Open questions as to what a Large vacuum energy implies for graviton production in a relic setting, i.e. a Toy Model to Consider

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Abstract

If we have a non infinite but huge negative value of the cosmological vacuum energy in the wormhole, then we have 10^{10} bits of computing information. When we leave the wormhole, we have 10^{120} bits of computing information We specify a transition between the two regions in terms of a causal discontinuity regime created by a(t) chaotic behavior due initially to the initially very large value of thermal vacuum energy transmitted. Note that this is a toy model to account for thermal transfer of energy from a prior to a present universe perhaps enabling graviton production. This is a companion piece to the Octonian gravity document.[1, 2]

Introduction

Details, and many more of them are needed to bridge this transition to the problem of structure formation and a drop of temperature. If we look at Ruutu's[3] (1996) ground breaking experiment we see vortex line filaments rapidly forming. Here are a few open questions which should be asked.

1) Do the filaments in any shape or form have an analogy to the cosmic strings so hypothesized by String theorists ? My guess is a flat MAYBE but one cannot be certain of this. This deserves to be analyzed fully. If they have an analogy to cosmic strings, then what is the phase transition from a maximally entangled space time continuum, with a soliton type behavior for temperatures of the order of $T \sim 10^{32}\,Kelvin$ to the formation of these stringy structures.
2) What is the mechanism for the actual transition from the initial 'soliton' at high temperatures to the symmetry breaking phase transition? This is trickier than people think. Many theorists consider that, in tandem with Ruutu's[3] (1996) experiment that Axion super partners, Saxions, actually are heated up and decay to release entropy. Do we have structures in initial space time analogous to super fluids allowing us to come up with such a transformation. Do axions/ Saxion super partner pairs exist in the onset of thermal transition from a prior universe to our present universe? How could this be experimentally determined with rigorous falsifiable experimental analysis?
3) One of the models considered as a super fluid candidate for this model has been the di quark one. This however was advanced by Zhitinisky[4] (2002) in terms of 'cold dark matter'. Could some analogy to di quarks be used for initial states of matter thermally impacted by a transfer of thermal energy via a wormhole to form a cosmic 'bubble' in line with the initial plasma state given in Ruutu's [3](1996) experiment?
4) Do the formation of such initial conditions permit us to allow optimal conditions for graviton production? If so, can this be transferred to engineering prototypes ? How can this be modeled appropriately ?

Now for a simplified model to as how to answer the above four questions

Here is a very simplified model as to what we may be able to expect if there is actual relic graviton production . I.e. Detecting gravitons as spin 2 objects with available technology .To briefly review what we can say now about standard graviton detection schemes, Rothman[5] states that the Dyson seriously 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

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

Here,

$$f_\gamma = \frac{L_\gamma}{L} \quad (2)$$

This has $\frac{L_\gamma}{L}$ 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 $\alpha_g = G m_p^2 / \hbar$ a constants r, while ε_γ is the graviton P.E. As stated in the manuscript, the problem then becomes determining a cross section σ for a graviton production process and $f_\gamma = \frac{L_\gamma}{L}$.

If this is the case, then what can we do to see how relic gravitons may emerge if we have a worm hole transferred burst of thermal/ vacuum energy ?[6]

TABLE 1. With respect to phenomenology.

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

Also, one can expect a difference in the upper limit of Park's four dimensional inflation value for high temperatures, onn the order of 10 to the 32 Kelvin, and the upper bound, as Barvinsky[7] (2006) predicts. If put into the Harkle-Hawking's wave function, this difference is equivalent to a nucleation-quantization condition, which, it is claimed, is a way to delineate a solution to the cosmic landscape problem that Guth (1981,2000,2003)[8, 9, 10] discussed. In order to reference this argument, it is useful to note that Barvinsky [7] in (2006) came up with

$$\Lambda_{\max}\Big|_{Barvinsky} \cong 360 \cdot m_P^2 \tag{3}$$

A minimum value of

$$\Lambda_{\min}\Big|_{Barvinsky} \cong 8.99 \cdot m_P^2 \tag{4}$$

This is in contrast to the nearly infinite value of the Planck's constant as given by Park[11] (2003)

$\cdot\Lambda_{4-\dim}$ is defined by Park [11](2003).with $\varepsilon * = \frac{U_T^4}{k^*}$ and $U_T \propto (external \quad temperature)$, and $k^* = \left(\frac{1}{' AdS \, curvature} \right)$ so that

$$\Lambda_{4-\dim, Max}\Big|_{Park} \xrightarrow[T \mapsto 10^{32} \, Kelvin]{} \infty \tag{5}$$

As opposed to a minimum value as given by Park [11](2003)

$$\cdot\Lambda_{4-\dim} = 8 \cdot M_5^3 \cdot k^* \cdot \varepsilon^* \xrightarrow[external \quad temperature \to 3 \, Kelvin]{} (.0004 eV)^4 \tag{6}$$

TABLE 2.What can be said about cosmological Λ in 5 and 4 dimensions.

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

This leads to presenting 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, wherewhere Gravitons have two independent polarization states), as given by Weinberg[12] (1972).

$$n(\omega)d\omega = \frac{\omega^2 d\omega}{\pi^2} \cdot \left[\exp\left(\frac{2 \cdot \pi \cdot \hbar \cdot \omega}{\bar{k}T} \right) - 1 \right]^{-1} \tag{7}$$

Thee hypothesis presented here is that input thermal energy (given by the prior universe) 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. This would permit an order-of-magnitude drop of axion density ρ_a from an initial temperature $T_{dS}\big|_{t \le t_P} \sim H_0 \approx 10^{-33} eV$.

Graviton power burst/ where did the missing contributions to the cosmological 'constant' parameter go?

To do this, one needs to refer to a power spectrum value that can be associated with the emission of a graviton. Fortunately, the literature contains a working expression of power generation for a graviton produced for a rod spinning at a frequency per second ω, per Fontana[13] (2005), for a rod of length $\widehat{L}$ and of mass m a formula for graviton production power. This is a variant of a formula given by Park [14] (1955), with mass $m_{graviton} \propto 10^{-60} kg$

$$P(power) = 2 \cdot \frac{{m_{graviton}}^2 \cdot \widehat{L}^4 \cdot {\omega_{net}}^6}{45 \cdot \left(c^5 \cdot G\right)} \tag{8}$$

The contribution of frequency here needs to be understood as a mechanical analogue to the brute mechanics of graviton production. The frequency ω_{net} is set as an input from an energy value, with graviton production number (in terms of energy) derived via an integration of Eq. (7) above, $\widehat{L} \propto l_P$. This value assumes a huge number of relic gravitons are being produced, due to the temperature variation
.

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

And then one can set a normalized "energy input "as $E_{eff} \equiv \langle n(\omega) \rangle \cdot \omega \equiv \omega_{eff}$; with $\hbar\omega \xrightarrow[\hbar \equiv 1]{} \omega \equiv \left| E_{critical} \right|$, which leads to the following table of results, where T^* is an initial temperature of the pre- inflationary universe condition[15]. If one uses the above Eq. (9) then one can easily re scale the toy model for graviton burst.

Namely

TABLE 3. Graviton burst.

Numerical values of graviton production	Scaled Power values
N1= 1.794×10^{-6} for $Temp = T^{*}$	Power = 0
N2= 1.133×10^{-4} for $Temp = 2T^{*}$	Power = 0
N3= $7.872\times10^{+21}$ for $Temp = 3T^{*}$	Power = $1.058\times10^{+16}$
N4= $3.612\times10^{+16}$ for $Temp = 4T^{*}$	Power $\cong$ very small value
N5= 4.205×10^{-3} for $Temp = 5T^{*}$	Power= 0

Here, N1 refers to a net graviton numerical production value as given by Eqn. (9). There.T is a distinct power spike of thermal energy that is congruent with a relic graviton burst.

Conclusion: Beginning of a simplified toy model to account for the following Graviton / Gravity Wave versus frequency burst model ?

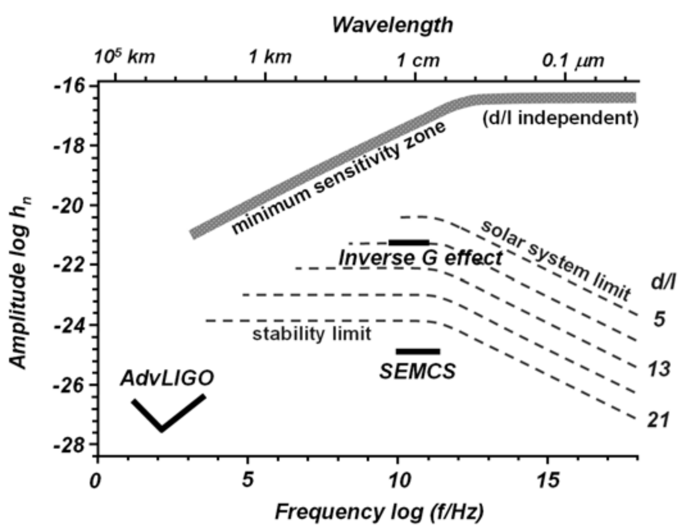

Figure 1 : *The amplitude and frequency of the HFGWs expected by the brane oscillation models in the submillimetre-size extra dimensions. The figure is taken from Ref. (16)[16], where* l *is the curvature scalar of the bulk,* d *is the distance between the "visible" brane and the "shadow" brane.*

We are looking forward to obtain a way to predict how GW frequency can be obtained as of up to about 10^{+10} Hertz. If gravitational waves are closely tied in with gravitons as we suspect, then the above. diagram may be correlated with the behavior of table 1, table, 2, and table 3. This is what we are working upon, in toy models which will be refined considerably, if GW astronomy commences and becomes an experimental science we can match with sufficient rigor.

Bibliography

[1] Beckwith, A.W.," Energy content of Graviton as a way to Quantify both Entropy and Information Generation in the early Universe", accepted for publication in JMP, February 2011

[2] Beckwith A.W, Li F.Y., et al.,"Is Octonian Gravity relevant near the Planck Scale", http://vixra.org/abs/1101.0017

3 Ruutu, V. , Eltsov, V, Gill, A., Kibble, T., Krusius, M., Makhlin, Y.G., Placais, B., Volvik, G, and Wen, Z., "Vortex Formation in neutron – irradiated 3He as an analog of cosmological defect formation," Nature 382, 334-336 (25 July 19 1996)

[4] Zhitinisky, A., "Dark Matter as Dense Color Superconductor' arXIV: astro-ph/0204218 v1 12 April 2002. ***Refer to the last version of this document***

[5] Rothman, T. and Boughn, S., " *Can Gravitons be Detected ?*", *Foundations of Physics*, **36**, No. 12,, 1801-1825 (December 2006), arXIV gr-qc/0601043 v 2 02 Jan 2006

[6] Beckwith, A.W, "How can Brane World physics influences the formation of a cosmological constant relevant to graviton production?" *arXIV physics/0612010,* accessible as http://arxiv.org/abs/physics/0612010, *E.J T.P., **4**, No. 15, 105-142* (July 2007)

[7] Barvinsky,A., Kamenschick,A., Yu, A. , " Thermodynamics from Nothing: Limiting the Cosmological Constant Landscape, Phy Rev D **74** 121502 (Rapid communications)

[8] Guth, A.H "Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems," *Phys. Rev*. D 23, 347-356 (1981)

[9] Guth. A.H., "Inflation and Eternal Inflation," http://www.citebase.org/cgi-bin/citations?id=oai:arXiv.org:astro-ph/0002156 (2000).

[10] Guth. A.H., "Eternal Inflation," http://online.itp.ucsb.edu/online/strings_c03/guth/pdf/KITPGuth_2.pdf (2003)

[11] Park, D.K., Kim, H., and Tamarayan, S., "Nonvanishing Cosmological Constant of Flat Universe in Brane world Senarios," *Phys.Lett*. **B**535 (2002) pp. 5-10

[12] Weinberg , S., *Gravitation and Cosmology: Principles and Applications of the General theory of Relativity*, John Wiley & Sons, Inc. New York, 1972

[13] Fontana, G., "*Gravitational Wave Propulsion*," in *CP746, Space Technology and Applications International Forum*-STAIF 2005, editede by M. S. El-Genk, American Institute of Physics, Melville, NY, 2005

[14] Park, D, "Radiations from a Spinning Rod,"*Physical Review*, **99**, No. 4, 1324-1325 (1955).

[15] Beckwith, A.W., **"**Does A Randall-Sundrum Brane World Effective Potential Influence Axion Walls Helping to Form a Cosmological Constant Affecting Inflation?**"** http://www.citebase.org/cgi-bin/citations?id=oai:arXiv.org:gr-qc/0603021 **(**2006**),** in *AIP Conf.Proc*.880:1170-1180 (2007).

[16] Clarkson C. and Seahra, S.,S. Class. Quant. Grav. 24, F33 (2007).