Competing Cosmology Models. Can entropy production help falsify cyclic models of cosmology, or variants along the lines discussed by Roger Penrose at the ICG conference in Penn State, 2007?

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Abstract: In the inaugural ICG meeting, on August 11, 2007 at Penn State, Roger Penrose[1] gave a presentation about an alternative to cyclic cosmological models, which needs experimental tests for falsifiability. As discussed by Beckwith, in EJTP [2], Penrose brought up how a De Albertain wave equation, as simplified in flat space could lead to a rising vacuum nucleation field which would engender the pop up behavior as sought in most emergent field models of gravity. The scalar field pop up with certain qualifications is not so startling in itself. Now for the radical extension Penrose brought to bear. Penrose asserted in his ICG lecture that there was a good chance that there was no collapse in future events, but that matter would be eventually sucked up by 'millions' of black holes, creating a clean up of most interstellar matter. The issue to be brought up is how to come up with a mapping for re combination of the black hole collected material, for a big bang. A topic which was not solved by Penrose. We also discuss a criteria for a first order phase transition which would be a feed into a new universe, which awaits experimental confirmation.

Introduction

Penrose asserted that the 'millions of black holes' would eventually undergo Hawking's evaporation [1] , i.e. that in some fashion that there would be a release of the matter- energy For those who wish to look it up, Hawking's evaporation of black holes, involves subtle quantum arguments and tries to reconcile black hole physics with known thermodynamics. ,eg. As an example the 2nd law of Black hole dynamics. Traschen[3] states the basic assumptions involved, while Hawkings [4] stated evaporation as to ways which may tie in with typical entropy / area calculations as given by Bernstein and other writers. The easiest conceptual starting point is to use the equivalence between number of operations which Lloyd [5] used in his model, and total units of entropy as the author referenced from Carroll [6], and other theorists. The key equation Seth Lloyd [5] wrote is as follows, assuming a low entropy value in the beginning

$$\left|S_{Total}\right| \sim \left|k_B \cdot \ln 2\right| \cdot \left[\#operations\right]^{3/4} \sim 10^5 - 10^6 \tag{1}$$

Seth Lloyd[5] is making a direct reference to a linkage between the number of operations a quantum computer model of how the Universe evolves is responsible for , in the onset of a big bang picture, and entropy. Needless to state though, Eq (1) above, and the issue of if or not there is a well defined threshold bulk electric and magnetic charge contribution to energy. If there is , indeed an evaporation effect of black hole physics, at what juncture does one have a collapse of a threshold effect for calculations about the minimum entropy based upon black hole models involving electric and magnetic charges ?

Assuming then, that the relevant Black holes evaporate, Penrose [1] next presented the question of an undetermined mapping of the evaporated Hawking radiation back to the nexus point for a new big bang. The author, Beckwith, asked Penrose repeatedly at the ICG about the nature of the mapping of released Hawking radiation back to a new big bang. Penrose threw the question back to Beckwith, as Beckwith's research problem, not his. .Assume, if one will that there are N number of universes under going Penrose style expansion and then black hole clean up of matter- energy as these N universes expand. Each universe contains roughly 10^{88} entropy units of computational information as embedded in say 10^{10} spiral galaxies. If each spiral galaxy has an entropy reading of about 10^{90} entropy 'units', this leads to an over hang of about 10^{100} entropy units, as opposed to an observable 10^{88} entropy units for the universe as can be accessed by instrumentation. Which leads asking what is the significance of that entropy gap ?

Secondly, and most important to this discussion, there is a strange attractor suck up of bits of information from each of the N expanding universes, and the Hawking radiation is, within a mega structure mapped back to the locus point of another sent of N big bangs via typical phase space strange attractor dynamics. How to verify this wild supposition experimentally? See the conclusion of this article for Beckwith's guess as to what to try to do experimentally to indirectly infer the existence of this mega structure and of strange attractor collapse of Hawkings radiation back to N locus points for N number of big bangs.

What is needed to be experimentally falsified: relic graviton production involves HFGWs, indicated by a rapid drop off of graviton creation after the onset of the big bang

We should first look at the key assumption of the Ng [7],[8] approach to entropy : the wavelength of the "particles" contributing to entropy are ultra-long, i.e., there is an order of magnitude difference between the cube of the wavelengths of the particles and of the containing volume of space, V, which is analyzed to obtain the entropy figure Ng [7],[8] uses to get his infinite quantum statistics.The same methodology of comparing the cube of wavelengths with the expected spacetime volume is used to get Ng's [7,[8]infinite quantum statistics, assuming that relic graviton production involves HFGWs. Then one analyzes entropy production what Ng did with DM and wavelengths, and the volume of space V,. But instead of DM, this involves gravitons, with an ultra-short wavelength, necessitating a small volume of space in the beginning of graviton production. So the same infinite quantum statistics procedure Ng used for DM can be used for gravitons, except that the gravitons are produced in the very *beginning* of the inflationary era. So the creation of gravitons is enhanced in the beginning of cosmological nucleation by the requirement of a one-to-one relationship between shortwave lengths of HFGW and a small space time volume for relic graviton creation .Then it's likely that the data sets observed in the Li-Baker detector could indicate a rapid drop off of graviton creation after the onset of the big bang. This should be investigated by falsifiable experimental procedures.

Prediction: a relatively narrow range of GW frequencies for relic graviton production

Appendix C examines this assumption and compares it directly with another assumption made by Giovannini[9], which is reformulated to assert that if all frequency ranges for GW radiation were permissible, one would see a total value of entropy of nearly 10^{90}. This is done while not assuming as we did HFGW conditions.

Therefore, Giovannini's (1993) prediction as written up in 2008 [9] is assumed to be indefensible, and that a relatively narrow range of GW frequencies for relic graviton production is what should be looked for via either the Li-Baker HFGW detector or by the Planck satellite mission.

Implication: How an inflaton could arise and fall from thermal inputs from a prior universe

Here are some additional possible spinoffs of these sorts of ideas, if they are experimentally verified. **Appendix D** based upon Beckwith's work, [9] shows a to-the-point presentation of how an inflaton could arise and fall from thermal inputs from a prior universe. These are notes adapted from a presentation by Dr. Penrose regarding his alternatives to typical cyclic-universe cosmologies [1]. We elaborate upon Penrose's startling conclusions, but his first part of his presentation is useful, since it fits very closely with the author's methodologies for thermal inputs from a prior universe.

Are irregularities in the CMBR spectra related to entropy production?

If this can be verified experimentally, the biggest payoff would be to address an issue that the author discussed with Sarkar of Oxford[10]. **Appendix A** gives the basic idea: are the irregularities in the CMBR spectra, due to non-standard physics, which are an extension of the standard inflaton model, used to justify entropy production? We think that there is merit to this idea and that it should be investigated. At the minimum, understanding entropy production would allow us to analyze if the structure formation methodology experimentally presented by Rtuu , et al. [11] ties in with models of entropy production, and if not, what about verifying the standard model for CMBR production, as G. Hingsaw [12] and others promote? Or what if Sarkar [11] is right? A summary of what A.W. Beckwith [13] thinks of these issues may be found in a presentation made at IDM 2008

Structure formation from entropy generation

Starting with what Beckwith used in 2008 [13], and also in Rencontres De Blois [14]

$$\left|S_{Total}\right|_{Initial-\inf-condt} \sim \left|k_B \cdot \ln 2\right| \cdot \left[\# operations\right]^{3/4} \approx N\left|-\log\frac{N}{10}+\log V_4^3+\log E^{3/2}\right| \sim 10^5 \quad (2)$$

Aiding in the development of confirming/falsifying Eqn. (2) above are structure formation questions that we leave as open questions to be addressed by the CMBR/astrophysics community: This would be aligned with the question of how structure formation could arise as a result of entropy generation. Sarkar [11] and others, with their race track models of inflation, have done useful pioneering work in defining coupled fields undergoing symmetry breaking that are coupled to the inflaton. The author, A.W. Beckwith, thinks that such suppositions need experimental verification, and that the boost of total entropy by the relic graviton value given in $\Delta S_{graviton-production} \propto 10^5$ in a Planck time interval could lead to additional insights into whether or not Sarkar [11] (2008) or Hingsaw [12] is right about the origins of irregularities in the CMBR spectra. Sarkar {11} states that the irregularities means physics beyond the standard cosmological model assumed for WMAP, while Hingsaw[12] states that the irregularities are merely statistical anomalies.

How initially huge vacuum energy and its rapid collapse in space-time to a much smaller cosmological constant value aids in the breakup and reformulation of entropy production ????

The author, A.W. Beckwith, wishes to close with what will be future projects to address some of the above issues. As discussed with Tchrakian,[15]Bremen, August 29^{th}, 2008, the author wishes to determine if or not the dichotomy between an initially huge vacuum energy, as specified above in this manuscript, and its rapid collapse in space-time to a much smaller cosmological constant value, aids in the breakup and reformulation of entropy production. The author's supposition is that it is relevant to two areas. First, the author assume that there is a breakup of the initial instanton structure from a prior universe. Since the author also views gravitons as a kink-antikink structure, the supposition is that initially, from a prior to a present universe, there would be a similar phenomenon: initial lack of numerical density of gravitons just before a second-order phase transition, which is discussed in part in **AppendixC.** Secondly if, after a second-order phase transition we see evidence of astrophysical data supporting the rebirth of both entropy and graviton production, we should take this hypothesis seriously. Should the cosmological constant/vacuum energy linkage be proved to be consistent with the breakup and then reformulation of graviton production in a phase transition, then the author, A.W. Beckwith, thinks that researchers could be on track for new experimentally falsifiable criteria, to be developed for CMBR physics.

Finally, Relic graviton produced entropy at the onset of the big bang . Why starting entropy would be so small while CMBR entropy would be so large

As a closing remark, Beckwith wishes to suggest a solution to Penrose's implied question about entropy as raised in Edingborough , Scotland [16] conference proceedings. Penrose talks about the 2^{nd} law, and its implied requirements as to the small initial value of early universe entropy, and then states that gravitational entropy would not be so major, whereas CMBR matter contributed entropy would be much larger. Beckwith is convinced that relic graviton production at the onset of the big bang, i.e. before the contribution of entropy from matter itself would be necessary to boost entropy from its small 10^5 value at the onset of the big bang, to a much higher level , and that entropy would be initially dramatically boosted by that process. I.e. the uniformity requirement Penrose talks about in structure would be actually as of up to the Electro weak transition , and far after the initial onset of inflation itself.

A new idea extending Penrose's suggestion of cyclic universes, black hole evaporation, and the embedding structure our universe is contained within

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Beckwith strongly suspects that there are no fewer than N (a large number) of universes under going Penrose 'infinite expansion' and all these are contained within a mega universe structure. Furthermore, that each of the N universes has black hole evaporation commencing, with the Hawking radiation from decaying black holes.

If each of the N universes is definable by a partition function, we can call $\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}$, then there exist an information minimum ensemble of mixed minimum information roughly correlated as about $10^7 - 10^8$ bits of information per each partition function in the set $\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}\Big|_{before}$, so minimum information is conserved between a set of partition functions per each universe

$$\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}\Big|_{before} \equiv \left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}\Big|_{after} \qquad (3)$$

However, that there is non uniqueness of information put into each partition function $\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}$.

Furthermore that within the mega structure, that 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 with a non unique venue of information placed in each of the N universes would strongly favor Ergodic mixing treatments of initial values for each of the N universes expanding from a quasi singularity beginning.If this idea is in any way confirmable, it would lend credence as to the formation of the dark flow hypothesis, and of how anharmonic perturbative contributions to initial inflationary expansion may occur , within a partially random ergotic background. Beckwith claims that such a process would inherently favor the small 10^7 bits of information per each partition function representing the 'start' of expansion of a new universe. Hopefully, in doing so, one can explain, eventually, the problems with entropy modeling presented in **Appendix C** below. This has a similarity with a construction done by Beckwith [18], namely looking at the following expression of energy flux being re formulated for each universe. I.e. start with the Alcubierre's [3] formalism about energy flux, assuming that there is a solid angle for energy distribution Ω for the energy flux to travel through. [18]

$$\frac{dE}{dt} = [\lim r \to \infty]\left[\frac{r^2}{16\pi}\right] \oint \left| \int_{-\infty}^{t} \Psi_4 dt' \right|^2 \cdot d\Omega \tag{4}$$

The expression Ψ_4 is a Weyl scalar which we will write in the form of

$$\Psi_4 = -\frac{1}{4} \cdot \left[\partial_t^2 h^+ - 2\partial_t \partial_r h^+ + \partial_r^2 h^+\right] + \frac{i}{4} \cdot \left[\partial_t^2 h^x - 2\partial_t \partial_r h^x + \partial_r^2 h^x\right] \tag{4a}$$

Our assumptions are simple, that if the energy flux expression is to be evaluated properly, before the electro weak phase transition, that time dependence of both h^+ and h^x is miniscule and that initially $h^+ \approx h^x$, so as to initiate a re write of Eq. (4a) above as

$$\Psi_4 \cong -\frac{1}{4} \cdot \left[+\partial_r^2 h^+\right] \cdot (-1 + i) \tag{5}$$

The upshot, is that the initial energy flux about the inflationary regime would lead to looking at

$$\left| \int_{-\infty}^{t} \Psi_4 dt' \right| \approx \left| \frac{1}{2} \cdot \left[+\partial_r^2 h^+\right] \right| \cdot \left(\tilde{n} \cdot t_{Planck}\right) \tag{6}$$

This will lead to an initial energy flux at the onset of inflation which will be presented as

$$\frac{dE}{dt} = \left[\frac{r^2}{64\pi}\right] \cdot \left|+\partial_r^2 h^+\right|^2 \cdot \left[\tilde{n} \cdot t_{Planck}\right]^2 \cdot \Omega \tag{7}$$

If we are talking about an initial energy flux, we then can approximate the above as

$$E_{initial-flux} \cong \left[\frac{r^2}{64\pi}\right] \cdot \left|+\partial_r^2 h^+\right|^2 \cdot \left[\tilde{n} \cdot t_{Planck}\right]^3 \cdot \Omega_{effective} \tag{8}$$

Inputs into both the expression $\left|\partial_r^2 h^+\right|$, as well as $\Omega_{effective}$ will comprise the rest of this document, plus our conclusions. The derived value of $\Omega_{effective}$ as well as $E_{initial-flux}$ will be tied into a way to present energy per graviton, as a way of obtaining n_f. The n_f value so obtained, will be used to make a relationship , using Y. J. Ng's entropy [7,8] counting algorithm of roughly $S_{entropy} \sim n_f$. We assert that in order to obtain $S_{entropy} \sim n_f$ from initial graviton production, as a way to quantify n_f, that a small mass of the graviton can be assumed.

How to tie in this energy expression , as given in Eq. (8) will be to look at the formation of a non trivial gravitional measure which we can state as a new big bang for each of the N universes as represented by [19] and $n(E_i)\cdot$ the density of states at a given energy E_i for a partition function defined by

$$\{\Xi_i\}_{i\equiv 1}^{i\equiv N} \propto \left\{ \int_0^\infty dE_i \cdot n(E_i)\cdot e^{-E_i} \right\}_{i\equiv 1}^{i\equiv N}. \tag{9}$$

Each of the terms E_i would be identified with Eq.(8) above, with the following iteration given, namely for N universes

$$\frac{1}{N}\cdot\sum_{j=1}^{N}\Xi_j\Big|_{j-before-nucleation-regime} \xrightarrow[vacuum-nucleation-tranfer]{} \Xi_i\Big|_{i-fixed-after-nucleation-regime} \tag{10}$$

For N number of universes, with each $\Xi_j\Big|_{j-before-nucleation-regime}$ for j = 1 to N being the partition function of each universe just before the blend into the RHS of Eq. (10) above for our present universe. Also, each of the independent universes given by $\Xi_j\Big|_{j-before-nucleation-regime}$ would be constructed by the absortion of say one million black holes sucking in energy**. I.e. in the end**

$$\Xi_j\Big|_{j-before-nucleation-regime} \approx \sum_{k=1}^{Max}\tilde{\tilde{\Xi}}_k\Big|_{black-holes-jth-universe} \tag{11}$$

One can treat Eq. (10) as a de facto Ergotic mixing of prior universes to a present universe, with the partition function of each of the universes defined by Eq (9) above.

Filling in the imputs into Eq. (9) to Eq. (11) is what will be done in the months aghead. $\left|\partial_r^2 h^+\right|$ will be the one to fill in, via considering [20] plus other models. Doing so will begin to allow us to form more precise evaluations of Eq. (9) to Eq. (11)

For the sake of convenience, one can write [21, 22]

$$\left|\partial_r^2 h^+\right| \sim k^2 h^+ \tag{12}$$

So, then

$$E_{initial-flux} \sim \left[\frac{r^2}{64\pi}\right]\cdot k^4\cdot\left[h^+\right]^2\cdot\left[\tilde{n}\cdot t_{Planck}\right]^3\cdot\Omega_{effective} \tag{13}$$

For our purposes, we shall call $r \sim l_{Planck} \propto 10^{-34}cm$, $t_{Planck} \sim 10^{-44}$ sec, $\Omega_{effective}$ an effective cross sectional area as to the emission of gravitons, and k defined as a physical wave vector. L. Crowell stated that GW would undergo massive red shifting [23]. Needless to state, the value of k to consider would be for the GHz band of GW [21,22]

$$\left(k \approx k_{GW}\right)^2 >> \left| \frac{1}{a} \cdot \frac{d^2 a}{d\eta^2} \right| \tag{14}$$

Also, for the frequences of [21,22] $10^9 - 10^{10}$ Hz, then

$$h \sim h_{rms} \sim 10^{-30} - 10^{-34} \tag{15}$$

Then the numerical count factor can either be of two times, either as a bit count, or just as straight For a primordial black hole.

Namely, if a net acceleration is such that $a_{accel} = 2\pi k_B cT/\hbar$ as mentioned by Verlinde [23], [22] as an Unruh result, and that the number of 'bits' is

$$n_{Bit} = \frac{\Delta S}{\Delta x} \cdot \frac{c^2}{\pi \cdot k_B^2 T} \approx \frac{3 \cdot (1.66)^2 g^*}{\left[\Delta x \cong l_p\right]} \cdot \frac{c^2 \cdot T^2}{\pi \cdot k_B^2} \tag{16}$$

This Eq. (16) has a T^2 temperature dependence for information bits , as opposed to [5]

$$S \sim 3 \cdot \left[1.66 \cdot \sqrt{\tilde{g}_*}\right]^2 T^3 \sim n_f \tag{17}$$

Should the $\Delta x \cong l_p$ order of magnitude minimum grid size hold, then conceivably when T ~ 10^{19} GeV[24]

$$n_{Bit} \approx \frac{3 \cdot (1.66)^2 g^*}{\left[\Delta x \cong l_p\right]} \cdot \frac{c^2 \cdot T^2}{\pi \cdot k_B^2} \sim 3 \cdot \left[1.66 \cdot \sqrt{\tilde{g}_*}\right]^2 T^3 \tag{18}$$

The situation for which one has [24], [25] $\Delta x \cong l^{1/3} l_{Planck}^{2/3}$ with $l \sim l_{Planck}$ corresponds to $n_{Bit} \propto T^3$ whereas $n_{Bit} \propto T^2$ if $\Delta x \cong l^{1/3} l_{Planck}^{2/3} >> l_{Planck}$.

Here, we make ths assumption that either $\tilde{n} \sim n_{Bit} \propto T^2$ or $\tilde{n} \sim n_{Bit} \propto T^3$ per unit volume of phase space with the temperature T varying from a low value to up to 10^{34} Kelvin (Planck temperature scale). All these scaling parameters would be placed in Eq. (13) above, with Eq. (13) then put in a discretized version of Eq. (9), Eq. (10), and Eq. (11). We shall next talk about if this analysis of bits and the like can be related to Stephan-Boltzmann and Casimir treatments of quantum fluctuations.

Looking at a general relation between thermal and quantum fluctuations in relativistic field theories

From considering a scalar field treatment of energy density and pressure for non interacting gases,a nd then relate the analysis to how domain wall break down would lead to GW generation, we shall consider how GW may be introduced in the present universe.

To begin with, go to the [26, 27, 28] construction given in table 1 below which compares the values as given by

Table 1

Stefan – Boltzmann	**Casmir**
$\varepsilon = \frac{\pi^2}{15} \cdot T^4$	$P = -\left(\frac{\pi^2}{15}\right) \cdot [L]^{-4}$

$p = \frac{\pi^2}{45} \cdot T^4$	$\varepsilon = -\left(\frac{\pi^2}{45}\right) \cdot [L]^{-4}$

The concept of a quantum phase transition involving the geometry of a spatial ‘ box’ of length L with a critical temperature is stated as [26, 27, 28] by parameters for a quantum phase tradition [29]

$$T_C = \frac{1}{L_C} \tag{19}$$

Depending upon the geometry of

Quantum phase transition, set by T_C with different values of $L_C \cong \Delta x \cong l^{1/3} l_{Planck}^{2/3}$

If one picks the value of $L_C \cong \Delta x \cong l^{1/3} l_{Planck}^{2/3}$, where if $\Delta x \cong l^{1/3} l_{Planck}^{2/3}$ with $l \sim l_{Planck}$ corresponds to $n_{Bit} \propto T^3$ and the value of $n_{Bit} \propto T^2$ corresponding to $\Delta x \cong l^{1/3} l_{Planck}^{2/3} >> l_{Planck}$ will then tell us how the absolute magnitude of energy density in a Casmir plate treatment of an initial energy density would scale as n_{Bit} . To get to the idea, we would make the next table, namely

Table 2

$L_C \cong \Delta x \sim l_{Planck}$ when $l \sim l_{Planck}$	$L_C \cong \Delta x >> l_{Planck}$
$n_{Bit} \propto T^3$	$n_{Bit} \propto T^2$
$T_C \approx \frac{1}{[\Delta x \cong l_{Planck}]}$	$T_C \approx \frac{1}{[\Delta x >> l_{Planck}]}$

The number of bits goes highest when $L_C \cong \Delta x \sim l_{Planck} \Leftrightarrow n_{Bit} \propto T^3 \Leftrightarrow T_C$ high, and the lower number of bits when $L_C \cong \Delta x >> l_{Planck} \Leftrightarrow n_{Bit} \propto T^2 \Leftrightarrow T_C$ low.

The main point is that having a high critical temperature $T_C \approx \frac{1}{[\Delta x \cong l_{Planck}]}$ is not the string theory picture, and corresponds to more traditional picture of a 4 dimensional universe. Haivng $T_C \approx \frac{1}{[\Delta x >> l_{Planck}]}$ is nmore consistent with regards to string theory and is congruent with [30,31,32]

When the bits drop is when $L_C \cong \Delta x >> l_{Planck}$, i.e. the string theory version minimum uncertainty means that one has less number of peak bits , whereas $L_C \cong \Delta x \sim l_{Planck}$ means a much higher peak value of bits may be possible. This can,be tied into a model of the universe where we get a maximum change in the flux of bits from a so called cold universe model. I.e. what if there was a nearly zero degrees Kelvin starting point for the increase in termperature ? Assessing what would happen in the brane theory case would be , for GW equivalent to ,

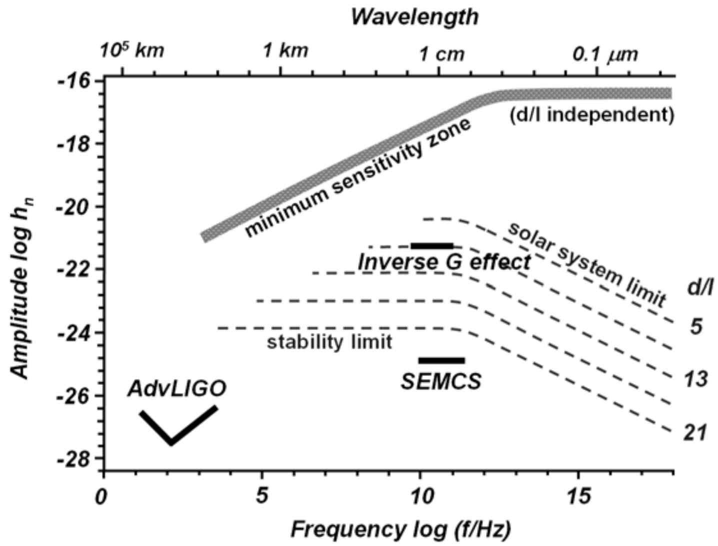

Figure 1, *The amplitude and frequency of the HFGWs expected by the brane oscillation models in the submillimetre-size extra dimensions. The figure is taken from* [33], *where* l *is the curvature scalar of the bulk,* d *is the distance between the "visible" brane and the "shadow" brane*

If one has high frequency Gravitational waves, with regards to brane theory, then this figure above would have to be reconciled to the value of Eq. (8) above, with, up to a point the initial energy defined via looking at Fig. (1) above, with Eq. (8) set as proportional to .

$$E_{initial-Energy-flux} \sim \hbar\omega_{Gravity-Wave} \quad (20)$$

The inter relationship between Eq. (20) and an absolute value of energy density for, say relic "particles" i.e. gravitons as information carriers

$$|\varepsilon_C| = \left| -\left(\frac{\pi^2}{45}\right)\cdot[L_C]^{-4} \right| \approx \left(\frac{\pi^2}{45}\right)\cdot T_C^4 \quad (21)$$

This would have to be established, i.e. how $\left(\frac{\pi^2}{45}\right)\cdot[L_C]^{-4} = |\varepsilon_C| \propto E_{initial-Energy-Flux}$ (22)

The idea which we have is that the details of filling in the steps of Eq. (22) above, and reconciling it to Eq. (20) and Eq. (8) will allow us to start to estimate the number of bits transferred from a prior to the present universe, in terms of when the precise value of L_C is obtained, that we are looking at a point where the quantum effects, and a first order phase transition have occurred.. Then , as an example, the precise value of $L_C \sim \Delta x$ being reached, via a build up of temperature , is defined by .a phase transition delineated with the rise of a temperature going from a low value up to reaching $T_C \approx \frac{1}{[\Delta x >> l_{Planck}]}$

We can close with this construction by saying that reaching up to a critical temperature T_C is a phase transition , with a subsequent decay of a domain wall occurring afterwards , in order to avoid the well known datum that if domain walls did not decay rapidly, that the CMBR spectrum would be dramatically different from what is observed today. [34]

Conclusion, organizing inputs into finding the mapping for Eq. (10) , from black Holes

Job one will be in determining if $\tilde{n} \sim n_{Bit} \propto T^2$ or $\tilde{n} \sim n_{Bit} \propto T^3$ per unit volume of phase space with the temperature T varying from a low value to up to 10^{34} Kelvin (Planck temperature scale). Once this would be established, then coming up with details of Eq. (10) mapping would be feasible. The author views this as a way to establish if there is an ergotic mixing protocol, of millions of black holes from different universes. The details of this mapping, as specified as an investigative protocol, where a discretization of Eq.(19) would be necessarily part of the physics research work. Also, it would necessitate making a linkage to what Beckwith et al put up as far as a numerical count for "massive" graviton counts in a per unit phase space volume of a GW detector which can be written as [20,35]

$$J_{effective} \cong n_{count} \cdot m_{4-D-Graviton} \tag{20}$$

As stated by Beckwith, in [35], $m_{4-D-Graviton} \sim 10^{-65}\, grams$, while n_{count} is the number of gravitons which may be in the detector sample. Getting Eq. (20) straight for a detector while understanding the inter relationship of n_{count} to $\tilde{n} \sim n_{Bit} \propto T^2$ or $\tilde{n} \sim n_{Bit} \propto T^3$ per unit volume of phase space initially is what we should be doing.[36]. In addition, our Table 1 results should be reconciled to Eq. (13)., i.e. what to do with the maximum energy density. That will require a lot of work.

Note that the initial GW emerging from inflation would be defined by some equivalent structure as defined in [37] with regards to an inter relationship between entropy, bits of information, and inflaton physics, details which we expect would be settled if and when GW astronomy becomes an iomperical science. What we would like to see, would be to get the mappings described by Eq. (10) rigorously defined. Doing so would enable use to make a connection with what was done by Beckwith i.e. making a connection between Eq. (10) and then the increase in the degrees of freedom problem Beckwith wrote about as follows.

The formula $E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto \tilde{\beta}$ is a feed into ω_g provided that we pick time $t \propto$ **Planck time**, and also by setting up the $E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \approx \tilde{\beta}$. In other words, for relic GW/ graviton production, a topological transformation and interrelationship between the components $\tilde{\alpha}$ and $E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto \tilde{\beta}$ in the initial increase in the degrees of freedom problem denoted by [20]

$$x_{i+1} = \exp\left[-\tilde{\alpha} \cdot x_i^2\right] + \tilde{\beta} \tag{21}$$

Appendix A: Variations in the CMBR spectra and what they imply for entropy production

Our guess is as follows: the matter-energy flux implied by the existence of a wormhole accounts for perhaps 10^7 bits of information. These could be transferred via a wormhole solution from a prior universe to our present , and there could be perhaps 10^{120} minus 10^{7} bits of information temporarily suppressed during the initial bozonification phase of matter right at the onset of the big bang itself .

Then we predict that there is a dramatic drop in the degrees of freedom during the beginning of the descent of temperature from about $T \approx 10^{32}\,Kelvin$ to at least three orders of magnitude less. The drop in degrees of freedom happens as we move out in time from an initial red shift, $z \approx 10^{25}$, to something lower, which is when the temperature drops from about $T \approx 10^{32}\,Kelvin$ to a significantly lower value of [17]

$$T \approx \sqrt{\varepsilon_V} \times 10^{28}\,Kelvin \sim T_{Hawkings} \cong \frac{\hbar \cdot H_{initial}}{2\pi \cdot k_B} \tag{A1}$$

Which model we can come up with that does this is the one we need to follow, experimentally. And it gives us hope of confirming whether or not we can eventually analyze the growth of structure in the initial phases of quantum nucleation of emergent space-time. We also need to consider the datum so referenced for the irregularities of the cooling-down phase of inflation, as mentioned by Sakar [38] in an e mail to the author, Beckwith,

"*Quasi-DeSitter space-time during inflation has no "lumpiness" -- it is necessarily very smooth. Nevertheless one can generate structure in the spectrum of quantum fluctuations originating from inflation by disturbing the slow-roll of the inflaton -- in our model this happens because other fields to which the inflaton couples through gravity undergo symmetry breaking phase transitions as the universe cools during inflation*."

The race track models, after the inflaton begins to decline, would be ideal in obtaining the necessary couplings between the inflaton, and fields which undergo a symmetry breaking transformation . We will refer to this topic in a future publication. We can make a few observations though about the assumed coupling. First, there is a question of whether there is a finite or infinite fifth dimension. String theorists have argued for a brane world with a warped, infinite extra dimension, allowing for the inflaton to decay into the bulk so that after inflation, the effective dark energy disappears from our brane. This is achieved by shifting away the decay products into the infinity of the 5th dimension. Nice hypothesis, but it presumes CMB density perturbations could have their origin in the decay of a MSSM flat direction. It would reduce the dynamics of the inflaton if there were separation between a Dp brane and $\overline{D}p$ antibrane via a moduli argument. that if we do not have an infinite fifth dimension? What if it is compacted only? We then have to change our analysis. Another thing. We place limits on inflationary models; for example, a minimally coupled $\lambda\phi^4$ is disfavored at more than 3 σ. Result? Forget quartic inflationary fields , as has been shown by . Peiris, Hingshaw et al. [39] We can realistically hope that WMAP will be able to parse through the race track models to distinguish between the different candidates. So far, "First-Year Wilkinson Microwave Anisotropy Probe (WMAP)1 Observations: Implications For Inflation" is giving chaotic inflation a run for its money.

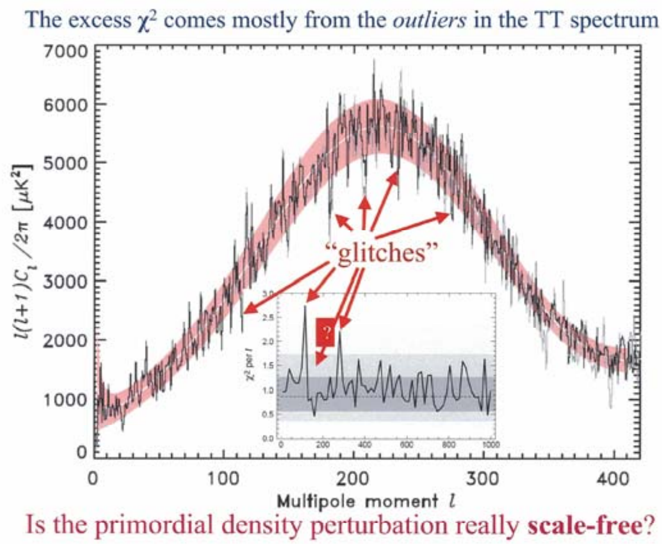

Figure 2 *by Sarkar shows the glitches that need to be addressed in order to make a CMBR data set congruent with an extension of the standard model of cosmology. Passed to the author, February 2008* [38, 40], *and brought up in IDM 2008* [13]

Appendix B: Formulation of criteria for a second-order phase transition at the onset of nucleation of a new universe

Let us first review Torrieri's and Mushuntin's [41] contribution to stability analysis of a wave functional treatment of a QCD bulk viscosity-over-entropy constant-ratio state equation. The idea is that we have initially a super hot plasma reaching a peak value of viscosity for a given temperature T, which is less than or equal to a critical temperature, T_C reflecting the QCD plasma having a peak value for viscosity. For those who wish to understand how this may work out, we can refer to a paper by Asakawa et al [36] which specified a sheer bulk viscosity approximated by a viscosity value with $d_f \approx O(100)$, which weakly depends upon the number of quark flavors n_f in the quark-gluon plasma

$$\eta_C = \left[d_f \cdot T^3 / g^4 \ln g^{-1} \right] \qquad \text{(B1)}$$

Here, g is fixed by the number of degrees of freedom of the system. Asakawa et al.[42] also specify that in a quark-gluon plasma, frequently there is an additional anomalous contribution to viscosity , η_A caused by turbulent fields within the quark-gluon plasma. Asakawa et al. [42] concluded in their document that frequently we have

$$\eta_{Total}^{-1} = \eta_C^{=1} + \eta_A^{-1} \qquad \text{(B2)}$$

Frequently we also have for extremely high temperatures to a good first approximation, $s_{Density} = \frac{2 \cdot \pi^2}{45} \cdot g_* \cdot T^3$ (B3)

Where $g_* \cdot$ is the net degrees of freedom of the plasma gas that we can model as an ultra-relativistic fluid. For high temperatures, if $g_* \cdot$ is on the order of 100, i.e., reflecting many initial degrees of freedom,

$$\eta_{Total} / s_{Density} \approx const \sim [1/4\pi] \tag{B4}$$

With classical fluid models, even for quark-gluon plasmas, this assumes we are working with η_A^{-1} as not a very strong contributing factor to Eq (B2) , leading to almost infinite viscosity if we have viscosity almost entirely dependent upon temperature, as the temperature climbs..

With the model of entropy so offered above, we have if the temperature is not elevated and the two terms in Eq. (B2) contribute , trouble in obtaining a stable value for Eq. (B4) above as a constant. It so happens that Torrieri's and Mushuntin's [41] idea is to incorporate a modification of the Bjorken equation for cosmology applications,

$$\tau^{-3} \frac{d[\tau^3 s]}{d\tau} = \frac{3s}{R\tau} \tag{B5}$$

where τ is conformal time, and R is the Reynolds number, and s is entropy density. This Eq. (B5) is well above the complexity level of what one expects from the simple linearized models, where we look at, say, if y represents space time "length," etc., with

$$s(\tau) = s_0(\tau) + \delta \cdot s(\tau, y) \exp[iky] \tag{B6}$$

And a velocity $v \propto x/t$ so that eventually we look at $x_1 = \delta \cdot s/s$ and $x_2 \equiv y - y_{space-time}$. So the stability analysis we have is

$$\tau \frac{\partial}{\partial \tau} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \equiv \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \tag{B7}$$

This is when we have at high temperatures a major simplification of the A_{ij} terms in the matrix in the right hand side of Eq. (B7) .This simplification of the right hand side of Eq. (7) happens when we write $\eta \approx T^3$ and $s \propto T^3$. We obtain with this simplification of entropy and viscosity a relatively constant Reynolds number R_0, and a relatively constant speed of "sound" in the viscous media c_s^0. The resulting simplification and drop out of terms in the evolution equation allows us to write [41,42]

$$A_{11} = c_s^{02} R_0^{-1} \tag{B8}$$

and

$$A_{12} = -k \cdot (1 - 2R_0^{-1}) \tag{B9}$$

and

$$A_{21} = kc_s^{02} \cdot (1 - 3R_0^{-1})/(1 - R_0^{-1}) \tag{B10}$$

and

$$A_{22} = -[\left(1 - c_s^{02}\right) + c_s^{02} R_0^{-1} + 3c_s^{02} R_0^{-1}\left(1 - R_0^{-1}\right) + k^2 \cdot R_0^{-1}] / \left(1 - R_0^{-1}\right) \tag{B11}$$

In this limit we have a stability analysis performed for the eigenvalues of

$$A + A^T \tag{B12}$$

Where we are using $A \equiv \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix}$, and with the summarized results that for $\{\lambda_{\min}, \lambda_{\max}\}$ of Eq (B12) are such that , if

$\lambda_{\min} > 0$ we always have instability (B13)

$\lambda_{\max} < 0$ we always have stability (B14)

$\lambda_{\min} < 0, \lambda_{\max} > 0$, we some times have stability, (B15)

and sometimes we do not have stability.

The forms of Eq (B13) to Eq (B15) remain the same, but we assert that if we deviate from strict adherence to $\eta \approx T^3$ and $s \propto T^3$ due to marked initial conditions, i.e., unusual contributions due to the anharmonic contribution to viscosity η_A we will have increasingly involved criteria for forming the matrix for Eqn. (B12) and Eq. (B7) to Eqn. (10). We are looking into what these criteria should be for very unstable initial GUT criteria, with the proviso that we are not able to use simple linearization in GUT initial conditions, but that the ratio of $\eta_{Total} / s_{Density} \sim [1/4\pi]$ holds.[41,42].

Appendix C: Comparing implementation of Jack Ng's $\Delta S \approx \Delta N$ for wavelengths cubed, of the order of magnitude of an entropy generating volume of space, with Giovannini's calculation of entropy for all permissible ranges of frequencies.

As stated above, our implementation of the $\Delta S \approx \Delta N$ rule for HFGW [7,8] assumes we are able to make a direct comparison between the wavelength of HFGWs and the region of space in which they are evaluated. This comparison yields an interpretation of a growth of entropy due to an infusion of vacuum energy at the onset of inflation, which we think needs to be falsified experimentally. I.e., that in the beginning of quantum nucleation, there were perhaps 10^7 bits of information present. That the production of relic gravitons in a HFGW early universe nucleation environment perhaps added up to 10^{30} bits of information in 10^{-10} seconds -- perhaps closer to an order of magnitude of 10^{-35} seconds in the boost effects of entropy from information transferred from a prior universe to our present universe. The analysis for how this could happen depends upon the verification of a supposition that HFGWs have a wavelength whose value cubed would be within an order of magnitude of the initial volume of space-time in which the HFGW are nucleated in relic inflationary conditions.

Saying this though leads us to consider: do all frequencies contribute to the generation of gravitational waves equally? (This has implications for the generation of entropy, for reasons we will get to next.)

On the face of it, this question is nonsense. LISA and LIGO, two very well engineered detectors, are superb detectors of low frequency gravitational waves , as was given by the Amaldi 5 meeting . In addition, the betting is that allegedly that signal/noise issues will make detection of HFGWs, especially from relic conditions, exceptionally difficult. The Li-Baker design effort, with its emphasis on a static magnetic field that can be impinged upon by HFGWs has a ready answer to this alleged difficulty. However, the sheer number of contributions to entropy if all ranges of frequencies contribute to GW production in the universe should be considered.[43]

Fortunately, there is a calculation authored by Giovannini [9] and others that does count to entropy generation in total from the entire spectrum of GW generated, with a startling conclusion: that the present high level of entropy today can be effectively generated by GW production ! This calculation reads as follows. If we set V as the space-time volume, then look at $\nu_0 \sim 10^{-18}$ Hz, and $\nu_1 \sim 10^{11}\left(H_1/M_P\right)^{3/2} \sim 10^{11}$ Hz as an upper bound, assuming no relationship like the GW wavelength cubed, as proportional to early universe volume, which leads to $r(\nu) \equiv \ln \bar{n}_{gravitons}$, where $\bar{n}_{gravitons}$ refers to the number of produced gravitons over a very wide spectral range of frequencies. This assumes that we are working with $H_1 \propto M_P$

$$S_{gw} = V \cdot \int_{\nu 0}^{\nu 1} r(\nu) \cdot \nu^2 d\nu \cong \left(10^{29}\right)^3 \cdot \left(H_1/M_P\right)^{3/2} \approx 10^{87} - 10^{88} \qquad \text{(C1)}$$

This should be compared with HFGW production in relic conditions $\Delta S\big|_{relic-HFGW} \approx \Delta N \sim 10^{21}$ right after the onset of nucleation of a new universe. I.e. there is have relic gravitational production, as occurring after the 2nd order initial phase transition referenced in **Appendix B**, for a GUT, with information/entropy for universe which Dr. Smoot pegs as less than or equal to 10^7 – information / 10^5 – entropy $\xrightarrow[2nd-order-phase-transition]{} 10^{120}$ – information / 10^{88} – entropy in our present universe, which will be explained more fully in future publications.

This should be compared with the result that Sean Carroll [6] came up with: that for the universe as a whole

$$S_{Total} \sim 10^{88} \qquad \text{(C2)}$$

This Eq.(C2) should be compared with the even odder result that the author discussed in a question and answer period in the Bad Honnef perspectives in quantum gravity [44] meeting, April 2008 to reconcile Eq. (C2) with the odd prediction given in Eq. (C3) namely , as presented by Carroll, [6]

$$S_{Black-Hole} \sim 10^{90} \cdot \left[\frac{M}{10^6 \cdot M_{Solar-Mass}}\right]^2 \qquad \text{(C3)}$$

I.e. the black hole in the center of our galaxy may have purportedly more entropy than the entropy of the entire KNOWN universe.

Our hierarchy of how to generate entropy from initial conditions present in the initial cosmological evolution is an attempt to make sense of the inherent weirdness present in Eq. (C1), Eq. (C2), and Eq. (C3). The three equations together do not fit as a consistent whole. We assert that there is no way that we can meaningfully justify the conclusions of Eq. (C1). And while we view graviton production as crucially important for the rise in entropy, as outlined by Dr. Smoot [45], graviton production is most likely to be concentrated as narrow relic graviton production as an onset to entropy generation.

We hope that the articles following this manuscript will enable us to handle the frankly physically absurd implications inherent in all three of the basic equations written in this document and permit us to develop an experimentally falsifiable set of experimental procedures to reasonably investigate entropy creation from first principles.

Appendix D: Emergent inflaton 'field' due to thermal input from a prior universe (The D'Albembertain operation in an equation of motion for emergent scalar fields)

This was presented at the IUCAA meeting in India by the author, Beckwith, in December 2007[46] and Beckwith [2]

We begin with the D'Albertain operator as part of an equation of motion for an emergent scalar field. We refer to the Penrose potential (with an initial assumption of Euclidian flat space for computational simplicity) to account for, in a high temperature regime, an emergent non-zero value for the scalar field ϕ due to a zero effective mass at high temperatures.

When the mass approaches far lower values is when a non-zero scalar field reappears.

Let us now begin to model the Penrose quintessence scalar field evolution equation. Look at the flat space version of the evolution equation

$$\ddot{\phi} - \nabla^2 \phi + \frac{\partial V}{\partial \phi} = 0 \qquad \text{(D1)}$$

In the Friedman-Walker metric, this uses the following as a potential system to work with, namely:

$$V(\phi) \sim -\left[\frac{1}{2}\cdot\left(M(T) + \frac{\Re}{6}\right)\phi^2 + \frac{\tilde{a}}{4}\phi^4\right] \equiv -\left[\frac{1}{2}\cdot\left(M(T) + \frac{\kappa}{6a^2(t)}\right)\phi^2 + \frac{\tilde{a}}{4}\phi^4\right] \qquad \text{(D2)}$$

This assumes $\kappa \equiv \pm 1, 0$, and a curvature signature compatible with an open universe.

That means $\kappa = -1, 0$ as possibilities. So we will look at the $\kappa = -1, 0$ values, beginning with

$$\ddot{\phi} - \nabla^2 \phi + \frac{\partial V}{\partial \phi} = 0 \Rightarrow$$

$$\phi^2 = \frac{1}{\tilde{a}}\cdot\left\{c_1^2 - \left[\alpha^2 + \frac{\kappa}{6a^2(t)} + M(T)\right]\right\} \qquad \text{(D3)}$$

$$\Leftrightarrow \phi \equiv e^{-\alpha \cdot r}\exp(c_1 t)$$

We find the following basic phenomena, namely

$$\phi^2 = \frac{1}{\tilde{a}}\cdot\left\{c_1^2 - \left[\alpha^2 + \frac{\kappa}{6a^2(t)} + \left(M(T) \approx \varepsilon^+\right)\right]\right\} \xrightarrow[M(T\sim high)\to 0]{} \phi^2 \neq 0 \qquad \text{(D4)}$$

$$\phi^2 = \frac{1}{\tilde{a}}\cdot\left\{c_1^2 - \left[\alpha^2 + \frac{\kappa}{6a^2(t)} + \left(M(T) \neq \varepsilon^+\right)\right]\right\} \xrightarrow[M(T\sim Low)\neq 0]{} \phi^2 \approx 0 \qquad \text{(D5)}$$

The difference is due to the behavior of $M(T)$. We use $M(T)$ ~ axion mass $m_a(T)$ in asymptotic limits with Kolb's [47]

$$m_a(T) \cong 0.1 \cdot m_a(T=0) \cdot (\Lambda_{QCD}/T)^{3.7} \tag{6D}$$

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