ &\neq -\hbar\tilde{\beta}\cdot\ell_{\text{Planck}}\cdot T_{i,j,k}\end{aligned} \tag{19}$$

Very likely, across a causal boundary, between $\pm l_p$ across the boundary due to the causal barrier, one gets [1]

$$\oint p_i \mathrm{d}x_k \neq \hbar \delta_{i,k} \tag{20}$$

I.e.

$$\oint_{\pm \ell_{\text{Pkack}}} p_i \mathrm{d}x_k \xrightarrow[i \to k]{} 0 \tag{21}$$

If so, [1] the regime of space time, for the feed in of, prior to the introduction of QM, that [1]

$$\left[x_j, p_i\right] \neq -\hbar \tilde{\beta} \cdot \left(\ell_{\text{Planck}} / l\right) \cdot T_{i,j,k} x_k \tag{22}$$

Furthermore we state that Equation (22) will not approach $i\hbar \delta_{j,i}$ in the Pre Planckian regime.

Equation (22) means that in the pre Planckian regime, and in between $\pm l_P$, QM no longer applies.

1.5. Does the Increase in Thermal Temperatures as Given in Table 1 Leads to Approaching Quantum Mechanics in Early Cosmology?

To do this we look at the G. Ecker article [20] as to how to look at the way we may have, if temperatures increase, as stated in **Table 1** above, from a low point to a higher one, for there to be a flattening of space time and the end of non communative geometry. This non communative geometry due to rising temperatures signifies conditions for the emergence of Equation (23) to become [1]

$$\left[x_i, p_j\right] \xrightarrow[\text{temperature} \to \infty]{} i\hbar \delta_{i,j} \tag{23}$$

In order to get conditions for Equation (24) the following can be referred to about non commutative geometry [20]

$$\left[x_i, x_j\right] = i \cdot \Theta_{i,j} \xrightarrow[\text{temperature} \to \infty]{} 0 \tag{24}$$

The essentials step is to say the anti symmetric real tensor is proportional to the square of 1 over the Parks representation of the "Planck constant", which has a temperature dependence built in it.

$$\Theta_{i,j} \approx \left[\Lambda_{\text{4-dim}}\right]^{-2} \propto 1/T^{2\beta} \xrightarrow[\text{temperature} \to \infty]{} 0 \tag{25}$$

When Equation (26) goes to zero, leading to Equation (24) going to zero, we submit that then Equation (24) is recovering quantum/Octoinian gravity. The Equation (24) above, according to the G. Ecker article [20], page 79, is linkable to initial violations of Lorentz invariance. We submit that the entire argument of Equation (22) to Equation (25), as given by Equation (25) with rising temperature is a way to understand the removal of non Euclidian space to approach Euclidian flat space.

2. Understanding How Phase Shift in Gravitational Waves May Be Affected by the Transition to and from a Causal Discontinuity, and Different Models of Emergent Structure Cosmologys

Passing gravitons through to a new universe is not the same thing though as a pre Planckian geometry, for Octonian gravity conditions arise in early Planckian space time.

2.1. Re Casting the Problem of GW/Graviton in a Detector for "Massive" Gravitons

The basics background we are referencing before proceeding is given in [21]. We now turn to the problem of detection. The following discussion is based upon with the work of Dr. Li, Dr/Beckwith, and other Institute of theoretical physics researchers in Chongqing University [22] [23]. References [24] and [25] supply us with the background which is used before we introduce the idea of stochastic GW which is given in [26]. Assuming that one was measuring stochastic HFGW using the disturbance of electromagnetic energy in a cavity, the minimum gravitational wave "magnitude" to be measured is limited by the Standard Quantum Limit (SQL), which is a description of quantum backaction as described by Braginsky, Grischuk, *et al.* [26]. For a cavity containing electromagnetic energy, if Q is the quality factor of a cavity, ξ is the total energy in a cavity, $\hbar\omega_{e^-}$ is the energy of a photon in the cavity, then the minimum sensitivity to a stochastic HFGW would need a metric "amplitude" of at least [27] [28] [29] [30]

$$h_{\min} \approx \frac{1}{Q} \cdot \sqrt{\frac{\hbar\omega_{e^-}}{\xi}} \tag{26}$$

This can be a significant limitation in practice. For example, as quoted from a document being written up by F. Li *et al.*, for publication [9] if $Q = 10^{11}$, $E = 10$ J, and ω_{e^-} is a frequency = 10^{12} Hz, then one will obtain $h_{\min} \sim 2.5 \times 10^{-17}$ for the stochastic HFGW. Therefore, we can conclude that advanced cavity detectors could be a promising way for the HFGW detection If much higher contained energies are developed. Similarly, if one has, instead, a coherent GW background, [9] [26] [27] [28] [29] then we can do Equation (26) again so that we have.

In this case $h_{\min} \sim 8.1 \times 10^{-23}$ for the non-stochastic HFGW, even at a very low contained energy of 10 J. It is therefore quite plausible that such a detection cavity could be tuned over a range of HFGW frequencies to scan for detectible gravitational waves of either a coherent or stochastic nature. Given these figures, it is now time to consider what happens if one is looking for traces of gravitons which may have a small rest mass in four dimensions**.** What Li *et al.* have shown in 2003 [23] which Beckwith commented upon and made an extension in [22] is to obtain a way to present first order perturbative electromagnetic power flux, *i.e.* what was called $\overset{(1)}{T^{uv}}$ in terms of a non zero four dimensional graviton rest mass, in a detector, in the presence of uniform magnetic field, when examining the following situation, *i.e.* [23] what if we have curved space time with say an energy momentum tensor of the electromagnetic fields in GW fields as given by

$$T^{uv} = \frac{1}{\mu_0} \cdot \left[-F_{\alpha}^{\mu} F^{\nu\alpha} + \frac{g^{\mu\nu}}{4} \cdot F_{\alpha\beta} F^{\alpha\beta} \right] \tag{27}$$

Li *et al.* [23] state that $F_{\mu\nu} = F_{\mu\nu}^{(0)} + \tilde{F}_{\mu\nu}^{(1)}$, with $\left|\tilde{F}_{uv}^{(1)}\right| \ll \left|F_{uv}^{(0)}\right|$ will lead to

$$T^{uv} = \overset{(0)}{T^{uv}} + \overset{(1)}{T^{uv}} + \overset{(2)}{T^{uv}} \tag{28}$$

The 1st term in right hand side of Equation (28) is the energy-momentum tensor of the back ground electromagnetic field, and the 2nd term to the right hand side of Equation (28) is the first order perturbation of an electromagnetic field due to the presence of gravitational waves. The above Equation (27) and Equation (28) will eventually lead to a curved space version of the Maxwell equations as

$$\frac{1}{\sqrt{-g}} \cdot \frac{\partial}{\partial x^{\nu}} \left(\sqrt{-g} \cdot g^{\mu\alpha} g^{\nu\beta} F_{\alpha\beta} \right) = \mu_0 J^{\mu} \tag{29}$$

as well as

$$F_{[uv,\alpha]} = 0 \tag{30}$$

Eventually, with GW affecting the above two equations, we have a way to isolate $\overset{(1)}{T^{uv}}$. If one looks at if a four dimensional graviton with a very small rest mass included [22] we can write

$$\frac{1}{\sqrt{-g}} \cdot \frac{\partial}{\partial x^{\nu}} \left(\sqrt{-g} \cdot g^{\mu\alpha} g^{\nu\beta} F_{\alpha\beta} \right) = \mu_0 J^{\mu} + J_{\text{effective}} \tag{31}$$

where for $\varepsilon^{+} \neq 0$ but very small

$$F_{[uv,\alpha]} \approx \varepsilon^{+} \tag{32}$$

The claim which A. Beckwith made [16] [22] is that

$$J_{\text{effective}} = n_{\text{graviton count}} \cdot \left[m_{\text{graviton}} \left(\text{4-dim version} \right) \right] \tag{33}$$

As stated by Beckwith, in [16] [22] $m_{\text{4-D Graviton}} \sim 10^{-65}\ \text{grams}$, while n_{count} is the number of gravitons which may be in the detector sample. What Beckwith, Li, and Chongqing university researchers intend to do is to try to isolate out an appropriate $\overset{(1)}{T^{uv}}$ assuming a non zero graviton rest mass, and using Equation (32), Equation (33) and Equation (34) below. From there, the energy density order contributions of $\overset{(1)}{T^{uv}}$, *i.e.* $\overset{(1)}{T^{00}}$ can be isolated, and reviewed in order to obtain traces of $\tilde{\beta}$, which can be used to interpret Equation (14). *I.e.* use $\tilde{\beta} \cong |F|$ and make a linkage of sorts with $\overset{(1)}{T^{00}}$. The term $\overset{(1)}{T^{00}}$ isolated out from $\overset{(1)}{T^{uv}}$ present day data.

2.2. Working with Note to Tame the Incommesurate Metrics, the Approximation Given Below Is Used as a Start to Come up with How to Make Measurements

$$h_0^2 \Omega_{GW} \sim 10^{-6} \tag{34}$$

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 afterwards.

2.3. Wavelength, Sensitivity and Other Such Constructions from Maggiore, with Our Adaptations and Comments

We will next give several of our basic considerations as to early universe geometry which we think are appropriate as to Maggiore's [30] treatment of both wavelength, strain, and Ω_{GW} among other things 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 tables, **Table 1** and **Table 2**. The idea will be to, if one has $h_0 = 0.51 \pm 0.14$, as a degree of measurement uncertainty begin as to understand what may be affecting an expansion of the wave lengths of pre Planckian GW/gravitons which are then increased up to ten orders of magnitude.

What we are expecting, as given to us by L. Crowell, [9] 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 $h_C \le 2.82 \times 10^{-30}$. In reality, only the 2nd and 3rd columns in **Table 1** above escape being seriously off and very different, since the interactions of gravitational waves/gravitons with quark-gluon plasmas and even neutrinos would serve to deform by at least an order of magnitude h_C. The particle per phase state count will be given as, if $h_0^2 \Omega_{GW} \sim 10^{-6}$ [30] [31]

$$n_f \sim h_0^2 \Omega_{GW} \cdot \frac{10^{37}}{3.6} \cdot \left[\frac{1000\ \text{Hz}}{f}\right]^4 \tag{35}$$

Secondly we have that a detector strain for device physics is given by [30] [31]

$$h_C \le \left(2.82 \times 10^{-21}\right) \cdot \left(\frac{1\ \text{Hz}}{f}\right) \tag{36}$$

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

Table 2. Managing GW generation from pre Planckian physics [30] [31].

$h_C \le 2.82 \times 10^{-33}$	$f_{GW} \sim 10^{12}$ Hertz	$\lambda_{GW} \sim 10^{-4}$ meters
$h_C \le 2.82 \times 10^{-31}$	$f_{GW} \sim 10^{10}$ Hertz	$\lambda_{GW} \sim 10^{-2}$ meters
$h_C \le 2.82 \times 10^{-29}$	$f_{GW} \sim 10^{8}$ Hertz	$\lambda_{GW} \sim 10^{0}$ meters
$h_C \le 2.82 \times 10^{-27}$	$f_{GW} \sim 10^{6}$ Hertz	$\lambda_{GW} \sim 10^{2}$ meters
$h_C \le 2.82 \times 10^{-25}$	$f_{GW} \sim 10^{4}$ Hertz	$\lambda_{GW} \sim 10^{1}$ kilometer
$h_C \le 2.82 \times 10^{-23}$	$f_{GW} \sim 10^{2}$ Hertz	$\lambda_{GW} \sim 10^{3}$ kilometer

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 $\lambda_{GW} \sim 10^{-1}\ \text{meters} \Rightarrow n_f \propto 10^6\ \text{graviton/unit phase space}$ for $f_{GW} \sim 10^9\ \text{Hertz}$ This is to have, say a starting point in pre inflationary physics of $f_{GW} \sim 10^{22}\ \text{Hertz}$ when $\lambda_{GW} \sim 10^{-14}\ \text{meters}$, *i.e.* a change of ~$10^{13}$ orders of magnitude in about 10^{-25} seconds, or less.

Table 3 is for identifying the commensurate metric models consistent with Equation (34) above.

To summarize, what we expect is that appropriate strain sensitivity values plus predictions as to frequencies may confirm or falsify each of these four 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 3**, we assume that Ω_{GW} are essentially not measurable in the relic GW sense for the classic GR model.

The best targets of opportunity, for viewing $\Omega_{GW} \approx 10^6$ are ***in*** the $1\ \text{Hz} < f < 10\ \text{GHz}$ range, with another possible target of opportunity in the $f \propto 10^{-6}\ \text{Hz}$ 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. See **Appendix D** for a description of these cosmology models.

3. Providing a Curve as a Modification/Extension of the Penrose Model Talked about

We can look now at the following approximate model for the discontinuity put in, due to the heating up implied in **Table 1** above, namely. This is adapted from Beckwith [12]. We will start off with

$$\frac{\Lambda_{Max} V_4}{8\pi G} \approx T^{00} V_4 = \rho \cdot V_4 = E_{\text{total}} \tag{37}$$

The approximation we are making, in this treatment initially is that $E_{\text{total}} \propto V(\phi)$ where we are looking at a potential energy term [14]. What we are paying attention to, here is [31]

$$V(\phi) = g \cdot \phi^{\alpha} \tag{38}$$

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, go to the following **Table 3**:

Table 3. Variance of the Ω_{GW} parameters as given by cosmology models [32]-[39].

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

$$V(\phi) = g \cdot \phi^{|\alpha|} \quad \text{for} \quad t < t_{\text{PLanck}} \tag{39}$$

Also, we would have

$$V(\phi) = g / \phi^{|\alpha|} \quad \text{for} \quad t \gg t_{\text{PLanck}} \tag{40}$$

The switch between Equation (39) and Equation (40) 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 [31], if $\in = \frac{\lambda^2}{16\pi G}$ and $H = 1/\in t$ so that one has a scale factor behaving as [31]

$$a(t) \propto t^{1/\in} \tag{41}$$

Then, if [31]

$$|V(\phi)| \ll (4\pi G)^{-2} \tag{42}$$

There are no quantum gravity effects. *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 [31]

$$\phi(t) = \frac{1}{\lambda} \ln\left[\frac{8\pi G g \in^2 t^2}{3}\right] \tag{43}$$

Then the scale factors, from Planckian time scale as [31]

$$\frac{a(t_2)}{a(t_1)} = \left(\frac{t_2}{t_1}\right)^{1/\notin} = \exp\left[\frac{(\phi_2 - \phi_1)\lambda}{2\in}\right] \tag{44}$$

The more $\frac{a(t_2)}{a(t_1)} \gg 1$, 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 $t_1 < t_{\text{Planck}}$ then what is done in Equation (44) no longer applies, and that one is no longer having any connection with even an octonionic Gravity regime.

3.1. We Get the Following Expression for the Energy/Frequency Spread

Start with working with the expression given beforehand as [15] [38]

$$E_{\text{thermal}} \approx \frac{k_B \cdot T_{\text{temperature}}}{2} \propto \tilde{\beta} \tag{45}$$

This is for having for a time $\breve{T} \sim 0^+$ to 10^{-44} seconds, $\Omega_{GW} \sim 10^6$, and a variance of frequency of

$$\Omega_0 \in [1\,\text{GHz}, 10\,\text{GHz}] \tag{46}$$

This is due to $T_{\text{temperature}} \sim 10^{32}$ Kelvin at the point of generation of the discontinuity leading to a discontinuity for a signal generation as given by δ_0 at about $\breve{T} \sim 10^{-44}$ seconds. This is for inputs into the relatively constant

$$\left[\Omega_0 \breve{T}\right] \sim \tilde{\beta} \tag{47}$$

The assumption is that the discontinuity, as given by δ_0 will be as of about temperature $T_{\text{temperature}} \sim 10^{32}$ Kelvin, for $\Omega_{GW} \sim 10^{6}$, ***meaning that the peak curve of frequency will be between 1 to 10 GHz for*** $\Omega_{GW} \sim 10^{6}$, with a rapidly falling value of Ω_{GW} ***for frequencies < 1 GHz.***

3.2. 1st Part of Conclusion. Can We Justify/Isolate out an Appropriate $\overset{(1)}{T^{uv}}$ If One Has Non Zero Graviton Rest Mass?

It is difficult. It depends upon understanding what is meant by emergent structure, as a way to generalize what is known in mathematics as the concept of "self-organized criticality" put forward by the Santa Fe school [39] as well as the concept of negator algebra referring to topos-theoretic results. In (2001) Zimmermann and Voelcker [39] refer to a pure abstract mathematical self organized criticality structure… We assert that the mathematical self organized criticality structure is akin to a definition as to how Dp branes arise at the start of inflation. What is the emergent structure permitting $\oint p_i \mathrm{d}x_k = \hbar \delta_{i,k}$ to hold? What is the self organized criticality structure leading to forming an appropriate $\overset{(1)}{T^{uv}}$ if one has non zero graviton rest mass? Answering such questions will permit us to understand how to link finding $\overset{(1)}{T^{uv}}$ in a GW detector, its full analytical linkage to $\tilde{\beta}$ in Equation (13), and Equation (14) [40] [41]. In doing so we make use of the ideas given in [42]. The following construction is used to elucidate how a EM Gaussian sense beam can perhaps be used to eventually help in isolating $\overset{(1)}{T^{uv}}$ in a GW detector. This construction below is to be used to investigate "massive gravitons"/and also the initial structure of self organized criticality, in the aftermath of graviton/gravitational wave generation. Further details can be accessed in Appendix F as to a GW detection system which may be able to help us isolate $\overset{(1)}{T^{uv}}$.

We are attempting to add more information than **Figure 2** below, via suitable analysis of $\overset{(1)}{T^{uv}}$ [43].

3.3. 2nd Part of Conclusion: In Terms of the Planckian Evolution, as Well as the Feed into It from Different Universes

We wish to summarize what we have presented in an orderly fashion. Doing so is a way of stating that Analog, reality is the driving force behind the evolution of inflationary physics

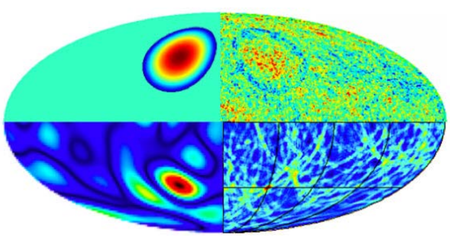

Figure 2. Based upon: First observational tests of eternal inflation [42].

1) Pre Octonian gravity physics (analog regime of reality) features a breakdown of the Octonian gravity commutation relationships when one has curved space time. This corresponds, as brought up in the Jacobi iterated mapping for the evolution of degrees of freedom to a buildup of temperature for an increase in degrees of freedom from 2 to over 1000 per unit volume of space time. The peak regime of where the degrees of freedom maximize is where the Octonian regime holds.

2) Analog physics, prior to the buildup of temperature can be represented by Equation (17) and Equation (18).

4. Treating the Problem of Entropy When Not Assuming Quintessence

References [2] [3] [4] [44]-[49] give us the structure which is fundamental to the idea of the application of expanding upon the idea given in [50].

We acknowledge that Glinka, in [50] pursued this idea in 2007. Our approach is fundamentally different from his, as well as specifying the mass of a graviton as 10^{-62} grams as given in [18]. Following up upon the Ng "infinite quantum statistics" as given by [50] so we then write, S (entropy) as $\sim N$ (counting number), and we specify N, via first of all an inflation mass of m given by the following formula and giving

$$\begin{aligned} & m \cong \frac{\lambda^{2/5}}{\left(\sqrt{2\pi^3}\right)^{2/5}} \cdot \left(T_P^{3/2} \cdot t_P^{\sqrt{50/32}}\right)^{2/5} \approx N_{\text{graviton}} m_{\text{graviton}} \\ & \Rightarrow N_{\text{graviton}} \approx S\left(\text{Entropy initially}\right) \approx \frac{\lambda^{2/5}}{\left(\sqrt{2\pi^3}\right)^{2/5}} \cdot \frac{\left(T_P^{3/2} \cdot t_P^{\sqrt{50/32}}\right)^{2/5}}{m_{\text{graviton}}} \end{aligned} \tag{48}$$

What we find in doing this assuming that the cosmological constant does not change due to quintessence is that we have a much simpler entropy expression, which is commensurate with the formation of many massive gravitons being emitted initially and forming micro sized black holes. There is though a problem with this, in that the approach may require extreme fine tuning of λ which may or may not be justified. In doing this, we are making use of [51] as a non quintessent model of a cosmological constant along the lines proposed in [51].

In addition [51] [52] allow for a bose Einstein condensate for early universe black holes, which shows up in applying a simpler model for entropy.

Finally keep in mind that quintessence, varying initial vacuum energy will disrupt applying [51] [52].

In all win some and lose some. It may be next impossible to reconcile octonionic structure with [51] [52] and if [51] [52] is verified, our major issue will be confirming if there is a linkage between massive gravity and the cosmological constant.

If so, by Novello [51], we then have a bridge to the cosmological constant as given by

$$m_g = \frac{\hbar \cdot \sqrt{\Lambda}}{c} \tag{49}$$

as well as verifying [52]

$$\begin{aligned} m &\approx \frac{m_P}{\sqrt{N_{\text{gravitons}}}} \\ M_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot m_P \\ R_{BH} &\approx \sqrt{N_{\text{gravitons}}} \cdot l_P \\ S_{BH} &\approx k_B \cdot N_{\text{gravitons}} \\ T_{BH} &\approx \frac{T_P}{\sqrt{N_{\text{gravitons}}}} \end{aligned} \tag{50}$$

And by [49]

$$\phi(r(t)) \sim \phi(t) \approx \sqrt{(50/32) \cdot m_{Pl}} \cdot \ln(t) \tag{51}$$

Then according to [50], we should look at the spontaneous symmetry breaking potential, given by

$$U(\phi) \sim -m^2\phi^2 + \lambda\phi^4 \tag{52}$$

Setting the temperature, T, and the time, t as Planck temperature and Planck time, and specifying we are still adhering to Equation (55) leads to a spontaneous symmetry breaking potential of the form which has λ

$$\begin{aligned} &\left(2.4\times10^{-11}\,\text{GeV}/c^2\right)^4 \cdot \left(1.2009^2 \times 10^{38}\,(\text{GeV})^2/c^4\right) \\ &\sim \frac{4\pi \cdot \lambda^{3/5}}{\left(\sqrt{2\pi^3}\right)^{8/5}} \cdot \left(T_{\text{Planck}}^{3/2} \cdot t_{\text{Planck}}^{\sqrt{50/32}}\right)^{8/5} \end{aligned} \tag{53}$$

Not using Octonionic gravity or space time may put a premium on the use of extreme fine tuning. This may be an experimental problem for data sets as the precision so forced may be beyond the scope of experimental detectors at this time.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix A: Highlights of J.-W. Lee's Paper as Used by the Authors

The following formulation is to highlight how entropy generation blends in with quantum mechanics, and how the breakdown of some of the assumptions used in Lee's paper coincide with the growth of degrees of freedom. What is crucial to Lee's formulation, is Rindler geometry, which is flat space time geometry, not the curved space formulation of initial universe conditions. To enable these ideas, the following formulas are used from [3]. First of all quoting from [4],

If gravity and Newton mechanics can be derived by considering information at Rindler horizons, it is natural to think quantum mechanics might have a similar origin. In this paper, along this line, it is suggested that quantum field theory (QFT) and quantum mechanics can be obtained from information theory applied to causal (Rindler) horizons, and that quantum randomness arises from information blocking by the horizons

To start this program, we look at the Rindler partition function, as given by [4]

$$Z_R = \sum_{i=1}^{n} \exp\left[-\beta H\left(x_i\right)\right] = Trace\left[\exp\left(-\beta H\right)\right] \tag{A1}$$

As stated by Lee [4], *we expect* Z_R *to be equal to the quantum mechanical partition function of a particle with mass m in Minkowski space time*. Furthermore, there exists the datum that: Lee made an equivalence between Equation (A1) and [4]

$$Z_Q = N_1 \int \wp x \cdot \exp\left[\frac{-i}{\hbar} \cdot I\left(x_i\right)\right] \tag{A2}$$

where $I\left(x_i\right)$ is the action "integral" for each path x_i, leading to a wave function for each path x_i

$$\psi \sim \exp\left[\frac{-i}{\hbar} \cdot I\left(x_i\right)\right] \tag{A3}$$

If we do a rescale $\hbar = 1$, then the above wave equation can lead to a Schrodinger equation.

<u>**The example given by Lee**</u> [4] is that there is a Hamiltonian for which

$$H\left(\phi\right) = \int \mathrm{d}^3 x \cdot \left[\frac{1}{2} \cdot \left[\left(\partial_t \phi\right)^2 + \left(\nabla \phi\right)^2\right] + V\left(\phi\right)\right] \tag{A4}$$

Here, V is a potential, and ϕ can have arbitrary values before measurement, and to a degree, Z represent uncertainty in measurement. In Rindler coordinates, $H \to H_R$, in co-ordinates $\left(\eta, r, x_2, x_3\right)$ with proper time variance $ard\eta$ then

$$H_R\left(\phi\right) = \int \mathrm{d}r\mathrm{d}x_{\perp} ar \cdot \left[\frac{1}{2} \cdot \left[\left(\frac{\partial \phi}{\partial r}\right)^2 + \left(\frac{\partial \phi}{\partial r \partial \eta}\right)^2 + \left(\nabla_{\perp} \phi\right)^2\right] + V\left(\phi\right)\right] \tag{A5}$$

Here, the $\perp$ is a plane orthogonal to the $\left(\eta, r\right)$ plane. If so then

$$Z = Trace\left[\exp(-\beta H)\right] \rightarrow Z_R = Trace\left[\exp(-\beta H_R)\right] \quad \text{(A6)}$$

Question: Can one transcribe Rindler co-ordinates to the "origin" of the big bang?

Provisional Answer: No. Also, Rindler co ordinates can be as good a description of present geometry. Note

$$F = -\frac{1}{\beta}\cdot \ln Z_R \cong F_{\text{ClassicaL}} \approx \left[I_E(x_i)\right] \quad \text{(A7)}$$

Here, $F_{\text{ClassicaL}} \approx \left[I_E(x_i)\right]$ **minimized**, means that change in entropy is **maximized**. If we look at Verlinde entropy as associated with lost particle information, it means, if $F = -k_B T\cdot \ln Z(T,V,\bar{N}) = -k_B T\cdot N\left[\ln(V/\lambda^3)+5/2\right]$ with $\lambda^3 \geq V$, with V an initial space time volume, and λ the wave length, of say a graviton or equivalent space time particle at/about the origin, then one would have up to a point,

$$F = -\frac{1}{\beta}\cdot \ln Z_R \cong F_{\text{Classical}} \cong \left(I_E(x_i)\right) \approx -k_B T\cdot N\left[\ln(V/\lambda^3)+5/2\right] \approx k_B TN \quad \text{(A8)}$$

Low temperature mean high entropy, and eventually, when one would get to the Planckian regime of space time, with the squeezing of space time geometry to a flat space Rindler geometry, the particle count algorithm

$$\Delta S \sim n(rellic) \sim \#\ \text{ of initial relic particles} \quad \text{(A9)}$$

Here, having $\lambda^3 \geq V$, with V the initial Planckian regime sized "volume" would be equivalent to the causal discontinuity relationship of **a certain amount of "information" as given above above**. Also, $\lambda^3 \geq V$ corresponds to having a filter for the creation of $J_{\text{effective}} \cong n_{\text{count}}\cdot m_{\text{4-D Gravtion}}$, for "massive" gravitons.

Appendix B: Highlights of S. Chaturvedi Paper (about MUB) as Used

Based upon [44] we will go through an accounting of what are Mutually Unbiased Bases, so as to lead up to their application in early universe geometry.

For our early universe purposes, the main benefit of MUB would be in "encryption" of information [5], a point which has direct relevance to highly complex geometry before the transition to quantum mechanics, where the geometry is, in part simplified to "flat space", where the rules of quantum Octonian gravity formulation hold.

Appendix C: Renyi Entropy (Using MUB) versus Y. Ng Particle Count Entropy

This section is to high light the similarities and differences in entropy, in the pre Planckian regime, Planckian space time, and then in doing so, suggest inputs into experimentally detecting δ_0. In a gravitational wave detector [6], we start off with the description from [6] as to what Renyi Entropy, for a MUB, and from there set up a protocol as to compare the difference in entropy between MUB Renyi Entropy, and Ng entropy [18]. Let us begin as to what is known as Entropic relations.

C1: Basics of Entropic relations

Let $|\psi\rangle \varepsilon \mathrm{H}_n$ be a quantum state of $n = \log N$ qubits. Set $B \equiv \{|b_i\rangle\}_{i=1,\cdots,n}$ be an orthonormal basis in H_n.

So, using the construction of an MUB as given in Appendix B, we can refer to $|\langle b||b'\rangle|^2 = 1/N$ for $\forall b\varepsilon B, b'\varepsilon B', B \neq B'\varepsilon\beta$: with β a set of N + 1 MUB for H_n.

C2: Theorem [Maasen-Uffink 88]

For any pair of mutually unbiased basis P and Q for H_n, and $|\psi\rangle \varepsilon \mathrm{H}_n$, then, $\exists$ a probability distribution for

$$B_{\psi(i)} = \|\langle b_i \mid \psi\rangle\|^2 \tag{C1}$$

$$H\left(B_{\psi(i)}\right) = -B_{\psi(i)} \log\left(B_{\psi(i)}\right) \tag{C2}$$

So now we go to the definition of Renyi entropy, *i.e.* for $-1 < \alpha < \infty$ defining the Renyi entropy of order α

$$H_\alpha\left(B_{\psi(i)}\right) = -\log\left(\sum_i B_{\psi(i)}^{1+\alpha}\right)^{1/\alpha} \tag{C3}$$

$$\begin{aligned} &H_0\left(B_{\psi(i)}\right) = H\left(B_{\psi(i)}\right), \\ &H_\infty\left(B_{\psi(i)}\right) = -\log\left(\max_i B_{\psi(i)}\right) \end{aligned} \tag{C4}$$

And now for the main result, *i.e.* the [Maasen-Uffink 88] theorem.

For any pair of mutually unbiased basis, P and Q for H_n, and state $|\psi\rangle \varepsilon \mathrm{H}_n$ then one has for $\log N = n$ quidbits

$$H\left(P_n\right) + H\left(Q_n\right) \geq \log N \tag{C5}$$

This inequality involving zeroth order Renyi entropy as given by Equation (C4) should be contrasted with Ng [20] entropy, *i.e.* $S \sim \langle n \rangle$.

Appendix D: Establishing GW Astronomy in Terms of a Choice between Models

A change of ~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 elsewhere [31] [33] [34] [35] [36] [37], particularly 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: The only thing which we seek is to keep the direction of time to be one directional. *I.e.* [45].

D1: The relic GWs in the pre-big-bang model.

Here, the relic GWs have a broad peak bandwidth from 1 Hz to 10 GHz. We can refer to other such publications for equivalent information as in the pre big model [32] [33]. 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 windows. If the relic GWs in the pre-big-bang model (or other similar models such as the cyclic model of the universe (41) [46] can be detectable, then its contribution to contemporary cosmological perspectives would be substantial

D2: The relic GWs in the ekpyrotic scenario

Relic GWs in the ekpyrotic scenario [47] and in the pre-big-bang [35] [36] 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.

D3: The relic GWs in the ordinary inflationary model

Also, for ordinary inflation [34], 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.