Supplying conditions for having up to 1000 degress of freedom in the onset of inflation, instead of 2 to 3 degrees of freedom, today, in space-time.

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The following document attempts to answer the role additional degrees of freedom have as to initial inflationary cosmology. I.e. the idea is to cut down on the number of independent variables to get as simple an emergent space time structure of entropy and its generation as possible. One parameter being initial degrees of freedom, the second the minimum allowed grid size in space time, and the final parameter being emergent space time temperature. In order to initiate this inquiry, a comparison is made to two representations of a scale evolutionary Friedman equation, with one of the equations based upon LQG, and another involving an initial Hubble expansion parameter with initial temperature $T_{Planck} \sim 10^{19} GeV$ used as an input into T^4 times N(T). Initial assumptions as to the number of degrees of freedom has for $T_{Planck} \sim 10^{19} GeV$ a maximum value of N(T)~ 10^3. Making that upper end approximation for the value of permissible degrees of freedom is dependent upon a minimum grid size length as of about $l_{Planck} \sim 10^{33}$ centimeters. Should the minimum uncertainty grid size for space time be higher than $l_{Planck} \sim 10^{33}$ centimeters, then top value degrees of freedom of phase space as given by a value N(T)~ 10^3 drops . In addition, the issue of bits, i.e. information is shown to not only have temperature dependence, but to be affected by minimum 'grid size' as well. A bifurcation diagram argument involving Hemoltz free energy as a 'driver' to push through a transition from a prior universe to the present universe, with classical physics behavior down to a grid size of $l_{Planck} \sim 10^{33}$ centimeters (i.e. start of quantum gravity effects) is employed to invoke use of classical physics down to $l_{Planck} \sim 10^{33}$ centimeters. Subsequent chaotic dynamics during the expansion phase driven by Helmholtz free energy leads to up to N(T)~ 10^3 degrees of freedom at the start of the inflationary regime. The possibility this semi classical argument for increase of the degrees of freedom up to N(T) ~ 10^3 is tied in with the possible emergence of space time E8 embedding is included as a speculative bonus. This is akin to Bogolyubov "spontaneous" particle creation arguments outlined in the article.

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A. INTRODUCTION

Recently, a big bounce has been proposed[1] as an alternative to singularity conditions that Hawkings, Ellis [1], and others use. A quantum bounce, with a non zero but finite initial radius inevitably will lead to questions as to relic particle production, and of the amount of information bits surviving the big bounce, from a prior universe. This paper intends to find ways to configure scaling procedures to answer the question as to what would be optimal conditions for initial entropy production and byte of information "production" initially . To begin this inquiry we can start with examining candidates for the initial configuration of the normalized energy density. .The normalized energy density of gravitational waves, as given by Maggiore **[2]** is

$$\Omega_{gw} \equiv \frac{\rho_{gw}}{\rho_c} \equiv \int_{\nu=0}^{\nu=\infty} d(\log \nu) \cdot \Omega_{gw}(\nu) \Rightarrow h_0^2 \Omega_{gw}(\nu) \cong 3.6 \cdot \left[\frac{n_\nu}{10^{37}}\right] \cdot \left(\frac{\nu}{1kHz}\right)^4 \qquad (1.1)$$

[1] Papers on LCQ at the 12th Marcell Grossman Meeting in 2009 (http://www.icra.it/MG/mg12/en/)

Where n_ν is a frequency-based count of gravitons per unit cell of phase space. Eq. (1.1) leads to , as given to Fig. 1. candidates as to early universe models which should be investigated experimentally.

The author, Beckwith, wishes to determine inputs into n_ν above, in terms of frequency, and also initial temperature. Doing so will , if one gets inputs into Eq. (1.1) right lead to examining how the arrow of time initial configuration , of entropy, influences choices as to models of what to chose from in terms of inflation. The author is convinced an answer to the above will be dependent upon the number of degrees of freedom present in early universe cosmology. In the LQG version by **[3],** the Friedman equation may be written as follows: If conjugate momentum is in many cases, "almost" or actually a constant

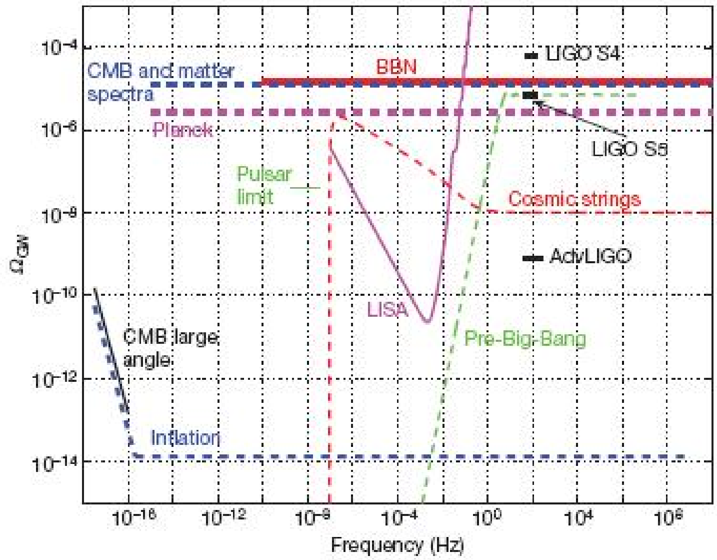

Figure 1. From. Abbott et al. **[4]** (2009) shows the relation between Ω_g and frequency.

Doing so leads to, first considering, a non standard Friedman equation which is written up as [4]

$$\left(\frac{\dot{a}}{a}\right)^2 \equiv \frac{\kappa}{6} \cdot \frac{p_\phi^2}{a^6} \tag{1.2}$$

This Eq. (1.2) assumes that the conjugate dimension in this case has a quantum connection specified via an effective scalar field, ϕ , obeying the relationship

$$\dot{\phi} = -\frac{\hbar}{i} \cdot \frac{\partial}{\partial \cdot p_\phi} \tag{1.3}$$

B . How to compare Eq. (1.2) with Friedman equation behavior, if thermal influences dominate initially with $T_{Planck} \sim 10^{19}\, GeV$

This inquiry explicitly assumes a Friedman equation dominated by temperature with N(T) a temperature dependent number of degrees of freedom present in a region of 'phase space' , and $\breve{a}$ a radiation constant, as given by Saunders(2005) [5]

$$H^2 = \left[4\pi G \cdot \breve{a} \cdot T^4 N(T) / 3c^2\right] \tag{1.4}$$

If we make the following minimum uncertainty value for momentum as given by Baez-Olson [6] , we have that

$\Delta p \geq \hbar / l_{Planck}$ if $l_{Planck} \sim \Delta l$, i.e. what can we expect if there is a minimum value for the length of order Planck length, as opposed to the Ng and Van Damn [7] value of $\Delta p \geq \hbar / l^{1/3} l_{Planck}^{2/3}$, with $l >> l_{Planck}$. Having made this choice of a minimum uncertainty grid, and if we set $\Delta p \approx \hbar / l_{Planck} = P_{\phi}$ and put that into Eq. (1.2) one obtains the following to compare, as a way of obtaining N(T). Namely

$$\left[4\pi G \cdot \breve{a} \cdot T^4 N(T) / 3c^2\right] \approx \frac{\kappa}{6} \cdot \frac{\left\lfloor p_{\phi}^2 = \left(\hbar / l_{Planck}\right)^2 \right\rfloor}{a^6} \tag{1.5}$$

The consequence of Eq. (1.5) would be to set conditions for which the following could be true.

$$N(T) \sim 10^3 \cong \left[\frac{c^2 \kappa \cdot \hbar}{8\pi G \cdot \breve{a}}\right] \cdot \frac{1}{T^4 a_{initial}^6 \cdot l_{Planck}^2} \tag{1.6}$$

If we take a dimensional re scaling of Eq. (1.6), with

$$N(T) \sim 10^3 \sim \frac{1}{\left[T^4 \approx T_{Planck}^4\right] \cdot \left[a_{initial}^6 = 10^{6 \cdot \beta}\right] \cdot l_{Planck}^2} \tag{1.7}$$

One can then obtain an algebraic equation to the effect that

$$76 - 4\delta^+ - 66 + 6\beta \approx -3 \Rightarrow a_{initial} \sim 1 \tag{1.8}$$

This above approximation would be assuming that $T \sim 10^{19-\delta^+} \, GeV$ i.e. close to the Planck temperature

The other assumption is that the starting point for Planck expansion, has $a_{initial} = 1$ with an enormous value for a in the present era as opposed to another scaling convention that $a = [1/1+z]$ where one can have the red shift with values at the onset of inflation of the order of $z_{initial} \sim 10^{25}$ at the start of inflation, and $z_{CMBR} \sim 1100 - 1000$ at the moment of CMBR photon radiation 'turn on' with $z_{Today} = 0$ .in the present era. Examining what happens if one substitutes in for l_{Planck} $l^{1/3} l_{Planck}^{2/3}$ in Eq. 1.7 would mean a substantially lower value for $N(T)$ if the following holds, i.e. $l >> l_{Planck}$ making plausible even at the onset of inflation $N(T) \sim 10^2$ as reported by Kolb and Turner, 1991[8], which is the usual value for degrees of freedom for the case of the electro weak era.

C. First principle evaluation of initial bits of information, as opposed to numerical counting, and entropy

A consequence of Verlinde's [9] generalization of this technique as far as entropy, and the number of 'bits' yields the following consideration, which will be put here for startling effect. Namely, if a net acceleration is such that $a_{accel} = 2\pi k_B c T / \hbar$ as mentioned by Verlinde[9] as an Unruth result, and that the number of 'bits' is

$$n_{Bit} = \frac{\Delta S}{\Delta x} \cdot \frac{c^2}{\pi \cdot k_B^2 T} \approx \frac{3 \cdot (1.66)^2 g^*}{\left[\Delta x \cong l_p\right]} \cdot \frac{c^2 \cdot T^2}{\pi \cdot k_B^2} \tag{1.9}$$

This Eq. (1.9) has a T^2 temperature dependence for information bits , as opposed to [10]

$$S \sim 3 \cdot \left[1.66 \cdot \sqrt{\tilde{g}_*}\right]^2 T^3 \tag{1.10}$$

Should the $\Delta x \cong l_p$ order of magnitude minimum grid size hold, then conceivably when T ~ 10^{19} GeV

$$n_{Bit} \approx \frac{3\cdot(1.66)^2 g^*}{[\Delta x \cong l_p]} \cdot \frac{c^2 \cdot T^2}{\pi \cdot k_B^2} \sim 3\cdot\left[1.66\cdot\sqrt{\tilde{g}_*}\right]^2 T^3 \qquad (1.11)$$

. The situation for which one has [8] $\Delta x \cong l^{1/3} l_{Planck}^{2/3}$ with $l >> l_{Planck}$ would correspond to having

$$n_{Bit} <<, 3\cdot\left[1.66\cdot\sqrt{\tilde{g}_*}\right]^2 T^3 \qquad (1.12)$$

even if one has very high temperatures. Note that for WIMPS a situation as Y. J. Ng has it that [10], [11]

$$S \cong n_{Particle-Count}, \qquad (1.13)$$

Note that Y. Jack Ng [10], [11] has $S \approx n_{Particle-count}$ for counting WIMP Dark Matter, with a much higher mass than what is observed with any accounting for 4 dimensional Gravitons. The current model WIMP model has individual particles as of up to 100 GeV

Next, if the additional degrees of freedom are warranted, comes the question of what are measurable protocol which may confirm / falsify this supposition. The following discussion will in part re cap and extend a discussion which the author, Beckwith has presented in DICE 2010, in Italy [10]

D. Consequences if there are up to 1000 degrees of freedom. I.e what if there are regimes of space time when bits of information count is very different from particle count for entropy ?

The problem, though, is that there may be more than one graviton per information bit as given by Beckwith's calculations for entropy, and also energy carried per graviton. As given by Beckwith, in DICE 2010, Beckwith has made the following estimate, i.e.[10]

Note that J. Y. Ng uses the following . **[11]** I.e. for DM, $S \sim n$, but this is for DM particles, presumably of the order of mass of a WIMP, i.e. $m_{WIMP} \approx 100\cdot GeV \sim 10^{11}$ **electron volts**, as opposed to a relic graviton mass – energy relationship [10]:

$$m_{graviton}(energy-\nu \approx 10^{10}\,Hz) \approx \left[100\cdot GeV \sim 10^{11}\,eV - WIMP\right]\times 10^{-16} \\ \sim 10^{-5}\,eV \qquad (1.14)$$

If one drops the effective energy contribution to $\nu \approx 10^0 \sim 1Hz$, as has been suggested , then the relic graviton mass- energy relationship is:

$$m_{graviton}(energy-\nu \approx 10^{0}\,Hz) \approx \left[100\cdot GeV \sim 10^{11}\,eV - WIMP\right]\times 10^{-26} \\ \sim 10^{-15}\,eV \qquad (1.15)$$

Finally, if one is looking at the mass of a graviton a billion years ago, with

$$m_{graviton}(red-shift-value \sim .55) \approx \left[100\cdot GeV \sim 10^{11}\,eV - WIMP\right]\times 10^{-38} \\ \sim 10^{-27}\,eV \qquad (1.16)$$

I.e. if one is looking at the mass of a graviton, in terms of its possible value as of a billion years ago, one gets the factor of needing to multiply by 10^{38} in order to obtain WIMP level energy-mass values, congruent with Y. Jack Ng's S counting algorithm [10], [11]. What the author is suggesting, as he brought up in DICE 2010 is that the extra degrees of freedom may be necessary for obtaining clumps of

10^{38} gravitons to form coherent clumps to obtain GW of sufficient semi classical initial conditions , to obtain conditions, initially to have the $S \sim N$ counting algorithm work

The author will later on attempt to prove that the 10^{38} factor so recorded is an artifact of Eq. (1.9) , i.e. that the scaling so implied in Eq. (1.9) with the square of temperature, divided by grid size length means that for very light particles, the influence of high levels temperature will make the 10^{38} factor inevitable.

Still though, it would be important to come up with criteria as to how one can obtain a temperature and a mass of a 'particle' regime for which $S \sim N$ work may be solvable via making the Ng. 'entropy' linkable to particle count. AND bits of information.at the same time. To do so may entail introducing a new concept , that of " configurational entropy", as introduced below.

E . Does S_C as 'configurational entropy' serve as a way to make a one to one connection between a particle count algorithm of entropy, and bits of information ? No matter what the "mass" of a particle and the initial background temperature ?

The author has been advised that Rubi et al, 2008 [12] has a net temperature, as given by the following, namely for non equilibrium processes, one can look at $\tilde{T}$ as an effective temperature, and S_C as 'configurational entropy', and $e_{Kin} = m_{graviton} \cdot v_{graviton}^2$ as the kinetic energy of a graviton

$$\frac{1}{\tilde{T}(x,v)} = \frac{\partial S_C}{\partial e_{Kin}} \tag{1.17}$$

In the case that the graviton has a very slight rest mass, one can . if [13] we pick E to be the rest energy, and $m_{graviton}$ the almost non existent rest mass of a graviton in four dimensions

$$v_{graviton}^2 = c^2 \cdot \left[1 - \left(m_{graviton}^2 c^4 / E^2\right)\right] \tag{1.18}$$

The net temperature may be considered to be a calculated function of a rise in temperature from almost non existent status, up to nearly Planck temperature, and the author is convinced, that one would have to, given different geometries, reconstruct the configurational entropy, once an idea of a minimum to the peak temperature, T, for Plank temperature values is obtained.

By doing so, the author hopes to obtain an evolution of S_C with different values of the temperature, in order to come up with an emergent structure with $S_C \sim S \sim 3 \cdot \left[1.66 \cdot \sqrt{\tilde{g}_*}\right]^2 T^3$. This should be done while paying attention to t Hooft's idea that an emergent structure would by necessity likely engage more than 100 dimensions. I.e. as Beckwith wrote about in [10] , so how one defines Eq. (1.17) may, with a proper definition of effective temperature, may force the adaptation of additional degrees of freedom.

D. How to set up a bifurcation diagram for creation of N(T)~ 10^3 degrees of freedom at the start of inflation.

In a word, the way to introduce the expansion of the degrees of freedom from nearly zero, at the maximum point of contraction to having **N(T)~ 10^3** is to first of all define the classical and quantum regimes of gravity in such a way as to minimize the point of the bifurcation diagram affected by quantum processes.

I.e. classical physics, with smoothness of space time structure down to a gird size of $l_{Planck} \sim 10^{33}$ centimeters at the start of inflationary expansion. Have, when doing this construction what would be needed would be to look at the maximum point of contraction, set at $l_{Planck} \sim 10^{33}$ centimeters as the quantum 'dot' , as a de facto measure zero set, as the bounce point, with classical physics behavior before and after t he bounce 'through' the quantum dot.

Dynamical systems modeling could be directly employed right 'after' the move through this purported 'quantum dot' regime, with a transfer of crunched in energy to Hemoltz free energy, as the driver 'force' for a Gauss map type chaotic diagram right after the transition to the quantum 'dot' point of maximum contraction. In a word, the diagram, in a bifurcation sense would look like an application of the so called Gauss mapping of

$$x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i^2\right] + \tilde{\beta} \tag{1.19}$$

In dynamical systems type parlance, one would achieve a diagram, with tree structure looking like what was given by Binous [14], using material written up by Lynch [15] , i.e. by looking at his bifurcation diagram for the Gauss map .Binous's demonstration plots the bifurcation diagram for user-set values of the parameter . Different values of the parameter lead to bifurcation, period doubling, and other types of chaotic dynamical behavior. For the authors purposes, the parameter x_{i+1} and x_i^2 as put in Eq. (1.19) would represent the evolution of number of number of degrees of freedom, with ironically, the near zero behavior, plus a Hemoltz degree of freedom parameter set in as feed into $\tilde{\beta}$. In a word, the quantum 'dot' contribution would be a measure set zero glitch in the mapping given by Eq. (1.19), with the understanding that where the parameter $\tilde{\beta}$ 'turns on' would be right AFTER the 'bounce' through the infinitesimally small quantum 'dot' regime. Far from being trivial, there would be a specific interative chaotic behavior initiated by the turning on of parameter $\tilde{\beta}$,corresponding as brought up by Dickau [16] as a connection between octo-octonionic space and the degrees of freedom available at the beginning of inflation. I.e. turning on the parameter $\tilde{\beta}$ would be a way to have Lisi's E8 structure [17] be nucleated at the beginning of space time.

As the author sees it, $\tilde{\beta}$ would be proportional to the Helmholtz free energy, F, where as Mandl [18] relates, page 272, the usual definition of F=E - TS , becomes, instead, here, using partition function, Z, with $\overline{N}$ a 'numerical count factor', so that [18]

$$F = -k_B T \cdot \ln Z(T, V, \overline{N}) \tag{1.20}$$

Note that Y. Jack Ng.[11] sets a modification of $Z_N \sim \left(\frac{1}{N!}\right) \cdot \left(\frac{V}{\lambda^3}\right)^N$ as in the use of his infinite quantum statistics, with the outcome that $F = -k_B T \cdot \ln Z(T, V, \overline{N}) \equiv -k_B T N \left[\ln(V/\lambda^3) + 5/2\right]$ with V ~ (Planck length)^3 , and us obeying [11]

$$S \approx N \cdot \left(\log\left[V/N\lambda^3\right] + 5/2\right) \xrightarrow[Ng-\inf inite-Quantum-Statistics]{} N \cdot \left(\log\left[V/\lambda^3\right] + 5/2\right) \approx N \tag{1.21}$$

Such that the free energy, using Ng. infinite quantum statistics reasoning would be [11], [18]

$$F = -k_B T \cdot \ln Z(T, V, \overline{N}) \equiv -\frac{5}{2} \cdot k_B T \overline{N} \tag{1.22}$$

The author's suggestion is that up to a constant, that one would observe

$$\tilde{\beta} \approx |F| \equiv \frac{5}{2} k_B T \cdot \overline{N} \qquad (1.23)$$

I.e. for a fixed arrow of time configuration, setting in phase space an entry number $\overline{N}$, $\tilde{\beta}$ would directly scale with (increase in) temperature. The significance of such a scaling with regards to temperature, would be that how the mapping $x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i^2\right] + \tilde{\beta}$ would evolve as a Gaussian bifurcation mapping , where for each step $x_i \propto N(T)$, how the Gaussian bifurcation mapping evolved would be dependent upon how the temperature T increased. I.e. we assume that the chemical potential obtained with a partial derivative of F evolved with respect to $\overline{N}$ would have an extremal value of F, leading to a zero chemical potential, i.e. for temperature dependent, but with a fixed $\overline{N}$ behavior for F , the chemical potential $\mu = 0$

F. Linking the behavior of $\tilde{\beta}$ increasing with temperature T , to the emergence of the Lisi E8 structure.

Our assumption is,that $\tilde{\beta}$ increasing up to a maximum temperature T would enable the evolution and spontaneous construction of the Lisi E8 structure as given by [17]. As Beckwith wrote up [19], including in additional energy due to an increase of $\tilde{\beta}$ due to increasing temperature T would have striking similarities to the following

Observe the following argument as given by V. F. Mukhanov, and Swinitzki [20], [21] , as to additional particles being 'created' due to what is an infusion of energy in an oscillator , obeying the following equations of motion [20], [21]

$$\begin{aligned} &\ddot{q}(t) + \omega_0^2 q(t) = 0, \text{ for } t < 0 \text{ and } t > \breve{T}; \\ &\ddot{q}(t) - \Omega_0^2 q(t) = 0, \text{ for } 0 < t < \breve{T} \end{aligned} \qquad (1.24)$$

,Given $\Omega_0 \breve{T} >> 1$, with a starting solution of $q(t) \equiv q_1 \sin(\omega_0 t)$ if t <0, Mukhanov state that for [20], [21] $t > \breve{T}$;

$$q_2 \approx \frac{1}{2}\sqrt{1 + \frac{\omega_0^2}{\Omega_0^2}} \cdot \exp\left[\Omega_0 \breve{T}\right] \qquad (1.25)$$

The Mukhanov et al argument leads to an exercise which Mukhanov claims is solutions to the exercise yields an increase in number count, as can be given by first setting the oscillator in the ground state with $q_1 = \omega_0^{-1/2}$, with the number of particles linked to amplitude by $\breve{n} = [1/2] \cdot \left(q_0^2 \omega_0 - 1\right)$, leading to

$$\breve{n} = [1/2] \cdot \left(1 + \left[\omega_0^2 / \Omega_0^2\right]\right) \cdot \sinh^2\left[\Omega_0 \breve{T}\right] \qquad (1.26)$$

I.e. for non zero $\left[\Omega_0 \breve{T}\right]$, Eq (1.24) leads to exponential expansion of the numerical state. For sufficiently large $\left[\Omega_0 \breve{T}\right]$, Eq. (1.24) and Eq. (1.25) are equivalent to placing of energy into a system, leading to vacuum nucleation. A further step in this direction is given by Mukhanov on page 82 of his book leading to a Bogolyubov particle number density of becoming exponentially large [20],[21]

$$\breve{\breve{n}} \sim \cdot \sinh^2[m_0 \eta_1] \tag{1.27}$$

Eq. (1.25) to Eq. (1.26) are , for sufficiently large $[\Omega_0 \breve{T}]$ a way to quantify what happens if initial thermal energy are placed in a harmonic system, leading to vacuum particle ' creation' Eq. (1.27) is the formal Bogolyubov coefficient limit of particle creation . Note that $\ddot{q}(t) - \Omega_0^2 q(t) = 0,$ for $0 < t < \breve{T}$ corresponds to a thermal flux of energy into a time interval $0 < t < \breve{T}$. If $\breve{T} \approx [t_{Planck} \propto 10^{-44} \sec]$ or some multiple of t_{Planck} and if $\Omega_0 \propto 10^{10} Hz$, then Eq (1.24), and Eq. (1.26) plus its generalization as given in Eq. (1.27) may be a way to imply either vacuum nucleation , or transport of gravitons from a prior to the present universe. Note that this would be akin to looking at the following. If one identified the evolution of temperature, with energy, and made the following identification, $\breve{T}$ for time, and Ω_0 for a special frequency range, as inputs into

$$E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto [\Omega_0 \breve{T}] \sim \tilde{\beta} \tag{1.28}$$

With $\tilde{\beta}$ 'varying directly with temperature $T_{temperature}$, then one could, with a specific increase in temperature up to the onset of inflation, up to time $\breve{T} \approx [t_{Planck} \propto 10^{-44} \sec]$ have a situation in which there would be addition to a structure , whose inputs into growth would be given by Eq. (1.26) and Eq. (1.27). We identify the growth of this structure as an embedding for the Lisi E8 group space time structure spontaneously rising into place. Co currently, as this structure gets put into place, we have increase in N(T) up to 1000, well above the usual degree of freedom upper bound of about 100 in the electro weak era.

As the coefficient $\tilde{\beta}$ increases with a rise in temperature going up to $T_{Planck} \sim 10^{19} GeV$, the bifurcation diagram increasing the number of degrees of freedom , as given by mapping Eq. (1.19) is fleshed out, with parameterization as either bifurcation, period doubling, and other types of chaotic dynamical behavior.

G. Conclusions. Extensions of this thought experiment, and comparison with entropy of photons.

Recently, the author has been fortunate enough to obtain Leff's [22] entropy of photons per unit volume paper where for a phase space volume, V, and temperature T,

$$S = (4/3)\ bVT^3 \tag{1.29}$$

This should be compared with Beckwith's derived "graviton clumping" entropy result [10] per unit volume of phase space as given by $S \sim 3 \cdot [1.66 \cdot \sqrt{\tilde{g}_*}]^2 T^3$ of Eq. (1.10), and subsequent modifications as given in Eq. (1.17)

What the author supposes, is that fine tuning the inter play between these two formulas, from the onset of inflation when there was likely coupling between gravitons, clumps of gravitons, and photons , may permit experimental measurements permitting investigation if there is an interplay between E&M and gravity, and also modifications of gravity theory along the lines brought up by Sidharth [22] , i.e. if Eq.(1.10), Eq. (1.17) and Eq. (1.19)are representations of a joint phenomenon as is suggested by Sidarth's (which incidently is for E and M radiation characterized by a given 'carrier wave' frequency)

$$A^{\mu} = \hbar \cdot \Gamma_{\mu}^{\mu\ \ \nu} \tag{1.30}$$

where A^{μ} can be identifed with the electromagnetic four potential The idea, as Beckwith sees it would be to determine if there could be coupling between E & M effects, and gravitation along the lines of employing the Quantum (coupled) oscillator frequency relationship for coherent "state" oscillation as given by Sidarth [22] via

$$G\hbar\omega_{\max} = c^{5} \tag{1.31}$$

This would be to come up with a realistic way to talk about clumps of gravitons which may have coherent oscillatory behavior and to use this to make sense of the structure of up to 10^{38} coherent gravitons to form coherent clumps to obtain GW of sufficient semi classical initial conditions , to obtain conditions, initially to have the $S \sim N$ counting algorithm work for gravitons as coherent clumps , allegedly in a structure defined by Eq. (1.21)

Then, after employing Eq. (1.31) to next examine the limits of, and interexchange of effects given in Eq. (1.14) and Eq. (1.15) to determine from there to what degree is Eq. (1.16) is giving us joint linkage of E&M and gravitational waves in early universe conditions. Also , the author hopes that examining a potential inter play of Eq. (1.10) to Eq. (1.31) that the datum that the 10^{38} coherent gravitons [10] to form coherent clumps to obtain GW is necessary derivation will also, allow for explaining further the inter play between the choice of minimum length and momentum , as given by $\Delta p \approx \hbar / l_{Planck} = P_{\phi}$ and the supposition of more initial degrees of freedom than is usually supposed by conventional cosmology , of the sort presented by Kolb And Turner's [8] book on cosmology. Finally, once this task is done, the author thinks that L. Glinka's formula [23], [24] of

$$n_{f} = [1/4] \cdot \left[\sqrt{\frac{\nu(a_{initial})}{\nu(a)}} - \sqrt{\frac{\nu(a)}{\nu(a_{final})}} \right] \tag{1.32}$$

could be investigated as being part of the bridge between phenomenology of both photon gases, and their entropy, as well as a modified treatment of L. Glinka's graviton gas [23], [24], with suitable inputs into the frequencies allowed for both 'gases'.

If Eq. (1.32) is a linkage to both photon and the given graviton gas, as may be the case, in terms of understanding if $S \sim N$ is proved, possibly by re defining S in terms of Eq. (1.17), and the idea of 'configurational entropy' [12], then the next step should be to examine what was brought up in terms of having the degrees of freedom, initially influenced by a Gaussian bifurcaton map, with degrees of freedom matched against a parameter proportional to the absolute value of Hemoltz Free energy.

The idea which the author finds more valuable to consider is if the Gaussian Bifurcation mapping of an increase of , and chaotic dynamics of degrees of freedom, against the absolute value of Hemoltz free energy, with H.F.E. defined in terms of a modified Y. Jack Ng partition function can have a counter part to the rise of structure, conceivably E8 style embedding in space time, at the same time. The arguments if true, would give an ultimately simplified scaling procedure, largely linked as to the degree of applications of Eq. (1,19) .

The key, as the author sees it, is that the limits of applications of Eq. (1.19) in terms of 'skipping over' or not engaging the quantum gravity grid size limit given by $l_{Planck} \sim 10^{33}$ are confirmed, than the use of semi classical treatments as of particle counts as given by Eq. (1.32) have to be taken seriously. The linkage of semi classical enhancement emergent structure of space time, as indicated by Eq. (1.24) to Eq. (1.28) if confirmed would go a long way toward showing the precise limits of and domains of quantum gravity, in space time, as well as when the classical regime of physics becomes most important. And perhaps give an answer to the question raised by t'Hooft and others in the Fundamental Frontiers of Physics 11 conference on if gravity is either classical or quantum in nature, and its initial starting genesis.

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