# How can Brane World physics influence Axion temperature dependence, initial vacuum states, and permissible solutions to the Wheeler-De Witt equation in early universe cosmology?

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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 are investigating if the Jeans instability criteria mandating a low entropy, low temperature initial pre inflation state configuration can be reconciled with thermal conditions of temperatures at or above ten to the 12 Kelvin, or higher, when cosmic inflation physics takes over. 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. The prior universe would provide thermal excitation into the Jeans instability mandated cooled down initial state, with low entropy, leading to extreme graviton production. occurs before the Bogomolnyi inequality compliments the assumption of axion wall mass disappearing due to high temperatures as a way to embed a quadratic chaotic inflationary scalar potential. Our argument pre supposes that the low entropy conditions due to Jeans instability can be successfully reconciled to a requirement later on that axion mass disappears with induced thermal excitation from inputs from the quantum bounce point from a prior universe, assuming the presence of a gravitational field in the beginning of nucleation of a pop up inflation field. We also affirmatively respond to questions whether existence of graviton production is confirmable using present detector methodology with explicit links between a five-dimensional brane world negative cosmological constant and a four-dimensional positive valued cosmological constant, whose temperature dependence permits an early universe graviton production activity burst. 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.

**Keywords:** branes, axion walls, Bogomolnyi inequality, four- and five-dimensional cosmological constant.
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**Shortened version of gr-qc/063021. Very crude estimate of power production given in eqn. 88 will be considerably 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

## INTRODUCTION

Our present paper is in response to suggestions by Dr. Wald (2005), Sean Carroll, and Jennifer Chen (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 also is consistent with an answer as to the supposition for the formation of a unique class of initial vacuum states, answering a question Guth raised in 2003 about if or not a preferred form of vacuum state for early universe nucleation was obtainable. This is in tandem with the addition of gravity changing typical criteria for astrophysical applications of the jeans instability criteria for weakly interacting fields, as mentioned by Penrose.

Contemporary graviton theory states as a given that there is a thermal upsurge which initiates the growth of graviton physics. This is shown in K.E. Kunzes well written (2002) article which gives an extremely lucid introduction as to early universe additional dimensions giving a decisive impetus to giving additional momentum to the production of relic gravitons. However, Kunze is relying upon enhanced thermal excitation states, which contradict the Jeans instability criteria which appears to rule out a gravitational field soaked initial universe configuration being thermally excited. Is there a way to get around this situation which appears to violate the Jeans instability criteria for gravitational fields/gravitons in the early universe mandating low entropy states? We believe that there is, and that it relies upon a suggestion given by Ashtekar, A., Pawlowski, T. and Singh, P (2006) 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, 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, 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.

A way of getting to all of this is to work with a variant of the Holographic principle, and an upper bound to entropy calculations. R.Busso, and L. Randall (2001) give a brane world variant of the more standard upper bounds for entropy in terms of area calculations times powers of either the fourth or fifth dimensional values of Planck mass, which still lead to minimized values if we go near the origins of the big bang itself. Our observations are then not only consistent with the upper bound shrinking due to smaller and smaller volume/area values of regions of space containing entropy measured quantities, but consistent with entropy/area being less than or equal to a constant times absolute temperatures, if we take as a given in the beginning low temperature conditions prior to the pop up of an inflation scalar field.

## SETTING UP CONDITIONS FOR ENTROPY BOUNDS VIA BRANE WORLD PHYSICS

Our starting point here is first 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

$$\breve{T} = 3 \cdot \left( M_5^3 / 4 \cdot \pi \cdot l \right) \tag{1}$$

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

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

We can then speak of a four dimensional volume $V_4$ and its relationship with a three dimensional volume $V_3$ via

$$V_4 = l \cdot V_3 \tag{3}$$

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

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

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 )

$$S_4(V_3) \le A_2 \cdot \left( M_4^2 / 4 \right) \tag{5}$$

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

$$A_2 \xrightarrow[t \to t_P]{} \varepsilon_{small \quad area} \Leftrightarrow S_5(V_4) \approx \delta_{small \quad entropy} \tag{6}$$

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 entropy

$$\frac{S}{A} \le \sqrt{n^*} \cdot T \tag{7}$$

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

$$T_{dS}\Big|_{t \le t_P} \sim H_0 \approx 10^{-33} eV \tag{8}$$

We shall next refer to how this relates to , considering a low entropy system an expression Wheeler wrote for graviton production and its implications for early relic graviton production, and its connection to axion walls and how they subsequently vanish at or slightly past . the Planck time $t_P$ .

## 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 $\omega$ 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)[9]

$$n(\omega)d\omega = \frac{\omega^2 d\omega}{\pi^2} \cdot \left[\exp\left(\frac{2 \cdot \pi \cdot \hbar \cdot \omega}{\bar{k}T}\right) - 1\right] \tag{9}$$

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. (9) above suggests that at low temperatures we have a large busts of gravitons.

Now, how do we get a way to get the $\omega$ 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 $\sim(10^{15}\ \text{cm})^{-1}$ .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 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. He states : *The expected gravitational wave logarithmic energy spectra are tilted towards high frequencies and characterized by two parameters: the inflationary curvature scale at which the transition to the stiff phase occurs and the number of (nonconformally coupled) scalar degrees of freedom whose decay into fermions triggers the onset of a gravitational reheating of the Universe. Depending upon the parameters of the model and upon the different inflationary dynamics (prior to the onset of the stiff evolution), the relic gravitons energy density can be much more sizable than in standard inflationary models, for frequencies larger than 1 Hz.* Giovannini claims that there are grounds for an energy density of relic gravitons in critical units (i.e., $h_0^2\Omega_{GW}$) is of the order of $10^{-6}$, roughly eight orders of magnitude larger than in ordinary inflationary models. That roughly corresponds with what could be expected in our brane world model for relic graviton production.

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 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. (8) above with a temperature dependence of

$$V(a) = m_a^2 \cdot (f_{PQ}/N)^2 \cdot (1 - \cos[a/(f_{PQ}/N])) \tag{10}$$

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 as given in the figure below

Another take on Eqn. (10) 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. Those wishing to see a low dimensional condensed matter discussion of applications of such methodology can read my articles in World press scientific, as well as consider how we can form a tunneling Hamiltonian treatment of current calculations. Either interpretation will in its own way satisfy the requirements of baryogensis, and also give a template as to the formation of dark energy.

i.e look at conditions for how Eqn. 10 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.

The question to ask though is what energy flux from a prior universe would be needed to thermally excite the axion walls enough to lead to the predicted collapse of what is a tilted washboard potential model . We actually can give some estimates as to what would be needed via the following calculations. For convenience, we will use the following symbol $\psi_a$ for axions, and then relate it to Guth inflationary potential scalar fields later on, and state that $\psi_a(t) = \psi_i$ is the initial misaligned value of the field. Also set $m_a(T)$ as the axion mass. Begin also with the initial evolution equation for axions as given by Ballin, D. and Love, A. (2004)

$$\ddot{\psi}_a + 3 \cdot H \cdot \dot{\psi}_a + m_a^2(T) \cdot \psi_a = 0 \tag{11}$$

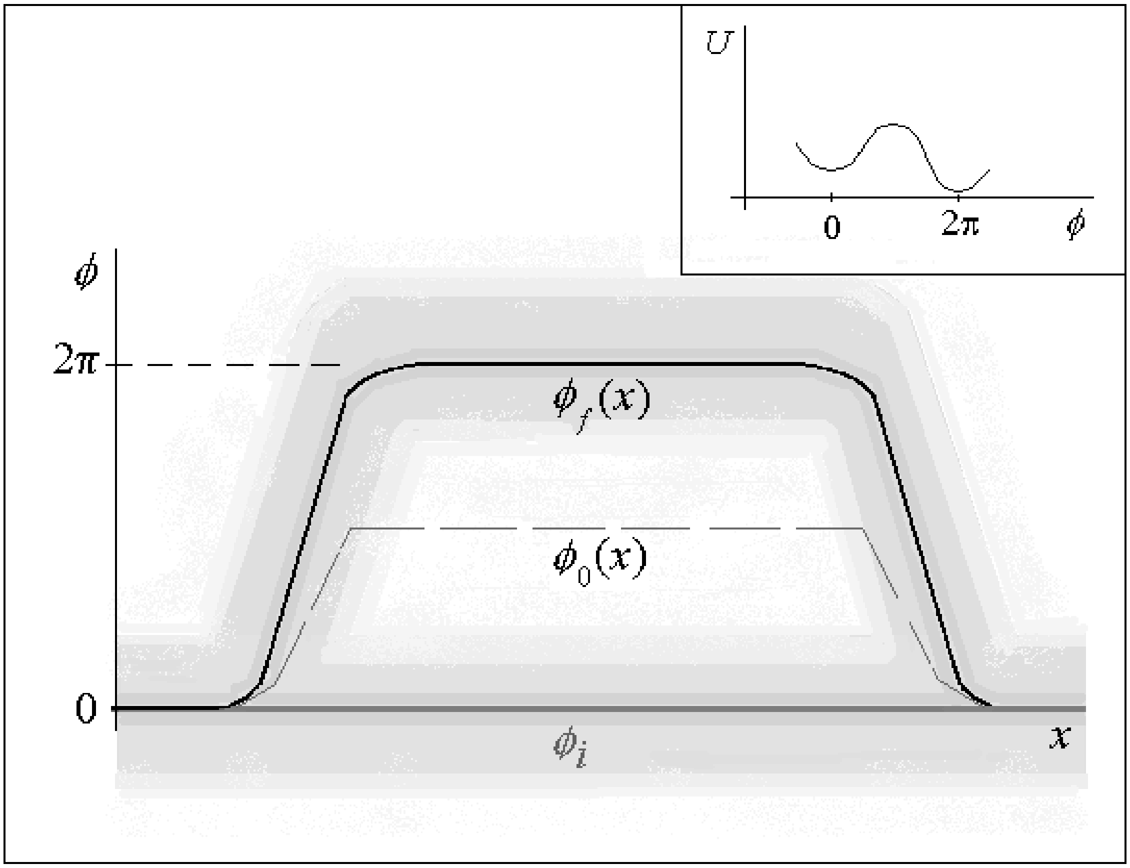
This will lead to an axion mass/ temperature dependence given by a varying by temperature dependent Hubble parameter

$$m_a(T) = 3 \cdot H(T) \tag{12}$$

This means that the axion 'matter' will oscillate with a 'frequency' proportional to $m_a(T)$. The hypothesis so presented is that input thermal energy given by the prior universe being inputted into an initial cavity / region dominated by an initially configured low temperature axion domain wall would be thermally excited to reach the regime of temperature excitation permitting an order of magnitude drop of axion density $\rho_a$ from an initial temperature[2] $T_{dS}\big|_{t \le t_P} \sim H_0 \approx 10^{-33}\, eV$ as given by

$$\rho_a(T_{ds}) \propto \frac{1}{2} \cdot m_a(T_{dS}) \cdot \psi_i^2 \xrightarrow[T \to 10 \;\; to \;\; 12th \;\; power \;\; Kelvin]{} \varepsilon^+ \tag{13}$$

At the same time this is happening, with the temperature in the initial configuration reaching higher values, the initial surge of energy from the prior universe quantum bounce would , indeed, undergo a massive relic graviton production effect which we will attempt to model later on. We also state that this is in tandem with the modeling of a Randall-Sundrum effective potential eventually being congruent with Guths quadratic 4-D inflation potential..




**Initial template for possible interpretation of formation/ disappearance of axion walls**

**FIGURE 1**

*Initial set up for nucleation of a Coleman-De Luccia Instanton ? Assuming that the initial state so referred to is in tandem with 1) creation of relic gravitons in an initially low temperature environment, and 2) the existence of temperature dependent axion walls as given by Eqn (10) above, both of which cease to contribute to inflation as temperatures rise dramatically to the critical value* $T_C$ *needed for electro weak transitions, i.e. GUT regime values. This would either confirm the prediction that Eqn. (10) contributes to a Coleman-De Luccia Instanton if indeed temperatures are initially quite low before a Planckian time interval* $t_P$ *, or give credence to the use of the topological domain wall formation/ subsequent collapse due to the Bogomolnyi inequality*

Given this first figure, 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.

We look at Our embedded in four dimensions potential structure is modeled via the following phase transition listed in Eqn.(4) below. Note that we refer to a scalar field using four dimensional space time, which we will call $\tilde{\phi}$ , and which leads to the potential having the following phase transformation given below, i.e.

$$\begin{array}{ll} \tilde{V}_1 & \to \tilde{V}_2 \\ \tilde{\phi}(increase) \le 2 \cdot \pi & \to \tilde{\phi}(decrease) \le 2 \cdot \pi \\ t \le t_P & \to t \ge t_P + \delta \cdot t \end{array} \qquad (14)$$

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.

$$\tilde{V}_1(\phi) = \frac{{M_P}^2}{2} \cdot \left(1 - \cos\left(\tilde{\phi}\right)\right) + \frac{m^2}{2} \cdot \left(\tilde{\phi} - \phi^*\right)^2 \tag{15}$$

$$\tilde{V}_2(\phi) \propto \frac{1}{2} \cdot \left(\tilde{\phi} - \phi_C\right)^2 \tag{16}$$

$\phi_C$ in Eqn. (13) is an equilibrium value of a true vacuum minimum in Eqn. (16) 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 $\pi$ . A Schwarzshild radius is proportional to the mass, with a proportionality constant involving the gravitational constant and the speed of light. The formula for the Schwarzschild radius can be found by setting the escape velocity to the speed of light Furthermore, mass $m << M_P$ **.** Frequently, m is called the mass of the gravitating object. And as a final note, we have that a soliton is a self-reinforcing solitary wave caused by a delicate balance between nonlinear and dispersive effects in the medium. Solitons are found in many physical phenomena, as they arise as the solutions of a widespread class of weakly nonlinear dispersive partial differential equations describing physical systems.

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We should note that the overall transformation from Eqn. (15) to Eqn (16) is covered by Sidney Coleman's classic paper on false vacuum nucleation. We should also note that $\phi^*$ in Eqn. (16) 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

## MODELING A FIFTH DIMENSION FOR EMBEDDING FOUR DIMENSIONAL SPACE TIME

We start off by explicit order calculations as to the order of the electroweak phase transition, via

$$\frac{\left(\langle\phi\rangle\big|_{T \equiv T_C} \equiv v(T_C)\right)}{T_C} \geq 1 \tag{17}$$

We address how to incorporate a more accurate reading of phase evolution and the minimum requirements of phase evolution behavior in a potential system permitting baryogenesis, which imply using a Sundrum fifth-dimension.

The fifth-dimension of the Randall-Sundrum brane world is, for $-\pi \le \theta \le \pi$ , a circle map which is written, with $R$ as the radius of the compact dimension $x_5$ Circle maps were first proposed by Andrey Kolmogorov as a simplified model for driven mechanical rotors (specifically, a free-spinning wheel weakly coupled by a spring to a motor). The circle map equations also describe a simplified model of the phase-locked loop in electronics..We are using a circle map here as a simple way to give a compact geometry to higher dimensional structures which are extremely important in early universe geometries. A closed string can wind around a periodic dimension an integral number of times. Similar to the Kaluza-Klein case they contribute a momentum which goes as p = w R (w=0, 1, 2, ...). The crucial difference here is that this goes the other way with respect to the radius of the compact dimension, R. As now as the compact dimension becomes very small these winding modes are becoming very light! For our purposes, we write our fifth dimension as.

$$x_5 \equiv R \cdot \theta \tag{18}$$

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

$$\phi(x^{\mu}, \theta) = \frac{1}{\sqrt{2 \cdot \pi \cdot R}} \cdot \left\{ \phi_0(x) + \sum_{n=1}^{\infty} [\phi_n(x) \cdot \exp(i \cdot n \cdot \theta) + C.C.] \right\} \tag{19}$$

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

## RANDALL SUNDRUM EFFECTIVE POTENTIAL

The consequences of the fifth-dimension considered in Eqn. (5) 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. In physics, the graviton is a hypothetical elementary particle that mediates the force of gravity in the framework of quantum field theory. If it exists, the graviton must be massless (because the gravitational force has unlimited range) and must have a spin of 2 (because gravity is a second-rank tensor field). When we refer to string theory, at high energies (processes with energies close or above the Planck scale) because of infinities arising due to quantum effects (in technical terms, gravitation is nonrenormalizable.) gravitons run into serious theoretical difficulties. 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. The strength of gravity depends on location, and away from the Planck brane it is exponentially suppressed. We can think of the brane geometry, in particular the IR brane as equivalent to a needed symmetry to solve a set of equations. This construction permits (assuming K is a constant picked to fit brane world requirements)[40]

$$S_5 = \int d^4x \cdot \int_{-\pi}^{\pi} d\theta \cdot R \cdot \left\{ \frac{1}{2} \cdot (\partial_M \phi)^2 - \frac{m_5^2}{2} \cdot \phi^2 - K \cdot \phi \cdot [\delta(x_5) + \delta(x_5 - \pi \cdot R)] \right\} \tag{20}$$

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

$$m_n^2 \equiv \frac{n^2}{R^2} + m_5^2 \tag{21}$$

To build the Kaluza–Klein theory, one picks an invariant metric on the circle $S^1$ that is the fiber of the $U(1)$-bundle of electromagnetism. In this discussion, an *invariant metric* is simply one that is invariant under rotations of the circle. We are using a variant of that construction via Eqn. (8) above. 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

$$S_5 = -\int d^4x \cdot V_{eff}\left(R_{phys}(x)\right) \to -\int d^4x \cdot \tilde{V}_{eff}\left(R_{phys}(x)\right) \quad (22)$$

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

We get

$$\tilde{V}_{eff}\left(R_{phys}(x)\right) = \frac{K^2}{2\cdot m_5}\cdot\frac{1+\exp\left(m_5\cdot\pi\cdot R_{phys}(x)\right)}{1-\exp\left(m_5\cdot\pi\cdot R_{phys}(x)\right)} + \frac{\tilde{K}^2}{2\cdot\tilde{m}_5}\cdot\frac{1-\exp\left(\tilde{m}_5\cdot\pi\cdot R_{phys}(x)\right)}{1+\exp\left(\tilde{m}_5\cdot\pi\cdot R_{phys}(x)\right)} \quad (23)$$

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

$$\Psi \propto \exp(-\int d^3x_{space}d\tau_{Euclidian}L_E) \equiv \exp\left(-\int d^4x\cdot L_E\right) \quad (24)$$

$$L_E \geq |Q| + \frac{1}{2}\cdot\left(\tilde{\phi}-\phi_0\right)^2\{\ \} \xrightarrow[Q\longrightarrow 0]{} \frac{1}{2}\cdot\left(\tilde{\phi}-\phi_0\right)^2\cdot\{\ \} \quad (25)$$

Part of the integrand in Eqn. (24) 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

$$\tilde{V}_{eff}\left(R_{phys}(x)\right) \approx \text{constant} + \tfrac{1}{2}\cdot\left(R_{phys}(x)-R_{critical}\right)^2 \propto \tilde{V}_2\left(\tilde{\phi}\right) \propto \frac{1}{2}\cdot\left(\tilde{\phi}-\phi_C\right)^2 \quad (26)$$

And

$$\{\ \} = 2\cdot\Delta\cdot E_{gap} \quad (27)$$

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, $E_{false\ min}$, and a true vacuum minimum energy $E_{true\ min}$, with the difference in energy reflected in Eqn. (27) above .

## USING OUR BOUND TO THE COSMOLOGICAL CONSTANT

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) for gravitation production. Here $R$ is proportional to the scale factor 'distance'.

$$B^2(R) = \frac{f_k(R)}{R^2} \quad (28)$$

Also there exists an 'impact parameter'

$$b^2 = \frac{E^2}{P^2} \quad (29)$$

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

$$b \geq B(R) \tag{30}$$

$$f_k(R) = k + \frac{R^2}{l^2} - \frac{\mu}{R^2} \tag{31}$$

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

$$l \equiv \sqrt{\frac{-6}{\Lambda_{5-\dim}}} \tag{32}$$

This assumes a negative bulk cosmological constant $\Lambda_{5-\dim}$ and that $\mu$ 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

$$B^2(R_t) = \frac{1}{l^2} + \frac{1}{4 \cdot \mu} \tag{33}$$

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

$$b \geq B\left(R_t\right) \tag{34}$$

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.

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

$$l_{eff} = \sqrt{\left|\frac{6}{\Lambda_{eff}}\right|} \tag{36}$$

**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,

$$k^* = \left(\frac{1}{'AdS\, curvature}\right) \tag{37}$$

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

$$U_T \propto (external \quad temperature) \tag{38}$$

We can define a quantity

$$\varepsilon * = \frac{U_T^4}{k^*} \tag{39}$$

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

$$\Lambda_{5-\dim} \equiv -3 \cdot \Lambda_{4-\dim} \cdot \left(\frac{U_T}{k^{*3}}\right)^{-1} \propto -3 \cdot \Lambda_{4-\dim} \cdot \left(\frac{external \quad temperature}{k^{*3}}\right)^{-1} \tag{40}$$

So

$$\Lambda_{5-\dim} \xrightarrow[external \quad temperature \to small]{} \text{large value} \tag{41}$$

And set

$$\left|\Lambda_{5-\dim}\right| = \Lambda_{eff} \tag{42}$$

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

$$\cdot\Lambda_{4-\dim} = 8 \cdot M_5^3 \cdot k^* \cdot \varepsilon^* \xrightarrow[external \quad temperature \to 3\,Kelvin]{} (.0004eV)^4 \tag{43}$$

Here, we define $\Lambda_{eff}$ as being an input from Eqn. (14) to (15) to Eqn (16) due to , in part

$$\begin{aligned} &\Delta\Lambda_{total}\Big|_{effective} = \lambda_{other} + \Delta V \\ &\xrightarrow[\Delta V \to end \quad chaotic \quad \inf lation \quad potential]{} \Lambda_{observed} \cong \Lambda_{4-\dim}\left(3\,Kelvin\right) \end{aligned} \tag{44}$$

This, for potential $V_{\min}$, is defined via transition between the first and the second potentials of Eqn. (15)and Eqn. (16)

$$B_{eff}{}^2(R_t) = \frac{1}{l_{eff}{}^2} + \frac{1}{4 \cdot \mu} \tag{45}$$

**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

$$L = \bar{\bar{\lambda}} \cdot a(t) \tag{46}$$

where L is the physical distance $\bar{\bar{\lambda}}$ 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

$$\bar{\bar{\lambda}} \equiv \int_{t_e}^{t} \frac{c \cdot dt'}{a(t')} \tag{47}$$

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.,

$$b^2 \geq B_{eff}{}^2(R_t) = \frac{1}{l_{eff}{}^2} + \frac{1}{4 \cdot \mu} \tag{48}$$

Which furthermore

$$\left.\frac{1}{l_{eff}{}^2}\right|_{t \leq t_P} >> \left.\frac{1}{l_{eff}{}^2}\right|_{t \equiv t_P + \Delta(time)} \tag{49}$$

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

$$\left(\Delta l_{eff}\right)^{-1} = \left(\sqrt{\left|\frac{6}{\Lambda_{eff}}\right|}\right)^{-1} \propto \Delta\left(external \quad temperature\right) \tag{50}$$

## BRANE WORLD AND DI QUARK LEAST ACTION INTEGRALS

Now for the question we are raising: Can we state the following for initial conditions of a nucleating universe?

$$S_5 = -\int d^4x \cdot \tilde{V}_{eff}\left(R_{phys}\left(x\right)\right) \propto \left(-\int d^3x_{space} d\tau_{Euclidian} L_E\right) \equiv \left(-\int d^4x \cdot L_E\right) \tag{51}$$

This leads to ask whether we should instead look at what can be done with S-S' instanton physics and the Bogolmyi inequality, in order to take into account baryogenesis. In physical cosmology, baryogenesis is the generic term for hypothetical physical processes that produced an asymmetry between baryons and anti-baryons in the very early universe, resulting in the substantial amounts of residual matter that comprise the universe today. $L_E$ is almost the same as Eqn. (25)above and requires elaboration of Eqn. (26) above. We should think of Eqn. (26) happening in the Planck brane mentioned above. Keep in mind that there are many baryogenesis theories in existence, The fundamental difference between baryogenesis theories is the description of the interactions between fundamental particles, and what we are doing with di quarks is actually one of the simpler ones.

## 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, we begin with

$$\psi_\mu(\phi) \equiv \psi_\mu \cdot \exp(\alpha_\mu \cdot \phi^2) \tag{52}$$

As well as an energy term

$$E_\mu = \sqrt{A_\mu \cdot B_\mu} \cdot m \cdot \hbar \tag{53}$$

$$\alpha_\mu = \sqrt{B_\mu / A_\mu} \cdot m \cdot \hbar \tag{54}$$

This is for a 'cosmic' Schrodinger equation as given by

$$\tilde{\hat{H}} \cdot \psi_\mu(\phi) = E_\mu(\phi) \tag{55}$$

This has $V_\mu$ is the eigenvalue of a so called volume operator. So:

$$A_\mu = \frac{4 \cdot m_{pl}}{9 \cdot l_{pl}^9} \cdot \left( V_{\mu+\mu_0}^{1/2} - V_{\mu-\mu_0}^{1/2} \right)^6 \tag{56}$$

And

$$B_\mu = \frac{m_{pl}}{l_{pl}^3} \cdot \left( V_\mu \right) \tag{57}$$

Ashtekar[8]works with as a simplistic structure with a revision of the differential equation assumed in Wheeler-De Witt theory to a form characterized by $\partial^2/\partial\phi^2 \cdot \Psi \equiv - \Theta \cdot \Psi$, and $\Theta \neq \Theta(\phi)$. This will lead to $\Psi$ having roughly the form alluded to in Eqn. (33), which in early universe geometry will eventually no longer be $L^P$, but will have a discrete geometry. This may permit an early universe 'quantum bounce' and an outline of an earlier universe collapsing , and then being recycled to match present day inflationary expansion parameters. The main idea behind the quantum theory of a (big) quantum bounce is that, as density approaches infinity, so the behavior of the quantum foam changes. The foam is a qualitative description of the turbulence that the phenomenon creates at extremely small distances of the order of the Planck length. Here $V_\mu$ is the eigenvalue of a so called volume operator and we need to keep in mid that the main point made above, is that a potential operator based upon a quadratic term leads to a Gaussian wave function with an exponential similarly dependent upon a quadratic $\phi^2$ exponent. This permits a match up with Eqn. (24) and Eqn. (25) above, with some additional curved space structure considerations thrown in.

## 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 wrote Dyson doubts we will be able to detect gravitons via present detector technology. The conundrum is that if one defines the criterion for observing a graviton as

$$\frac{f_\gamma \cdot \sigma}{4 \cdot \pi} \cdot \left( \frac{\alpha}{\alpha_g} \right)^{3/2} \cdot \frac{M_s}{R^2} \cdot \frac{1}{\varepsilon_\gamma} \geq 1 \tag{58}$$

Here,

$$f_\gamma = \frac{L_\gamma}{L} \tag{59}$$

This has $f_\gamma \approx \breve{L}_\gamma / \breve{L}$ as 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 $\varepsilon_\gamma$ is the graviton potential energy. Here, $\breve{L}_\gamma -$ luminosity of graviton producing process $\geq$ 7.9 x 10 to the 14th ergs/s, while $\breve{L} -$ general background luminosity where $usually >> \breve{L}_\gamma$ . At best, we usually can set $f_\gamma = .02$, which does not help us very much. That means we need to look else where than the usual processes to get satisfaction for Graviton detection. This in part is why we are looking at relic graviton production for early universe models, usually detectable via the criteria developed for white dwarf stars of one graviton for $10^{13-14}$ neutrinos.

We should state that we will generally be referring to a cross section which is frequently the size of the square of Plancks length $l_P$ which means we really have problems in detection, if the luminosity is so low. An upper bound to the cross section $\sigma$ for a graviton production process $\approx 1/M$ with $M - Planck$ scale in 4+n dimensions $\equiv \left(M_P^2 / \hat{V}_n\right)^{1/2+n}$ ,and this is using a very small $\hat{V}_n - Compactified$ early universe extra dimension 'square' volume ≈ 10-15 mm per side.

.As stated in the manuscript, the problem then becomes determining a cross section $\sigma$ for a graviton production process and $f_\gamma = L_\gamma / L$. Here, a 4-dimensional graviton emission cross section goes like 1/M. The existence of branes is relevant to graviton production. In addition, it would permit us to give in confirmation of the existence of Ashtekar's candidate [8]or a discrete wave functional for a modified Wheeler de Witt equation we would write up as follows. The point is that if we understand the contribution of Eqn. (58) above to space time dynamics, we will be able to confirm or falsify the existence of space time conditions as given by a non $L^P$ structure as implied below. This will entail either confirming or falsifying the structure given to $\Theta$. Also, and more importantly the above mentioned $\Theta$ 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

$$\max \tilde{\Psi}(k) = \tilde{\Psi}(k)\Big|_{k \equiv k^*} \tag{61}$$

This is for a crucial 'momentum' value

$$p_\phi^* = - \left(\sqrt{16 \cdot \pi \cdot G \cdot \hbar^2 / 3}\right) \cdot k^* \tag{62}$$

And

$$\phi^* = -\sqrt{3/16 \cdot \pi G} \cdot \ln\left|\mu^*\right| + \phi_0 \tag{63}$$

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

$$e_k^s(\mu) = \left(1/\sqrt{2}\right) \cdot \left[e_k(\mu) + e_k(-\mu)\right] \tag{64}$$

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

$$\Psi(\mu, \phi) = \int_{-\infty}^{\infty} dk \cdot \tilde{\Psi}(k) \cdot e_k^s(\mu) \cdot \exp\left[i\omega(k) \cdot \phi\right] \tag{65}$$

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[9]make reference to a revision of this momentum operation along the lines of basis vectors $|\mu\rangle$ by

$$\hat{p}_\iota |\mu\rangle = \frac{8 \cdot \pi \cdot \gamma \cdot l_{PL}^2}{6} \cdot \mu |\mu\rangle \tag{66}$$

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

$$\frac{\partial^2}{\partial \phi^2} \cdot \Psi \equiv - \ \Theta \cdot \Psi \tag{67}$$

$\Theta$ in this situation is such that

$$\Theta \neq \Theta(\phi) \tag{68}$$

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

$$\Delta t \cong t_P \propto \frac{1}{4\pi} \cdot \sqrt{\frac{45}{\pi \cdot (\Delta N(T))_P}} \cdot \left(\frac{M_P}{T^2}\right) \tag{69}$$

This creates problems, so we look for other ways to get what we want. Grushchuk writes that the energy density of relic gravitons is expressible as

$$\varepsilon(v) \equiv \frac{\pi}{(2 \cdot \pi)^4} \cdot \frac{1}{a(t)^4} \cdot H_i^2 \cdot H_f^2 \cdot a(t)_f^4 \tag{70}$$

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. How can we tie in with the Gaussian wave functional $\tilde{\Psi}(k)$ given in Eqn (50) and defined as an input into the data used to specify Ashtekar's quantum bounce. 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 $E(energy) \equiv \varepsilon(v) \cdot$(initial nucleation volume) , we can read off from Eqn. (74), 'pre inflationary' universe values for the k values of Eqn. (61)can be obtained, with an optimal value selected. This assumes of course that there is a small separation in conditions between the peak energy density of relic gravitons as specified in Eqn. (74) and the formation of them, in numerical values from a volume of space smaller than what is specified by Eqn. (69) 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

$$|k^*| = \sqrt{3/16 \cdot \pi \cdot G \cdot \hbar^2} \cdot \left( \varepsilon(v) \cdot \left( initial \ \ nucleation \ \ volume \right) / c \right) \tag{71}$$

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

$$\varepsilon(v) \cdot \left( initial \quad volume \right) \approx \hbar \cdot \omega(net) \equiv p^{*} \cdot c \tag{72}$$

in order to use Eqn. (62) 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. (65) above.

$$\Psi(k) \approx \frac{1}{Value} \cdot \exp\left( - \quad c_2 \cdot \left(k - k^{*}\right)^2 \right) \tag{73}$$

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. (15) leading to Eqn (16) for a chaotic inflationary potential.

## TIE IN WITH ANSWERING GUTHS QUESTION ABOUT THE EXISTENCE OF A PREFERRED VACUUM NUCLEATION STATE?

First of all, this is separate from the question of the existence of a scale factor. We are assuming that the scale factor would exist for cosmological times of the order of magnitude of Plancks time interval. This is also assuming that the nucleation of the favored vacuum state would commence for values of a scalar potential in line with conditions leading to the formation of Eqn. (16) above. Having said that, let us commence looking at what suffices to initiate chaotic inflation? Note that a potential

$$V \approx (1/n) \cdot \phi^{n} \tag{74}$$

involves a change of scale factor of the form

$$a(\phi(t)) \cong a_{init} \cdot \exp\left( \frac{4 \cdot \pi}{n} \cdot \left( \phi^{2}{}_{init} - \phi^{2}(t) \right) \right) \tag{75}$$

What is involved is a reduction of the degrees of freedom of the initial physical system which permitted the di quark condensate to form in the first place. This would cause the physical system to shift from the 1st to the final Guth chaotic potential form alluded to above which is involving a drop off of higher order terms as seen in Eqn. (16). This would be in tandem with higher powers of n disappearing, leading to

$$V \approx (1/n) \cdot \phi^{n} \xrightarrow[AXION \to 0]{} (1/2) \cdot \phi^{2} \tag{76}$$

This would be in tandem with

$$a_{init} \cdot \exp\left( \frac{4 \cdot \pi}{n} \cdot \left( \phi^{2}{}_{init} - \phi^{2}(t) \right) \right) \xrightarrow[AXION\,WALL \to \varepsilon^{+}]{} a_{init} \cdot \exp\left( \frac{4 \cdot \pi}{2} \cdot \left( \phi^{2}{}_{init} - \phi^{2}(t) \right) \right) \tag{77}$$

We can argue that this would make exceedingly difficult a consistent model of scale factor evolution. This is akin to making the following assertion. Namely that at the start of a new universe that the relationship given below ceases to hold, namely :

$$\left.\frac{H^2}{\left|\dot{\phi}_{cl}\right|}\right|_{t \equiv t_P} \neq \frac{\delta\rho}{\rho} \Rightarrow \text{(scalar) density perturbations are NOT of order } O(1) \text{ at time } t_P \tag{78}$$

And that one needs a new starting point for pre inflationary cosmological models. To get this start, we shall try to ascertain if or not a favored vacuum state actually exists. We claim it does. The action given by the following structure $S_5 = -\int d^4x \cdot \widetilde{V}_{eff}\left(R_{phys}(x)\right) \propto (-\int d^3x_{space} d\tau_{Euclidian} L_E) \equiv \left(-\int d^4x \cdot L_E\right)$ is in tandem with writing along the lines of the quantum bounce as given by Sidney Coleman, and treating $\left.S_5\right|_{non-Euclidian\ \ time}$ as a phase factor

$$\Psi_{wave\ \ fucntion\ \ of\ \ the\ \ universe} \propto \exp(-S_5) \approx \exp\left(i \cdot \left.S_5\right|_{non-Euclidian\ \ time}\right) \tag{79}$$

via the following quantum mechanical theorem: We have a path way to a generic behavior of an ensemble of wave functionals with equivalent phase evolution behavior. Taking into account the quantum mechanical theorem stated as mentioned below :

*In quantum theory for example it is well known that you may change the phase of the wave functions by an arbitrary amount without altering any the physical content or structure of the theory, provided that you change the all wave functions in the same way, everywhere in space. We are doing the same thing here with respect to:*

$$\text{Wave function} \sim \exp\left( - i \cdot \text{integral (effective potential )}\right) \tag{80}$$

*That condition of changing the ensemble of wave functions in the same way will force the simplest form of construction , of a vacuum state consistent with respect to* **Eqn. (79)** *above as a favored initial starting point for forming a phase evolution consistent with one favored vacuum state .*

The upshot of having a favored vacuum state is that we can then ascertain if or not we have a formation of a quantum bounce in line with Ashtekar, A., Pawlowski, T. and Singh, P (2005)suppositions given in the modification of the Wheeler – De Witt equation given in their Phys Rev. D article. This in its own way would lead to investigating the feasibility of a prior universe providing us with initial input of energy needed to stimulate relic graviton production on the scale so visualized, as well as reconciling the initial low temperature state visualized by a gravity dominated early universe with low entropy , with the peaks of temperature given at the onset of Guth inflationary potential cosmology.

## SIMILARITIES/DIFFERENCES WITH GHOST INFLATION, AND INQUIRES AS TO THE ROLE OF CONDENSATES FOR INITIAL VACUUM STATES

Arkani-Hamed recently has used the Ghost inflation paradigm to eliminate using slow roll as a way to initiate inflation with far lower energy scales than is usually associated with standard inflation models. His prediction does, which we disagree with, postulate far fewer gravity waves / relic gravitons than is associated with standard models of inflation. We postulate MORE, rather than less assumed relic graviton production. However, we also think that his analysis makes many cogent points which we will enumerate here, which are pertinent to the initial condensate nucleation, which we will put forward here.

Standard slow roll is premised upon the following quantum fluctuation assumptions:

1) Quantum fluctuations are important on small scales, if and only if one is working with a static space time (i.e. no expanding universe )
2) For inflating space times, quantum fluctuations are 'expanded' to be congruent in magnitude with classical sizes ( classical fluctuations)
3) Simple random walk picture: In each time interval of $\Delta t \equiv H^{-1}$, the average field $\phi$ receives an increment with root means squared, of $\Delta\phi_{qu} = \frac{H}{2 \cdot \pi}$. This increment is super imposed upon the classical motion, which is downward.
4) Quantum fluctuations are equally likely to move field $\phi$ 'up or down' the well of a 'harmonic' style potential.

Those who read the presentation should note the conclusion which is something which raises serious questions : i.e.

5) In equations, the probability of an upward fluctuation exceeds $1/e^3 \cong \frac{1}{20}$ if

$$\Delta\phi_{qu} \approx \frac{H}{2 \cdot \pi} > 0.61 \cdot \left|\dot{\phi}_{cl}\right| \cdot H^{-1} \Leftrightarrow \frac{H^2}{\left|\dot{\phi}_{cl}\right|} > 3.8 \tag{81}$$

But

$$\frac{H^2}{\left|\dot{\phi}_{cl}\right|} \sim \frac{\delta\rho}{\rho} \Rightarrow \text{(scalar) density perturbations are of order } O(1) \tag{82}$$

In addition, we have that If we look at

$$\left(\frac{V_{,\phi}}{V}\right)^2 << 1 \tag{83}$$

We find that $\widetilde{V}_1$ of Eqn. (9) fits this requirement for small $\phi$ values, but is inconsistent w.r.t.

$$\left|\frac{V_{,\phi\phi}}{V}\right| << 1 \tag{84}$$

However, if we work with $\widetilde{V}_2$ of Eqn. (16) that both of these conditions would be amply satisfied. We can either do two things. First of all state that $\widetilde{V}_1$ of Eqn. (15)is such a fleeting instant of nucleated time, that the slow roll condition does not hold, and consider that the de facto history as we can manage it of Cosmological evolution is after a time $\Delta t \approx t_P$ in which we consider only $\widetilde{V}_2$ of Eqn. (16) . If we consider though that the initial phases of nucleation as we postulate are our candidate for relic graviton production we need to question how feasible making the assumption so out lined as to ignoring Eqn. (84)are for such a short instant of time.

Enter in Arkani-Hamed's ghost inflation paper. He configures the evolution of de Sitter phases via a ghost scalar field $\widehat{\phi}$ condenses in a background with a non zero velocity along the lines of (assuming M is a generic mass term)

$$\left\langle \dot{\hat{\phi}} \right\rangle = M^2 \Rightarrow \left\langle \hat{\phi} \right\rangle = M^2 t \quad (85)$$

This leads to a density fluctuation along the lines of, assuming an upper bound of $M \leq 10MeV$

$$\left.\frac{\delta\rho}{\rho}\right|_{Ghost} \approx \left(\frac{H}{M}\right)^{5/4} \quad (86)$$

As opposed to, when $\in$ is a slow roll parameter proportional to $(V'/V)^2$

$$\left.\frac{\delta\rho}{\rho}\right|_{Inflation} \approx \left(\frac{H}{m_P \cdot \sqrt{\in}}\right) \quad (87)$$

The ghost inflation paradigm so outlined postulates that there exists a maximum energy scale of the order of $V_0 \sim (1000TeV)^4$ which allegedly rules out relic gravitons. The model so outlined here, which we are working with assumes a massive relic graviton production surge. So it appears that we cannot ignore some variant of inflation. We need to do additional investigations as to if or not it is realistic to suppose that time restrictions below Planck time are enough to lead to a 'temporary' violation of Eqn. (84)

We thereby will from now on stick to our model which appears to give criteria for graviton production. But Arkani-Hamed's ghost inflation if true would probably eliminate the feasibility of graviton space travel systems. We have outlined initial universe conditions which if replicated would allow them to exist, and which could be used for space travel.

## 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 $\omega$, which is by Fontana (2005) at a STAIF new frontiers meeting, which allegedly gives for a rod of length $\hat{L}$ and of mass m a formula for graviton production power,

$$P(power) = 2 \cdot \frac{m_{graviton}{}^2 \cdot \hat{L}^4 \cdot \omega_{net}{}^6}{45 \cdot \left(c^5 \cdot G\right)} \quad (88)$$

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 $\omega_{net}$ as an input from an energy value, with graviton production number ( in terms of energy) as given approximately via an integration of eqn. (9) above, $\hat{L} \propto l_P$, 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.

## CONCLUSION

To answer Guth (2002), when there are $10^{1000}$ vacuum states produced by String theory and when inflation produces overwhelmingly one preferred type of vacuum states over the other possible types of vacuum states Eqn. (69) is too inexact. Instead, we have baryogenesis consistent with Eqn. (17) for $\Delta t \approx t_P$ interval.

Eqn. (1) is for a critical temperature $T_C$ defined in the neighborhood of an initial grid of time $\Delta t \approx t_P$. If so, baryogenesis plays a role in forming early universe wave functions that are congruent with respect to the Wheeler De Witt equation. We need to investigate if or not these wave functions are congruent with Abbay Akshenkar's supposition[8]for a quantum bounce. If they are, it would lead credence to Akshenkar's supposition of an earlier universe imploding due to contraction to the point of expansion used in measuring the birth of our universe.

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.'

Eqn. (17)is for a critical temperature $T_C$ defined in the neighborhood of an initial grid of time $\Delta t \approx t_P$. Here, $T \equiv T_c \sim 250 \quad GeV \Rightarrow N(T_c) \cong 51.5$. This among other things leads to a change in volume along the lines of, to crude first approximation imputing in numerical values to obtain

$$V = volume = \frac{5.625 \times 10^{57}}{T^6} \cdot \frac{1}{N^{3/2}(T)} \tag{89}$$

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.

Now for suggestions as to future research. We are in this situation making reference to solving the cosmological "constant" problem without using G. Gurzadyan and She-Sheng Xue's approach which is fixed upon the scale factor $a(t)$ for a present value of the cosmological constant. We wish to obtain, via Parks method of linking four and five dimensional cosmological constants a way to obtain a temperature based initial set of conditions for this parameter, which would eliminate the need for the scale factor being appealed to, all together. 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 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.