Entropy growth in the early universe, and the search for determining if gravity is classical or quantum, part I (Confirmation of initial big bang conditions?)

Andrew Beckwith
abeckwith@uh.edu, beckwith@aibep.org

PACs: 98.80.Cq, 95.35.+d, 95.30.Sf, 65.40.gd, 11.25.Uv

Abstract

We begin our inquiry by asking two questions. First, is there an approximate match up between the total entropy of the universe, and the sum total of entropy between super massive black holes at the center of spiral galaxies? Note that Sean Carroll in 2005 presented a black hole entropy value which could have a super massive black hole in the center of a galaxy having more than 10^{89} non dimensionalized units of entropy in value. This value would be greater than what H. J. de Vega calculated as the entropy value of the entire universe. And there are conceivably up to a million spiral galaxies. Secondly, we accept what De Vega presented about entropy, i.e. its approximate present day value was nearly reached during the end of the re heating of the universe, right after the big bang. If so, the second question is what initiated entropy growth in the beginning ? This paper shows how increased entropy values from an initially low big bang level can be measured experimentally by counting relic gravitons. Furthermore the physical mechanism of this entropy increase is explained via analogies with early-universe phase transitions. The role of Jack Ng's revised infinite quantum statistics in the physics of gravitational wave detection is acknowledged. Ng's infinite quantum statistics can be used to show that $\Delta S \approx \Delta N_{gravitons}$ is a starting point to the increasing net universe cosmological entropy. Finally, in a nod to similarities with ZPE analysis, it is important to note that the resulting/\] $\Delta S \approx \Delta N_{gravitons} \neq 10^{89}$, that in fact it is much lower, allowing for evaluating initial graviton production as an emergent field phenomena, which may be similar to how ZPE states can be used to extract energy from a vacuum if entropy is not maximized.. Finally, the implications of if or not gravitons have mass will be reviewed as far as how graviton mass issues, and the nature of gravitational waves, may affect experimental measurements of relic big bang conditions. The relationship of some models of KK gravitons as having similar evolution equations to GW in GR models will be commented upon, with suggestions as to how that ties in DM values.

INTRODUCTION

What we would like to do is to add content to what Seth Lloyd presented about Entropy

By necessity, entropy will be examined, using the equivalence between number of operations which Seth Lloyd used in his model, and total units of entropy as the author referenced from Sean Carroll, and other theorists. The key equation Seth Lloyd wrote is as follows, assuming a low entropy value in the beginning

$$\left|S_{Total}\right| \sim \left|k_B \cdot \ln 2\right| \cdot \left[\# operations\right]^{3/4} \qquad *(0.0)$$

Seth Lloyd is making a direct reference to a linkage between the number of operations a quantum computer model of how the Universe evolves is responsible for , in the onset of a big bang picture, and entropy..If equation (0.0) is accepted, which is debatable, then the issue is what is the unit of operation, i.e. the mechanism involved for an operation for assembling a graviton A good question is, if this is done, then how to get an appropriate operation, linkable with the number of emergent gravitons, so **at least** equation (0) will be congruent with . One very interesting side effect of quantifying emergent universe entropy with gravitons would be in either confirming / falsifying a prediction made by **Alves, Miranda, and Araujo (2009)** about how graviton mass could serve the same function as DE as enabling acceleration of the universe to be increasing, and /or to say something about over all density values, i.e. conceivably energy density of an evolving universe. A question to ask which is important is if or not equation *(0.0) corresponds with requirements necessary for vacuum nucleation of particle counts for initial entropy generation. What will be necessary for such vacuum nucleation will be brought up at the end of this article. As part of a discussion of future research projects Another even more important datum is possibly linking gravitons and gravitinos and or KK gravitons with DM, as can be started with the following observation. Note that the simple assumption that the dark matter (DM) is a thermal relic is surprisingly restrictive. The limit $\omega_X \lesssim 1$ implies that the mass of a DM relic must be less than about 500 TeV . The standard lore is that the hunt for DM should concentrate on particles with mass of the order of the weak scale and with interactions with ordinary matter on the scale of the weak force. This has been the driving force behind the vast effort in DM detectors. What would be useful would be in investigating if or not taking the limit $\sigma|v| < M_X^{-2}$, for DM cross sections, as denoted with subscript X can lead to, as an example, a non equilibrium process of $\left(\frac{200\,\text{TeV}}{M_X}\right)^2\left(\frac{T_*}{M_X}\right) < 1$. occurring, which may signify conditions for $M_X \gtrsim 200$ TeV was created at $T_* < M_X$. Note that Edward (Rocky) Kolb uses this argument to argue for Wimpzillas, with enormous mass. It can, if $T_* > M_X$ be an entry point as to much lower DM masses. The non equilibrium process if examined fully can lead to possible linkage between DM mass values, and graviton mass, once certain assumptions are explored concerning DM, SUSY super partners, and gravitons are examined. The simplest connection the author, Beckwith is examining is identifying the gravitino as having similar characteristics with the KK graviton.

We do think that equation *(0.0) above will be crucial to delineating the non equilibrium process. Furthermore, understanding it fully may help clear a linkage between gravitons and their super partners, gravitinos from purely a theoretical stand point/ construction, to a possible experimentally falsifiable set of measurement criterion to be developed by experimental astro physics researchers.. I.e. if one can actually come up with experimental protocol to make a linkage between different 'particles' and their super partners, this in itself would be extraordinarily important for the development of physics. This can be done if we can define a linkage between a gravitino and the KK graviton. Not simple. But doing the KK graviton first, and showing its inter relationship with more conventional gravitons may be a step in this direction.

This article is to get definition as to Seth Lloyds supposition, in terms of candidates for the 'number of operations' of entropy and emergent structure, relic gravitons

There are three components as to analyzing both entropy, and machine collection of astrophysical data which may obtain relic conditions for astro physical data which may permit a useful research and development program for tying in the growth of entropy, in relic conditions with falsifiable data sets of big bang physics.

The section called basic premises, i.e. the **zeroth Chapter**, is a review of entropy from the stand point of traditional cosmology, as presented by H.J. de Vega who did an outstanding job at the International School of Astro particle physics, Como, Italy [villa Olmo] in outlining how, and why entropy build up occurred relatively rapidly during the first 10^{-36} seconds of the big bang. We do not disagree with his conclusions, but ask the question which he avoided as to how and why the entropy build up occurred in the first place. In addition, we ask as to what would cause entropy to increase as to the number of operations, as out lined by formula zero, i.e. the foundational entropy formula given in formula zero.

Furthermore, after stating this, there is one very serious issue to examine, which will be summarized as follows. If there exists one million or so spiral galaxies, each with a super massive black hole, what is the relationship between the totality of SM black hole entropy values from these galaxies, and the over all figure of roughly 10^{89} cited by de Vega in the ISAPP school, meeting for total entropy. i.e. for super massive black holes, how does their total entropy value stack up with regards to 10^{89}.. Note that Sean Carroll wrote in 2005 about Black Hole entropy as having an overall value of

$$S_{Black-Hole} \sim 10^{90} \cdot \left[\frac{M}{10^{6} \cdot M_{Solar-Mass}}\right]. \qquad * (0.7)$$

As opposed to a value given by Malencala, in the IAS public lecture series (2002) of

$$S_{black-hole} \sim \frac{A_{Event-Horizon-area-BH}}{(10^{-33}\, centimeters)^2} \qquad *(0.8)$$

Both of these formulas have to be regularized and compared with the Hawkings result of $S_{Black-Hole} \equiv \left(k \cdot A / 4 \cdot l_P^2\right)$, with A being the area of a Black Hole event horizon, , k as Boltzmann's constant and l_P as Planck's length which is proportional to 10^{-35} meters may break down in part for black holes above a certain mass. Note that in the situation where formula*(0.2) is used that $\hbar = c = 1$ This issue will be discussed later than chapter zero, but it is fundamental to our understanding of entropy. While we are at it, it is worth while to note that many calculations of the event horizon results depend upon the metric used for the space time about the black hole . Usually, Wheeler- Nordstrom metrics are employed to take into account curvature effects ,and presumed charges inherent in a black hole. So happens that inflation removes curved space, i.e. one has abrupt flattening of space within 10^{-36} seconds of the big bang. The stated benefit of removing curved space is to remove spurious, non observed monopole / other relic particles from the aftermath of the big bang. However, the space time about black holes is, as generally accepted, increasingly curved as one approaches the event horizon of a black hole. Balancing the entropy equation , leading to roughly 10^{89} for entropy, non dimensional units, during the cosmological re heat era, which would assume flat space metrics may have to be compared to localized curved space metrics about a million or so super massive black holes in spiral galaxies.

If the relative entropy of 10^{89} is roughly equivalent to the sum total of one million or so black holes in the center of one million spiral galaxies, then it may remove the necessity of embedding the universe in a larger super structure. If on the other hand, there is a radical difference in the summed value, this difference may be a smoking gun indicating either the necessity of higher dimensions than four for our universe's space time, (note that four dimensions is what LQG assumes for space time), or that the metrics for curved space time used to compute event horizons are seriously flawed and need additional work.

The implications to LQG, and and LQG entropy of SM black holes, as being the same, or close to 10^{89} has pronounced implications as to the singularity theorems of GR. Recent papers in LQG which the author was exposed to in the 12 Marcel Grossman conference, assumed that big bounce replaced the singularity conditions Hawkings , Ellis, and others . In particular, Marco Valerio Batistini, in a PRD article as of 2009 uses Snyder geometry to find a common basis in which to make a limiting approximation as to how to either derive either brane world, or LQG conditions for cosmological evolution. The heart of what Batistini works with is a defomed Euclidian synder space, when we use the $\hbar = c = 1$ units, obtaining then $[q,p] = i \cdot \sqrt{1 - \alpha \cdot p^2} \Leftrightarrow \Delta q \Delta p \geq \frac{1}{2} \cdot \left| \left\langle \sqrt{1 - \alpha \cdot p^2} \right\rangle \right|$. The LQG condition is $\alpha > 0$, and Brane worlds have, instead $\alpha < 0$. As Batistini indicated, in PRD, 2009, it is possible to obtain a string theory limit of

$$\Delta q \geq \left[(1/\Delta p) + l_s^2 \cdot \Delta p\right] \equiv (1/\Delta p) - \alpha \cdot \Delta p \,. \qquad *(0.9)$$

We will use this result explicitly in the document as to differentiating between criteria as to information transfer from a prior to a present universe , as a way to distinguish, on falsifiable experimental grounds, how to determine if minimimal spatial uncertainty requirements for space time can distinguish between LQG, and brane world scenarios. The tie in with entropy and information processing comes in , with regards to order of magnitude estimates as to what would be minimum informational content needed to preserve continuity of basic physical law between our present and a past cosmos. Continuity would be preserved in physical law if the fundamental physical contstants of nature remain invariant.

If there is a basic discontinuity between a present and past cosmos in terms of primary physical constants, likely it means that there is a multiverse construction, with many universes possible. If there is a basic continuity, due to the LQG, then we can speak of, perhaps, one basic universe, in terms of recycled content. And can then abandon the multi verse/ potentially infinite universes.

The starting point will lie in falsifiable criteria to if or not the graviton has some sort of mass value, and if or not it can be conflated with information / entropy. If mass values are not obtained for the graviton, then different criteria have to be sought to investigate information transfer to our present universe. A search which is not impossible, but requires extremely rigorous experimental protocol to investigate. Note that string theory, as a matter of procedure, estimate that we have very low mass values for the graviton. This is important, and will have many implications which will be presented in the manuscript. One of the results of the brane theory, versus LQG treatment of minimum length, Δq is that the value for this spatial variation Δq is less in the LQG scenario, than in the Brane theory case. Recall that in Brane theory/ string theory , that gravitons have zero mass, or for all intensive cases , next to zero mass. In the manuscript, there is a detailed analysis of how graviton mass could be linked to actual gravitational wave dispersion, via the well known formula of modification of tensor fluctuations, via the existence of a graviton mass, m_g . Here, then the dispersion relationship for gravitational waves would then be written as

$$\omega_{gw} = \sqrt{p^2 + m_{graviton}^2} \,. \tag*{*(0.10)}$$

Dubovsky, Flauger, Starobinsky, and Tkachev in 2009 cited measurements which in their estimation give $m_{graviton} \le 10^{-30}\,eV \approx 1.677 \times 10^{-47}$ grams, with the author, Beckwith, using values as low as $m_{graviton} \sim 10^{-60}$ grams. This should be evaluated in terms of understanding how M Novello and R P Neves (2003) in Classical and Quantum gravity , used anti de Sitter space time, the to obtain

$$m_{graviton}^2 = -\frac{2}{3} \cdot \Delta_{anti-de-Sitter} \tag*{*(0.11)}$$

with the anti de Sitter cosmological value < 0. So being this necessitated a very small graviton mass. LQG so far does not have explicit rules or bounds, YET on the graviton mass, other than providing a propagator for the existence of a graviton as a spin two ‘object’. It is to be noted that $m_{graviton}^2 = -\frac{2}{3} \cdot \Delta_{anti-de-Sitter}$ is not inconsistent with $m_{graviton} \sim 10^{-60}$ grams, and that we use a deliberately low graviton mass to ascertain if or not enough information from a prior universe can be transferred to our present universe, in order to maintain the same values for basic physical parameters such as G and $\hbar$, and α , i.e. the fine structure constant. Non withstanding Visser’s 1998 paper about a stress – energy tensor T_{uv} admitting graviton mass (his paper did not allow for black holes!) , there is theoretical work done , as reported by Herbert W. Hambler (2009) about how how gravitons with mass would lead to the creation via free graviton propagator techniques of two ghost state masses, for the graviton, one of a spin two graviton mass given by $m_2 = spin-2-graviton-mass = \mu \big/ \sqrt{a}$, and another $m_0 = spin-0-graviton-mass = \mu \big/ \sqrt{2b}$. Unless tachyon masses are involved (no they are not) both a and b are > 0. The mass μ would be ot the order of planck mass values, i.e. $\mu \propto 1.21 \times 10^{19}\, GeV / c^2 \equiv M_{planck}$, which would lead to a variation of the static Newtonian gravitational potential to

$$h_{00} \sim \frac{1}{r} - \frac{4}{3} \cdot \frac{\exp(-m_2 r)}{r} + \frac{1}{3} \cdot \frac{\exp(-m_0 r)}{r} \tag*{*(0.12)}$$

The primary application of the above is not wildly inconsistent with $m_{graviton} \sim 10^{-60}$ grams, but the above equation for h_{00} application would primarily be in planck length distances, i.e. $l_P \sim 1.63 \times 10^{-33}$ centimers and would need to be compared with making sense of the geometry inherient in

$m^2_{graviton} = -\frac{2}{3} \cdot \Delta_{anti-de-Sitter}$ AdS-CFT space time geometry. That will take a lot of work. The primary value the author sees in applying *(0.11) and reconciling it with *(0.12) would be for structure formation, and it may be in part a link between graviton production in relic conditions, and deviations of the density profiles of DM halos, which will be commented upon later. This is in part not all tha different from reconciling the overall DM problem, as stated in *(0.3) , *(0.5), and *(0,6) with the possibility that the starting point given by *(0.3) may be similar to *(0.12) and that $m^2_{graviton} = -\frac{2}{3} \cdot \Delta_{anti-de-Sitter}$ can be adapted to give the same information as *(0.5) once assembly of the graviton commences due to applying *(0.0) appropriately.

The **First**, **chapter** is to examine if or not GW from the big bang were either high, medium, or low frequency. This is relevant to what detectors may be utilized for GW frequency based signatures from the big bang. Part of this first section is determining if or not GW, for short wave length, HFGW play a dominant role in entropy generation as would be expected if relic GW are high frequency, We wish to state that if HFGW do not exist, for relic conditions, that low frequency GW are not important for entropy development, but DM production as within the region of space before the photon turn on of the CMBR sphere of approximately 400 thousand years after the big bang would be the most important contributing factor for entropy .The longer the wave length , i.e. the lower the energy contribution is, from material being injected into our universe from a prior universe, the more likely it is DM as a boost to entropy along the lines of the suggestion offered by Jack Ng (2007, 2008).

Chapter 0. The standard introduction of entropy during the big bang

This section is largely introducing what H. J. De Vega concluded and brought up in the ISAPP school , in Villa Olmo, Italy which the author attended in July 2009. First of all, De Vega gave a starting energy/ mass density scale of $10^{16}\,GeV$ at the start of the big bang, which is important, since it ties in very closely with the temperature range the author, myself, found useful for initial relic graviton production. What De Vega paid special attention to what how and why vacuum energy could turn into particles, going so far as to introduce present day entropy as $.97 \times 10^{89}$ (non dimensionalized) units in value, while stating that in the re heat phase, right after the big bang, that there was a net entropy of $S_{re-heat} \geq 10^{89}$, corresponding to a temperature at the end of inflation of $10^{14}\,GeV$, and with an analytical entropy expression of $S_{re-heat} \approx \frac{2 \cdot \pi^2}{45} \cdot T_{re-heat} \cdot g_{re-heat} \cdot d_{re-heat}$ .Vega set the re heat temperature as $T_{re-heat} \geq 10^{14}\,GeV$, whereas the degrees of freedom in the re heating ear, $g_{re-heat} \approx 1000$, according to De Vega, while dropping to $g_{electro-weakt} \approx 100$ in the electro weak era. This value of the space time degrees of freedom, according to de Vega has reached a low of $g_{today} \approx 2-3$. Whereas de Vega very pointedly refused to speculate if or not the degrees of freedom would go much above 1000 in the region before $g_{re-heat} \approx 1000$. This lack of information as far as applications of a temperature, and degrees of freedom based value for entropy, as a pre re head refinement to $S_{re-heat} \approx \frac{2 \cdot \pi^2}{45} \cdot T_{re-heat} \cdot g_{re-heat} \cdot d_{re-heat}$, partly due to finding the horizon size at the end of inflation $d\left(t_{end-of-\inf}\right) \approx \frac{\exp(N_{total} \equiv 63)}{H}$, where H is the Hubble parameter, and this the basis for defining horizon size for re hearing as

$d_{re-heat} \equiv \sqrt{\frac{H}{H_{re-heat}}} \cdot d\left(t_{end-of-\inf}\right)$, and $H_{re-heat} \equiv \frac{\pi^2 \cdot g_{re-heat}}{90M_{Pl}^2} \cdot T_{re-heat}^4$. The fact that it is, by classical theory next to impossible to ascertain accurately degrees of freedom greater than $g_{re-heat} \approx 1000$ for space times before the re heating regime, i.e. what are the degrees of freedom at or before 10^{-36} seconds after the big bang, as well as how temperature varied from $10^{16} GeV$ at the start of the big bang to $10^{14} GeV$ at the close of the big bang, means we have to find a different genesis for the initial growth of entropy. This is what the article is about, i.e. to seriously examine what could have initiated entropy growth from the very beginnings. Note that if there is a way to have additional dimensions, that there are non four standard dimensional structures to boost a massive graviton on, in order to generate DM. The preferred method appears to be to conflate KK gravitinos with massive gravitons, and to conflate the massive gravitons being rapidly accelerated in some non standard 4 dimensional space time structure with DM, and to show a linkage between the two. Easiest way to make a linkage between KK gravitons, and standard massive gravitons is to note, as Masato Minamitsuji, Misao Sasaki, and David Langlois did, in April 2005 , to call KK gravitons as equivalent to massive gravitons on the brane with masses m>3H/2, where H represents the expansion rate of a dS brane. I.e. if we start off with gravitons, for the pre inflationary right up to beginning of inflation conditions, as not being expanded rapidly on dS branes, we have , perhaps $m_{graviton} \sim 10^{-65} - 10^{-60}$ grams, , i.e. at the start, in pre inflationary conditions we set the 'at rest' $m_{graviton} \leq 10^{-30} eV$ which then right after the start of expansion linked to inflation on the dS brane boosts to $m_{KK-graviton} \sim .5TeV \sim .5 \times 10^9 eV$. If so, the technical problem to work out is the inter relationship between the dS 'brane' structure and our standard space time. To do this, note that second Randall-Sundrum (RS II) type brane cosmology, as given by Masato Minamitsuji (arXIV 0805.3818) has a division between what happens in compactified dimensions, and a regime when the dimensions are non compactified. As Minamitsuji writes "As is expected, in the early times, namely when the brane is located in the near-horizon region, the effective cosmology on the brane coincides with that in the second Randall-Sundrum (RS II) model. Then, the brane cosmology starts to deviate from the RS type one since the dynamics of KK compactified dimensions becomes significant. We find that the brane Universe cannot reach the asymptotic infinity, irrespectively of the components of matter on the brane". I.e. the initial picture is to have compactified dimensions, presumably corresponding to where the traditional low mass graviton 'lives', and then a regime where non compactified dimensions become important,leading to huge massive graviton masses, presumably linkable to DM.

How to compare SM black hole entropy with de Vega's value of 10^{89} for the entire universe ?

The starting point is to examine if or not the entropy of black holes in the center of galaxies exceeds the number, 10^{89}, given by de Vega as the entropy of the universe, today. To do this, it is feasible to look at the following formula, as given by Juan Maldacena, in an IAS public lecture, 2002, as to black hole entropy. Taking the following dimensional conventions , i.e. $\hbar = c = 1$, so that $M_{Planck} = E_{Planck} = 1/\sqrt{G}$, and we have $t_{Planck} = l_{Planck} = \sqrt{G}$, then it is possible to re write the entropy of a black hole, $S_{black-hole} \sim \frac{A_{black-hole-EH}}{(10^{-33} centimeters)^2}$. Using elementrary reasoning, based upon the Schwarzshild radius of a (super massive in the center of a spiral Galaxy) black hole $r_{black-hole-event-horizon} = R_{b-h-e-h} \equiv \frac{2 \cdot M_{black-hole} \cdot G}{c^2} \equiv 2 \cdot M_{black-hole} \cdot G$, Obviously, the surface area of an event horizon is, to first order for a Schwartzshield model black hole, $\pi \cdot R_{b-h-e-h}^2$. A SM black hole, in the center of the galaxy would have an event horizon 1/10 the Earth- Sun radius, i.e. nine million miles, for a SM black hole $4\times10^6\cdot M_{sun}$, i.e. a radii of 14.6×10^6 kilometers, i.e . 14.6×10^{10} centimeters. If one squares this value, then one gets a feeling of how fast entropy builds up, from say a black hole of sun size mass with a radii of about 2.9511896×10^4 centimeters . Then the entropy of a super massive Black Hole at the center of the Milky way would be of the order of $\pi\cdot\left(14.6\times10^{10}\right)^2\times10^{66}\equiv\pi\cdot(313.16)\times10^{86}\approx10^{89}$. I.e. it is almost the value of the total entropy of the universe.

Obviously, something is wrong. There are two possible resolutions of this. First of all, the Schwartzshield radius value may be too large. If the event horizon is much smaller , then the fact that there are numerous spiral Galaxies, perhaps up to a million, each with their central, SM black hole will not yield a total entropy on the order of 10^{89}. Having the value of up to a million spiral galaxy super massive black holes with combined entropy $\le10^{89}$ would permit having a four dimensional representation of how the present universe is set up, and in many ways negate the reason for looking for higher dimensions and/or a larger super structure for our universe to be embedded within. If, on the other hand the total sum of spiral galaxy SM black hole entropy is $>10^{89}$, then some sort of embedding and/ or higher dimensional super structure for our present universe is probably necessary. Sean Carroll,, Mathew Johnson, and Lisa Randall, in 2009 wrote up an extremal Black Hole paper where an offered formula linking a Euclidian action, I_E with the total entropy of the black hole was presented to be $S_{Black-Hole}=\left(\beta\frac{d}{d\beta}-1\right)\cdot I_E$, with the coefficient β as a so called periodicity parameter, as opposed to string theory calculations with a non zero entropy Carroll gives in this paper of $S_{Black-Hole}\equiv(\rho/4G)$, where the ρ parameter is part of the $AdS_2\times S^2$ metric geometry of $dS^2=\rho^2\cdot\left[-\left(\sinh^2\chi\right)d\psi+d\Omega_2^2\right]$. If one interprets the $d\Omega_2^2$ term as being equivalent to traditional four space geometry. This should be compared to what Ghosh, A.; Mitra, P. put up in (2005), of $S_{Black-Hole}\ge\left[\frac{\lambda A}{2}-\frac{(\ln A)^3}{3\lambda^2}\right]$, which is using $\left(\frac{\lambda}{2\cdot\pi}\right)\approx.274$, and a non dimentionalization of the Immirzi parameter γ of the form $4\pi\gamma\cdot l_P^2=1$, as well as a horizon area $A\equiv2\cdot\sum_j s_j\cdot\left\lfloor\sqrt{j\cdot(j+1)}\right\rfloor$. So then we can, at least make a thought experiment between a minimum value of $S_{Black-Hole}\sim\left[\frac{\lambda A}{2}-\frac{(\ln A)^3}{3\lambda^2}\right]$ and $S_{Black-Hole}\equiv(\rho/4G)$, provided an equivalent comparison can be made between $\frac{\lambda A}{2}$, and $(\rho/4G)$. If so, then the LQG result, appears to have a lower minimum value than $S_{Black-Hole}\equiv(\rho/4G)$, which suggests, depending on how the horizon is calculated, that the LQG could have the sum of all entropies of SM black holes less than or equal to 10^{89}, whereas the string theory summation of SM black hole entropies could be greater than or equal to 10^{89}.

Chapter 1. The nature of entropy ?/ Does "entropy" have an explicit meaning in astrophysics?

This paper will assert that there is a possibility of an equivalence between predicted Wheeler De Witt equation early universe conditions and the methodology of string theory, based upon a possible relationship between a counting algorithm for predicting entropy, based upon an article by Jack Ng (which he cites string theory as a way to derive his counting algorithm for entropy).

This is due to re stating as entropy $S \approx$ <n> $\Big|_{gravitons}$ with <n> as a numerical graviton density and the expression given by Glinka (2007) for entropy (where Glinka uses the Wheeler De Witt equation), if we identify Ω as a partition function due to a graviton-quintessence gas. If confirmed, this may also lead to new ways to model gravity/ graviton generation as part of an emergent 'field' phenomenon. Now why would anyone wish to revisit this problem in the first place? The reason is because that there are doubts people understand entropy in the first place. As an example of present confusion, please consider the following discussion where leading cosmologists, i.e. Sean Carroll (2005) asserted that there is a distinct possibility that mega black holes in the center of spiral galaxies have more entropy, in a calculated sense, i.e. up to 10^{90} in non dimensional units. This has to be compared to Carroll's (2005) stated value of up to 10^{88} in non dimensional units for observable non dimensional entropy units for the observable universe. Assume that there are over one million spiral galaxies, with massive black holes in their center, each with entropy 10^{89}, and then there is due to spiral galaxy entropy contributions $10^{6} \times 10^{89} = 10^{95}$ entropy units to contend with, vs. 10^{89} entropy units to contend with for the observed universe. I.e. at least a ten to the eight order difference in entropy magnitude to contend with. The author is convinced after trial and error that the standard which should be used is that of talking of information, in the Shannon sense, for entropy, and to find ways to make a relationship between quantum computing operations, and Shannon information. Making the identification of entropy as being written as $S \sim \ln[partition - function]$. This is Shannon information theory with regards to entropy, and the convention will be the core of this text. What is chosen as a partition function will vary with our chosen model of how to input energy into our present universe. This idea as to an input of energy, and picking different models of how to do so leading to partition functions models is what motivated research in entropy generation . From now on , there will be an effort made to identify different procedural representations of the partiton function, and the log of the partion function with both string theory representations, i.e. the particle count algorithm of Y.Jack Ng, and the Wheeler De Witt version of the log of the partition function as presented by Glinka (2007). Doing so may enable researchers to eventually determine if or not gravity/ gravitational waves are an emergent field phenomenon. A further datum to consider is that Eqn (1) with its variance of density fluctuations may eventually be linkable to Kolmogrov theory as far as structure formation . If we look at R. M. S. Rosa (2006) , and energy cascades of the form of the 'energy dissipation law' , assuming u_0, l_0 are minimum velocity and length, with velocity less than the speed of light, and the length at least as large, up to 10^{6} time larger than Planck length l_{Planck}

$$\varepsilon \approx \frac{u_0^3}{l_0} \tag{1}$$

Equ (1) above can be linked to an eddy break down process, which leads to energy dissipated by viscosity. If applied appropriately to structures transmitted through a 'worm hole' from a prior to a present universe, it can explain

1) How there could be a break up of 'encapsulating' structure which may initially suppress additional entropy beyond $S_{initial} \sim 10^{5}$, in the onset of inflation
2) Provide a 'release' mechanism for $\Delta S \approx \Delta N_{gravitons} < 10^{54} << 10^{89}$, with $\Delta S \approx \Delta N_{gravitons} \sim 10^{21}$ perhaps a starting point for increase in entropy in $\Delta t \approx t_{Planck} \sim 5 \times 10^{-44}$ sec, rising to $\Delta S \approx \Delta N_{gravitons} \leq 10^{54} << 10^{89}$ for times up to 10^{-36} seconds after the big bang.

3 Different senarios for Entropy growth depending upon If or not we have Low to high Frequency GW from the big bang.

As mentioned above, there is a question of what frequency range of GW is dominant during the onset of the big bang. To begin with let us look at frequency range of GW from relic conditions. As given by for a peak amplitude as stated by **Tina Kahniashvili (2007). Now for the amplitude of a GW, as detected today**

$$h_c(f) = 1.62 \times 10^{-18} \left(\frac{T_*}{100\,\mathrm{GeV}}\right)\left(\frac{g_*}{100}\right)^{-5/6}\left(\frac{\gamma}{0.01}\right)^{3/2}\left(\frac{\zeta}{0.01}\right)^{1/2}\left[k_0^3 f H_{ijij}(2\pi f, 2\pi f)\right]^{1/2}. \tag{1a}$$

The equation , as given by Kahniashvili (2007) with a frequency f given below in Eqn. (2) which is for todays detected GW frequency a detector would observe, whereas ω_* is the frequency of a process synthesizing GW during a 2nd order phase transition in the early universe. Also, T_* is a mean temperature during that 2nd order phase transition. If as an example T_* is many times larger than 100 GeV, which is the case if GW nucleation occurred at the ORIGIN of the big bang, i.e. at temperatures $\sim 10^{32}\,Kelvin$, then it is likely that f in Equation 2 below is capable of approaching values of the order of what was predicted by Grishkuk (2007) , i.e. approaching 10 Giga Hertz. Eqn (1) **above**, would have either a small, or a huge T_*, which would pay a role as to how large the amplitude of a GW would be, detected today, as opposed to what it would be at the origin, say, of the big bang. . The larger f is, the more likely the amplitude is, of Eqn (1) would be very large. In both Eqn (1) above, and Eqn. (2) below, g_* is a degree of freedom for spatial conditions factor , which has , according to Kolb and Turner (1991) high values of the order of 100 right after the big bang, to values closer to 2 and/or 3 in the modern era. I.e. the degrees of freedom radically dropped in the evolution of space time.

$$f = 1.55 \times 10^{-3}\,\mathrm{Hz}\left(\frac{\omega_*}{k_0}\right)\left(\frac{g_*}{100}\right)^{1/6}\left(\frac{\gamma}{0.01}\right)^{-1}\left(\frac{T_*}{100\,\mathrm{GeV}}\right), \tag{2}$$

Here, in this choice of magnitude h of a GW today , and frequency f detected today , as presumed by using a factor given by Kahniashvili (2007) as

$$H_{ijkl}(\mathbf{x}', \mathbf{k}, \omega) = \frac{1}{(2\pi)^4}\int \mathrm{d}^3\xi \mathrm{d}\tau e^{i(\omega\tau - \mathbf{k}\xi)} R_{ijkl}(\mathbf{x}', \xi, \tau). \tag{3}$$

Why? The factor H_{ijkl} is due to complicated physics which gives a tensor/scalar ratio. As well as

$$R_{ijkl}(\mathbf{x}', \xi, \tau) = \frac{1}{\mathrm{w}^2}\langle S_{ij}(\mathbf{x}', t) S_{kl}(\mathbf{x}'', t+\tau)\rangle, \tag{4}$$

Why? Eqn (4) is a two correlation point function, much in the spirit of calculations of two point correlation functions , i.e. greens functions of Quantum field theory . See Peskin's (1995) QFT reference as to how such functional calculations are to show the degree of interaction between $S_{i,j}(x',t)\,\&\,S_{k,l}(x'',t+\tau)$, with each individual $S_{i,j}$ defined as part of a GR 'stress tensor' contribution of

$$S_{ij}(\mathbf{x}, t) = T_{ij}(\mathbf{x}, t) - \frac{1}{3}\delta_{ij} T^k_k(\mathbf{x}, t), \tag{5}$$

This is where, commonly, we have a way to interpret $h_{i,j}$ in terms of $S_{i,j}$ via

$$h_{ij}(\mathbf{x},t) = 4G\int d^3x' \frac{S_{ij}(\mathbf{x}', t - |\mathbf{x}-\mathbf{x}'|)}{|\mathbf{x}-\mathbf{x}'|}. \quad (1) \tag{6}$$

As well as a wave equation we can write as

$$\nabla^2 h_{ij}(\mathbf{x},t) - \frac{\partial^2}{\partial t^2} h_{ij}(\mathbf{x},t) = -16\pi G S_{ij}(\mathbf{x},t). \quad (1) \tag{7}$$

What is above, is a way for making sense of GW 'density' as given by the formula

$$\rho_{GW}(\omega) \equiv \frac{d\rho_{GW}}{d\ln\omega} = 16\pi^3\omega^3 G \mathrm{w}^2 \tau_T H_{ijij}(\omega,\omega). \tag{8}$$

Here, the temperature T_* for the onset of a phase transition,i.e. usually interpreted as a 2nd order phase transition plays a major role as to if or not the frequency, f, for today is very low, or higher, and if or not energy density is high, or low, as well as the attendant amplitude of a GW, as given by Eqn (1) above is important. Furthermore appropriate calculations of Eqn. (8) very much depend upon the correlation function as given by Eqn (4) is correctly done, allowing for a minimization of sources of noise , of the sort alluded to by Michelle Maggiore (2008). Possibly though, cosmological evolution is so subtle that no simple use of correlation functions will be sufficient to screen noise by typical f ield theory derived methods.If temperature T_* for the onset of a phase transition,is very high, it is almost certain that we are looking at HFGW, and relic gravitons which are severely energized, i.e. ω* would be enormous. If so, then for high T_* and enormous ω*, at the onset of inflation, we are looking at HFGW, and that

$$\Delta S \approx \Delta N_{gravitons} \tag{9}$$

If the frequency is much lower, we will see , if the particle-wave duality has large λ , for DM candidates\

$$\Delta S \approx \Delta N_{DM-Candidates} \tag{10}$$

So what did we conclude? It's not clear, until experiments are done to answer questions about the relative importance of HFGW to re contructing relic big bang conditions. . We determine of or not the change in entropy is due to either the number of DM candidates nucleated at or before 400 thousand years after the big bang, as given by Eqn (10) if GW were not high frequency dominated in the aftermath of the big bang. .

Models will work for what purpose?. And why are string theories relevant here? The models are for explaining what choices may be relevant toward understanding early universe nucleation conditions. The reason why string theory came up at all, is for two reasons.

Zeroth order reason, but it is not to be forgotten. Gravitons may be de composed via an instanton – anti instanton structure.i.e. that the structure of SO(4) gauge theory is initially broken due to the introduction of vacuum energy, and that after a second-order phase transition, the instanton-anti-instanton structure of relic gravitons is reconstituted. This will be crucial to link graviton production with entropy, provided we have sufficiently HFGW at the origin of the big bang. The linkage to SO(4) gauge theory and gravitons was brought up by Kuchiev, M. Yu, and we think it leads to a kink-anti kink pair tie in for attendant gravitons . Note that Kuchiev writes that "Conventional non-Abelian *SO*(4) gauge theory is able to describe gravity provided the gauge field possesses a specific polarized vacuum state. In this vacuum the instantons and anti-instantons have a preferred direction of orientation.", and furthermore "Gravitons appear as the mode describing propagation of the gauge field which strongly interacts with the oriented instantons" Furthermore, as given by Ivan Andrić, Larisa Jonke and Danijel Jurman, in a Classical and quantum gravity article, 2006, what is called an *n*-soliton solution is shown to have an equivalence with the following, namely "semiclassical solutions correspond(ing) to giant gravitons described by matrix models obtained in the framework of AdS/CFT correspondence" . Solitons have a kink- anti kink structure, even in low dimensions, as was worked out by Beckwith (2006) in a condensed matter application. The string theory methodology is merely extending much the same thinking up to higher than four dimensional situations..

1. Modeling of entropy, generally, as kink-anti-kinks pairs with $\breve{N}$ the number of the kink-anti-kink pairs. This number, $\breve{N}$ is, initially in tandem with entropy production, as will be explained later,

2. The tie in with entropy and gravitons is this: The two structures are related to each other in terms of kinks and antikinks. It is asserted that how they form and break up is due to the same phenomenon: a large insertion of vacuum energy leads to an initial breakup of both entropy levels and gravitons. When a second-order phase transition occurs, there is a burst of relic gravitons. Similarly, there is an initial breakup of net entropy levels, and after a second-order phase transition, another rapid increase in entropy.

First of all, String theory has been, when applied, a good way to introduce instanton physics insights as to embedding particle creation criteria into the fabric of space time . I.e. the idea of Edward Witten, as of 1996 was to embed instantons as de facto physical objects. This is similar in part to what C. Bachas, and Elias Kiritsis wrote as of 1993 , that "We identify exact gauge-instanton-like solutions to (super)-string theory using the method of dimensional reduction. We find in particular the Polyakov instanton of 3d QED, and a class of generalized Yang-Mills merons. We discuss their marginal deformations, and show that for the 3d instanton they correspond to a dissociation of vector- and axial-magnetic charges" I.e. string theory was/ has been useful for higher dimensional generalization of charges of 'particle' objects in space time.

Recalling what was said about entropy, if particles (either gravitons and/or dark matter) in early universe conditions are indeed composed of 'instanton- anti instanton physical componets, as will be explained later then their formation, and in certain cases, as seen in charge density wave physics, disassociation as modeled by Beckwith (2006) are a way to get insight as to current/ rate increase calculations for non equilibrium physical processes . Strings could, do much of what Beckwith did in 2006 for low dimensional CDW problems in terms of clarifying transport behavior for unusual non linear processes. And, early universe models are the ultimate non linear evolutionary equation problem. Having said that, we remind the readers that we will employ a 'counting algorithm' of 'particles' as an entropy measurement , as indicated by Jack Ng (2007,2008)

Secondly, strings showed up in entropy calculations due to the determination of certain theorists to apply the string theory monikor to every conceivable thermodynamic situation in particle astro physics. This is a new tradition in the making with all its attendant virtues and faults. In particular, although it is not appreciated .there are some similarities of black hole physics, and early universe conditions. We are NOT referring to the initial near singularity as a 'white' (reverse) hole, but some of the later works did, as as been shown byYasunari Kurita et al 2008, do credible work in extending the simple no hair theorem of black hole physics to topics such as stated "After a brief review of thermodynamic quantities of the black hole solutions, we calculate thermodynamic potentials relevant for several thermodynamic environments". This was a way to relate black hole thermodynamics, five dimensional strings, and Kalusa Klein model physics,". If one insists upon higher dimensional embedding of space time, strings are a natural way to do just that. Unfortunately, certain people have made strings an end into themselves. Like all technques, some common sense has to be employed..Having said this, let us proceed to look at different versions of how to employ the kink- anti kink structure of entropy, and tie it in to a 'particle count' . The place to start is to present what Jack Ng (2007,2008)said about $\Delta S \approx \Delta N_{particle-count}$ in terms of partition functions. Note that Vishnu Jejjala, Michael Kavic, and Djordje Minic (2007) are cited as doing much the same thing with M theory, so Ng ties his $\Delta S \approx \Delta N_{particle-count}$ algorithm as a string theory result, which it is

Let us now briefly review what Ng proposed for $\Delta S \approx \Delta N_{particle-count}$

We will reproduce Jack Ng's treatment (2007,2008)of how he derived entropy as proportional to $\langle n \rangle$, i.e., a numerical density of a species of particles, and then apply it to gravitons, as an adaption of his treatment of dark matter. The fact that entropy in both the dark matter and in the relic graviton production case have similar statistics will be the starting point of our derivation of relic graviton production values, which may be linked to falsifiable experimental measurements. Ng used the following approximation of temperature and its variation with respect to a spatial parameter, starting with temperature $T \approx R_H^{-1}$ (R_H can be thought of as a representation of the region of space where we take statistics of the particles in question). Furthermore, assume that the volume of space to be analyzed is of the form $V \approx R_H^3$ and look at a preliminary numerical factor we shall call $N \sim (R_H / l_P)^2$, where the denominator is Planck's length (on the order of 10^{-35} centimeters). We also specify a "wavelength" parameter $\lambda \approx T^{-1}$. So the value of $\lambda \approx T^{-1}$ and of R_H are approximately the same order of magnitude. Now this is how Jack Ng changes conventional statistics: he outlines how to get $S \approx N$, which with additional arguments we refine to be $S \approx < n >$ (where <n> is graviton density). Begin with a partition function

$$Z_N \sim \left(\frac{1}{N!}\right) \cdot \left(\frac{V}{\lambda^3}\right)^N \tag{11}$$

This, according to Ng, leads to an entropy of the limiting value of

$$S \approx N \cdot \left(\log\left[V / N\lambda^3\right] + 5/2\right) \tag{12}$$

But $V \approx R_H^3 \approx \lambda^3$, so unless N in Eqn (12) above is about 1, S (entropy) would be < 0, which is a contradiction. Now this is where Jack Ng introduces removing the N! term in Eqn (1) above , i.e., inside the Log expression we remove the expression of N in Eqn. (12) above. This is a way to obtain what Ng refers to as Quantum Boltzmann statistics, so then we obtain for sufficiently large N

$$S \approx N \tag{13}$$

The supposition we are making here is that the value of N so obtained is actually proportional to a numerical graviton density we will refer to as <n>., provided that there is a bias toward HFGW, which would mandate a very small value for $V \approx R_H^3 \approx \lambda^3$.Furthermore, structure formation arguments, as given by Perkins (2004) give ample evidence that if we use an energy scale, m, over a Planck mass value M_{Planck}, as well as contributions from field amplitude ϕ, and using the contribution of scale factor behavior $\frac{\dot{a}}{a} \equiv H \approx -m \cdot \frac{\phi}{3 \cdot \dot{\phi}}$, where we assume $\ddot{\phi} \cong 0$ due to inflation

$$\frac{\Delta\rho}{\rho} \sim H\Delta t \sim \frac{H^2}{\dot{\phi}} \sim \left(\frac{m}{M_{Planck}}\right) \times \left(\frac{\phi}{M_{Planck}}\right) \sim 10^{-5} \tag{14}$$

At the very onset of inflation, $\phi << M_{Planck}$, and if m (assuming $\hbar = c = 1$) is due to inputs from a prior universe, we have a wide range of parameter space as to ascertain where $\Delta S \approx \Delta N_{gravitons} \neq 10^{89}$ comes from and plays a role as to the development of entropy in cosmological evolution In the next Chapter , we will discuss if or not it is feasible / reasonable to have data compression of prior universe 'information'. It suffices to say that if $S_{initial} \sim 10^5$ is transferred from a prior universe to our own universe at the onset of inflation,, at times less than Planck time $t_P \sim 10^{-44}$ seconds, that enough information **MAY** exit for the preservation of the prior universe's cosmological constants, i.e. $\hbar, G, \alpha$ (fine structure constant) and the like. Confirmation of this hypothesis depends upon models of how much 'information' $\hbar, G, \alpha$ actually require to be set in place, at the onset of our universe's inflation, a topic which we currently have no experimental way of testing at this current time.

Is each 'particle count unit' as brought up by Ng, is equivalent to a brane-anti brane 'unit in brane treatments of entropy? How does this tie in with string/ brane theory treatments of entropy?

It is useful to state this convention for analyzing the resulting entropy calculations, because it is a way to explain how and why the number of instanton – anti instanton pairs, and their formulation and break up can be linked to the growth of entropy. If, as an example, there is a linkage between quantum energy level components of the quantum gas as brought up by Glinka (2007) and the number of instanton- anti instanton pairs, then it is possible to ascertain a linkage between a Wheeler De Witt worm hole introduction of vacuum energy from a prior universe to our present universe, and the resulting brane- anti brane (instanton-anti instanton) units of entropy. What would be ideal would be to make an equivalence between a quantum number, n, say of a quantum graviton gas, as entering a worm hole, i.e. going back to the Energy (quantum gas) $\approx n \cdot \hbar\omega$, and the number <n> of pairs of brane- anti brane pairs showing up in an entropy count, and the growth of entropy. We are fortunate that Dr. Jack Ng's research into entropy (2007,2008) not only used the Shannon entropy model, but also as part of his quantum infinite statistics lead to a quantum counting algorithm with entropy proportional to 'emergent field' particles. If as an example a quantum graviton gas exists, as suggested by Glinka(2007) , if each quantum gas 'particle' is equivalent to a graviton, and that graviton is an 'emergent' from quantum vacuum entity, then we fortuitously connect our research with gravitons with Shannon entropy, as given by $S \sim \ln[partition - function]$. This is a counter part as to what *Asakawa* et al, (2001, 2006) suggested for quark gluon gases, and the 2nd order phase transition written up by Torrieri et al (2008) brought up at the nuclear physics Erice (2008) school, in discussions with the author.. Furthermore, finding out if or not it is either a drop in viscosity, when $\left|\frac{\eta}{s} \approx \varepsilon^{+}\right| << \frac{1}{4\pi}$, or a major increase in entropy density may tell us how much information is , indeed, transferred from a prior universe to our present. If it is $s \to \infty$, for all effective purposes, at the moment after the pre big bang configuration , likely then there will be a high degree of 'information' from a prior universe exchanged to our present universe. If on the other hand, $\eta \to 0^{+}$ due to restriction of 'information from four dimensional 'geometry' to a variable fifth dimension, so as to indicate almost infinite collisions with a closure of a fourth dimensional 'portal' for information flow, then it is likely that significant data compression has occurred. While stating this, it is note worthy to state that the Penrose-Hawking singularity theorems do not give precise answers as to information flow from a prior to the present universe. Hawking's singularity theorem is for the whole universe, and works backwards-in-time: it guarantees that the big-bang has infinite density. This theorem is more restricted, it only holds when matter obeys a stronger energy condition, called the *dominant energy condition*, which means that the energy is bigger than the pressure. All ordinary matter, with the exception of a vacuum expectation value of a scalar field, obeys this condition. This leaves open the question of if or not there is 'infinite' density of ordinary matter, or if or not there is a fifth dimensional leakage of 'information' from a prior universe to our present. If there is merely infinite 'density', and possibly infinite entropy 'density/ disorder at the origin, then perhaps no information from a prior universe is transferred to our present universe.On the other hand, having $\eta \to 0^{+}$, or at least be very small may indicate that data compression is a de rigor way of treating how information for cosmological parameters, such as $\hbar$, G, and the fine structure constant. α arose, and may have been recycled from a prior universe..Details about this have to be worked out, and this because that as of present one of the few tools which is left to formulation and proof of the singularity theorems is the Raychaudhuri equation, which describes the divergence θ of a congruence (family) of geodesics, which has a lot of assumptions behind it, as stated by Naresh Dadhich(2005). As indicated by Hawkings theorem, infinite density is its usual modus operandi, for a singularity, and this assumption may have to be revisited. Natário, J. (2006) has more details on the different type of singularities involved. The supposition is that the value of N is proportional to a numerical DM density referred to as <n> $\big|_{Dark-matter}$. HFGW would play a role if $V \approx R_H^3 \approx \lambda^3$ has each λ of the order of being within an order of magnitude of the Planck length value, as implied by Beckwith (2009). What the author is examining is, if or not there can be linkage made between $S \approx \langle n \rangle \Big|_{gravitons}$ and the expression given by Glinka (2007) of, if we identify $\Omega = \dfrac{1}{2|u|^2 - 1}$ as a partition function (with u part of a Bogoliubov transformation) due to a graviton-quintessence gas, to get information theory based entropy

$$S \equiv \ln \Omega \tag{16}$$

Such a linkage would open up the possibility that the density of primordial gravitational waves could be examined, and linked to modeling gravity as an effective theory, as well as giving credence to how to avoid dS/dt = ∞ at S=0 . If so, then one can look at the research results of Samir Mathur (2007). This is part of what has been developed in the case of massless radiation, where for D space-time dimensions, and E, the general energy is

$$S \sim E^{(D-1/D)} \tag{17}$$

This suggests that entropy scaling is proportional to a power of the vacuum energy, i.e., entropy ~ vacuum energy, if $E \sim E_{total}$ is interpreted as a total net energy proportional to vacuum energy, as given below**.** Conventional brane theory actually enables this instanton structure analysis, as can be seen in the following. This is adapted from a lecture given at the ICGC-07 conference by Andrew Beckwith (2007b)

$$\frac{\Lambda_{Max} V_4}{8 \cdot \pi \cdot G} \sim T^{00} V_4 \equiv \rho \cdot V_4 = E_{total} \tag{18}$$

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

$$S_{Total} \sim \breve{a} \cdot \left[\frac{E_{Total}}{2^n} \right]^{\lambda} \cdot \prod_{j=1}^{\breve{N}} \left(\sqrt{M_{p\,j,0}} + \sqrt{M_{\bar{p}\,j,0}} \right) \tag{19}$$

This expression for entropy (based on the number of brane-anti-brane pairs) has a net energy value of E_{Total} as expressed in Eqn (22) above, where E_{Total} is proportional to the cosmological vacuum energy parameter; in string theory, E_{Total} is also defined via

$$E_{Total} = 4\lambda \cdot \sqrt{M_{p\,j,0} \cdot M_{\bar{p}\,j,0}} \tag{20}$$

Equation 10 can be changed and rescaled to treating the mass and the energy of the brane contribution along the lines of Mathur's CQG article (2007) where he has a string winding interpretation of energy: putting as much energy E into string windings as possible via $[n_1 + \bar{n}_1]LT = [2n_1]LT = E/2$, where there are n_1 wrappings of a string about a cycle of the torus , and $\bar{n}_1$ being "wrappings the other way,", with the torus having a cycle of length L , which leads to an entropy defined in terms of an energy value of mass of $m_i = T_P \prod L_j$ (T_P is the tension of the i th brane, and L_j are spatial dimensions of a complex torus structure). The toroidal structure is to first approximation equivalent dimensionally to the minimum effective length of $\tilde{N}^{\alpha} \cdot l_P \sim \tilde{N}^{\alpha}$ times Planck length $\propto 10^{-35}$ centimeters

$$E_{Total} = 2\sum_i m_i n_i \tag{21}$$

The windings of a string are given by figure 6.1 of Becker et al , as the number of times the strings wrap about a circle midway in the length of a cylinder. The structure the string wraps about is a compact object construct Dp branes and anti-branes. Compactness is used to roughly represent early universe conditions, and the brane-anti brane pairs are equivalent to a bit of "information.". This leads to entropy expressed as a strict numerical count of different pairs of Dp brane-Dp anti-branes, which form a higher-dimensional equivalent to graviton production. The tie in between Eqn. (22) below and Jack Ng's treatment of the growth of entropy is as follows: First, look at the expression below, which has $\breve{N}$ as a stated number of pairs of Dp brane-antibrane pairs: The suffix $\breve{N}$ is in a 1-1 relationship with $\Delta S \approx \Delta N_{gravitons}$

$$S_{Total} = A \cdot \prod_i^{\breve{N}} \sqrt{n_i} \tag{22}$$

Now that at least qualitiative arguments have been put in place as to an equivalence between kink- anti kink pairs, in both entropy, and what may be happening with gravitons (kink – anti kink pair constitution) it is reasonable to investigate the likely hood that significant entropy contributions came shortly later, i.e. through the quark gluon plasma regime. For reasons outlined in the next section, that appears to be dubious.

Limitations of the Quark-Gluon analogy and how such limitations impact AdS/CFT correspondence applications

What is being alluded to, is that variations in the AdS/CFT correspondence applications exist from what is usually assumed for usual matter. The differences, which are due to quark-gluon plasma models breaking down in the beginning of the big bang point to the necessity of using something similar to the counting algorithm as introduced by Ng, as a replacement for typical string theory models in strict accordance to AdS/CFT correspondence.The goal of exploring the degree of divergence from AdS/CFT correspondence will be in quantifying a time sequence in evolution of the big bang where there is a break from causal continuity. A break down in causal continuity will, if confirmed, be a way of signifying that encoded information from a prior era has to be passed through to the present universe in likely an emergent field configuration.. If much of the information is passed to our present universe in an emergent field configuration , this leaves open the question of if or not there is a time sequence right after the initial phases of the big bang where there was a re constitution of information in traditional four space geometry. One candidate for specifying such a re constitution of entropy / space time information would be to model gravitons as kink – anti kink 'pairs' which are re constituted in space time right after the big bang. Conceivably, in such a situation, a fifth 'higher dimension' could be a conduit of 'graviton' information / entropy packaging from a prior universe, to our own, with the spill over of this information being re constituted in four space with the re appearance of , via kink – anti kink pairs after a thermal phase transition occurs. To begin this analysis, let us look at what goes wrong in models of the early universe. The assertion made is that this is due to the quark – Gluon model of plasmas having major 'counting algorithm' breaks with non counting algorithm conditions, i.e. when plasma physics conditions BEFORE the advent of the Quark gluon plasma existed. Here are some questions which need to be asked.

1. Is QGP strongly coupled or not? Note : Strong coupling is a natural explanation for the small (viscosity) Analogy to the RHIC: J/y survives deconfinement phase transition
2. What is the nature of viscosity in the early universe? What is the standard story? (Hint: AdS-CFT correspondence models). Question 2 comes up since

$$\frac{\eta}{s} = \frac{1}{4\pi} \tag{23}$$

typically holds for liquid helium and most bosonic matter. However, this relation breaks down. At the beginning of the big bang. As follows

i.e. if Gauss- Bonet gravity is assumed, in order to still keep casuality , one needs $\lambda_{BG} \leq \dfrac{9}{100}$

This even if one writes for a viscosity over entropy ratio the following

$$\frac{\eta}{s} \equiv \frac{1}{4\pi} \cdot [1 - 4\lambda_{GB}] \leq \frac{1}{4\pi} \tag{24}$$

A careful researcher may ask why this is so important. If a causal discontinuity as indicated means the $\dfrac{\eta}{s}$ ratio is $\approx \dfrac{1}{4\pi} \cdot \dfrac{33}{50}$, or less in value, it puts major restrictions upon viscosity, as well as entropy. A drop in viscosity, which can lead to major deviations from $\dfrac{1}{4\pi}$ in typical models may be due to more collisions. Then, more collisions due to WHAT physical process? Recall the argument put up earlier. I.e. the reference to causal discontinuity in four dimensions, and a restriction of information flow to a fifth dimension at the onset of the big bang/ transition from a prior universe? That process of a collision increase may be inherent in the restriction to a fifth dimension, just before the big bang singularity, in four dimensions, of information flow. In fact, it very well be true, that initially, during the process of restriction to a 5th dimension, right before the big bang, that $\left| \dfrac{\eta}{s} \approx \varepsilon^{+} \right| << \dfrac{1}{4\pi}$. Either the viscosity drops nearly to zero, or else the entropy density may, partly due to restriction in geometric 'sizing' may become effectively nearly infinite. It is due to the following qualifications put in about Quark – Gluon plasmas which will be put up, here. **Namely,** more collisions imply less viscosity. More Deflections ALSO implies less viscosity. Finally, the more momentum transport is prevented, the less the viscosity value becomes. Say that a physics researcher is looking at viscosity due to turbulent fields. Also, perturbatively calculated viscosities: due to collisions . This has been known as *Anomalous Viscosity* in plasma physics ,(this is going nowhere, from pre-big bang to big bang cosmology). So happens that **RHIC models for viscosity assume**

$$\frac{1}{\eta} \approx \frac{1}{\eta_A} + \frac{1}{\eta_C} \tag{25}$$

As Akazawa noted in an RHIC study, equation 25 above makes sense if one has stable temperature T, so that

$$\frac{\eta_A}{s} = \bar{c}_0 \cdot \left(\frac{T}{g^2 |\nabla u|} \right)^{\frac{2n-1}{2n+1}} \Leftrightarrow \frac{\eta_C}{s} = \text{constant} \tag{26}$$

If the temperature T wildly varies, as it does at the onset of the big bang, this breaks down completely. This development is **Mission impossible: why we need a different argument for entropy. I.e. Even for the RHIC, and in computational models of the viscosity for closed geometries—what goes wrong in computational models**

- **Viscous Stress is *NOT* $\propto$ *shear***

- **Nonlinear response: impossible to obtain on lattice (computationally speaking)**
- **Bottom line: we DO NOT have a way to even define SHEAR in the vicinity of big bang!!!!**

We now need to ask ourselves what may be a way to present entropy/ entropy density in a manner which may be consistent with having / explaining how $\left|\frac{\eta}{s} \approx \varepsilon^{+}\right| << \frac{1}{4\pi}$ may occur, and also what may be necessary to explain how the entropy / entropy density may become extraordinarily large, and that , outside of the restriction to a fifth dimension argument mentioned earlier for 'information' transferral to the onset of the big bang, that it is not necessary to appeal to nearly infinite collisions in order to have a drop in viscosity.

Appendix I. Basic physics of achieving minimum $l_{\min - length - string} \equiv 10^{\alpha} \cdot l_{Planck}$ precision in CMBR power spectra measurements

Begin first of all looking at

$$\frac{\Delta T}{T} \equiv \sum_{l,m} a_{lm} Y_{l,m}(\theta, \phi) \tag{1}$$

This leads to consider what to do with

$$C_l = \left\langle \left| a_{l,m} \right|^2 \right\rangle \tag{2}$$

Samtleben et al (2007) consider then what the experimental variance in this power spectrum, to the tune of an achievable precision given by

$$\frac{\Delta C_l}{C_l} = \sqrt{\frac{2}{2l+1}} \cdot \left(\frac{1}{\sqrt{f_{sky}}} + \frac{4\pi \cdot (\Delta T_{\exp})^2}{C_l} \cdot \sqrt{f_{sky}} \cdot e^{l^2 \sigma_b^2} \right) \tag{3}$$

f_{sky} is the fraction of the sky covered in the measurement , and $\Delta T_{\exp}$ is a measurement of the total experimental sensitivity of the apparatus used. Also σ_b is the width of a beam , while we have a minimum value of $l_{\min} \approx (1/\Delta\Theta)$ which is one over the fluctuation of the angular extent of the experimental survey.

I.e. contributions to C_l uncertainty from sample variance is equal to contributions to C_l uncertainty from noise. The end result is

$$4\pi \cdot f_{sky} = C_l \cdot \left(\exp\left[-l^2 \sigma^2\right]\right) / (\Delta T)^2 \tag{4}$$

Appendix II : Cosmological perturbation theory and tensor fluctuations (Gravity waves)

Durrer (2004) reviews how to interpret C_l in the region where we have $2 < l < 100$, roughly in the region of the Sachs-Wolf contributions due to gravity waves. We begin first of all by looking at an initial perturbation , using a scalar field treatment of the ' Bardeen potential' Ψ This can lead us to put up, if H_i is the initial value of the Hubble expansion parameter

$$k^3 |\Psi|^2 \cong \left(\frac{H_i}{M_P} \right)^2 \tag{1}$$

And

$$\left\langle |\Psi|^2 \right\rangle \cdot k^3 = A^2 k^{n-1} \cdot \eta_0^{n-1} \tag{2}$$

Here we are interpreting $A =$ amplitude of metric perturbations at horizon scale, and we set $k = 1/\eta_0$, where η is the conformal time, according to $dt \equiv a d\eta =$ physical time, where we have a as the scale factor..Then for $2 < l < 100$, and $-3 < n < 3$, and a pure power law given by

$$\left\langle |H(k, \eta = 1/k)|^2 \right\rangle \cdot k^3 = A_T^2 k^{n_T} \cdot \eta_0^{-n_T} \tag{3}$$

We get for tensor fluctuation, i.e. gravity waves,, and a scale invariant spectrum with $n_T = 0$

$$C_l^{(T)} \approx \frac{A_T^2}{(l+3)\cdot(l-2)} \cdot \frac{1}{15\pi} \tag{4}$$

Appendix III: Managing what to do with racetrack inflation, as cool down from initial expansion commences

P. Brax, A. Davis et al devised a way to describe racetrack inflation as a way to look at how super gravity directly simplifies implementing how one can have inflation with only three T (scalar) fields . The benefit to what we work with is that we may obtain two gaugino condensates and look at inflation with a potential given by Brax , et al (2008)

$$V = V_0 + V_1 \cos(aY) + V_2 \cos(bY) + V_3 \cos(|a-b| \cdot Y) \tag{1}$$

This has scalar fields X, ϕ as relatively constant and we can look at an effective kinetic energy term along the lines of

$$\Im_{Kinetic} = 3 \cdot (\partial Y)^2 / 4 (\partial X)^2 \tag{2}$$

This ultra simple version of the race track potential is chosen so that the following conditions may be applied

(1) Exist a minimum at $Y = Y_0$; i.e. we have $V^{'}(Y_0) = 0,$ and $V^{''}(Y_0) > 0,$ when we are not considering scalar fields X, ϕ

(2) We set a cosmological constant equal to zero with $V(Y_0) = 0$

(3) We have a flat saddle at $Y \approx 0$; i.e. $V^{''}(0) = 0$

(4) We re - scale the potential via $V \to \lambda V$ so as to get the observed power spectra $P = 4\times 10^{-10}$

Doing all this though frequently leads to the odd situation that $|a-b|$ must be small so that $X >> 1$ in a race track potential system when we analyze how to fit Eqn. (1) for flat potential behavior modeling inflation. This assumes that we are working with a spectra index of the form so that if the scalar field power spectrum is

$$P = \frac{V}{150\pi^2\varepsilon} \tag{3}$$

Then the spectral index of the inflaton is consistent with WMAP data. I.e. if we have the number of e foldings $N > N_* \approx .55$

$$n_s = 1 - \frac{d\ln P}{dN} \approx .95 \pm .02 \tag{4}$$

These sort of restrictions on the spectral index will start to help us retrieve information as to possible inflation models which may be congruent with at least one layer of WMAP data. This model says nothing about if or not the model starts to fit in the data issues Subir Sarkar identified in is Pune, India lecture in 2007.

Appendix 1V: Linking the thin shell approximation, Weyl quantization , and the Wheeler De Witt equation

This is a re capitulation of what is written by S. Capoziello, et al (2000) for physical review A, which is assuming a generally spherically symmetric line element . The upshot is that we obtain a dynamical evolution equation, similar in part to the Wheeler De Witt equation which can be quantified as $H|\Psi\rangle = 0$

Which in turn will lead to, with qualifications, for thin shell approximations $|x| << 1$,

$$\Psi'' + a^2 x^4 \Psi = 0 \tag{1}$$

so that $Z_{1/6}$ is a spherical Bessel equation for which we can write

$$\Psi \equiv \sqrt{x} Z_{1/6}\left(\frac{a}{3}x^3\right) \sim x^{2/3} \tag{2}$$

Similarly, $|x| >> 1$ leads to

$$\Psi \equiv \sqrt{x} Z_{1/6}\left(\frac{a}{3\cdot\sqrt{2}}x^3\right) \tag{3}$$

Also, when $x \cong 1$

$$\Psi \equiv \left[\sqrt{2a^2\cdot(x-1)}\right]^3 Z_{-3/4}\left(\frac{8}{3}\cdot a\cdot(x-1)^{3/2}\right) \tag{4}$$

Realistically, in terms of applications, we will be considering very small x values, consistent with conditions near a singularity/ worm hole bridge between a prior to our present universe. This is for $x \equiv R / R_{equilibrium}$

BIBLIOGRAPHY

Andrić, I, Jonke , L. and Jurman , D."Solitons and giants in matrix models", JHEP12(2006)006

Asakawa M. , Hatsuda, T. and. Nakahara, Y., Prog. Part. Nucl. Phys. 46, 459(2001)

Asakawa M, Bass SA, and Müller B.," Anomalous viscosity of an expanding quark-gluon plasma", Physical review letters 96(25):252301 2006 Jun 30

Asakawa M. , Hatsuda, T. and. Nakahara, Y., Prog. Part. Nucl. Phys. 46, 459(2001)

Altman C, Pykacz J and Zapatrin R. "Superpositional Quantum Network Topologies," International Journal of Theoretical Physics Vol 43, No 10.

Amaldi 5 meeting proceedings; http://www.ligo.caltech.edu/LIGO_web/amaldi5/scripts/papers.shtml

Avetissian, A. K.," Plancks constant evolution as a cosmological evolution test for the early universe",.Gravitation and Cosmology, 2009, Vol 15, number 1, pp 10-12

Bachas, C., Kiritsis, E., "Exact string-theory instantons by dimensional reduction", Physics Letters B, Volume 325, Issues 1-2, 14 April 1994, Pages 103-114

Baker, R.M.L, Stephenson, G. V. , and Li Fangyu (2008), "Proposed Ultra-High Sensitivity HFGW Detector,"in the proceedings of Space Technology and Applications International Forum (STAIF-2008), edited by M.S. El-Genk, American Institute of Physics Conference Proceedings, Melville , NY 969, pp. 1045-54 http://www.gravwave.com/docs/ProposedUltraHighSensitivityHFGWDetector2005-15-08.pdf

Barvinsky, A. "Quantum geometrodynamics: The Wheeler-DeWitt equations for the wave function of the universe"Physics letters B, Volume 175, issue 4, August 14, 1986, pp 401-404Barvinsky, A. Kamenschick, A., and Yu , A, " Thermodynamics from Nothing: Limiting the Cosmological Constant Landscape, Phy Rev D 74 121502 (Rapid communications)

Baumann, Daniel, Ichiki, Kiyotomo, Steinhardt, Paul J. Takahashi , Keitaro ," Gravitational Wave Spectrum Induced by Primordial Scalar Perturbations", arXiv:hep-th/0703290

Beckwith,A.W.," A New soliton-anti soliton pair creation rate expression improving upon Zener curve fitting for I-E plots", Mod.Phys.Lett.B20:849-861,2006, http://arxiv.org/abs/math-ph/0411045

Beckwith, A. W. "Symmetries in evolving spacetime from prior to present universes", arXIV math-ph/0501028 (2007)

Beckwith, A.W. "Instanton formation of vacuum energy via the Reissner-Nordstrom geometry of a wormhole bridge between a prior to our present universe.", arXiv:0710.3788, October 2007

Beckwith, A.W., Presented at 6th International Conference on Gravitation and Cosmology (ICGC-2007), Ganeshkhind, Pune, India, 17-21 Dec 2007 in 20 minute presentation, with a lot of other topics.

Beckwith, A.W. "Penrose Model potential, compared with Coleman-Weinberg Potential for early universe scalar evolution", Electron.J.Theor.Phys.5N17:95-106,2008.

Beckwith, A.W., "Implications for the Cosmological Landscape: Can Thermal Inputs from a Prior Universe Account for Relic Graviton Production?" AIP Conference Proceedings 969, (2008), pp. 1091-1102

Beckwith, A. W. "Relic High Frequency Gravitational waves from the Big Bang, and How to Detect Them", http://arxiv.org/abs/0809.1454 (2009), AIP Conf.Proc.1103:571-581,2009 (SPESIF)

Bodgan, M.,Kapner, D., Santleben, D., " Digital control and Acquisition system for the QUIET Experiment", Nuclear Methods and Instrumentations in Physics Research, A, 572, (2007), PP 338-339

Brax, Ph., Davis, A., Davis, S., Jeannerot, R., Postman, M., " D-term Uplifted Racetrack Inflation", Journal of Cosmology and Astroparticle Physics, JCAP01(2008) 08

Camp, J. , and Cornish, N., "Gravitational wave Astronomy",pp 525-577, as part of " Annual Review of Nuclear and Particle Science", Volume 54, with Kayser, B., Holstein, B., and Jawahery, A. as editors. Menlo Park, California, 2004

Capozziello, S., Feoli, A., Lambiase, G., Papini, G., ' Thin shell quantization in Weyl Space – time', Physics Letters A, 273 (2000), pp 25-30

Carroll, Sean," An Introduction to General Relativity SPACE TIME AND GEOMETRY", Addison Wesley Publishing house, San Francisco, California, USA, 2004

Ceresole, A., D' Auria, R., Ferrara, S., and van Poeyen, A., " Duality transformations in super symmetric Yang-Mills theories, coupled to supergravity," Nucl. Phys. B444 (1995), pp 92-124, hep-th/ 9502072

Chiao, Ray, "Super Conductors as Quantum Transducers, and Antennas for Gravitational and Electromagnetic Radiation", gr-qc/0204012 v3, 29 July 2002

Clarke, James," An Evidence Based Ring-down Search", http://gwdaw11.aei.mpg.de/abstract_list

Copied from Dr. Sarkar's website and Bad Honnif 07 talk and reproduced here with explicit permission of the original presenter

Creighton, T., Jenet, F., and Price, R., ,"Pulsar Timing and Space Time Curvature", 2009 ApJ 693 1113-1117, March 10

Crowell, L., “Quantum Fluctuations of Space Time “, World Scientific Series in Contemporary Chemical Physics, Vol 25, World Scientific, PTE, LTD, 2005, Singapore
Dadhich, N., “Derivation of the Raychaudhuri Equation”, http://arxiv.org/abs/gr-qc/0511123,
Dowker, H.F. “Causal sets and the deep structure of spacetime”, arXIV gr-qc/0508109v1 26 Aug 2005; in 100 Years of Relativity Space-Time Structure: Einstein and Beyond, edited by Ashtekar, A., World Press Scientific, Singapore, 2005
Durrer, R., “ Cosmological Pertubation theory”, From the book “Physics of the Early Universe”, in Lecture Notes in Physics, 653”, with Papantonopoulos, E., as editor and printed by Springer- Verlag 2004
D. M. Eardley, “High frequency gravitational waves,” JSR-08-506, October, the JASON defense science advisory panel and prepared for the Office of the Director of National Intelligence, Oct. 2008
Enqvist, K., Mazumdar, A., Perez--Lorenzana, A., “ Dumping inflaton energy out of this world”,Phys Rev D, Volume 70, 103508
Favata, Mark, “ Gravitational wave memory revisited: Memory from the merger and recoil of binary black holes”, arxiv.org/PS_cache/arxiv/pdf/0811/0811.3451v1.pdf, put in as of November 2008
Feng, Jonathan L. and Kumar, Jason “Dark-Matter Particles without Weak-Scale Masses or Weak Interactions.” Physical Review Letters (2008). Available online: http://link.aps.org/doi/10.1103/PhysRevLett.101.231301.
Feinstein,A , Vazquez-Mozo, M.A, “M-theory resolution of four-dimensional cosmological singularities
via U-duality” , http://arxiv.org/abs/hep-th/9906006 , Nucl.Phys. B568 (2000) 405-420
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
Honig, W. M., “ A minimum photon rest mass- using Planck’s constant and discontinuous Electromagnetic waves”, Foundations of physics, Volume 4, number 3, 1974, pp 367-380
Hunt , Peter, and Sarkar, Subir “Constraints on large scale voids from WMAP-5 and SDSS” http://arxiv.org/PS_cache/arxiv/pdf/0807/0807.4508v2.pdf;
http://meghnad.iucaa.ernet.in/~ctscmb/talks/sarkar_lecture.pdf
Galvaviz, I, “Deformation quantization for Fermionic Fields”, Reviews Mexicana De Fisica, S, 53 (4), pp 51-55
Gasperini, M., Maharana, J. and Veneziano, G.,”Graceful exit in String cosmology,” Nucl. Phys. B, 472, (1996), pp. 349-356
Gehrels, N., et al. “The Compton Gamma Ray Observatory”, Scientific American, December 1993, pp.68-77
M. E. Gertsenshtein, “Wave resonance of light and gravitational waves,” Soviet Physics JETP,
vol.14, no. 1, pp. 84-85, 1962.
Giovannini, Massimo, ” A Primer on the Physics of the Cosmic Microwave Background”, World Press Scientific, 2008, Singapore, Republic of Singapore, (2008)
Glinka, L. “Quantum Information from Graviton-Matter Gas ”, Sigma 3, (2007), 087, 13 pages
Grishchuk,L. “Discovering Relic Gravitational Waves in Cosmic Microwave Background Radiation”, http://arxiv.org/abs/0707.3319 (2008)
Gunaydin, M., Neitzke, A., Pioline, B., and Waldron, A., “Quantum Attractor Flows”, http://arxiv.org/abs/0707.0267, (2007), with journal reference JHEP0709:056,2007
Gutt, S., Waldmann, S. “ Deformation of the Poisson Bracket on a Sympletic Manifold”,pp 119-129, Volume 11 of “ The encyclopedia of Mathematical Physics; Algebraic Topology; Sympletic Geometry and Topology; Ordinary and Partial Differential Equations , editors Franciose, Naber, and Tsun (2006)
Hartle, J., and Hawking, S.W., "Wave function of the universe", Phys. Rev. D28, 2960 (1983)
Hawking, S.W., “Evaporation of two-dimensional black holes”, Phys. Rev. Lett. 69, 406 - 409(1992)
Hawking, Hertog, and Reall, "Brane New World”, Phys. Rev. D62 (2000) 043501.
Heavens, A., Jimenez, R., Lahav, O ,” Massive Lossless Data Compression and Multiple Parameter Estimation from Galaxy Spectra”, Mon.Not.Roy.Astron.Soc. 317 (2000) 965, http://arxiv.org/PS_cache/astro-ph/pdf/9911/9911102v2.pdf
Hogan, C. “Holographic discreteness of Inflationary Perturbations”, arXIV astro-ph/0201020 v 2, May 27, 2002
Jaeckel (2009). Private discussion with the author as occurred in the ISEG 2009 meeting in Kochi, India on experimental gravity.
Kahniashvili ,.Tina”Relic Gravitational Wavesas a Test of the Early Universe”,arXiv:0705.1733 [astro-ph], (2007)
Kawai, S.; Soda, J.(1999), “Evolution of fluctuations during graceful exit in string cosmology.” Phys. Lett. B, Vol. 460, No. 1 - 2, p. 41 - 46Koffman, L., “Pre heating After Inflation “, pp 55-79, in Lecture notes in Physics 738, Inflationary cosmology , editors M. Lemoine, J. Martin, P. Peter, as Editors, Springer Verlag, 2008 Berlin, Federal Republic of Germany
Kolb, E., and Turner, S. “The Early Universe”, Westview Press, Chicago, USA, 1994
Kuchiev, M. Yu, “Can gravity appear due to polarization of instantons in SO(4)gauge theory?”, Class. Quantum Grav. 15 1895-1913 doi: 10.1088/0264-9381/15/7/008
Dawood Kothawala, T. Padmanabhan , Sudipta Sarkar, “Is gravitational entropy quantized ?” Phys. Rev., D78 , 104018 (2008) [arXiv:0807.1481]
Hogan, P.A., O'Farrell, S. “Generating Electromagnetic Waves from Gravity Waves in Cosmology”, http://arxiv.org/abs/0905.2834,

Jejjala,V., Kavic, M., and Minic D.," Fine Structure of Dark Energy and New Physics", Adv.HighEnergyPhys.2007:21586,2007, http://arxiv.org/abs/0705.4581
Kuchiev, M. Yu, "Can gravity appear due to polarization of instantons in SO(4)gauge theory?", Class. Quantum Grav. 15 1895-1913 doi: 10.1088/0264-9381/15/7/008
Kumar, Jason, "A Brief Comment on Instanton-like Singularities and Cosmological Horizons", JHEP 0301 (2003) 010, arXiv arXiv:hep-th/0204119v2, 27 Apr 2002
Kurita, Y, and Ishihara, H.," Thermodynamics of squashed Kaluza–Klein black holes and black strings: a comparison of reference backgrounds", 2008 Class. Quantum Grav. 25 085006 (19pp)
Lecture notes taken at IGC conference, http://www.gravity.psu.edu/igc/conf_files/program_complete.pdf with respect to the Penrose presentation, " Conformal Cyclic cosmology, Dark Matter, and Black Hole Evaporation", plus questions asked of the lecturer in the aftermath of that presentation
Li, Fangyu, Baker, Robert. M.L., and Chen , Zhenya (2006), "Perturbative photon flux generated by high frequency relic gravitational waves and utilization of them for their detection," http://arxiv.org/abs/gr-qc/0604109
Li, Fangyu, Baker, Robert M L., Fang, Zhenyun, Stephenson, Gary V., and Chen, Zhenya, "Perturbative Photon Fluxes Generated by High-Frequency Gravitational Waves and Their Physical Effects," [Li-Baker Chinese HFGW Detector], European Physical Journal C., 56, 407- 423 (2008) ,
http://www.gravwave.com/docs/Li-Baker%206-22-08.pdf
Li, Fangyu, Tang Mengxi, "Electromagnetic detection of high-frequency gravitational waves" International Journal of Modern Physics D Vol.11 No.7 1049-1059 (2002)
Lifschytz, G., " Black Hole thermalization rate from brane antibrane model ", arXIV hep-th/ /0406203 v1 23 june, 2004
Linde in article in Physics 738, Inflationary cosmology , editors M. Lemoine, J. Martin, P. Peter, as Editors, Springer Verlag, 2008 Berlin, Federal Republic of Germany
Lloyd , Seth "Computational capacity of the universe", Phys. Rev. Lett. 88, 237901 (2002)
Loinger, Angelo, "On PSR1913+16", http://arxiv.org/abs/astro-ph/0002267v1
Maggiore, M. "Gravitational Waves, Volume 1 : Theory and Experiment", Oxford, 2008
Mathur, S., and Chowdhury, B., " Fractional Brane States in the Early Universe", Classical and Quantum Gravity, 24 (2007), pp. 2689-2720;
Meissner,K.A. and Nicolai, H. "Neutrinos, Axions, and Conformal Symmetry," http://arxiv.org/PS_cache/arxiv/pdf/0704/ 0704.3215v1.pdf, (2008).
Mina, A., Takuya, O., and Hirosi, O, "Quantum entanglement of baby universes", Nuclear Physics B, Volume 778, Issue 1-2, p. 36-68. (2007)
Mithras (2009), Personal communications exchanged with author at ISEG 2009, in Kochi, India.
Mortonson, M. and Hu, W., "Model-Independent Constraints on Reionization from Large-Scale Cosmic Microwave Background Polarization", 2008 ApJ 672 pp. 737-751
Natário, J. (2006). Relativity and Singularities - A Short Introduction for Mathematicians. March 8. http://arxiv.org/abs/math.DG/0603190.
Ng, Y. Jack, "Holographic foam, dark energy and infinite statistics," Phys. Lett. B, 657, (2007), pp. 10-14
Ng, Y.Jack,"Article: Spacetime Foam: From Entropy and Holography to Infinite Statistics and Nonlocality" Entropy 2008, 10(4), 441-461; DOI: 10.3390/e10040441
Ng, Y. Jack ," Quantum Foam and Dark Energy", International work shop on the Dark Side of the Universe, http://ctp.bue.edu.eg/workshops/Talks/Monday/QuntumFoamAndDarkEnergy.pdf
Padmanabhan, Thanu "From Gravitons to Gravity: Myths and Reality" Int.J.Mod.Phys., D 17, 367-398 (2008) [gr-qc/0409089]
Park, D, "Radiations from a Spinning Rod,"Physical Review, 99, No. 4, 1324-1325 (1955)
Park, D.K., Kim, H., and Tamarayan, S., "Nonvanishing Cosmological Constant of Flat Universe in Brane world Senarios," Phys.Lett. B535 (2002) pp. 5-10
Penrose, Roger,"Singularities and Time – Assymmetry", pp 581-638 of "General Relativity, an Einstein Centenary Survey", edited by Hawkings, S.W., and Israel, W., Cambridge University Press, 1979, 32 East 57 street, New York, NY, zip 10022, USA
Penrose, Roger," Conformal Cyclic Cosmology, Dark Matter, and Black Hole Evaporation", August 11, 2007 ,IGC Inaugural Conference. State College, PA. Penn State University ... August 7 – August 11, 2007.
Perkins, Donald, " Particle Atro Physics" , Oxford Master series in Particle Physics, Astrophysics, and Cosmology, by Oxford , 2005
Peskins, M. ,Schroeder, D. " An introduction to Quantum Field Theory", Westview Press, (1995)
Physics arXIV blog, from 'Technology review' May 21, 2009, http://www.technologyreview.com/blog/arxiv/23556/
Polarski D. and Ranquet, A, "On the equation of state of dark energy". Physics Letters B, Volume 627, Issues 1-4, 27 October 2005, Pages 1-8
Rosa, R.M.S. " Turbulence Theories", pp. 253-261, of " Encyclopedia of Mathematical physics, Volume 2, 2006, Editors ofFranchioise, Jean- Pierre , Naber, Gregory, Tsun Tsou Sheung
Rothman, Tony and Boughnm S., "Can Gravitons be Detected?" Foundations of Physics, 36(12), December (2006), pp. 1801-1825.

Samtleben, D, "QUIET - Measuring the CMB polarization with coherent detector arrays" http://arxiv.org/abs/0806.4334,
Samtleben, D., Staggs, S., Winstein, B., "The Cosmic Microwave Background for Pedestrians: A Review for Particle and Nuclear Physicists", Annu..Rev . Nucl. Part. Sci. 2007, 57, : 245-83
Shannon, Claude E, "A Mathematical Theory of Communication", The Bell System Technical Journal, Vol 27, pp 379-423, pp. 623-656 , July, October 1948 ; http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf; http://www.data-compression.com/theory.html
Sharpe, H.N, "A Heliosheath Model for the Origin of the CMB Quadrupole Moment" http://arxiv.org/abs/0905.2978
http://chalonge.obspm.fr/Programme2007.html
Sternheimer, D."Deformation Quantization, 20 years afterwards", arXIV math/9809056, vol 1, 1998
Steinhardt, Paul J., Turok, Neil,"Endless Universe, Beyond the Big Bang" Doubleday Broadway Publishing Group, a division of Random House, Inc., New York (2007); http://map.gsfc.nasa.gov/media/060915/index.html
Vardanyan , M., Trotta , R., Silk, J., "How flat can you get? A model comparison perspective on the curvature of the Universe", http://arxiv.org/abs/0901.3354
Visser, Matt, " Mass of the graviton", Gen.Rel.Grav. 30 (1998) 1717-1728, http://arxiv.org/abs/gr-qc/9705051 (1998)
Witten, Edward, "Small Instantons in String Theory", Nucl.Phys. B460 (1996) 541-559, http://arxiv.org/abs/hep-th/9511030
Witten, Radford M. Neal, and John G. Cleary, Arithmetic Coding for Data Compression, CACM 30(6):520-540, June 1987
Whitelock et al.,"SN1987a Light Curves", Proceedings of the Tenth Santa Cruz Workshop in Astronomy and Astrophysics, Springer- Verlag, 1991
Woods, Clive, personal communications to Dr. Beckwith, May 21st, 2009