How can Brane World physics influence the existence of a relic graviton burst in the onset of inflation?

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Abstract

We use an explicit Randall-Sundrum brane world effective potential as congruent with conditions needed to form a minimum entropy starting point for an early universe vacuum state. We justify this by pointing to the Ashtekar, Pawlowski, and Singh (2006) article about a prior universe being modeled via their quantum bounce hypothesis which states that this prior universe geometrically can be modeled via a discretized Wheeler – De Witt equation , with it being the collapsing into a quantum bounce point singularity converse of the present day universe expanding from the quantum bounce point so delineated in their calculations. In doing so, we use thermal/ gravitational inputs into our present universe, using a simplified model of graviton production similar to what was done by Wheeler in the 1970s for spin two gravitons . Doing so permits modeling of experimental conditions needed for directional graviton production which conceivably could be used for space craft in the foreseeable future once an experimental verification of early universe conditions for graviton production and power radiation are finalized. This leads to intense power production using a model for power production reported by Dr. Fontana in 2005 in the new frontiers section of STAIF. We report upon what we think is a range of intense graviton production parameters in the onset of cosmological inflation. This builds upon an idea of a semi resonant cavity effect for spin two gravitons, with the walls dissolving after ten to the minus 43 seconds, with a build up of temperature, and a steady energy insertion leading to , after axion wall collapse due to rising temperatures, a massive release of relic gravitons at the same time the initiation of inflation takes place. This answers the apparent incongruency of low entropy, low temperatures postulated by S. Carroll, and J. Chen, with a naturally occurring 'laboratory' as to necessary and sufficient conditions needed to model graviton production on a large scale.

Keywords: branes, axion walls, Bogomolnyi inequality, gravitons, jeans inequality

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Very crude estimate of power production given in eqn. 61 will be refined and presented with graphics in the following STAIF new frontiers research section as given in the following link

http://www.unm.edu/~isnps/conferences/conferencefpapers.html

I. INTRODUCTION

Our present paper is in response to suggestions by Dr. Wald[1] (2005), Sean Carroll, and Jennifer Chen [2](2005) , and others in the physics department in the U. of Chicago about a Jeans instability criteria leading to low entropy states of the universe at the onset of conditions before inflationary physics initiated expansion of inflaton fields. We agree with their conclusions and think it ties in nicely with the argument so presented as to a burst of relic gravitons being produced.. This is leading to thermal inputs into a newly nucleated universe which leads to intense graviton production. Here is why we took this path of analysis.

Is there a way to get around this situation which appears to violate the Jeans instability[3] criteria for gravitational fields/gravitons in the early universe mandating low entropy states[2]? We believe that there is, and that it relies upon a suggestion given by Ashtekar, A., Pawlowski, T. and Singh, P (2006)[4,5] as to the influence of the quantum bounce via quantum loop gravity mirror imaging a prior universe collapsing into a 'singularity' with much the same geometry as the present universe. If this is the case, then we suggest that an energy flux from that prior universe collapse is transferred into a low entropy thermally cooled down initial state[6], leading to a sudden burst of relic gravitons as to our present universe configuration. The first order estimate for this graviton burst comes from the numerical density equation for gravitons written up by Weinberg as of 1971[7], with an exponential factor containing a frequency value divided by a thermal value, T, minus 1. If the frequency value is initially quite high, and the input given by a prior universe 'bounce', with an initial very high value of energy configuration, then we reason that this would be enough to introduce a massive energy excitation into a thermally cooled down axion wall configuration which would then lead to the extreme temperatures of approximately 10^{12} Kelvin forming at or before a Planck interval of time t_P, plus a melt down of the axion domain wall, which we then says presages formations of a Guth style inflationary quadratic and the onset of chaotic inflationary expansion. This will lead to what we report in the end part of our article, namely relic graviton production in the onset of inflation. This is in tandem with a brane world interpretation done after we cite short comings of the physics of $w(z) = \frac{P}{\rho}$ paradigm of the Friedman equation , plus a very successful Chaplygin Gas model fix for the problem[8], when $\alpha \leq .6$, which is only un done when there comes questions for how to define a scaling factor $a(t)$ for time regimes $t \leq t_P$ makes a Chaplygin Gas model description of density states not tendable.

II. REVIEW OF WHAT CAN BE IDENTIFIED VIA SCALING ARGUMENTS AND VARYING MODELS OF DARK ENERGY

We will now review the scaling arguments as to permissible entropy behavior and use this to begin our inquiry as to what to expect from brane models. U. Alam, and A. Strobinsky et al in July 2004 [9]. To begin with, they summarize several dark energy candidates as having the following inquiry schools, which I will reproduce in part for different equations of state, $w(z) = \frac{P}{\rho}$ as the ratio of pressure over observed density of states

(1) Dark energy with $w(z) \leq -1$

(2) Chaplygin Gas models with $w(z) = 0$ for high red shift to $w(z) \cong -1$ today

(3) Brane world models where acceleration, cosmology wise, is due to the gravity sector, rather than matter sector

(4) Dark energy models with negative scalar potentials

(5) Interacting models of dark energy and dark matter

(6) Modified gravity and scalar-tensor models

(7) Dark energy driven by quantum effects

(8) Dark energy with a late time transition in the equation of state

(9) Unified models of dark energy and inflation

The model they ultimately back in part due to astro physics observations is closest to one with $w(z) = 0$ in the distant past, to one with $w(z) \cong -1$ today. We will next go to scaling argument in part to talk about the significance of such thinking in terms of entropy. The model results they have in initial cosmology is not significantly different in part from the modeled values obtained by Knop[10] et al with $-1.61 < w(z) < -.78$ and in some particulars are close to what the Chaplygin Gas model predicts when dark energy - dark matter unification is achieved through an exotic background fluid whose equation of state is given by $p = - A/\rho^{\alpha}$, and with $0 < \alpha \leq 1$ We are not specifically endorsing this model, but are using the equation of state values to investigate some fundamental initial conditions for vacuum nucleation and brane world comology. We should note that if we consider $w(z) \cong -1$ we are introducing driven inflation via cosmological constant models.

To begin, we start with scale models , which we claim break down in part as follows:

Start with

$$\frac{\ddot{a}}{a} \equiv -\frac{4}{3} \cdot \rho \cdot \left[1 + \left(\left[\frac{3}{w(z)} \right] = 3P \right) \right] \tag{1}$$

The generalized Chaplygin gas (GCG) model allows for an unified description of the recent accelerated expansion of the Universe and the evolution of energy density perturbations. If we use $w(z) \propto \varepsilon^{+}$ we have the following, namely for

$$\frac{\ddot{a}}{a} \approx -\frac{4}{3} \cdot \rho \cdot \left[\left(1 + \frac{3}{\varepsilon^{+}} \right) \equiv N^{+} \right] \tag{2}$$

If we have a situation for which

$$\rho \equiv \rho_0 \cdot e^{-C \cdot t_1} \tag{3}$$

Before proceeding on applying the third equation, we need to show how it ties in with the Chaplygin Gas model predictions, and generalized fluid models

Begin first with a density varying as, due to a red shift $z \equiv 1/(a-1)$

$$\rho_i = \rho_{i0} \cdot (1+z)^{3\cdot(1+w_i(z))} \tag{4}$$

This is in tandem with the use of , for $H = \dot{a}/a$ and an ith density parameter of $\Omega_i \equiv \rho_{i0}/\rho_C$ and ρ_C a critical density parameter, with $\Omega_i \equiv \rho_{i0}/\rho_C \xrightarrow[w \to -1]{} \Lambda$ (like a cosmological constant)

$$H^2 \equiv \sum_i \Omega_i \cdot a^{-3\cdot(1+w_i)} + (1 - \sum_i \Omega_i) \cdot a^{-2} \tag{5}$$

The upshot is that if $w_i \approx 0 \Leftrightarrow .8 \le z \le 1.75$ which occurs if time t is picked for $t_{present} >> t \ge t_P$

$$\rho \sim \rho_{i0} \cdot (1+z)^2 \le 8 \cdot \rho_{i0} \tag{6}$$

Versus the later time estimate of, close to the present era of z =0 and w almost = -1

$$\rho \sim \rho_{i0} \tag{7}$$

I.e there was a major drop off of density values from earlier conditions to the present era. And this is not even getting close to the density values one would have for times $t \le t_P$ which we will comment upon later. Given this though., let us now look at some consequences of this drop off of density

To begin with, we can consider a force on the present 'fluid' constituents of a joint dark energy – dark mass model.

$$-\frac{dV}{da} = -(1 + 3 \cdot w_i) \cdot \Omega_i \cdot a^{-(2+3\cdot w_i)} \tag{8}$$

When we have a small interval of time after $t \ge t_P$, we have $w_i \approx \varepsilon^+$ leading to , for small values of the scale factor $a(t) \sim \delta^+$, and a potential system we call V_{early} for early universe scalar field conditions

$$\frac{dV_{early}}{da} = (1 + 3 \cdot \varepsilon^+) \cdot \Omega_i \cdot \left(a \sim \delta^+\right)^{-2} \approx \Omega_i / \delta^+ \tag{9}$$

This implies a large force upon any structure in the early universe which so happens to be accurate.

We can contrast this with, for $w_i \approx -1$

$$\frac{dV_{Today}}{da} = -(2) \cdot \Omega_i \cdot (a \sim Big)^{-2} \approx -N^{++}\Omega_i \tag{10}$$

This is implying a large positive force leading to accelerated expansion, whereas Eqn. (9) predicts at or before time t_P a negative force which would be consistent with early universe pre big bang conditions. Furthermore, we can also look at what this implies for the Friedman equations w.r.t. the scale factor at (or before) Plancks time t_P , i.e

$$\frac{\ddot{a}}{a} \approx -\frac{4}{3} \cdot \rho_0 \cdot \left[\exp(-C_1 t)\right] \cdot \left[N^+\right] \tag{11}$$

If we for small time intervals look at $a \sim t^{1/3+\tilde{\gamma}}$, then Eqn. (11) above reduces to for times near the Planck unit

$$-(2/9)\cdot t_p^{-2} \approx -4\cdot G\cdot \rho_0 \cdot N^+ / \left(3\cdot \left[\left[(1+C_1\cdot t_P) = \varepsilon^+\right] + C_1^2 \cdot t_P^2/2\right]\right) \tag{12}$$

This leads to

$$C_1 = \frac{-1+\varepsilon^+}{t^P} \tag{13}$$

This is in the neighborhood of Plank unit time confirmation of the graceful exit from inflation, i.e. a radical negative acceleration value we can write as

$$\frac{\ddot{a}}{a} \approx -\frac{4\cdot G\cdot \rho_0}{3}\cdot N^+ \tag{14}$$

As well as a provisional density behavior we can write as

$$\rho \sim \rho_0 \cdot \exp\left[\frac{-\varepsilon^+(small \quad time)+t}{t_P}\right] \tag{15}$$

If we have a situation for which time is smaller than the Planck interval time, we have Eqn. 15 predicting that there is decreasing density values , and that Eqn. 15 would predict peak density values at times $t \approx t_P$, which in a crude sense is qualitatively similar to the picture we will outline later of a nucleation of a vacuum state leading to a final nucleated density. This however, also outlines the limits of the Friedman equation for early universe cosmology. It is useful to note though that should one pick $w_i \geq -1$ as is indicated is feasible in the observational sense that Eqn. 1 above predicts a positive right hand side implying positive acceleration of scale factors. This is akin to the gas model predicting increased acceleration in the present cosmological era.

So then we really need to look at the Chaplygin model when we no longer can work with the $w(z) = \frac{P}{\rho}$ equation of state model in the Friedman equation.

What else can we say about density variations via this Chaplygin Gas model? If we scale the pressure-density equation via(assuming A is a positive constant) [8]

$$p_{ch} = -\frac{A}{\rho_{ch}^{\alpha}} \tag{15a}$$

We have a violation of known observational physics if and when $\alpha = 1$ and in fact the known datum that the speed of sound predicted by this model cannot exceed the speed of light, plus the WMAP data rules out $\alpha = 1$ and in fact restricts $\alpha \leq .6$ with actual preferred values of $\alpha \cong .2$ being most acceptable.

$$C_s^2 = \alpha \cdot A / \rho_{ch}^{1+\alpha} \leq 1 \tag{15b}$$

However, if we pick this value of $\alpha \cong .2$ we will have major problems with equations of state leading to the right hand side of Eqn. (1) being consistent with early universe conditions which often favor $w(z) \approx \varepsilon^{+}$ being consistent with the necessary datum that the right hand side of Eqn. (1) must be positive, leading to

$$\frac{\ddot{a}}{a} \equiv -\frac{4}{3} \cdot \left[\rho_{ch} + \left(-\frac{3A}{\rho_{ch}^{\alpha \approx .2}} \right) \right] > 0 \tag{15c}$$

i.e. one must have

$$\rho_{ch} \left[1 + \left(-\frac{3 \cdot C_s^2}{\alpha} \right) \right] < 0 \tag{15d}$$

So long as $\alpha \leq .6$ we get what we want for speed of sound models approaching the speed of light, i.e. $\frac{3 \cdot C_s^2}{\alpha} > 1$

Which is definitely satisfied when $C_S^2 \to 1^{-} \leq 1$. Needless to say though that for early universe conditions that we have

$$\frac{\ddot{a}}{a} \equiv -\frac{4}{3} \cdot \rho \cdot \left[1 + \left(-\frac{3C_s^2}{\alpha} \right) \right] < 0 \tag{15e}$$

Only when

$$\frac{3 \cdot C_s^2}{\alpha} < 1 \tag{15f}$$

If we write

$$\rho_{ch}^{1+\alpha} = \left(A + \frac{B}{a^{3 \cdot (1+\alpha)}} \right) = \frac{\alpha}{C_s^2} \tag{15g}$$

We have a model implying very large densities, which is what we find, but this will not mesh well with the dark energy / matter candidate which has an undefined value of the cosmological scale factor when we have[11]

$$V \approx (1/n) \cdot \phi^{n} \xrightarrow[AXION \to 0]{} (1/2) \cdot \phi^{2} \tag{16}$$

This would be in tandem with

$$a_{init} \cdot \exp\left(\frac{4 \cdot \pi}{n} \cdot \left(\phi^{2}{}_{init} - \phi^{2}(t) \right) \right) \xrightarrow[AXION \to 0]{} a_{init} \cdot \exp\left(\frac{4 \cdot \pi}{2} \cdot \left(\phi^{2}{}_{init} - \phi^{2}(t) \right) \right) \tag{17}$$

This will in its own way lead us to make sense of a phase transition we will write as a four dimensional embedded structure within the Sundrum brane world structure

$$\begin{aligned} &\tilde{V}_1 &&\to \tilde{V}_2 \\ &\tilde{\phi}(increase) \le 2\cdot\pi &&\to \tilde{\phi}(decrease) \le 2\cdot\pi \\ &t \le t_P &&\to t \ge t_P + \delta\cdot t \end{aligned} \tag{18}$$

The potentials $\tilde{V}_1$, and $\tilde{V}_2$ will be described in terms of **S-S'** di quark pairs nucleating and then contributing to a chaotic inflationary scalar potential system. Here, $m^2 \approx (1/100)\cdot M_P^2$

$$\tilde{V}_1(\phi) = \frac{{M_P}^2}{2}\cdot\left(1-\cos(\tilde{\phi})\right) + \frac{m^2}{2}\cdot\left(\tilde{\phi}-\phi^*\right)^2 \tag{19}$$

$$\tilde{V}_2(\phi) \propto \frac{1}{2}\cdot\left(\tilde{\phi}-\phi_C\right)^2 \tag{20}$$

III. THE WHEELER GRAVITON PRODUCTION FORMULA FOR RELIC GRAVITONS

As is well known, a good statement about the number of gravitons per unit volume with frequencies between ω and $\omega + d\omega$ may be given by (assuming here, that $\bar{k}$ = $1.38 \times 10^{-16}\, erg/{}^0K$, and ${}^0K$ is denoting Kelvin temperatures, while we keep in mind that Gravitons have two independent polarization states) [7]

$$n(\omega)d\omega = \frac{\omega^2 d\omega}{\pi^2}\cdot\left[\exp\left(\frac{2\cdot\pi\cdot\hbar\cdot\omega}{\bar{k}T}\right)-1\right] \tag{21}$$

This formula predicts what was suggested earlier. A surge of gravitons commences due to a rapid change of temperature. I.e. if the original temperature were low, and then the temperature rapidly would heat up? Here is how we can build up a scenario for just that. Eqn. (21) above suggests that at low temperatures we have a large busts of gravitons.

Now, how do we get a way to get the ω and $\omega + d\omega$ frequency range for gravitons, especially if they are relic gravitons? First of all, we need to consider that certain researchers claim that gravitons are not necessarily massless, and in fact the Friedmann equation acquires an extra dark-energy component leading to accelerated expansion. The mass of the graviton allegedly can be as large as ~$(10^{15}\text{ cm})^{-1}$ .This is though if we connect massive gravitons with dark matter candidates, and not necessarily with relic gravitons. Having said this we can note that Massimo Giovannini[12] writes in an introduction to his Phys Rev D article about presenting a model which leads to post-inflationary phases whose effective equation of state is stiffer than radiation. We also are as stated earlier , stating that the energy input into the frequency range so delineated comes from a prior universe collapse , as modeled by Ashtekar, A., Pawlowski, T. and Singh, P (2006) via their quantum bounce model as given by quantum loop gravity calculations. We will state more about this later in this document.

Let us now consider a suitable axion wall boundary model for the relic gravitons to hit into. I.e. we look at axion walls specified by Kolbs book[13] about conditions in the early universe (1991) with his Eqn. (10.27) vanishing and collapsing to Guths quandratic inflation. i.e. having the quadratic contribution to a inflation potential arise due to the vanishing of the axion contribution of the first potential of Eqn. (18) above with a temperature dependence of

$$V(a) = m_a^2 \cdot (f_{PQ} / N)^2 \cdot (1 - \cos[a/(f_{PQ} / N]) \qquad (22)$$

Here, he has the mass of the axion potential as given by m_a as well as a discussion of symmetry breaking which occurs with a temperature $T \approx f_{PQ}$. Furthermore, he states that the axion goes to a massless regime for high temperatures, and becomes massive as the temperature drops.. Here, N>1 leads to tipping of the wine bottle potential , and N degenerate CP-conserving minimal values. The interested reader is urged to consult section 10.3 of Kolb's Early universe book for additional details. This is in tandem with supposing that axion walls abruptly vanishing due to a heat up of initial conditions being congruent with the following figure given below. Where the pop up so alluded to is in tandem with the production of a bubble formation, described by Coleman - de Luccia instanton. The novel part of this discussion is that it also assumes that relic graviton production occurred during the pop up process and ceased as the scalar potential reached its final state .

Another take on Eqn. (18) is that the domain walls are removed via a topological collapse of domain walls as alluded to by the Bogomolnyi inequality. This would pre suppose that early universe conditions are in tandem with Zhitinisky's (2002) supposition of color super conductors[14]. Those wishing to see a low dimensional condensed matter version[15,16] can consider how we can look at conditions for how Eqn. 18 may be linked to a false vacuum nucleation. The diagram for such an event is given below, with a tilted washboard potential formed via considering the axion walls with a small term added on, which is congruent with, after axion wall disappearance with Guths chaotic inflation model[17].

Given this , let us consider a four dimensional potential system, which is for initial low temperatures, and then next consider how higher temperatures may form, and lead to the disappearance of axion walls. To do this we refer to what is written in Eqn. 18 Eqn. 21

Note that potentials $\tilde{V}_1$, and $\tilde{V}_2$ are two cosmological inflation potential, and $t_P =$ Planck time. For the benefit of those who do not know what Planck time is, Planck time is the time it would take a photon traveling at the speed of light to cross a distance equal to the Planck length $\approx 5.39121(40) \times 10^{-44}$ seconds. Planck length denoted by l_P, is the unit of length approximately 1.6×10^{-35} meters. It is in the system of units known as Planck units. The Planck length is deemed "natural" because it can be defined from three fundamental physical constants: the speed of light, Planck's constant, and the gravitational constant

We are showing the existence of a phase transition between the first and second potentials, with a rising and falling value of the magnitude of the four dimensional scalar fields. When the scalar field rises corresponds to quantum nucleation of a vacuum state represented by $\tilde{\phi}$ .As we will address later, there is a question if there is a generic 'type' of vacuum state as a starting point for the transformation to standard inflation, as given by the 2nd scalar potential system.

The potentials $\tilde{V}_1$, and $\tilde{V}_2$ were described in terms of **S-S'** soliton-anti soliton style di quark pairs nucleating in a manner similar in part, for the first potential similar in part to what is observed in instanton physics showing up in density wave current problems , while the second potential is Guths typical chaotic inflationary cosmology potential dealing with the flatness problem.

Note that this requires that we write ϕ_C in Eqn. (19) as an equilibrium value of a true vacuum minimum in Eqn. (19) after quantum tunneling through a barrier. Note that M_P = Plancks mass ≈ 1.2209×10^{19} GeV/c^2 = 2.176×10^{-8} kg . It is the mass for which the Schwarzschild radius is equal to the Compton length divided by π .

We should note that the overall transformation from Eqn. (19) to Eqn (20) is covered by Sidney Coleman's classic paper on false vacuum nucleation. We should also note that ϕ^* in Eqn. (20) is a measure of the onset of quantum fluctuations. This in the context of the fluctuations having an upper bound of $\tilde{\tilde{\phi}}$ (Here, $\tilde{\tilde{\phi}} > \phi_C$) and $\tilde{\phi} \equiv \tilde{\tilde{\phi}} - mt / \sqrt{12 \cdot \pi \cdot G}$, where we use $\tilde{\tilde{\phi}} > \sqrt{60/2\pi} M_P \approx 3.1 M_P \equiv 3.1$. This last reference is to Quantum fluctuation covered by Guth in his now famous cosmological inflation articles of the late 1980s, and 2000[18]

IV. MODELING A FIFTH DIMENSION FOR EMBEDDING FOUR DIMENSIONAL SPACE TIME AND THE RANDALL SUNDRUM EFFECTIVE POTENTIAL

The fifth-dimension of the Randall-Sundrum brane world is[19], for $-\pi \le \theta \le \pi$, a circle map which is written, with R as the radius of the compact dimension and for our model, we write a fifth dimension as.

$$x_5 \equiv R \cdot \theta \tag{23}$$

This fifth dimension x_5 also creates an embedding potential structure leading to a complimentary embedded in five dimensions scalar field we model as:

$$\phi(x^\mu, \theta) = \frac{1}{\sqrt{2 \cdot \pi \cdot R}} \cdot \left\{ \phi_0(x) + \sum_{n=1}^{\infty} \left[\phi_n(x) \cdot \exp(i \cdot n \cdot \theta) + C.C. \right] \right\} \tag{24}$$

This scaled potential structure will be instrumental in forming a Randall Sundrum effective potential

The consequences of the fifth-dimension considered in Eqn. (23) show up in a simple warped compactification involving two branes, i.e., a Planck world brane, and an IR brane. Let's call the brane where gravity is localized the Planck brane The first brane is a four dimensional structure defining the standard model 'universe', whereas the second brane is put in as structure to permit solving the five dimensional Einstein equations. Before proceeding, we need to say what we call the graviton is, in the brane world context. A localized graviton plus a second brane separated from the brane on which the standard model of particle physics is housed provides a natural solution to the hierarchy problem—the problem of why gravity is so incredibly weak.

$$S_5 = \int d^4 x \cdot \int_{-\pi}^{\pi} d\theta \cdot R \cdot \left\{ \frac{1}{2} \cdot (\partial_M \phi)^2 - \frac{m_5^2}{2} \cdot \phi^2 - K \cdot \phi \cdot [\delta(x_5) + \delta(x_5 - \pi \cdot R)] \right\} \tag{25}$$

Here, what is called m_5^2 can be linked to Kaluza Klein "excitations" via (for a number $n > 0$)

$$m_n^2 \equiv \frac{n^2}{R^2} + m_5^2 \tag{26}$$

Note that In 1926, Oskar Klein proposed that the fourth spatial dimension is curled up in a circle of very small radius, so that a particle moving a short distance along that axis would return to where it began. The distance a particle can travel before reaching its initial position is said to be the size of the dimension. This extra dimension is a compact set, and the phenomenon of having a space-time with compact dimensions is referred to as compactification In modern geometry.

Now, if we are looking at an addition of a second scalar term of opposite sign, but of equal magnitude, where

$$S_5 = -\int d^4x \cdot V_{eff}\left(R_{phys}(x)\right) \to -\int d^4x \cdot \tilde{V}_{eff}\left(R_{phys}(x)\right) \tag{27}$$

We should briefly note what an effective potential is in this situation.

We get

$$\tilde{V}_{eff}\left(R_{phys}(x)\right) = \frac{K^2}{2 \cdot m_5} \cdot \frac{1+\exp\left(m_5 \cdot \pi \cdot R_{phys}(x)\right)}{1-\exp\left(m_5 \cdot \pi \cdot R_{phys}(x)\right)} + \frac{\tilde{K}^2}{2 \cdot \tilde{m}_5} \cdot \frac{1-\exp\left(\tilde{m}_5 \cdot \pi \cdot R_{phys}(x)\right)}{1+\exp\left(\tilde{m}_5 \cdot \pi \cdot R_{phys}(x)\right)} \tag{28}$$

This above system has a metastable vacuum for a given special value of $R_{phys}(x)$. Start with

$$\Psi \propto \exp(-\int d^3x_{space} d\tau_{Euclidian} L_E) \equiv \exp\left(-\int d^4x \cdot L_E\right) \tag{29}$$

$$L_E \geq |Q| + \frac{1}{2} \cdot \left(\tilde{\phi} - \phi_0\right)^2 \{\ \} \xrightarrow[Q \longrightarrow 0]{} \frac{1}{2} \cdot \left(\tilde{\phi} - \phi_0\right)^2 \cdot \{\ \} \tag{30}$$

Part of the integrand in Eqn. (29) is known as an action integral, S = ∫ L dt, where L is the Lagrangian of the system. Where as we also are assuming a change to what is known as Euclidean time, via $\tau = i \cdot t$, which has the effect of inverting the potential to emphasize the quantum bounce hypothesis of Sidney Coleman. In that hypothesis, *L* is the Lagrangian with a vanishing kinetic energy contribution, i.e. $L \to V$, where V is a potential whose graph is 'inverted' by the Euclidian time. Here, the spatial dimension $R_{phys}(x)$ is defined so that

$$\tilde{V}_{eff}\left(R_{phys}(x)\right) \approx \text{constant} + \tfrac{1}{2} \cdot \left(R_{phys}(x) - R_{critical}\right)^2 \propto \tilde{V}_2\left(\tilde{\phi}\right) \propto \frac{1}{2} \cdot \left(\tilde{\phi} - \phi_C\right)^2 \tag{31}$$

And

$$\{\ \} = 2 \cdot \Delta \cdot E_{gap} \tag{32}$$

We should note that the quantity $\{\ \} = 2 \cdot \Delta \cdot E_{gap}$ referred to above has a shift in minimum energy values between a false vacuum minimum energy value, $E_{\text{false min}}$, and a true vacuum minimum energy $E_{\text{true min}}$, with the difference in energy reflected in Eqn. (32) above . The way we formed the Bogomolnyi inequality[20,21] lead in part to the gap energy we write above in Eqn. (32) above. This will lead to in part to an analysis of the Wheeler – De Witt equation.

V. SHORT COMINGS IN THE BRANE WORLD PICTURE IF WE DO NOT CONSIDER INTENSE GRAVITON PRODUCTION

M. Maia et al in 2002[22] brought up an interesting point about the degree of quantum fluctuation engendered by brane world physics. The main point we will lead up to is that if we do not have a structure equivalent to the results referred to in Eqn. (31) above that we have inescapable problems due to the role of γ_b as showing up in a brane world version of 'bending energy' ρ_b due to brane world physics and intrinsic 'pressure'

$$\rho_b \equiv \left(\gamma_b - 1\right) \cdot p_b \tag{33}$$

This is arising from a brane world physics modification of the Friedman equations as given here: with *b* being a fluctuation from brane world contributions and k being curvature values of either +1, -1 , or zero.

$$\dot{a}^2 + k = \frac{8 \cdot \pi \cdot G}{3} \cdot \rho \cdot a^2 + \frac{\lambda}{3} \cdot a^2 + \frac{b^2}{a^2} \tag{34}$$

We shall following Maia et al in giving a simple treatment of b and introduce what its consequences are. Here if γ_b is a constant, we can write

$$\frac{\dot{b}}{b} = \frac{1}{2} \cdot (4 - 3\gamma_b) \cdot \frac{\dot{a}}{a} \Rightarrow b(t) = b_0 \cdot a(t)^{(1/2)\cdot(4-3\cdot\gamma_b)} \tag{35}$$

Leading to a bending energy

$$\rho_b = \frac{3 \cdot a^{-3\cdot\gamma_b}}{8 \cdot \pi \cdot G} \tag{36}$$

Let us look at various values of what this says about the Friedman equation above. If we have γ_b is a constant, and small, i.e. $\gamma_b \approx \delta^+$, and we have $\rho_b \equiv \rho$ almost a time independent constant for the region we analyze

$$a_{Total} \approx a_{initial} \cdot \left[\left[\exp\left(\left(\sqrt{(8 \cdot \pi \cdot G \cdot \rho/3) + \lambda/3}\right)\right) \cdot t\right] + \exp\left(\sqrt{b_0} \cdot t\right)\right] \tag{37}$$

This value of Eqn. (37) leads to well behaved values of Eqn. (33) but in a manner probably consistent with later times, i.e. conditions approaching modern day cosmological evolution. It also assumes a small value for b_0 .

If we have that $\left(2 - \frac{3}{2} \cdot \gamma_b\right) \approx \varepsilon^+$,while still maintaining that we have $\rho_b \equiv \rho$ almost a time independent constant, we can write, instead , for small times

$$a_{Total} \approx a_{initial} \cdot \left[\left[\exp\left(\left(\sqrt{(8 \cdot \pi \cdot G \cdot \rho/3) + \lambda/3}\right)\right) \cdot t\right] + \left(\sqrt{b_0} \cdot t\right) + small \quad H.O.T.s\right] \tag{38}$$

Finally, if we have $\gamma_b \approx N >> 0$, i.e. very large, and we have $\rho_b \equiv \rho$ almost a time independent constant we obtain

$$a_{Total} \approx a_{initial} \cdot \left[\left[\exp\left(\left(\sqrt{(8 \cdot \pi \cdot G \cdot \rho/3) + \lambda/3}\right)\right) \cdot t\right]\right] \tag{39}$$

But this value of Eqn. (39) leads to

$$\rho_b \cong (\gamma_b) \cdot p_b \tag{40}$$

This last value is in contradiction with modern day cosmology and would only be consistent with early universe conditions with $p_b \rightarrow 0$. So unless we postulate a serious phase transition changing the character of initial phase evolution along the lines of the axion wall contribution so mentioned earlier, we will have problems with brane world quantum style fluctuations contributing to the evolution of the Friedman equations and scale factor evolution from early universe times. The problems do not end here. In addition, we need to consider entropy in the VERY early universe .i.e. a weird set of conditions which pretty much force us to consider thermal/energy inputs into a new universe via a prior universe's quantum bounce.

VI. SETTING UP CONDITIONS FOR ENTROPY BOUNDS VIA BRANE WORLD PHYSICS, AND LEADING UP TO THE NECESSITY OF A QUANTUM BOUNCE TO BRIDGE TO TEMPERATURE REGIMES SEEN IN CHAOTIC INFLATION.

Our starting point here is showing equivalence of entropy formulations in both the Brane world and the more typical four dimensional systems. A Randall-Sundrum Brane world will have the following as a line element and we will continue from here to discuss how it relates to holographic upper bounds to both anti De sitter metric entropy expressions and the physics of dark energy generating systems.

To begin with, let us first start with the following as an $A \cdot dS_5$ model of tension on brane systems, and the line elements . If there exists a tension $\breve{T}$, with Plank mass in five dimensions denoted as M_5, and a curvature value of l on $A \cdot dS_5$ we can write[23]

$$\breve{T} = 3 \cdot \left(M_5^3 / 4 \cdot \pi \cdot l \right) \tag{41}$$

Furthermore, the $A \cdot dS_5$ line element, with $r =$ distance from the brane, becomes

$$\frac{dS^2}{l^2} = \left(\exp(2 \cdot r)\right) \cdot \left[-dt^2 + d\rho^2 + \sin^2 \rho \cdot d\Omega_2 \right] + dr^2 \tag{42}$$

We can then speak of a four dimensional volume V_4 and its relationship with a three dimensional volume

$$V_4 = l \cdot V_3 \tag{43}$$

And if a Brane world gravitational constant expression $G_N = M_4^{-2} \Leftrightarrow M_4^2 = M_5^3 \cdot l$ we can get a the following space bound Holographic upper bound to entropy

$$S_5\left(V_4\right) \leq V_3 \cdot \left(M_5^3 / 4\right) \tag{44}$$

If we look at an area 'boundary' A_2 for a three dimensional volume V_3, we can re cast the above holographic principle to (for a volume V_3 in Planck units)

$$S_4\left(V_3\right) \leq A_2 \cdot \left(M_4^2 / 4\right) \tag{45}$$

We link this to the principle of the Jeans inequality for gravitational physics and a bound to entropy and early universe conditions, as given by S. Carroll and J.Chen (2005)via stating if $S_4(V) = S_5(V_4)$ then if we can have

$$A_2 \xrightarrow[t \to t_P]{} \varepsilon_{small \quad area} \Leftrightarrow S_5\left(V_4\right) \approx \delta_{small \quad entropy} \tag{46}$$

Low entropy conditions for initial conditions, as stated above give a clue as to the likely hood of low temperatures as a starting point via R. Easther et al. (1998) relationship of a generalized non brane world entropy bound, assuming that $n^* \approx$ bosonic degrees of freedom and T as generalized temperature, so we have as a temperature based elaboration of the original work by Susskind on holographic projections forming area bound values to

$$\frac{S}{A} \leq \sqrt{n^*} \cdot T \tag{47}$$

Similar reasoning, albeit from the stand point of the Jeans inequality and instability criteria lead to Sean Carroll and J. Chen (2005) giving for times at or earlier than the Planck time t_P that a vacuum state would initially start off with a very low temperature

$$T_{dS}\Big|_{t\le t_P} \sim H_0 \approx 10^{-33} eV \tag{48}$$

Abbay Ashtekar's quantum bounce inputs of energy from a prior universe gives us a way out of the seeing impossibility of bridging the low entrophy – low temperature conditions postulated for the early universe, and the massive temperature run up seen in early inflationary conditions for Guth style chaotic inflation. In addition, we are also postulating that a collapse of axion domain walls so configured as axions cease to exist as far as domain wall contributions to the onset of conditions configured for chaotic inflation. This would in its own way remove the weird situation showing up in Eqn. (40) above with its manifestly unphysical small bound required for fluctuations as a result of brane world evolution.

VII. DI QUARK POTENTIAL SYSTEMS AND THE WHEELER DE-WITT EQUATION

Abbay Ashtekar's quantum bounce gives a discrete version of the Wheeler De Witt equation, as well as a Gaussian input functional into the quantum bounce[4,5]. As already mentioned Θ is a difference operator, allowing for a treatment of the scalar field as an 'emergent time', or 'internal time' so that one can set up a wave functional built about a Gaussian wave functional defined via

$$\max \tilde{\Psi}(k) = \tilde{\Psi}(k)\Big|_{k\equiv k^*} \tag{49}$$

This is for a crucial 'momentum' value

$$p_\phi^* = -\left(\sqrt{16\cdot\pi\cdot G\cdot\hbar^2/3}\right)\cdot k^* \tag{50}$$

And

$$\phi^* = -\sqrt{3/16\cdot\pi G}\cdot \ln\left|\mu^*\right| + \phi_0 \tag{51}$$

Which leads to, for an initial point in 'trajectory space' given by the following relation $\left(\mu^*,\phi_0\right)=$ (initial degrees of freedom [dimensionless number] ~'eigenvalue of 'momentum', initial 'emergent time ') So that if we consider eigen functions of the De Witt (difference) operator, as contributing toward

$$e_k^s(\mu) = \left(1/\sqrt{2}\right)\cdot\left[e_k(\mu)+e_k(-\mu)\right] \tag{52}$$

With each $e_k(\mu)$ an eigen function of Θ above, we have a potentially numerically treatable early universe wave functional data set which can be written as

$$\Psi(\mu,\phi) = \int_{-\infty}^{\infty} dk\cdot\tilde{\Psi}(k)\cdot e_k^s(\mu)\cdot\exp\left[i\omega(k)\cdot\phi\right] \tag{53}$$

The existence of gravitons in itself would be able to either confirm or falsify the existence of non L^P structure in the early universe. This structure was seen as crucial to Ashtekar, A, Pawlowski, T. and Singh, in their arXIV article[4,5]make reference to a revision of this momentum operation along the lines of basis vectors $\left|\mu\right\rangle$ by

$$\hat{p}_{\iota}|\mu\rangle = \frac{8\cdot\pi\cdot\gamma\cdot l_{PL}^2}{6}\cdot\mu|\mu\rangle \tag{54}$$

With the advent of this re definition of momentum we are seeing what Ashtekar works with as a simplistic structure with a revision of the differential equation assumed in Wheeler – De Witt theory to a form characterized by

$$\frac{\partial^2}{\partial\phi^2}\cdot\Psi \equiv - \quad \Theta\cdot\Psi \tag{55}$$

Θ in this situation is such that

$$\Theta \neq \Theta(\phi) \tag{56}$$

This in itself would permit confirmation of if or not a quantum bounce condition existed in early universe geometry, according to what Ashtekar's two articles predict. In addition it also corrects for another problem. Prior to brane theory we had a too crude model. Why ? When we assume that a radius of an early universe—assuming setting the speed of light $c \equiv 1$ is of the order of magnitude $3\cdot(\Delta t \cong t_P)$ —we face a rapidly changing volume that is heavily dependent upon a first order phase transition, as affected by a change in the degrees of freedom given by $\cdot(\Delta N(T))_P$. Without gravitons and brane world structure, such a model is insufficient to account for dark matter production and fails to even account for Baryogenesis. It also will lead to new graviton detection equipment re configuration well beyond the scope of falsifiable models configured along the lines of simple phase transitions given for spatial volumes (assuming c = 1) of the form[24]

$$\Delta t \cong t_P \propto \frac{1}{4\pi}\cdot\sqrt{\frac{45}{\pi\cdot(\Delta N(T))_P}}\cdot\left(\frac{M_p}{T^2}\right) \tag{57}$$

Here, we look at appropriate choices for an optimum momentum value for specifying a high level of graviton production. If gravitons are, indeed, for dark energy, as opposed to dark matter, without mass, we can use, to first approximation something similar to using the zeroth componet of momentum $p^0 = E(energy)/c$, calling $E(energy) \equiv \varepsilon(\nu)\cdot$(initial nucleation volume) , and the formation of gravitons in values from a volume of space smaller than what is specified by Eqn. (57) above after multiplying it by the speed of light , which we can assume has a radius in dimensional length is less than or equal in radius than Plancks length l_P . This is equivalent to using to first approximation the following. The absolute value of k^* , which we call $|k^*|$ is

$$|k^*| = \sqrt{3/16\cdot\pi\cdot G\cdot\hbar^2}\cdot\left(\varepsilon(\nu)\cdot\left(initial \quad nucleation \quad volume\right)/c\right) \tag{58}$$

An appropriate value for a Gaussian representation of an instanton awaits more detailed study. But for whatever it is worth we can refer to the known spaleraton value for a multi dimensional instanton via the following procedure . We wish to have a finite time for the emergence of this instanton from a pre inflation state.

If we have this, we are well on our way toward fixing a range of values for $\omega 2 < \omega(net) < \omega 1$, which in turn will help us define

$$\varepsilon(v)\cdot\left(initial \quad volume\right)\approx \hbar\cdot\omega(net)\equiv p^{*}\cdot c \tag{59}$$

Which is using an expression which was written by Grushchuk, in the 1990s as to initial energy density (gravitons, etc)

Grushchuk[25] writes that the energy density of relic gravitons is expressible as

$$\varepsilon(v)\equiv\frac{\pi}{(2\cdot\pi)^{4}}\cdot\frac{1}{a(t)^{4}}\cdot H_{i}^{2}\cdot H_{f}^{2}\cdot a(t)_{f}^{4} \tag{59a}$$

where the subscripts i and f refer to initial and final states of the scale factor , and Hubble parameter. This expression though is meaningless in situations when we do not have enough data to define either the scale factor, and Hubble parameter at the onset of inflation. If this is partially true then we can use Eqn (59a) and also Eqn (59)in order to use Eqn. (42) to get a value for k^{*}. This value for k^{*} can then be used to construct a Gaussian wave functional about k^{*} of the form, as an anzatz. To put into Eqn.(33) above.

$$\Psi(k)\approx\frac{1}{Value}\cdot\exp\left(-\quad c_{2}\cdot\left(k-k^{*}\right)^{2}\right) \tag{60}$$

If so, then, most likely, the question we need to ask though is the temperature of the 'pre inflationary' universe and its link to graviton production.This will be because the relic graviton production would be occurring before the nucleation of a scalar field. We claim, as beforehand that this temperature would be initially quite low, as given by the two University of Chicago articles, but then rising to a value at or near 10^{12} degrees Kelvin after the dissolving of the axion wall contribution given in the dominant value of Eqn. (19) leading to Eqn (20) for a chaotic inflationary potential.

VIII. GRAVITON SPACE PROPULSION SYSTEMS

We need to understand what is required for realistic space propulsion. To do this, we need to refer to a power spectrum value which can be associated with the emission of a graviton. Fortunately, the literature contains a working expression as to power generation for a graviton being produced for a rod spinning at a frequency per second ω, which is by Fontana[26] (2005) at a STAIF new frontiers meeting, which allegedly gives for a rod of length $\widehat{L}$ and of mass m a formula for graviton production power,

$$P(power)=2\cdot\frac{m_{graviton}{}^{2}\cdot\widehat{L}^{4}\cdot\omega_{net}{}^{6}}{45\cdot\left(c^{5}\cdot G\right)} \tag{61}$$

The point is though that we need to say something about the contribution of frequency needs to be understood as a mechanical analogue to the brute mechanics of graviton production. For the sake of understanding this , we can view the frequency ω_{net} as an input from an energy value, with graviton production number (in terms of energy) as given approximately via an integration of eqn. (21)above, $\widehat{L}\propto l_{P}$, mass $m_{graviton}\propto 10^{-60}kg$. This crude estimate of graviton power production will be considerably refined via numerical techniques in the coming months. It also depends upon a **<u>HUGE</u>** number of relic gravitons being produced, due to the temperature variation so proposed.

Here is what I found, so far. The first column refers to graviton production based upon a numerical integration of Eqn. (21), and the second is a very rough power calculation done w.r.t. Eqn. (61) , with $\omega 1 < \omega_{net} < \omega 2$

$$\langle n(\omega)\rangle = \frac{1}{\omega_{net}} \int_{\omega 1}^{\omega 2} \frac{\omega^2 d\omega}{\pi^2} \cdot \left[\exp\left(\frac{2 \cdot \pi \cdot \hbar \cdot \omega}{\bar{k} T} \right) - 1 \right] \tag{62}$$

N1 is in reference to a first value of temperature inserted. N2 is with a doubling of that initial temperature input, with N3 a tripling of the initial temperature input into Eqn. (62) above, with N4 and N5 values of Eqn. (62) above subsequent multiplications of $T_{initial}$ by factors of 4 and 5 . The power calculation is done with a net energy input, times the value of the different values of Eqn. (62) above ,i.e. frequency times the different values of Eqn. (62) above which becomes effectively the energy , if we assume $\hbar$ is re scaled to a unity value, times $\langle n(\omega)\rangle$ to the sixth power inserted into the numerator of Eqn. (45) above. As is noted, the important datum is the dramatic collapse in radiated power which occurs merely for increasing by four times the available temperature inserted in the integrand of Eqn. (46) above.

N1=1.2881 *10^65	Power= 1.552 *10^275 (Ergs?)
N2=4.373 * 10^32	Power= 3.107 * 10^80 (Ergs?)
N3=7.872 * 10^21	Power= 1.058 * 10^16 (Ergs?)
N4=3.612 *10^16	Power= 0
N5= 2.368 *10^13	Power= 0

The first column entry is assuming a constant energy input due to Akshenkars quantum bounce entry[4,5] of energy into an axion 'cavity' region which would shortly afterwards 'warm up' and dissipate according to the axion mass temperature dependence given by Eqn. (21). However, in doing this, we have that the increase in temperature as given in the division of input energy as specified, leads to a very narrow range of power emission in graviton generation.

IX. CONSIDERATIONS AS TO BRANE WORLD FORMALISM BETWEEN FOUR AND FIVE DIMENSIONAL COSMOLOGICAL 'CONSTANTS' AND THEIR ROLE AS TO GRAVITON PRODUCTION

Gravitons are also definable as to four and five dimensional brane world representations. Here, we use our bound to the cosmological constant to obtain a conditional escape of gravitons from an early universe brane. To begin, we present conditions (Leach and Lesame, 2005)[27] for gravitation production. Here R is proportional to the scale factor 'distance'.

$$B^2(R) = \frac{f_k(R)}{R^2} \tag{63}$$

Also there exists an 'impact parameter'

$$b^2 = \frac{E^2}{P^2} \tag{64}$$

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

$$b \geq B(R) \tag{65}$$

$$f_k(R) = k + \frac{R^2}{l^2} - \frac{\mu}{R^2} \tag{66}$$

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

$$l \equiv \sqrt{\frac{-6}{\Lambda_{5-\dim}}} \tag{67}$$

This assumes a negative bulk cosmological constant $\Lambda_{5-\dim}$ and that μ is a five-dimensional Schwartzshield mass. We assume emission of a graviton from a bulk horizon via scale factor, so $R_b(t) = a(t)$. Then we have a maximum effective potential of gravitons defined via

$$B^2(R_t) = \frac{1}{l^2} + \frac{1}{4 \cdot \mu} \tag{68}$$

This leads to a bound with respect to release of a graviton from an anti De Sitter brane (Leach and Lesame, 2005) as

$$b \geq B\left(R_t\right) \tag{69}$$

In the language of general relativity, anti de Sitter space is the maximally symmetric, vacuum solution of Einstein's field equation with a negative cosmological constant Λ. Mathematically, anti de Sitter can be a quotient of group

$$AdS_n \equiv \frac{SO(2, n-1)}{SO(1, n-1)} \tag{70}$$

This quotient formulation gives to AdS_n an homogeneous space structure that ties in with branes. That is, our universe is a five-dimensional anti de Sitter space and the elementary particles, except for the graviton, are localized on a (3 + 1)-dimensional brane or branes. In this setting, branes, and *p*-branes, are spatially extended objects that appear in string theory. The variable *p* refers to the dimension of the brane; a 0-brane is a zero-dimensional particle, a 1-brane is a string, a 2-brane is a "membrane," etc. Every *p*-brane sweeps out a (*p*+1)-dimensional *world-volume* as it propagates through spacetime.

How do we link this to our problem with respect to di quark contributions to a cosmological constant? Here we make several claims.

Claim 1: It is possible to redefine $l \equiv \sqrt{-6/\Lambda_{5-\dim}}$ as

$$l_{eff} = \sqrt{\left|\frac{6}{\Lambda_{eff}}\right|} \tag{71}$$

Proof of Claim 1: There is a way, for finite temperatures for defining a given four-dimensional cosmological constant (Park, Kim,). We define, via Park's article,

$$k^{*} = \left(\frac{1}{{}'AdS\,curvature} \right) \tag{72}$$

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

$$U_T \propto (external \quad temperature) \tag{73}$$

We can define a quantity

$$\varepsilon * = \frac{U_T^4}{k^*} \tag{74}$$

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

$$\Lambda_{5-\dim} \equiv -3 \cdot \Lambda_{4-\dim} \cdot \left(\frac{U_T}{k^{*3}} \right)^{-1} \propto -3 \cdot \Lambda_{4-\dim} \cdot \left(\frac{external \quad temperature}{k^{*3}} \right)^{-1} \tag{75}$$

So

$$\Lambda_{5-\dim} \xrightarrow[external \quad temperature \to small]{} \text{large value} \tag{76}$$

And set

$$\left| \Lambda_{5-\dim} \right| = \Lambda_{eff} \tag{77}$$

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

$$\cdot\Lambda_{4-\dim} = 8 \cdot M_5^3 \cdot k^* \cdot \varepsilon^* \xrightarrow[external \quad temperature \to 3\,Kelvin]{} \left(.0004 eV \right)^4 \tag{78}$$

Here, we define Λ_{eff} as being an input from Eqn. (18) to Eqn. (19) to Eqn. (20) partially due to

$$\begin{aligned} &\Delta\Lambda_{total}\Big|_{effective} = \lambda_{other} + \Delta V \\ &\xrightarrow[\Delta V \to end \quad chaotic \quad \inf lation \quad potential]{} \Lambda_{observed} \cong \Lambda_{4-\dim} \left(3\,Kelvin \right) \end{aligned} \tag{79}$$

This, for potential $V_{\min}$, is defined via transition between the first and the second potentials of Eqn. (19) and Eqn. (20).

$$B_{eff}{}^2(R_t) = \frac{1}{l_{eff}{}^2} + \frac{1}{4 \cdot \mu} \tag{80}$$

Claim 2: $R_b(t) = a(t)$ ceases to be definable for times 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. This is a given in standard inflationary cosmology where traditionally the scale factor in cosmology is a, parameter of the Friedmann-Lemaître-Robertson-Walker model, and is a function of time which represents the relative expansion of the universe. It relates physical coordinates (also called proper coordinates) to co moving coordinates. For the FLRW model

$$L = \bar{\bar{\lambda}} \cdot a\left(t\right) \tag{81}$$

where L is the physical distance $\bar{\tilde{\lambda}}$ is the distance in co moving units, and a(t) is the scale factor. While general relativity allows one to formulate the laws of physics using arbitrary coordinates, some coordinate choices are natural choices, which are easy to work with. *Comoving coordinates* are an example of such a natural coordinate choice. They assign constant spatial coordinate values to observers who perceive the universe as isotropic. Such observers are called *comoving observers* because they move along with the Hubble flow. *Comoving distance* is the distance between two points measured along a path of constant cosmological time. It can be computed by using t_e as the lower limit of integration as a time of emission

$$\bar{\tilde{\lambda}} \equiv \int_{t_e}^{t} \frac{c \cdot dt'}{a(t')} \tag{82}$$

This claim 2 breaks down completely when one has a strongly curved space, which is what we would expect in the first instant of less than Planck time evolution of the nucleation of a new universe.

Claim 3: Eqn. (4) has a first potential which tends to be for a di quark nucleation procedure which just before a defined Planck's time t_P. But that the cosmological constant was prior to time t_P likely far higher, perhaps in between the values of the observed cosmological constant of today, and the QCD tabulated cosmological constant which is 10^{120} time greater. i.e.,

$$b^2 \geq B_{eff}{}^2(R_t) = \frac{1}{l_{eff}{}^2} + \frac{1}{4 \cdot \mu} \tag{83}$$

Which furthermore

$$\left.\frac{1}{l_{eff}{}^2}\right|_{t \leq t_P} >> \left.\frac{1}{l_{eff}{}^2}\right|_{t \equiv t_P + \Delta(time)} \tag{84}$$

So then that there would be a great release of gravitons at or about time t_P.

Claim 4: Few gravitons would be produced significantly after time t_P.

Proof of Claim 4: This comes as a result of temperature changes after the initiation of inflation and changes in value of

$$\left(\Delta l_{eff}\right)^{-1} = \left(\sqrt{\left|\frac{6}{\Lambda_{eff}}\right|}\right)^{-1} \propto \Delta\left(external \quad temperature\right) \tag{85}$$

X. HOW PRIOR FIXES TO THE COSMOLOGICAL PROBLEM HAVE DEPENDED UPON SCALE FACTORS EVEN WHEN THE SCALE FACTORS ARE UNDETERMINED AT THE ONSET OF COSMOLOGICAL NUCLEATION

We get a glimpse of what goes wrong when we consider the following history of smart but flawed attempts to address the cosmological 'constant' problem. We should note what a common misconception as to the cosmological constant is. In dimensional terms we often see it referred to as a 'natural' cosmological constant value in terms of

Planck Energy values. This is similar to the problems one observes in a Quantum Field theoretic vacuum summation of zero point energy bosonic fields up to Planck energy values[28,29]

$$\Lambda_{natural} \sim \frac{E_{Plank}^4}{\hbar^3 \cdot c^3} >> \Lambda_{observed} \tag{86}$$

V.G. Gurzadyan, and She-Sheng Lue wrote a derivation to the effect that one can calculate a realistic value for the cosmological constant based upon a wave number based upon a vacuum fluctuation model which gives a Fourier style de composition of vacuum fluctuation wave modes such that if we assume no angular momentum 'twisting' and a flat FRW metric[30]

$$\Lambda = 8 \cdot \pi \cdot G \cdot \int \frac{d^3 k}{(2 \cdot \pi)^3} \cdot \left(\tilde{\varepsilon}(k) = \sqrt{k_r^2} \right) \tag{87}$$

Needless to say though, that any energy density so accumulated would be far, far less than what was assumed in the typical bosonic field calculation, above, especially since if $a_{scale} \equiv$ scale factor size of the universe.

$$k_r = \frac{n \cdot \pi}{a_{scale}} \tag{88}$$

This equation would get dramatically smaller for increasing age of the universe to present conditions, with the initial values of it to be similar in 'form' to the enormous values of initial energy density outlined above for an initial nucleating universe, especially if we model the initial energy as proportional to the square of Eqn. (88) above. This, however, has a serious defect in that it does not give a genesis, or origins reference as to how the cosmological constant could evolve from initial big bang conditions. Mainly due to it being extremely difficult to form $a_{scale} \equiv$ scale factor size of the universe for initial conditions in the neighborhood of a cosmic singularity for times in the neighborhood of Planck's time t_P.

Part of the misconception which is endemic in this field with respect to forming a cosmological constant which is consistent with known astrophysics observations lies in the difficulty of forming of an effective Field theoretic Hamiltonian for calculation of vacuum energy, i.e. for quasi particles making sense of [28,29]

$$\varepsilon_{vacuum} = \frac{1}{V} \cdot \left\langle H_{QFT} \right\rangle_{vacuum} \tag{89}$$

G.E. Volovick writes a candidate for an acceptable Hamiltonian in this above equation as having a chemical potential addition[3], i.e.

$$H_{QFT} \equiv \hat{H} - \mu_{chemical} \cdot \hat{N} \tag{90}$$

This assumes that one can actually define a number operator for quasi particles, i.e.

$$\hat{N} = \int d^3 x \cdot \Psi^* \cdot \Psi \tag{91}$$

Again, for early universe conditions, how does one form Ψ for early states of matter? There is a huge literature on this subject, which will be referred to at the end of this document[31,32]but the wavefunctionals of the universe ideas, while promising in their own right for tunneling probability conditions for initial nucleation are time INDEPENDENT constructions and do not answer as to changes of initial states of matter-energy very effectively. In addition it is also important to note that initial states of cosmology are being modeled by application of topological defect, and branes very successfully[33] .Still though, if Eqn. (91) were actually defined well, we could then start to calculate a field theoretic version of Eqn. (89), at least in principle, without having an undetermined at Planck time

t_P scale factor, as seen in early universe versions of Eqn. (90). These considerations plus a discussion with Dr. Steinheart at the UCLA dark matter conference in February 2006 lead to a review of Abbots original hypothesis about the cosmological constant[34]

XI.THE NOBLE FAILURE, ABBOTS 1985 ATTEMPT TO OBTAIN LOW VALUES FOR THE COSMOLOGICAL CONSTANT.

As of the mid 1980s, Abbot initiated using a tilted washboard potential model for $V(\phi)$ which allegedly would permit work with a satisfactory cosmological constant[34] value based upon a vacuum energy expression given below(with λ_{other} being non a non axion field ϕ contribution to total vacuum energy)

$$\Lambda_{total} = \lambda_{other} + V(\phi) \tag{92}$$

As Abbot admitted though, this model, while giving certain qualitatively attractive features involved an

unacceptably long period of final tunneling time based upon

$$\Gamma \propto M^4 \cdot \exp(-\widetilde{B}) \tag{93}$$

with

$$\widetilde{B} \approx M^2 f / V_N \tag{94}$$

This assumes as Abbot postulated a cascading series of minimum values of $V(\phi)$ for a potential given by.

$$V_N(\phi) \equiv M^4 \cos\left(\frac{\phi_N}{2 \cdot \pi \cdot f}\right) + \frac{\in}{2 \cdot \pi \cdot f} \cdot \phi_N \tag{95}$$

Eqn. (95) lead to a cascading series of local minimum values, where Abbot scaled the local minimum values via setting his scalar field as $\phi_N = N$, where N is an integer. It so happens that each minima of Eqn. (95) had a vacuum density value of

$$V_N = V_0 + \in \tag{96}$$

This assumes V_0 is the vacuum energy of the minimum with the smallest given value of Eqn. (19) possible. Also, we assume that $V_N - V_{N-1} = \in$ Typical values for the constants above were $M \sim 1 \ ev, f \sim 10^{16} \ ev, \in \sim .1 \ ev$ This lead to, for final values of tunneling time of the order of $10^{10^{120}}$ [1,2,3] years, for a final cascade value of $V_{N \equiv 0}(\phi)$ chosen so that $\Lambda_{total} \leq \ \in$ for a value of vacuum energy which was in sync with observed values of a model with realistic cosmological parameters. In particular, it is useful to keep in mind that $\Lambda_{QCD} \leq 100 \ \ MeV$, and that we are attempting to remove such eccentric values from our calculations. This is in line with a through going construction of a potential system which has ONE transition from a false to a true vacuum, rather than the multiple local minimums Abbot used in his washboard potential model. We expect this will lead to criteria for formation of the escape of gravitons from an early universe brane construction which evolves toward De Sitter space cosmology as a consequence of inflation. In addition we will also address how gravitons could exist, and tie in with the initial production of dark matter-dark energy, while accepting the difficulty of detecting them in post inflationary cosmology models of galaxies, and other strong gravitational centers seen in present day astrophysics.

XI. FORMING ANSWERS TO DYSONS CHALLENGE TO THE ASTRO PHYSICS COMMUNITY ABOUT THE REALITY OF GRAVITONS, I.E. DETECTING GRAVITONS AS SPIN 2 OBJECTS WITH AVAILABLE TECHNOLOGY

To briefly review what we can say now about standard graviton detection schemes, as mentioned above, Rothman states that Dyson seriously doubts we will be able to detect gravitons via present detector technology[27]. The conundrum is that if one defines the criterion for observing a graviton as

$$\frac{f_\gamma \cdot \sigma}{4 \cdot \pi} \cdot \left(\frac{\alpha}{\alpha_g} \right)^{3/2} \cdot \frac{M_s}{R^2} \cdot \frac{1}{\varepsilon_\gamma} \geq 1 \tag{97}$$

Here,

$$f_\gamma = \frac{L_\gamma}{L} \tag{98}$$

This has L_γ / L a graviton sources luminosity divided by total luminosity and R as the distance from the graviton source, to a detector. Furthermore, $\alpha = e^2/\hbar$ and $\alpha_g = Gm_p^2/\hbar$ a constant while ε_γ is the graviton P.E. A datum to consider is that the probability of graviton interaction with the detector 'matter' is of the order of 10 to the -60 power, whereas that for a corresponding photon would be significant orders of magnitude higher. As stated in the manuscript, the problem then becomes determining a cross section σ for a graviton production process and $f_\gamma = L_\gamma / L$. Here, a 4-dimensional graviton emission cross section goes like 1/M.

We can honestly say that the scheme outlined as of Eqn. (61) above appears to have a chance go get around the problems mentioned above, but that the earlier, cross section based criteria outlined by Eqn. (97) and Eqn. (98) will doom most detection of gravitons unless we have a scheme which initiates a process similar to relic graviton production mentioned in section VIII above.

XIII. HOW OUR BRANE WORLD COSMOLOGICAL CONSTANT MODEL COMPARES WITH OTHER DYNAMIC MODELS AS TO EVOLUTION OF THE 'COSMOLOGICAL' CONSTANT.

Recently, F.Rahaman, M.Kalam, M.Sarker, A.Ghosh, B.Raychaudhuri have in an arxiv article[35] suggested the following constraint upon the cosmological 'constant' Λ_{eff}

$$\left(\Lambda_{eff} / 8 \cdot \pi \right) \propto p(pressure) \tag{99}$$

Should pressure as so defined be defined via the Chaplygin Gas model, i.e. when dark energy - dark matter unification is achieved through an exotic background fluid whose equation of state is given by $p = - A/\rho^\alpha$ with a density given as (assuming r is a spatial variable, and B a positive constant)

$$\rho \propto r^{-B} \tag{100}$$

We recover the brane world picture so recovered in section IX above. However, we also claim that we need to consider the case where the initial set up of a vacuum state is formed, thereby avoiding the absurdity of an infinite density value at the onset of pre inflation physics. This is why we, among other things work with the axion wall transformation alluded to in Eqn. (18) above. We also claim that Eqn. (100) would contravene low entropy-low temperature conditions postulated by Sean Carroll and Jennifer Chen in their recent arXIV article (2005). Needless to say , F. Rahaman et al include variations of the 'cosmological constant' implicitly in their work when they write

$$\frac{d}{dr}\left(p - \frac{\Lambda_{eff}}{8 \cdot \pi}\right) = \frac{2 \cdot (n-1)}{r} \cdot p \tag{101}$$

XII. CONCLUSIONS

Gravitons would appear to be produced in great number in the $\Delta t \approx t_P$ neighborhood, according to a brane world interpretation just given. This depends upon the temperature dependence of the 'cosmological constant.' As outlined in gr-qc/ 0603021 This is to correct for the situation created by Eqn. (57)is for a critical temperature T_C defined in the neighborhood of an initial grid of time $\Delta t \approx t_P$. This among other things leads to a change in volume along the lines of, to crude first approximation imputing in numerical values to obtain, for $T \equiv T_c \sim 250 \quad GeV \Rightarrow N(T_c) \cong 51.5$

$$V = volume = \frac{5.625 \times 10^{57}}{T^6} \cdot \frac{1}{N^{3/2}(T)} \tag{102}$$

The radius of this 'volume' is directly proportional to $3 \cdot t$ (setting the speed of light c =1). Note that we are interested in times t < $\Delta t \approx t_P$ for our graviton production, whereas we have a phase transformation which would provide structure for Guth's quadratic powered inflation.

A Randall-Sundrum effective potential, as outlined herein, would give a structure for embedding an earlier than axion potential structure, which would be a primary candidate for an initial configuration of dark energy .This structure would, by baryogenesis, be a shift to dark energy. We need to get JDEM space observations configured to determine if WIMPS are in any way tied into the supposed dark energy released after a $\Delta t \approx t_P$ time interval.

In doing this, we should note the following. First of all, we have reference multiple reasons for an initial burst of graviton activity, i.e. if we wish to answer Freeman Dysons question about the existence of gravitons in a relic graviton stand point. This builds upon an idea of a semi resonant cavity effect for spin two gravitons, with the walls dissolving after ten to the minus 43 seconds, with a build up of temperature, and a steady energy insertion leading to , after axion wall collapse due to rising temperatures, a massive release of relic gravitons at the same time the initiation of inflation takes place

Now for suggestions as to future research. In doing so we also will attempt to either confirm or falsify via either observations from CMB based systems, or direct neutrino physics counting of relic graviton production the exotic suggestions given by Holland and Wald for pre inflation physics and/or shed light as to the feasibility of some of the mathematical suggestions given for setting the cosmological constant parameter given by other researchers. Among other things such an investigation would also build upon earlier works initiated by Kolb, and other scientists who investigated the cosmological 'constant ' problem and general scalar reconstruction physics for early universe models at FNAL during the 1990s Doing all of this will enable us, once we understand early universe conditions to add more substance to the suggestions by Bonnor , as of 1997[36] for gravity based propulsion systems. As well as permit de facto engineering work pertinent to power source engineering for this concept to become a space craft technology.. As a final comment, we need to briefly mention some of the short falls of models which purport to have dual modeling of dark energy and dark matter. As mentioned in the first section, the Chaplygin Gas model predicts when dark energy - dark matter unification is achieved through an exotic background fluid whose equation of state is given by $p = - A/\rho^{\alpha}$, and with $0 < \alpha \leq .6$. The flaws in thesemodels is two fold. For very early universe models, the Friedman equation for evolution of the scale expansion model appears to give undefinable values for a scale factor $a(t)$ for times $t \leq t_P$, and one needs to have a defined scale factor $a(t)$, in order to have negative acceleration and defined values of the density in Chaplygin Gas models in both early and late time evolution which runs right into resolving the first issue of undefinable scale factor behavior for $a(t)$ for times $t \leq t_P$. Once we are past the time interval $t \leq t_P$ we have a very good agreement with cosmology requirements for both early and later universe expansion, but we have a scaling factor disconnect in a major way in the onset of initial nucleation of a vacuum substrate. Finally, we need to get analytical / observational confirmation as to the feasibility of prior universe inputs into evolving temperature conditions in the early universe which make sense of the jump in initially low temperature conditions as postulated by Caroll and Chen, to the ten to the 12 th power , Kelvin, and higher inflationary cosmology temperature values.

The upshot of such modeling would be to find an analytical argument which would among other things determine how the initial low temperature-low entropy results can be made consistent with initial conditions a space drive would need to use to generate gravitons, i.e. as a way to initiate graviton production which would not be mechanically dangerous to execute and which would become a reverse engineering problem , not just a toy model.

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