Entropy production and a toy model as to irregularities in the CMBR spectrum

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Abstract:

While assuming the relatively narrow spectrum of graviton frequencies in the onset of inflation, it is necessary to examine how this could tie into instanton-anti-instanton production. We do so via a thermal input from the prior universe model. We also discuss how the break up of such structure could influence later inflationary cosmology –physics. The following paper attempts a thought experiment as to how to present a genesis of irregularites in the CMBR spectrum. This is not meant to be a substitute for Sakar's ground breaking work, but an addendum as to how the initially very smooth start of inflation could lead to the pronounced irregularities Dr. Sarkar commented upon.

Introduction

We will introduce conditions for instanton break up and also discuss how and why instaton physics could be part of the transfer of information from a prior to the present universe**.** Doing so is akin to the following, namely Comparing different models of inputting thermal-radiation energy

Begin first with looking at different value of the cosmological vacuum energy parameters, in four and five dimensions [1]

$$\left|\Lambda_{5-\dim}\right| \approx c_1 \cdot \left(1/T^{\alpha}\right) \tag{1}$$

in contrast with the more traditional four-dimensional version of the same, minus the minus sign of the brane world theory version. The five-dimensional version is actually connected with Brane theory and higher dimensions, whereas the four-dimensional version is linked to more traditional De Sitter space-time geometry, as given by Park (2003) [2]

$$\Lambda_{4-\dim} \approx c_2 \cdot T^{\beta} \tag{2}$$

If one looks at the range of allowed upper bounds of the cosmological constant, the difference between what Barvinsky (2006) [3] recently predicted, and Park (2003) [2] is:

$$\Lambda_{4-\dim} \propto c_2 \cdot T^{\beta} \xrightarrow[graviton-production-as-time>t(Planck)]{} 360 \cdot m_P^2 << c_2 \cdot \left[T \approx 10^{32}\,K\right]^{\beta} \tag{3}$$

Right after the gravitons are released, one still sees a drop-off of temperature contributions to the cosmological constant .Then one can write, for small time values $t \approx \delta^1 \cdot t_P, 0 < \delta^1 \leq 1$ and for temperatures sharply lower than $T \approx 10^{12}\,Kelvin$, Beckwith (2007), where for a positive integer n [4]

$$\frac{\Lambda_{4-\dim}}{\left|\Lambda_{5-\dim}\right|} - 1 \approx \frac{1}{n} \tag{5}$$

If there is an order of magnitude equivalence between such representations, there is a quantum regime of gravity that is consistent with fluctuations in energy and growth of entropy. An order-of-magnitude estimate will be used to present what the value of the vacuum energy should be in the neighborhood of Planck time in the advent of nucleation of a new universe. The significance of Eqn (5) is that at very high temperatures, it completely breaks from what the author brought up with Tigran Tchrakian, in Bremen,[5] August 29th, 2008. I.e., one would like to have a uniform value of the cosmological constant in the gravitating Yang-Mills fields in quantum gravity in order to keep the gauges associated with instantons from changing. When one has, especially for times $t_1, t_2 <$ Planck time t_P and $t_1 \neq t_2$, with temperature $T(t_1) \neq T(t_2)$, then $\Lambda_4(t_1) \neq \Lambda_4(t_2)$. I.e., in the regime of high temperatures, one has $T(t_1) \neq T(t_2)$ for times $t_1, t_2 <$ Planck time t_P and $t_1 \neq t_2$, such that gauge invariance necessary for soliton (instanton) stability is broken [5].

Also, the conditions and the inter relationships of especially, since Tchrakian established [5] that invariance of a cosmological constant in his gravitating Yang-Mills fields is necessary for the gauge conditions for instanton formation and stability.

TABLE 1

Cosmological Λ in 5 and 4 dimensions [4]

Time $0 \le t << t_P$	**Time** $0 \le t < t_P$	**Time** $t \ge t_P$	**Time** $t > t_P \rightarrow$ **today**
$\lvert\Lambda_5\rvert$ undefined, $T \approx \varepsilon^+ \rightarrow T \approx 10^{32} K$ $\Lambda_{4-\dim} \approx$ almost ∞	$\lvert\Lambda_5\rvert \approx \varepsilon^+$, $\Lambda_{4-\dim} \approx$ extremely large $10^{32} K > T > 10^{12} K$	$\lvert\Lambda_5\rvert \approx \Lambda_{4-\dim}$, T much smaller than $T \approx 10^{12} K$	$\lvert\Lambda_5\rvert \approx$ huge, $\Lambda_{4-\dim} \approx$ constant , $T \approx 3.2K$

For times $t > t_P \rightarrow$ today, a stable instanton is assumed, along the lines brought up by t'Hooft [6], due to the stable $\Lambda_{4-\dim} \approx$ constant ~ very small value, roughly at the value given today. This assumes a radical drop-off of the cosmological constant for, say right after the electroweak transition. This would be in line with Kolb's assertion of the net degrees of freedom in space-time drop from about 100 to less than two, especially if $t > t_P \rightarrow$ today in terms of the value of time after the big bang.

We reference in this document how an instanton could be embedded in five dimensional space. In addition we also have a model as given in **Appendix A** how Sherrer K essence [7] could be linked to emergent field treatment of instantons without an explicit potential, permitting use of thermal treatment as indicated in table 1 above, as an emergent field construction.

Our idea, which will be elaborated, is that the break up and re formulation of instanton structure, is a contributor to the sort of perturbed state evolution eventually leading to Fig 1 and Fig 2 of this manuscript as far as the CMBR. This toy model approach, which is started here is meant to compliment a vastly more complex race track inflation model which is referred to in **Appendix B.** We also access a model as to how to quantify a phase transition in terms of inflaton physics, in **Appendix C**

Ground zero approximation used. Gravitons an instanton-anti instanton construct. I.e. connected to instanton-anti instanton approximation as to entropy.

First of all how to approximate Gravitons, in terms of instanton-anti instanton emergent structure. **Appendix D** presents this in terms of an analogy from Density Wave physics, If one looks at figures 1 and 2 of Appendix D, they get the 1+epsilon quasi one dimensional treatment of what an instanton – anti instatnon pair is.

The corresponding treatment in 5 dimensions , is very similar. But we should also realize that if one reads Appendix E that one has a 1-1 relationship between branes and instantons, and anti braines, and anti instantons, with a Here, $M_{p\,j,0}$ is the number of branes in an early universe configuration, while $M_{\bar{p}\,j,0}$ is anti-brane number . I.e., there is a kink in the given $brane \sim M_{p\quad j,0} \leftrightarrow CDW \quad e^{-}$ electron charge and for the corresponding anti-kink $anti-brane \sim M_{\bar{p}\quad j,0} \leftrightarrow CDW \quad e^{+}$ positron charge. Here, in the bottom expression, $\breve{N}$ is the number of kink-anti-kink charge pairs, which is analogous to the simpler CDW structure.

$$S_{Total} \sim \breve{a} \cdot \left[\frac{E_{Total}}{2^{n}} \right]^{\lambda} \cdot \prod_{j=1}^{\breve{N}} \left(\sqrt{M_{p\,j,0}} + \sqrt{M_{\bar{p}\,j,0}} \right) \tag{6}$$

where one has eventually due to Ng. for gravitons [8]

$$S_{Total} \sim \breve{N} \tag{7}$$

This $\breve{N}$ is in relic GW conditions linked to a graviton count, per unit volume, whereas each graviton, counted in $S_{Total} \sim \breve{N}$ has a brane in an early universe configuration, and an an anti-brane The Brane-anti brane configuration is similar to the CDW construction given in Appendix D

Basic Phenomenology for how to analyze problem

We can though make the following summary of phenomenology, put here for edification [4]

TABLE 2. With respect to phenomenology.

Time	Thermal inputs	Dynamics of axion	Graviton Eqn.
Time $0 \le t << t_P$	Use of quantum gravity to give thermal input via quantum bounce from prior universe collapse to singularity. Brane theory predicts beginning of graviton production.	Axion wall dominant feature of pre inflation conditions, due to Jeans inequality with enhanced gravitational field, Quintessence scalar equation of motion valid for short time interval	Wheeler formula for relic graviton production beginning to produce gravitons due to sharp rise in temperatures.
Time $0 \le t < t_P$	End of thermal input from quantum gravity due to prior universe quantum bounce. Brane theory predicts massive relic graviton production	Axion wall is in process of disappearing due to mark rise in temperatures. Quintessence valid for short time interval	Wheeler formula for relic graviton production produces massive spike gravitons due to sharp rise in temperatures
Time $0 < t \approx t_P$	Relic graviton production largely tapering off, due to thermal input rising above a preferred level, via brane theory calculations. Beginning of regime where the Λ_{4-Dim} is associated with Guth style inflation.	Axion wall disappears, and beginning of Guth style inflation. Quintessence scalar equations are valid . Beginning of regime for $\frac{\Lambda_{4-\dim}}{\lvert\Lambda_{5-\dim}\rvert} - 1 \approx \frac{1}{n}$ 5 dim $\rightarrow$ 4 dim	Wheeler formula for relic graviton production leading to few relic gravitons being produced.

Also, one can expect a difference in the upper limit of Park's[2] four dimensional inflation value for high temperatures, onn the order of 10 to the 32 Kelvin, and the upper bound, as Barvinsky [3](2006) predicts. If put into the Harkle-Hawking's wave function, this diffenence is equivalent to a nucleation-quantization condition, which, it is claimed, is a way to delineate a solution to the cosmic landscape problem that Guth (1981,2000,2003) [9,10,11] discussed. In order to reference this argument, it is useful to note that Barvinsky [3] in (2006) came up with

$$\Lambda_{\max}\big|_{Barvinsky} \cong 360 \cdot m_P^2 \tag{8}$$

A minimum value of [3]

$$\Lambda_{\min}\big|_{Barvinsky} \cong 8.99 \cdot m_P^2 \tag{9}$$

This is in contrast to the nearly infinite value of the Planck's constant as given by Park (2003)[2]

$\cdot\Lambda_{4-\dim}$ is defined by Park (2003)[2].with $\varepsilon * = \frac{U_T^4}{k^*}$ and $U_T \propto (external \quad temperature)$, and $k^* = \left(\frac{1}{' AdS\, curvature} \right)$ so that

$$\Lambda_{4-\dim, Max}\Big|_{Park} \xrightarrow[T \mapsto 10^{32}\, Kelvin]{} \infty \tag{10}$$

As opposed to a minimum value as given by Park (2003)[2]

$$\cdot\Lambda_{4-\dim} = 8 \cdot M_5^3 \cdot k^* \cdot \varepsilon^* \xrightarrow[external \quad temperature \to 3\, Kelvin]{} (.0004 eV)^4 \tag{11}$$

The initial breakup of instanton structure during a squeeze to a near-cosmological singularity would lead to a release of energy. Also, reformulation of suitable conditions of SO(4) gauge theory[12] would lead to brane-antibrane construction of generalized entropy. And massive production of entropy as implied by the formulation of a one to one relationship between the cube of wave lengths of HFGW, and an initial volume of space for the nucleation of relic gravitons would lead to an increase in gravitons, for the reason stated in Appendix E**.** The gravitons are composed of kink-anti kink structures which would be formulated within a small region of space, subject to intial break up due to thermal excitation, and then a re formulation after a 2nd order phase transformation . And this would be in a very small region of space, comparatively speaking due to the ultra high frequency requirement as indicated by Jack Ng's infinite quantum statistics [8]. Furthermore, not only are the gravitons composed of kinks and anti kinks, the brane – anti brane structure used to indicate kinks and anti kinks is also duplicated in string theory , as we have discussed above. A Dp brane paired with a Dp anti brane is also in almost a one to one information bit , so not only is the graviton in early universe conditions equivalent to an information bit, so is entropy itself.

Where we disagree with what Giovannini's [13]calculation implies, i.e. that the total entropy of the entire universe is due to gravitons, is that we state that entropy is initially boosted dramatically by relic graviton production.

Breaking gauge invariance as a way to obtain a point in space-time where soliton/instanton structure no longer holds

How can we show that gauge field invariance, so important to the formation of instanton structure is broken at the onset of early cosmological Universe nucleation? The easiest way is to look at how soliton /instanton nucleation is linked first to:

0) A (relatively) constant cosmological constant value (which we claim is violated at the onset of cosmological nucleation via a huge thermal input from a prior universe structure)

1) M. Yu Kuchiev [12] 1998 argued in "Can gravity appear due to polarization of instantons in SO(4) gauge theory?" that "Conventional non-Abelian SO(4) gauge theory is able to describe gravity provided the gauge field possesses a specific polarized vacuum state. In this vacuum the instantons and anti-instantons have a preferred direction of orientation." We agree with this interpretation. We argue that the breaking of conditions of a non-Abelian SO(4) gauge theory at the onset of nucleation of a new universe (due to a huge increase of the cosmological constant for times less than or equal to the Planck time interval t_P) would break up the instanton-anti-instanton structure for gravitons. I.e., gravitons, as stated, appear as the mode describing propagation of the gauge field, which strongly interacts with the oriented instantons. The punch line being as follows.

If there is a large-scale breakup of the instanton structure, as would occur at the onset of cosmological nucleation -- due to a very large cosmological vacuum energy that would very rapidly decline to a constant value -- we would see, right after the breakup of the instanton structure pushed through a near singularity, a huge increase of entropy, i.e., information, as presented by Smoot [14]. The abrupt reformulation of a near-constant cosmological constant, i.e., more stable vacuum energy conditions right after the big bang itself, would allow for reformulation of SO(4) gauge theory conditions [12]. This would happen right after the breakup of the initial instanton due to extreme conditions, and then lead to gravitons. As stated, gravitons would appear as the mode describing propagation of the gauge field, which strongly interacts with the oriented instantons reappearing in a significant manner shortly after a Planck time t_P.

Initial statement of the problem concerning entropy, and also what we should be concerned with, i.e. making comparison 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 $\Delta S \approx \Delta N$ **[8], [15], [16]** rule for HFGW 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

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. In addition, the betting is that allegedly that signal/noise issues will make detection of HFGWs, especially from relic conditions, exceptionally difficult.

Fortunately, there is a calculation authored by Giovannini [13] 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 $\nu_1 \sim 10^{11}(H_1/M_P)^{3/2} \sim 10^{11}$ 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 $H_1 \propto M_P$

$$S_{gw} = V \cdot \int_{\nu 0}^{\nu 1} r(\nu) \cdot \nu^2 d\nu \cong \left(10^{29}\right)^3 \cdot \left(H_1/M_P\right)^{3/2} \approx 10^{87} - 10^{88} \tag{12}$$

This should be compared with HFGW production in relic conditions $\Delta S|_{relic-HFGW} \approx \Delta N \sim 10^5 - 10^7$ **[14],** 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, for a GUT, with information/entropy for universe which Dr. Smoot [14]pegs as less than or equal to 10^{10} − information / 10^{7} − 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[17] came up with: that for the universe as a whole

$$S_{Total} \sim 10^{88} \tag{13}$$

This Eq. (13) should be compared with the even odder result that the author discussed in a question and answer period in the Bad Honnef [18] perspectives in quantum gravity meeting, April 2008 to reconcile Eq. (13) with the odd prediction given in Eq. (12), namely [17],[18]

$$S_{Black-Hole} \sim 10^{90} \cdot \left[\frac{M}{10^{6} \cdot M_{Solar-Mass}} \right]^{2} \tag{14}$$

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 oddities present in Eq. (12), Eq. (13), and Eq. (14). We assert that there is no way that we can meaningfully justify the conclusions of Eqn. (1). And while we view graviton production as crucially important for the rise in entropy, as outlined by Dr. Smoot[14], graviton production is most likely to be concentrated as narrow relic graviton production as an onset to entropy generation.

Now for an argument as to a partial break in information transfer from a prior to the present universe, and its implications.

What leads to causal discontinuity in scale factor evolution?

The Friedmann equation [19] for the evolution of a scale factor $a(t)$,

$$(\dot{a}/a)^{2} = \frac{8\pi G}{3} \cdot \left[\rho_{rel} + \rho_{matter}\right] + \frac{\Lambda}{3} \tag{15}$$

suggests a non-partially ordered set evolution of the scale factor with evolving time, thereby implying a causal discontinuity. The validity of this formalism is established by rewriting the Friedman equation as follows: $a(t^{*}) < l_{P}$ for $t^{*} < t_{P}$ =Planck time, and $a_{0} \equiv l_{P}$, for a discrete equation model of Eq (15) leads to [4]

$$\left[\frac{a(t^* + \delta t)}{a(t^*)}\right] - 1 <$$

$$\frac{\left(\delta t \cdot l_P\right)}{\left(\sqrt{3/8\pi\Lambda}\right)} \cdot \left[\frac{1}{24\pi \cdot a^2(t^*)} + \frac{1}{\Lambda} \cdot \left[(\rho_{rel})_0 \cdot \frac{a_0^4}{a^6(t^*)} + (\rho_m)_0 \cdot \frac{a_0^3}{a^5(t^*)}\right]\right]^{1/2}$$
$$\xrightarrow[\delta t \to \varepsilon^+, \Lambda \neq \infty, a \neq 0]{} \left(\frac{\delta t \cdot [l_P / a(t^*)]}{\sqrt{3/8\pi}}\right) \cdot \sqrt{\frac{(\rho_{rel})_0 a_0^4}{a^4(t^*)} + \frac{(\rho_m)_0 a_0^3}{a^3(t^*)}} \approx \varepsilon^+ << 1 \tag{16}$$

So in the initial phases of the big bang, with very large vacuum energy $\neq \infty$ and $a(t^*) \neq 0, 0 < a(t^*) << 1$, the following relation, which violates (signal) causality, is obtained for very small fluctuation $a(t^*) < l_P$ for $t^* < t_P =$Planck time, and $a_0 \neq l_P, a_0 >> l_P$, which indicates that [19]

$$\rho_{rel} \equiv \left(\frac{a_{present-era}}{a(t)}\right)^4 \cdot (\rho_{rel})_{present-era} \tag{17}$$

And

$$\rho_m \equiv \left(\frac{a_{present-era}}{a(t)}\right)^3 \cdot (\rho_m)_{present-era} \tag{18}$$

Using the above equation creates the following as plausible estimates, which can be reviewed, as needed. For large, but not infinite temperatures, and for $\Lambda \sim c_1 T^{\alpha}$ [4]

$$\left(\frac{\delta t \cdot [l_P / a(t^*)]}{\sqrt{3/8\pi}}\right) \cdot \sqrt{\frac{(\rho_{rel})_0 a_0^4}{a^4(t^*)} + \frac{(\rho_m)_0 a_0^3}{a^3(t^*)}} \sim 10^{-45} \cdot 10^1 \cdot \sqrt{10^{80}} \approx 10^{-4} << 1 \tag{19}$$

If we examine what happens with $\left|\Lambda_{5-\dim}\right| \sim c_2 T^{-\beta}$

$$\frac{\left(\delta t \cdot [l_P / a(t^*)]\right)}{\left(\sqrt{3/8\pi\Lambda}\right)} \cdot \left[\frac{1}{24\pi} + \frac{1}{\Lambda} \cdot \left[(\rho_{rel})_0 \cdot \frac{a_0^4}{a^4(t^*)} + (\rho_m)_0 \cdot \frac{a_0^3}{a^3(t^*)}\right]\right]^{1/2}$$
$$\sim \left(\frac{\delta t \cdot [l_P / a(t^*)]}{\sqrt{3/8\pi}}\right) \cdot \sqrt{\frac{(\rho_{rel})_0 a_0^4}{a^4(t^*)} + \frac{(\rho_m)_0 a_0^3}{a^3(t^*)}} \sim 10^{-45} \cdot 10^1 \cdot \sqrt{10^{80}} \approx 10^{-4} << 1 \tag{20}$$

This assumes large, but non-infinite temperatures, which would not be in excess of, say $T \sim 10^2 \cdot T_{QG-threshold} \approx 10^{34} K$ .This also assumes a baseline time unit of $t^* < t_P \sim 10^{-45} s$, and $\delta \cdot t \le t_P \sim 10^{-45} s$. If $\delta \cdot t << t_P \sim 10^{-45} s$, then the right hand side of Eq. 9 above will be much smaller.

So, the nomenclature of 0 used to denote present-day conditions for a discrete equation model of Eq (15), which leads to Dr. Dowker's paper on causal sets [20]. That requires the following ordering with a relation $\prec$, where we assume that initial relic space-time is replaced by an assembly of discrete elements to create, initially, a partially ordered set C:

(1) If $x \prec y$, and $y \prec z$, then $x \prec z$

(2) If $x \prec y$, and $y \prec x$, then $x = y$ for $x, y \;\; \varepsilon \;\; C$

(3) For any pair of fixed elements x and z of elements in C, the set $\{ y \mid x \prec y \prec z \}$ of elements lying in between x and z is finite, which is fulfilled by Eq. (21) below [4].

$$\left[\frac{a(t^* + \delta t)}{a(t^*)} \right] < 1 \quad . \tag{21}$$

Items (1) and (2) of the list for Dr. Dowker's axioms [20] permits C as a partially ordered set and the third item permits local finiteness. When combined with a model for how the universe evolves via a scale factor equation, this permits violation of partial ordering. It is our contention that this will lead to the increase in entropy as the instanton is broken by Eqn (21) above.

Another way to present this, and to tie into chaotic evolution, is to make the following approximations to Eqn. (15) above: If $u = a^{-1}$ [4]

$$\sqrt{\frac{\Lambda}{3}} \cdot \int dt \equiv -\int \frac{du}{\sqrt{1 + \frac{8\pi}{\Lambda}\left[(\rho_{rel})_0 a_0^4 u^4 + (\rho_m)_0 a_0^3 u^3 \right]}} \tag{22}$$

Integrating leads to the following polynomial expression for $u = a^{-1}$

$$u^9 + A_1 \cdot \frac{u^8}{a_0} + A_2 \cdot \frac{u^7}{a_0^2} - A_3 \cdot \left(\frac{\Lambda}{8\pi} \right) \cdot \frac{u^5}{a_0^4} - A_4 \cdot \left(\frac{\Lambda}{8\pi} \right) \cdot \frac{u^4}{a_0^5} + A_5 \cdot \left(\frac{\Lambda}{8\pi} \right)^2 \cdot \frac{u^1}{a_0^8} + A_6 \cdot \left(\frac{\Lambda}{8\pi} \right)^2 \cdot \frac{t}{a_0^9} \cong 0 \tag{23}$$

We could go considerably higher in polynomial roots of Eq.(22) above, depending upon the degree of accuracy we wished to obtain. This truncation so picked above assumes a non-infinite value of $u = a^{-1}$, as well as a non-zero value and non-infinite value for the Λ term. In doing so, we would obtain an extremely non-standard evolution for the scale factor, assuming when we do so that

$$A_1 = \frac{9}{4} \cdot \frac{(\rho_m)_0}{(\rho_{rel})_0} \ , A_2 = \frac{(\rho_m)_0^2}{(\rho_{rel})_0^2} \ ,$$

$$A_3 = \frac{1/5}{(\rho_{rel})_0^1} \ , A_4 = \frac{(\rho_m)_0 \cdot (1/4)}{(\rho_{rel})_0^2} \ , A_5 = \frac{1}{(\rho_{rel})_0^2} \ , A_6 = \frac{1}{(\rho_{rel})_0^2} \cdot \sqrt{\frac{\Lambda}{3}} \tag{24}$$

Beginning with Mukhanov [21]setting his spatial dimension for a "particle" as $\rho_m \sim r \propto a \sim \hat{\varepsilon}^{-1}$, we look at how to implement Eq. (24) above. If we write

$$a\left(t^* + \delta \cdot t\right) < a\left(t^*\right) \Leftrightarrow \frac{1}{\Delta\hat{\varepsilon}} . < \frac{1}{\hat{\varepsilon}_1} \Leftrightarrow \hat{\varepsilon}_1 < \Delta\hat{\varepsilon} < \hat{\varepsilon}_2 \tag{25}$$

The transition from $\hat{\varepsilon}_1 = \hat{\varepsilon}_2 - \Delta\hat{\varepsilon} \longrightarrow \Delta\hat{\varepsilon}$ as $t^* \to t^* + \delta \cdot t$ would correspond to the following picture. Let $\Delta\hat{\varepsilon}$ be the net energy density inside an instanton, with a boundary region of $\hat{\varepsilon}_2 - \Delta\hat{\varepsilon} \geq 0$ energy density on the boundary of the instanton. As $\hat{\varepsilon}_2 - \Delta\hat{\varepsilon} \to 0$, we have a release of $\Delta\hat{\varepsilon}$ from the interior of the soliton (instanton). If we look at the following Seth Lloyd [22] supplied relationship), i.e., if we set energy density dimensions here as ρ_2

$$[\#operations]_2 \approx \rho_2 \cdot (c \equiv 1)^5 \cdot t_P^4 \leq 10^{120} \tag{26}$$

Now if one has the following cautions put in, about entropy and gravitons, above, what can be said about relic graviton production?

Inputs into the Relic Graviton burst

We shall reference what the AW. Beckwith presented in 2008 STAIF,[4] which we think still has current validity for reasons we will elucidate upon in this document. We use a power law relationship first presented by Fontana [23], who used Park's [24] earlier derivation: when $E_{eff} \equiv \langle n(\omega) \rangle \cdot \omega \equiv \omega_{eff}$

$$P(power) = 2 \cdot \frac{m_{graviton}{}^2 \cdot \hat{L}^4 \cdot \omega_{net}{}^6}{45 \cdot \left(c^5 \cdot G\right)} \tag{27}$$

This expression of power should be compared with the one presented by Massimo Giovannini [13] on averaging of the energy-momentum pseudo tensor to get his version of a gravitational power energy density expression, namely

$$\overline{\rho}_{GW}^{(3)}(\tau, \tau_0) \cong \frac{27}{256 \cdot \pi^2} H^2 \cdot \left(\frac{H}{M}\right)^2 \cdot \left[1 + \vartheta \cdot \left(\frac{H^4}{M^4}\right)\right] \tag{28}$$

Giovannini states that should the mass scale be picked such that $M \sim m_{Planck} >> m_{graviton}$, that there are doubts that we could even have inflation. However, it is clear that gravitational wave density is faint, even if we make the approximation that $H \equiv \frac{\dot{a}}{a} \cong \frac{m\phi}{\sqrt{6}}$ as stated by Linde [25], where we are following $\dot{\phi} = -m\sqrt{2/3}$ in evolution, so we have to use different procedures to come up with relic gravitational wave detection schemes to get quantifiable experimental measurements so we can start predicting relic gravitational waves. This is especially true if we make use of the following formula for gravitational radiation, as given by L. Kofman [26], with $M = V^{1/4}$ as the energy scale, with a stated initial inflationary potential V. This leads to an initial approximation of the emission frequency, using present-day gravitational wave detectors.

$$f \cong \frac{(M = V^{1/4})}{10^7 GeV} Hz \tag{29}$$

For example, if $f \sim 10^{10} Hz$, it means $Temp = 5T^* \approx 10^{32}$ Kelvin, i.e., a huge energy flux, and the power inputs would have been enormous.

We have, in other documents started a discussion about gravitons as a composite kink-anti kink construction. What will be done here, will be to access a model as to how to embed an instanton structure into a 5 dimensional cosmos, which may exist.

Embedding a four-dimensional instanton structure in a five-dimensional version of the Weiner-Nordstrom metric

We will attempt to build up a radiation-based instanton of a Reissner-Nordstrom metric embedded in a five-dimensional space- time metric, and see if this satisfies conditions for an instanton. This allows us to determine, using the Risessner-Nordstrom metric as given, by Kip Thorne, Wheeler, and Misner [27], an added cosmological 'constant' Λ and 'charge' Q. This will be shown to lead to using appropriately [28]

$$M_g(r) = \int \left[T_0^0 - (T_1^2 + 2 \cdot T_2^2)\right] \cdot \sqrt{-g_4}\, dV_3 \tag{30}$$

What we could consider , in such an embedding is what happens to this structure if

$$\begin{aligned} M_g(r) &\approx \pi \cdot c_1^2 \cdot \left[\frac{r^3}{3} - 2M \cdot \frac{r^2}{2} + Q \cdot r - \frac{\Lambda}{15} \cdot r^5\right] + \\ & 4\pi \cdot c_1 \cdot \left[r^2 - 8 \cdot M \cdot r - \frac{\Lambda}{3} \cdot r^4\right] \xrightarrow[r \to \delta]{} \varepsilon^+ \approx 0 \end{aligned} \tag{31}$$

To do this, we start off with the following space-time line metric in five dimensions. This is a modification of Wesson's book.[28]

$$\begin{aligned} dS_{5-\dim} &= \left[\exp(i\pi/2)\right] \cdot \begin{Bmatrix} e^{2\Phi(r)} dt^2 \\ + e^{2\tilde{\Lambda}(r)} dr^2 + R^2 d\Omega^2 \end{Bmatrix} \\ &+ (-1) \cdot e^{\mu} dl^2 \end{aligned} \tag{32}$$

We claim that what is in the $\{\ \}$ brackets is just the Reissner-Nordstrom line metric[27],[28] in four-dimensional space. The parameters in the $\{\ \}$ brackets are linked to the Reissner-Nordstrom metric via

$$e^{2\Phi(r)} = \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right) \qquad (33)$$

And

$$e^{2\tilde{\Lambda}(r)} = \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right)^{-1} \qquad (34)$$

And this is assuming that $R \sim r$ as well as using $\mu \approx c_1 \cdot r$ with a maximum value topped off by a Planck's length value due to $\mu_{Maximum} \approx c_1 \cdot r_{Maximum} \sim l_P \equiv 10^{-35}\,cm$. So, being the case, we get the following stress tensor values

$$T_0^0 = \left(\frac{-1}{8\pi}\right) \cdot \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2\right) \cdot \left(\frac{c_1^2}{4} + \frac{c_1}{r} + \frac{c_1}{4} \cdot \left[\frac{\frac{2M}{r^2} - \frac{2Q}{r^3} - \frac{2\Lambda r^2}{3}}{1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2}\right]\right) \qquad (35)$$

$$T_1^1 = \left(\frac{-1}{8\pi}\right) \cdot \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2\right) \cdot \left(\frac{c_1}{r} + \frac{c_1}{4} \cdot \left[\frac{\frac{2M}{r^2} - \frac{2Q}{r^3} - \frac{2\Lambda r^2}{3}}{1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2}\right]\right) \qquad (36)$$

$$T_2^2 = T_3^3 = \left(\frac{-1}{8\pi}\right) \cdot \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2\right) \cdot \left(\frac{c_1^2}{4} + \frac{c_1}{r} + \frac{c_1}{2} \cdot \left[\frac{\frac{2M}{r^2} - \frac{2Q}{r^3} - \frac{2\Lambda r^2}{3}}{1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2}\right]\right) \qquad (37)$$

Furthermore, we get the following determinant value [28]

$$\sqrt{-g_4} = \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2\right) \qquad (38)$$

. Let us now see how this same geometry contributes to a wormhole bridge and a solution for forming the instanton flux wave functional between a prior and present universe. The Reissner-Nordstrom metric permits us to have a radiation-dominated "matter" solution whose matter "contribution" drops off rapidly as the spatial component of geometry goes to zero. This is in tandem with radiation pressure and density falling off rapidly, as we leave the center of such a purported soliton/instanton. This is extremely useful because it ties in with the notion of fractional branes contributing to entropy calculations. In fact, it is useful to state that these two notions dovetail with each other quite closely. The only difference is that the construction above does not in itself lend to the complexity of what we would observe, which is in itself a multiple-joined network of charge centers and shifting geometry.

The claim that this leads to an instanton structure is as follows. If the spatial region goes to zero, the relative mass of the Instanton, as shown below, also goes to zero, as stated earlier.

$$M_g(r) \approx \pi \cdot c_1^2 \cdot \left[\frac{r^3}{3} - 2M \cdot \frac{r^2}{2} + Q \cdot r - \frac{\Lambda}{15} \cdot r^5 \right] + 4\pi \cdot c_1 \cdot \left[r^2 - 8 \cdot M \cdot r - \frac{\Lambda}{3} \cdot r^4 \right] \xrightarrow[r \to \delta]{} \varepsilon^+ \approx 0$$

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

Our guess is as follows: the thermal flux implied by the existence of a wormhole accounts for perhaps [14] 10^{10} 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^{10} bits of information temporarily suppressed during the initial bozonification phase of matter [29]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 [30]

$$T \approx \sqrt{\varepsilon_V} \times 10^{28}\, Kelvin \sim T_{Hawkings} \cong \frac{\hbar \cdot H_{initial}}{2\pi \cdot k_B} \qquad (39)$$

Whichever 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.

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.[31] 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 $\overline{Dp}$ antibrane via a moduli argument.

What 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 H. V. Peiris, G. Hingshaw et al.[32] 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. We shall endeavor for numerical work using some of the tools brought up in this present discussion to falsify or confirm figures 1 and 2 of that imply variance in the CMBR spectrum [33],[34] , [35].

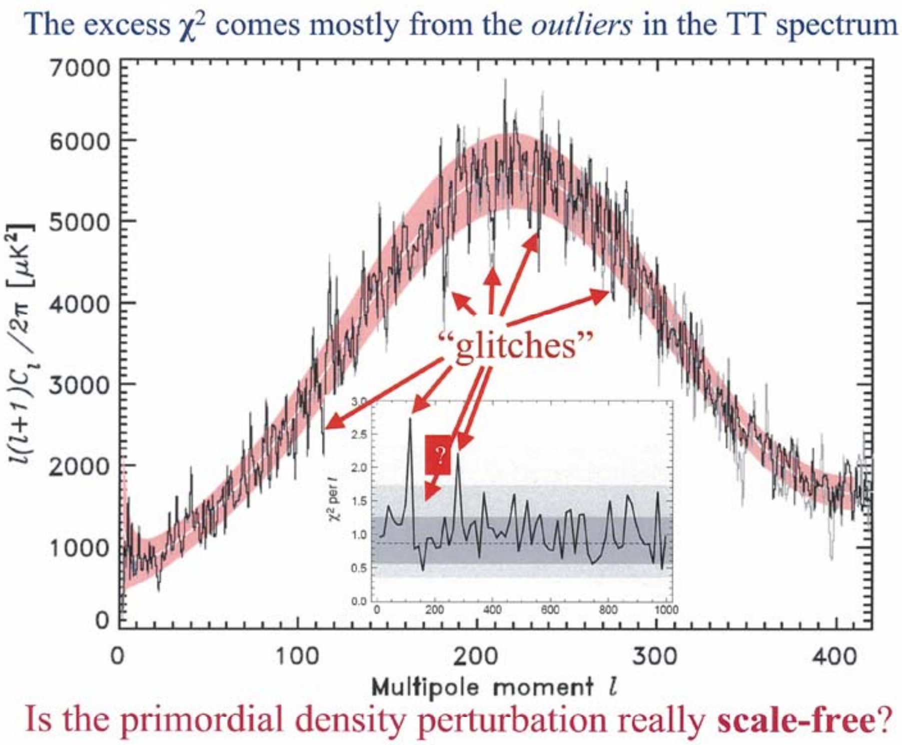

Figure 1 *by Subir Sarkar shows the glitches that need to be addressed in order to make a CMBR data set congruent with an extension of the standard model of cosmology.*[33],[34], [35]

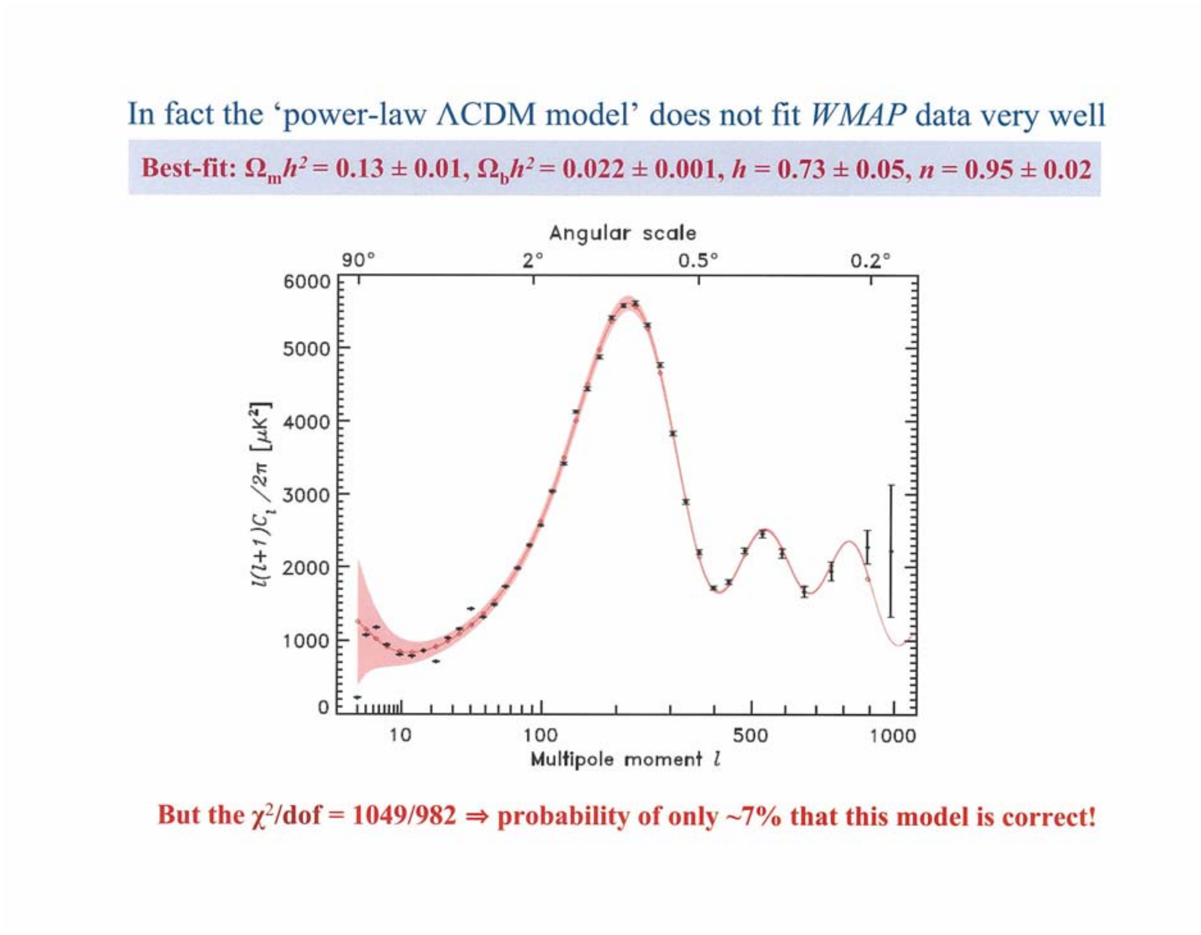

Figure 2 . Self explanatory Can be explained via Subir Sarkar Bad Honnef (2007) [33],[34],[35],[36]

We also need to consider the datum so referenced for the irregularities of the cooling-down phase of inflation, as mentioned by Sakar to the author in e mail and also in India. [33],[34],[35], [36]

"*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*."

Hopefully, the toy model so mentioned above, will be the beginning of how to find mechanisms as to why this may happen.

Appendix A. Matching Sherrer's k essence argument with behavior of scalar fields permitting application to cosmological constant question

Abstract

Our prior articles showe how we can have particle – anti particle pairs as a model of how nucleation of a new universe occurs. We now can build upon this idea and construct a evolution of the resulting scalar field which would permit formation of gravitons using Sherrers k-essence model construction [7] . This same construction permits a definitive analysis of when conditions for pure cosmological constant behavior but no growth of density perturbations occurs, largely as a matter of change of slope of a S-S' pair during the nucleation process of a new universe.

Introduction

We have in a prior publication [37]investigated the role an initial false vacuum procedure plays in the nucleation of a scalar field contributing to inflationary cosmology. Here we manage to show how that same scalar field blends naturally into the chaotic inflationary cosmology presented by Guth [38] which has its origins in the evolution of nucleation of an electron- positron pair type instantons as for the creation of a graviton in a de Sitter cosmology . The final results of this model when $\phi \to \varepsilon^{+}$ appears to be congruent with the existence of a region which matches the flat slow roll requirement of $\left|\frac{\partial^2 V}{\partial \phi^2}\right| << H^2$, and the negative pressure requirement involving both 1st and 2nd derivatives of the potential w.r.t. scalar fields divided by the potential itself being very small quantities, where H is the expansion rate which is a requirement of realistic inflation models [39]. This is due to having the potential in question $V \propto \phi^2 \xrightarrow[\phi \to \varepsilon^{+}]{} V_0 \equiv$ constant for declining scalar values.

We have formed , using Scherrers recent article[7] , a template for evaluating initial conditions which would shed light on if or not this model universe would be radiation dominated in the beginning, or would be more in sync with having dynamics determined by assuming a straight cosmological constant.

Our surprising answer is that close to a thin wall approximation of a scalar field of a nucleating universe that we do not have conditions for formation of a cosmological constant dominated era, but that this is primarily due to an extremely sharp change in slope of the would be potential field ϕ . The sharpness of this slope, leading to a near delta function behavior for kinematics at the thin wall approximation for the initial conditions of an expanding universe would lead at a later time to conditions appropriate for necessary and sufficient for cosmological dynamics largely controlled by a cosmological constant when the scalar field itself ceases to be affected by the thin wall approximation but is a general slowly declining slope .

I. Template for a near thin wall approximation of ϕ as way to model gravitons as instaton-anti instation construction

We shall define k essence as any scalar field with non-cannonical kinetic terms. Following Scherrer [7], we will introduce a momentum expression via

$$p = V(\phi) \cdot F(X) \tag{A1}$$

where we will define the potential in the manner we have stated for our simulation as well as set [7]

$$X = \frac{1}{2} \cdot \nabla_{\mu}\phi \quad \nabla^{\mu}\phi \tag{A2}$$

and use a way to present *F* expanded about its minimum and maximum[7]

$$F = F_0 + F_2 \cdot (X - X_0)^2 \tag{A3}$$

where we define X_0 via $F_X \big|_{X=X_0} = \left.\frac{dF}{dX}\right|_{X=X_0} = 0$ as well as use a density function [7]

$$\rho \equiv V(\phi) \cdot [2 \cdot X \cdot F_X - F] \tag{A4}$$

where we find that the potential neatly cancels out of the given equation of state so [7]

$$w \equiv \frac{p}{\rho} \equiv \frac{F}{2 \cdot X \cdot F_X - F} \tag{A5}$$

as well as a growth of density perturbations terms factor Garriga and Mukhanov [39] wrote as

$$C_x^2 = \frac{(\partial p / \partial X)}{(\partial \rho / \partial X)} \equiv \frac{F_X}{F_X + 2 \cdot X \cdot F_{XX}} \tag{A6}$$

where $F_{XX} \equiv d^2 F / dX^2$, and since we are fairly close to an equilibrium value, we will pick a value of X close to an extremal value of X_0 .[7]

$$X = X_0 + \tilde{\varepsilon}_0 \tag{A7}$$

where if we make an averaging approximation of the value of the potential due to figure 1b , as very approximately a constant , we may write the equation for the k essence field as taking the form (where we assume $V_\phi \equiv dV(\phi)/d\phi$) [7]

$$(F_X + 2 \cdot X \cdot F_{XX}) \cdot \ddot{\phi} + 3 \cdot H \cdot F_X \cdot \dot{\phi} + (2 \cdot X \cdot F_X - F) \cdot \frac{V_\phi}{V} \equiv 0 \tag{A8}$$

as approximately

$$(F_X + 2 \cdot X \cdot F_{XX}) \cdot \ddot{\phi} + 3 \cdot H \cdot F_X \cdot \dot{\phi} \cong 0 \tag{A9}$$

which may be re written as [7]

$$(F_X + 2 \cdot X \cdot F_{XX}) \cdot \ddot{X} + 3 \cdot H \cdot F_X \cdot \dot{X} \cong 0 \tag{A10}$$

This means that we have in this situation that we have a very small value for the ‘growth of density pertubations’ [7]

$$C_S^2 \cong \frac{1}{1 + 2 \cdot (X_0 + \tilde{\varepsilon}_0) \cdot (1/\tilde{\varepsilon}_0)} \equiv \frac{1}{1 + 2 \cdot \left(1 + \frac{X_0}{\cdot \tilde{\varepsilon}_0}\right)} \tag{A11}$$

if we can approximate the *kinetic energy* from

$$(\partial_\mu \phi) \cdot (\partial^\mu \phi) \equiv \left(\frac{1}{c} \cdot \frac{\partial \phi}{\partial \cdot t}\right)^2 - (\nabla \phi)^2 \cong -(\nabla \phi)^2 \to -\left(\frac{d}{dx}\phi\right)^2 \tag{A12a}$$

if we assume that we are working with a comparatively small contribution w.r.t. time variation, but a very large in many cases contribution w.r.t. spatial variation of phase

$$|X_0| \approx \frac{1}{2} \cdot \left(\frac{\partial \phi}{\partial x}\right)^2 >> \tilde{\varepsilon}_0 \tag{A12b}$$

$$0 \le C_S^2 \approx \varepsilon^+ << 1 \tag{A13}$$

and

$$w \equiv \frac{p}{\rho} \cong \frac{-1}{1 - 4 \cdot \left(X_0 + \tilde{\varepsilon}_0\right) \cdot \left(\dfrac{F_2}{F_0 + F_2 \cdot \left(\tilde{\varepsilon}_0\right)^2} \cdot \tilde{\varepsilon}_0\right)} \approx 0 \tag{A14}$$

We get these values for the phase being nearly a 'box' of height approximately scaled to be about $2 \cdot \pi$ and of width $\boldsymbol{L}$. Which we obtained by setting [37]

$$\phi \approx \pi \cdot \left[\tanh b \cdot (x + L/2) - \tanh b \cdot (x - L/2)\right] \tag{A15}$$

This means that the initial conditions we are hypothesizing are in line with the equation of state conditions appropriate for a cosmological constant but near zero effective sound speed . As it is, we are approximating

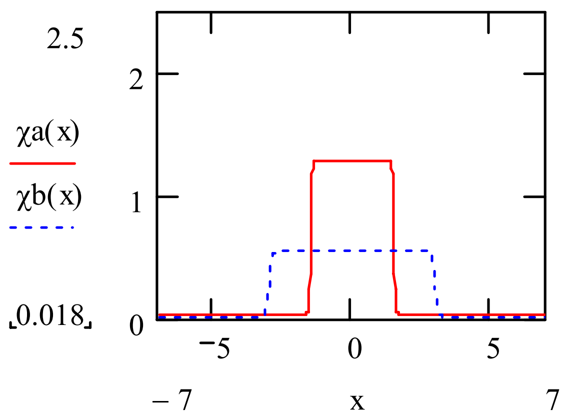

Figure 1a

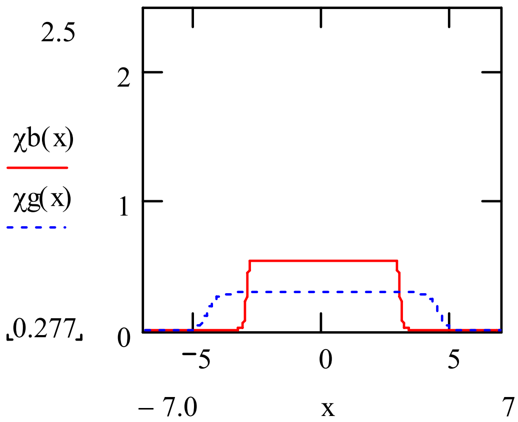

Figure 1b

Fig 1a,b **:** *Evolution of the phase from a thin wall approximation to a more nuanced thicker wall approximation with increasing L between S-S' instanton componets. The 'height' drops and the 'width' L increases corresponds to a de evolution of the thin wall approximation. This is in tandem with a collapse of an initial nucleating 'potential' system to the standard chaotic scalar* ϕ^2 *potential system of Guth* **[38]** .. *As the 'hill' flattens, and the thin wall approximation dissipates, the physical system approaches standard cosmological constant behavior.*

$$|X_0| \approx \frac{1}{2} \cdot \left(\frac{\partial \phi}{\partial x} \right)^2 \cong \frac{1}{2} \left[\delta_n^2 (x + L/2) + \delta_n^2 (x - L/2) \right] \qquad \text{(A16)}$$

with

$$\delta_n (x \pm L/2) \xrightarrow[n \to \infty]{} \delta \ (x \pm L/2) \qquad \text{(A17)}$$

as the slope of the **S-S'** pair approaches a box wall approximation in line with thin wall nucleation of **S-S'** pairs being in tandem with $b \to$ *larger* . We specifically in our simulation had $b \to 10$ above , rather than go to a pure box style representation of **S-S'** pairs , which if we had would lead to an unphysical situation with respect to delta functions giving infinite values of infinity which would force both C_s^2 and $w \equiv \frac{p}{\rho}$ to be zero for $|X \approx X_0| \cong \frac{1}{2} \cdot \left(\frac{\partial \phi}{\partial x} \right)^2 \to \infty$ if the ensemble of **S-S'** pairs were represented by a pure thin wall approximation [1] , i.e. a box. . If we adhere to a finite, but steep slope convention to modeling both C_s^2 and $w \equiv \frac{p}{\rho}$ we get the following. When $b \geq 10$ we obtain the conventional results of

$$w \cong \frac{-1}{1 - 4 \cdot \frac{X_0 \cdot \tilde{\varepsilon}_0}{F_2}} \to -1 \qquad \text{(A18)}$$

and recover Sherrer's solution for the 'speed of sound' [7] [3]

$$C_S^2 \approx \frac{1}{1 + 4 \cdot X_0 \left(1 + \frac{X_0}{2 \cdot \tilde{\varepsilon}_0} \right)} \to 0 \qquad \text{(A19)}$$

(if an example $F_2 \to 10^3$, $\tilde{\varepsilon}_0 \to 10^{-2}$, $X_0 \to 10^3$) Similarly, we would have if $b \to 3$ in eqn 12 above

$$w \cong \frac{-1}{1 - 4 \cdot \frac{X_0 \cdot \tilde{\varepsilon}_0}{F_2}} \to -1 \qquad \text{(A20)}$$

and

$$C_S^2 \approx \frac{1}{1 + 4 \cdot X_0 \left(1 + \frac{X_0}{2 \cdot \tilde{\varepsilon}_0} \right)} \to 1 \qquad \text{(A21)}$$

if $F_2 \to 10^3$, $\tilde{\varepsilon}_0 \to 10^{-2}$. Furthermore $|X_0| \to$ *a small value* which would be for $b \to 3$ in eqn 12, leading to $C_S^2 \approx 1$, i.e when the wall boundary of a **S-S'** pair no longer is approximated by the thin wall approximation. . This would eliminate having the initial state as behaving like pure radiation state (as Cardone et al [40] postulated) . i.e we then recover the cosmological constant .When $|X_0| \approx \frac{1}{2} \cdot \left(\frac{\partial \phi}{\partial x} \right)^2 >> \tilde{\varepsilon}_0$ no longer holds, we can have a hierarchy of evolution of the universe as being first radiation dominated, then dark matter, and finally dark energy.

Neither limit leads to a physical simulation making sense if $\left|X \approx X_0\right| \cong \frac{1}{2} \cdot \left(\frac{\partial \phi}{\partial x}\right)^2 \rightarrow \infty$, so we then mention the contributing slope as always being large but not infinite, in this problem. We furthermore have , even with $w = -1$

$$C_s^2 \equiv 1 \xrightarrow[b1 \rightarrow 3]{} 1 \text{ [7]}$$

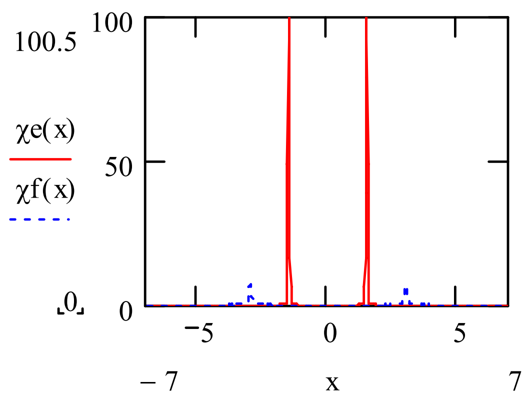

Figure 2a

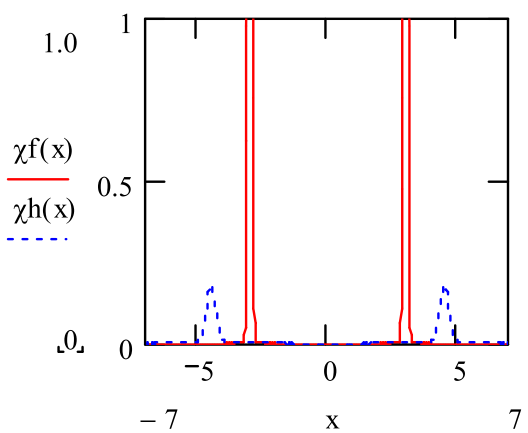

Figure 2 b

Fig 2a,b *: As the walls of the* ***S-S'*** *pair approach the thin wall approximation , one finds that for a normalized distance* $L = 9 \rightarrow L = 6 \rightarrow L = 3$ *that one has an approach toward delta function behavior at the boundaries of the new, nucleating phase. As L increases, the delta function behavior subsides dramatically. Here, the*

$L = 9 \Leftrightarrow$ *conditions approaching a cosmological constant.* $\boldsymbol{L} = 6 \Leftrightarrow$ *conditions reflecting Sherrer's dark energy – dark matter mix.* $L = 3 \Leftrightarrow$ *approaching unphysical delta function contributions due to a pure thin wall model. indicating that the evolution of the magnitude of the phase* $\phi \to \varepsilon^{+}$ *corresponds with a reduction of our cosmology from a dark energy-dark matter mix to the more standard cosmological constant models used in astrophysics*.

X. Conclusions

We have a situation for which we can postulate an early universe which is NOT necessarily radiation dominated as Carbone et al [40] postulated. We should keep in mind that Sherrers entire analysis was with regards to looking at , for very small ε_1 and a constant $a_1 > a$, with a written as an expansion scale factor .

$$X = X_0 \cdot \left(1 + \varepsilon_1 \cdot \left(\frac{a}{a_1} \right)^{-3} \right) \tag{A22}$$

so he could then get a GENERAL solution of

$$1 >> C_x^2 \equiv \left(X - X_0 \right) / (3 \cdot X - X_0) \equiv \frac{1}{2} \cdot \varepsilon_1 \cdot \left(a / a_1 \right)^{-3} \approx \varepsilon^{+} \geq 0 \tag{A23}$$

while at the same time keeping $w = -1$. I have two comments about Sherrer's [7]procedure. First of all, Sherrer [7] does not take into consideration if or not the dark energy-dark mass regime is primarily dominant at a given time in cosmological evolution, and throws out the positive cosmological constant all together. Secondly, Sherrers model [7] does not take into consideration if or not cosmic inflation was dominated by the dark energy- dark mass in the beginning. I argue that having such a mixture of dark energy-dark mass in cosmic expansion would be the 'driving force' for set up of the cosmic expansion parameters as we know them today.

In addition, our kinetic model can be compared with the very interesting Chimentos [41] purely kinetic k –essence model , with density fluctuation behavior at the initial start of a nucleation process. The model indicate our density function reach $\rho =$ constant after passing through the tunneling barrier as mentioned in the first papers nucleation of a S-S' pair ensemble. Topological arguments blends the k essence results indicating Sherrer's dark energy – dark matter mixture[7] during the inflationary cosmological period to the decay of the thin wall approximation of the scalar field to conditions permitting the dominant contribution of the cosmological constant to present changes in the Hubble parameter.

Appendix B Using our bound to the cosmological constant to link relic graviton production to branes

We use our bound to the cosmological constant to obtain a conditional escape of gravitons from an early universe brane. To begin, we present using the paper written by J.Leach et al. [42] on conditions for gravitaton production

$$B^2(R) = \frac{f_k(R)}{R^2} \tag{B1}$$

Also there exists an 'impact parameter'

$$b^2 = \frac{E^2}{P^2} \tag{B2}$$

This leads to, practically, a condition of 'accessibility' via. R so defined is with respect to 'bulk dimensions'

$$b \geq B(R) \tag{B3}$$

$$f_k(R) = k + \frac{R^2}{l^2} - \frac{\mu}{R^2} \tag{B4}$$

Here, k = 0 for flat space, k = -1 for hyperbolic three space, and k = 1 for a three sphere, while an radius of curvature

$$l \equiv \sqrt{\frac{-6}{\Lambda_{5-\dim}}} \tag{B5}$$

Here, we have that we are given [42]

$$k^* = \left(\frac{1}{'\, AdS\, curvature} \right) \tag{B6}$$

Park et al note that if we have a 'horizon' temperature term [42]

$$U_T \propto (external \quad temperature) \tag{B7}$$

We can define a quantity

$$\varepsilon * = \frac{U_T^4}{k^*} \tag{B8}$$

Then there exists a relationship between a four-dimensional version of the Λ_{eff} , which may be defined by noting

$$\Lambda_{5-\dim} \equiv -3 \cdot \Lambda_{4-\dim} \cdot \left(\frac{U_T}{k^{*3}} \right)^{-1} \propto -3 \cdot \Lambda_{4-\dim} \cdot \left(\frac{external \quad temperature}{k^{*3}} \right)^{-1} \tag{B9}$$

So

$$\Lambda_{5-\dim} \xrightarrow[external \quad temperature \to small]{} \text{very large value} \tag{B10}$$

In working with these values, one should pay attention to how $\cdot \Lambda_{4-\dim}$ is defined by Park, et al. [2]

$$\cdot \Lambda_{4-\dim} = 8 \cdot M_5^3 \cdot k^* \cdot \varepsilon^* \xrightarrow[external \quad temperature \to 3\, Kelvin]{} (.0004eV)^4 \tag{B11}$$

Here, I am defining $\Lambda_{5-\dim}$ as being an input from changes in the actual potential system due to

$$\Lambda_{5-\dim} \equiv -3 \cdot \Lambda_{4-\dim}(\Delta V) \cdot \left(\frac{U_T}{k^{*3}} \right)^{-1} \tag{B12}$$

Here we are looking at how the initial vacuum energy 'cosmological constant' parameter may be effected by a change in the potential system with the $\Lambda_{4-\dim}(\Delta V)$ tern with different temperature values implied for input into the four dimensional vacuum energy. I.e. $\Lambda_{4-\dim}(\Delta V)$ starts off with a given temperature value input as we look at (ΔV) for a maximized potential value, and subsequently dropping as the potential system evolves to a different value as inflation proceeds..

This, for potential, $(\Delta V)$is defined via transition between the first and the second potentials of the form given by[42]

$$V \equiv V_0 - c_3 \phi^3 + \frac{1}{2} \lambda \cdot \phi^2 \cdot \rho^2 + ... \tag{B13}$$

Sarkar treated the inflaton as having a varying effective mass, with an initial value of effective mass of $m_\phi{}^2 = \frac{d^2 V}{d\phi^2}$ given a before and after phase transition value of

$$m_\phi{}^2 = -6c_3 \cdot \langle \phi \rangle \Big|_{Before-phase-transition} \xrightarrow[phase-transition]{} -6c_3 \cdot \langle \phi \rangle + \lambda \cdot \Sigma^2 \Big|_{after-phase-transition} \tag{B14}$$

Either this potential can be used, or we just use a variant of a transition to the Race track potential given by

$$V(s,\phi) = \frac{1}{2s}\cdot\left(A\cdot(2s+N_1)\cdot e^{-s/N_1} + B\cdot(2s+N_2)\cdot e^{-s/N_2}\right)^2 + \frac{1}{s}\cdot A\cdot B\cdot(2s+N_1)\cdot(2s+N_2)\cdot e^{-s/N_1}\cdot e^{-s/N_2}\cdot(1-\cos(\phi\cdot\varepsilon)) \tag{B15}$$

This with a version of the scalar field in part be minimized. This is assuming that we are having $s \to N_a \neq \infty$, leading to minima for $\phi_k = k\pi/\varepsilon$, with k being the positive and negative integers, i.e. this helps delineate between two condensates. If we have a complex scalar field $\phi_j = X_j + i\cdot Y_j$. we have moduli arguments which add far more structure . Either type of structure can be used and put in so we come up with an effective value for a potential system. I.e. at a given [42]

$$B_{eff}^{\ 2}(R_t) = \frac{1}{l_{eff}^{\ 2}} + \frac{1}{4\cdot\mu} \tag{B16}$$

Claim : $R_b(t) = a(t)$ ceases to be definable for times $t \le t_P$ where the upper bound to the time limit is in terms of Planck time and in fact the entire idea of a de Sitter metric is not definable in such a physical regime.

Appendix C: A first approximation as to a phase transition in term of inflaton physics. ϕ

Conventional brane theory actually enables instanton structure analysis, as can be seen in the following. This is adapted from a lecture given at the ICGC-07 conference by Beckwith [43]

$$\frac{\Lambda_{Max}V_4}{8\cdot\pi\cdot G} \sim T^{00}V_4 \equiv \rho\cdot V_4 = E_{total} \tag{C1}$$

The approximation we are making, in this treatment initially is that $E_{total} \propto V(\phi)$ where we are looking at a potential energy term.[43]

What we are paying attention to, here is the datum that for an exponential potential (effective potential energy) [44] as taken from Weinberg

$$V(\phi) = g\cdot\phi^{\alpha} \tag{C2}$$

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,

$$V(\varphi) \propto \phi^{|\alpha|} \qquad \text{for } t < t_{PLanck} \tag{C3}$$

Also, we would have

$$V(\varphi) \propto 1/\phi^{|\alpha|} \qquad \text{for } t >> t_{PLanck} \tag{C4}$$

The switch between Eq. (C2) and Eq. (C3) is not justified analytically. I.e. it breaks down. Beckwith thinks this the boundary of a causal discontinuity.

Now according to Weinberg [44] , if $\in = \frac{\lambda^2}{16\pi G}, H = 1/\in t$ so that one has a scale factor behaving as

$$a(t) \propto t^{1/\in} \qquad \text{(C5)}$$

Then, if

$$|V(\phi)| << (4\pi G)^{-2} \qquad \text{(C6)}$$

there are no quantum gravity effects worth speaking of. I.e., if one uses an exponential potential a scalar field could take the value of , when there is a drop in a field from ϕ_1 to ϕ_2 for flat space geometry and times t_1 to t_2 [44]

$$\phi(t) = \frac{1}{\lambda} \ln\left[\frac{8\pi Gg \in^2 t^2}{3}\right] \qquad \text{(C7)}$$

Then the scale factors, from Planckian time scale as [44]

$$\frac{a(t_2)}{a(t_1)} = \left(\frac{t_2}{t_1}\right)^{1/\in} = \exp\left[\frac{(\phi_2 - \phi_1)\lambda}{2\in}\right] \qquad \text{(C8)}$$

The more $\frac{a(t_2)}{a(t_1)} >> 1$, then the less likely there is a tie in with quantum gravity. Note those that the way this potential is defined is for a flat , Roberson-Walker geometry, and that if and when $t_1 < t_{Planck}$ then what is done in Eq. (8) no longer applies, and that one is no longer having any connection with even an octonionic Gravity regime. If so, as indicated by Beckwith, et al (2011)[45] one may have to tie in graviton production due to photonic (“ light “) inputs from a prior universe, i.e. a causal discontinuity, with consequences which will show in both GW and graviton production.

Appendix D. An analogy from Density Wave physics, CDW in term of Gravitons

Here is, in a nutshell the template for the Gravitons which will examine, and eventually link to Gravitational waves, and entropy.

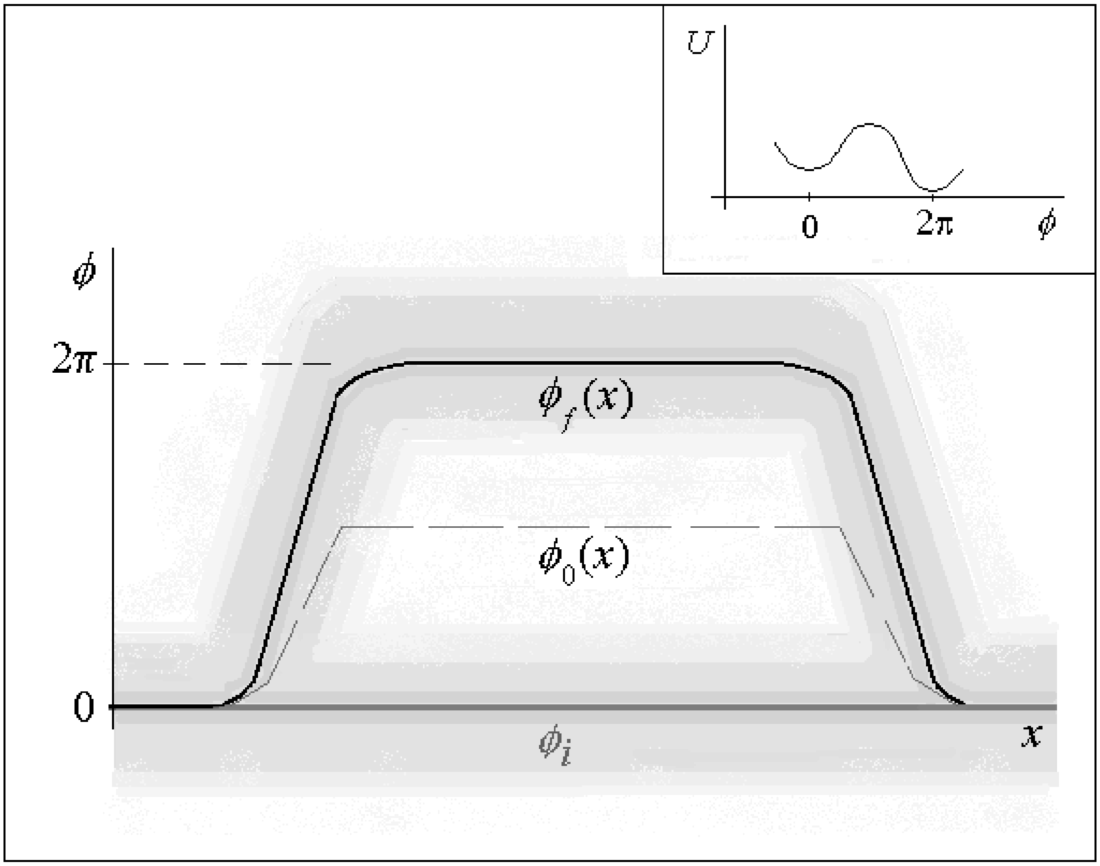

Fig 1: *Here, the left hand side corresponds to a soliton, the right hand side is an anti soliton*[46]

The work of Gilad Lifschytz [47] in 2004. Lifschyztz (2004)[47] codified thermalization equations of the black hole, which were recovered from the model of branes and antibranes and contribution to total vacuum

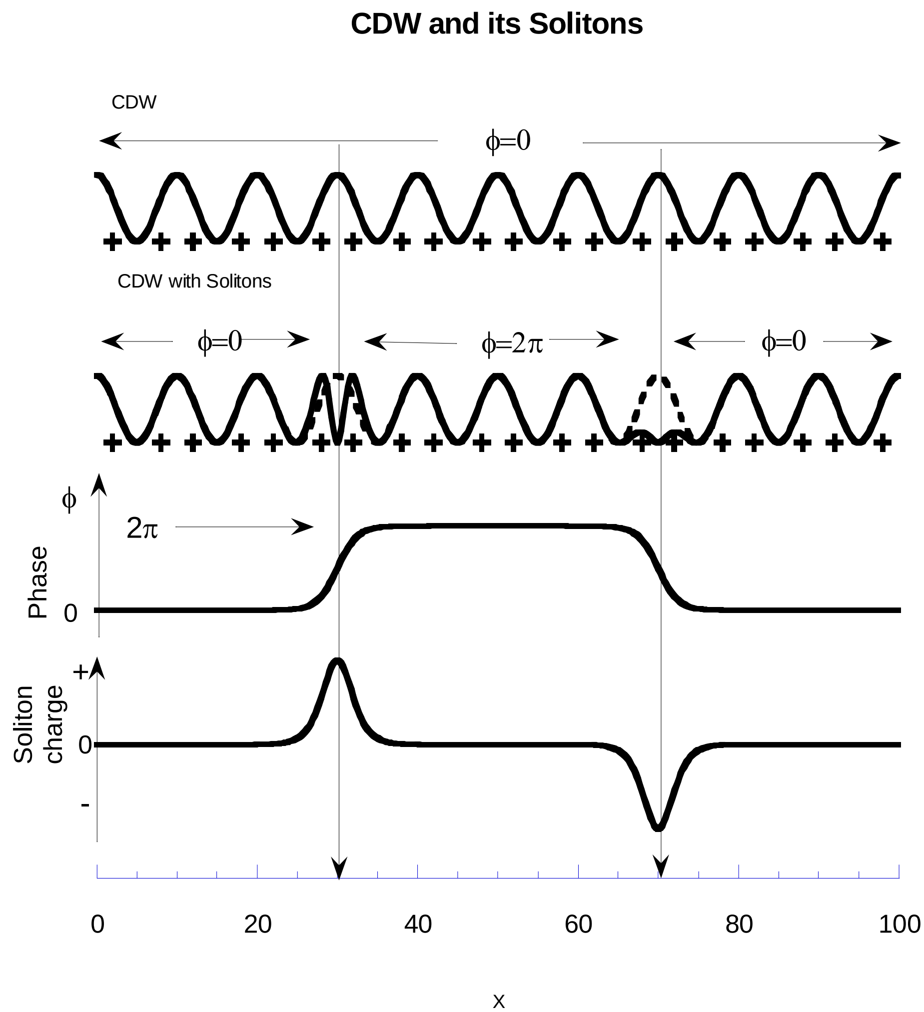

Figure 2. For Density wave physics. Here, instantons are positive charges, and anti instantons are negative charges. [46]

energy. The author suggests that a similar instanton – anti instanton construction exists for gravitons. Now, there is a 1-1 relationship between the S-S' in gravitons and in entropy. In lieu of assuming an antibrane is merely the charge conjugate of say a Dp brane. Here, $M_{p\,j,0}$ is the number of branes in an early universe configuration, while $M_{\bar{p}\,j,0}$ is anti-brane number . I.e., there is a kink in the given

$brane \sim M_{p\ \ j,0} \leftrightarrow CDW\ \ e^{-}$ electron charge and for the corresponding anti-kink $anti-brane \sim M_{\bar{p}\ \ j,0} \leftrightarrow CDW\ \ e^{+}$ positron charge. Here, in the bottom expression, $\breve{N}$ is the number of kink-anti-kink charge pairs

Here, in this situation, we have that in density wave physics, we would havethe formation of a soliton (anti soliton), that we use a multi-chain simulation Hamiltonian with Peierls condensation energy used to couple adjacent chains (or transverse wave vectors) as represented by [46],[48] [49], [50]

$$H = \sum_{n}\left[\frac{\Pi_n^2}{2\cdot D_1} + E_1\left[1-\cos\phi_n\right] + E_2\left(\phi_n - \Theta\right)^2 + \Delta'\cdot\left[1-\cos\left(\phi_n - \phi_{n-1}\right)\right]\right] \tag{D1}$$

5.b with ‘momentum ‘we define as [46], [48], [49] [50]

$$\Pi_n = \left(\hbar/i\right)\cdot \partial/\partial\phi_n \tag{D2}$$

5c We then use a nearest neighbor approximation to use a Lagrangian based calculation of a chain of pendulums coupled by harmonic forces to obtain a differential equation which has a soliton solution .To do this, we write the interaction term in the potential of this problem as [46], [48], [49], [50]

$$\Delta'\left(1-\cos\left[\phi_n - \phi_{n-1}\right]\right) \rightarrow \frac{\Delta'}{2}\cdot\left[\phi_n - \phi_{n-1}\right]^2 + \text{very small H.O.T.s.} \tag{D3}$$

and then consider a nearest neighbor interaction behavior via [46], [48], [49], [50]

$$V_{n.n.}(\phi) \approx E_1\left[1-\cos\phi_n\right] + E_2\left(\phi_n - \Theta\right)^2 + \frac{\Delta'}{2}\cdot\left(\phi_n - \phi_{n-1}\right)^2 \tag{D4}$$

5e Here, we set $\Delta' >> E_1 >> E_2$, so then this is leading to a dimensionless Sine–Gordon equation we write as [46],[48],[49],[50]

$$\frac{\partial^2\phi(z,\tau)}{\partial\tau^2} - \frac{\partial^2\phi(z,\tau)}{\partial z^2} + \sin\phi(z,\tau) = 0 \tag{D5 }$$

5f. so that [46]

$$\phi_{\pm}(z,\tau) = 4\cdot\arctan\left(\exp\left\{\pm\frac{z+\beta\cdot\tau}{\sqrt{1-\beta^2}}\right\}\right) \tag{D6}$$

I.e.

5g where the value of $\phi_{\pm}(z,\tau)$ is between 0 to $2\cdot\pi$ .. phase we call in position space[46]

$$\phi(x) = \pi\cdot\left[\tanh b\left(x - x_a\right) + \tanh b\left(x_b - x\right)\right] \tag{D7}$$

Appendix E: A brief note on how Brane theory talks about Entropy

Conventional brane theory actually enables this instanton structure analysis, as can be seen in the following. This is adapted from a lecture given at the ICGC-07 conference by Samir Mathur[51] The supposition is that branes and antibranes form the working component of an instanton. This is part of what has been developed in the case of massless radiation, where for D space-time dimensions, and E, the general energy is

$$S \sim E^{(D-1/D)} \tag{E0}$$

This suggests that entropy scaling is proportional to a power of the vacuum energy, i.e., entropy ~ vacuum energy, if $E \sim E_{total}$ is interpreted as a total net energy proportional to vacuum energy, as given below[43]

$$\frac{\Lambda_{Max} V_4}{8 \cdot \pi \cdot G} \sim T^{00} V_4 \equiv \rho \cdot V_4 = E_{total} \tag{E1}$$

Traditionally, minimum length for space-time benchmarking has been via the quantum gravity modification of a minimum Planck length for a grid of space-time of Planck length, whereas this grid is changed to something bigger $l_P \sim 10^{-33}\, cm \xrightarrow[Quantum-Gravity-threshold]{} \breve{N}^{\alpha} \cdot l_P$. So far, we this only covers a typical string gas model for entropy. $\breve{N}$ is assigned as the as numerical density of brains and anti-branes. A brane-antibrane pair corresponds to solitons and anti-solitons in density wave physics. The branes are equivalent to instanton kinks in density wave physics, whereas the antibranes are an anti-instanton structure. Density wave physics would require a one- to-one relationship between the instanton as an electronic charge and the anti-instanton as a positron charge. In CDW, this is a way to get a thin-wall approximation of CDW dynamics. First, a similar pairing in both black hole models and models of the early universe is examined, and a counting regime for the number of instanton and anti-instanton structures in both black holes and in early universe models is employed as a way to get a net entropy-information count value. One can observe this in the work of Gilad Lifschytz [47] in 2004. Lifschyztz [47] codified thermalization equations of the black hole, which were recovered from the model of branes and antibranes and a contribution to total vacuum energy. In lieu of assuming an antibrane is merely the charge conjugate of say a Dp brane in this situation, one can write an entropy value as a numerical average value of winding numbers of brane and antibrane contributions to entropy. Here, $M_{p\,j,0}$ is the number of branes in an early universe configuration, while $M_{\bar{p}\,j,0}$ is anti-brane number . I.e., there is a kink in the given $brane \sim M_{p\ j,0} \leftrightarrow CDW\ \ e^{-}$ electron charge and for the corresponding anti-kink $anti-brane \sim M_{\bar{p}\ j,0} \leftrightarrow CDW\ \ e^{+}$ positron charge. Here, in the bottom expression, $\breve{N}$ is the number of kink-anti-kink charge pairs, which is analogous to the simpler CDW structure.[51]

$$S_{Total} \sim \breve{a} \cdot \left[\frac{E_{Total}}{2^n} \right]^{\lambda} \cdot \prod_{j=1}^{\breve{N}} \left(\sqrt{M_{p\,j,0}} + \sqrt{M_{\bar{p}\,j,0}} \right) \tag{E2}$$

This expression for entropy (based on the number of brane-anti-brane pairs) has a net energy value of E_{Total} as expressed in Eqn (E1) above, where E_{Total} is proportional to the cosmological vacuum energy parameter; in string theory, E_{Total} is also defined via [51]

$$E_{Total} = 4\lambda \cdot \sqrt{M_{p\,j,0} \cdot M_{\bar{p}\,j,0}} \qquad \text{(E3)}$$

This can be changed and rescaled to treating the mass and the energy of the brane contribution along the lines of Mathur's CQG article [51]where he has a string winding interpretation of energy: putting as much energy E into string windings as possible via $[n_1 + \bar{n}_1]LT = [2n_1]LT = E/2$, where there are n_1 wrappings of a string about a cycle of the torus , and $\bar{n}_1$ being "wrappings the other way,", with the torus having a cycle of length L , which leads to an entropy defined in terms of an energy value of mass of $m_i = T_P \prod L_j$ (T_P is the tension of the i th brane, and L_j are spatial dimensions of a complex torus structure). The toroidal structure is to first approximation equivalent dimensionally to the minimum effective length of $\widetilde{N}^{\alpha} \cdot l_P \sim \widetilde{N}^{\alpha}$ times Planck length $\propto 10^{-35}$ centimeters [51]

$$E_{Total} = 2\sum_i m_i n_i \qquad \text{(E4)}$$

This leads to entropy expressed as a strict numerical count of different pairs of Dp brane-Dp anti-branes, which form a higher-dimensional equivalent to graviton production. This is done in Jack Ng's[8] procedure for graviton production in the creation of entropy, since gravitons are modeled as a kink-anti=kink model with much the same results as used for Dp branes and antibranes.

The tie in between Eq. (E5) below and Jack Ng's treatment of the growth of entropy [8] is as follows: First, look at the expression below, which has $\breve{N}$ as a stated number of pairs of Dp brane-antibrane pairs:[51]

$$S_{Total} = A \cdot \prod_i^{\breve{N}} \sqrt{n_i} \qquad \text{(E5)}$$

First, entropy is determined by numerical counting of kink-anti-kink pairs. Gravitons are also found as a kink-anti-kink pair, but formed in a different setting. The commonality of the two approaches is shown by:

1. Modeling gravitons as a kink-anti-kink combination
2. Modeling of entropy, generally, as kink-anti-kinks pairs with $\breve{N}$ the number of the kink-anti=kink pairs. This value of $\breve{N}$ directly contributes to the value of entropy, as given in Eq. (E5)
3. The tie in with entropy and gravitons is this: The two structures are related to each other in terms of kinks and antikinks. It is asserted that how they form and break up is due to the same phenomenon: a large insertion of vacuum energy leads to an initial breakup of both entropy levels and gravitons. When a second-order phase transition occurs, there is a burst of relic gravitons. Similarly, there is an initial breakup of net entropy levels, and after a second-order phase transition, another rapid increase in entropy.

It is also asserted that the counting algorithm Jack Ng [8] initially proved for dark matter "particles" also fits for gravitons. This numerical one-to-one ratio allows for considering the growth of entropy, if the "particles" so arising due to vacuum nucleation lead to more gravitons being produced. And if the gravitons are produced this way, there is growth of entropy, due initially to relic graviton production.

The growth of entropy starts from a low point given by Smoot[14] (initial values in the range of about 10^7 to 10^8), which then radically expands. The task in En. (E6) below is to configure the initial starting point for entropy.

The assertion is that the breakdown of entropy and information from a prior universe will lead to a surviving structure of Dp branes and antibranes and in a Planck interval of time at the very beginning of the inflationary era, leads to [52]

$$\left| \left[S_{Total} = A \cdot \prod_{i}^{N} \sqrt{n_i} \right] \Big/ k_B \ln 2 \right| \approx [\# operations]^{3/4} \approx 10^8 \qquad \text{(E6)}$$

It is also claimed that the interaction of the branes and antibranes will form an instanton structure, which is implicit in the treatment outlined in Eq. (E6), and that the numerical counts given in Eqn (E6) merely reflect that branes and antibranes -- even if charge conjugates of each other -- have the same "wrapping number" n_i.

It should be noted that this sort of treatment of entropy has to be reconciled with the standard radiation era, i.e., right after the big bang value of entropy, usually written as [53]

$$s_{Density} = \frac{2 \cdot \pi^2}{45} \cdot g_* \cdot T^3 \qquad \text{(E7)}$$

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