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Entropy growth in the early universe and how to obtain experimentally falsifiable criteria for the measurement of relic entropy , gravitational waves, and pre cursors of the onset of inflation

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Abstract

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.As summarized by Thanu Padmanabhan (IUCAA) in the recent 25th IAGRG presentation he made, "Gravity: The Inside Story ", entropy can be thought of as due to 'ignored' degrees of freedom, classically, and is generalized in general relativity by appealing to to extremising entropy for all the null surfaces of space time. Padmanabhan claims the process of extemizing entropy then leads to equations for the background metric of the spacetime. I .e. that the process of entropy being put in an entremal form leads to the Einsteinian equations of motion. What is done in this present work is more modest. I.e. entropy is thought of in terms of being increased by relic graviton production, and the discussion then examines the consequence of doing that in terms of GR space time metric evolution. How entropy production is tied in with graviton production is via recent work by Jack Ng. The role of Jack Ng's (2008a, 2008b) 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. The gate way toward showing this role of graviton production as adding to entropy is to make sense of if or not the entropy of a spiral galaxy black hole can be thought of as equivalent to the entropy of the general universe, as stated by Sean Carroll, in recent publications.

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INTRODUCTION

Does "entropy" have an explicit meaning in astrophysics?

Sean Carroll has estimated (2005), as well as others, that the black hole at the center of a major spiral galaxy could have up to 10^{90} units of entropy, whereas the universe is stated to have on the order of 10^{88} units of entropy. The author has querried both brane theorists and loop quantum gravity personnel at the conclave at Bad Honnef in Germany known as "Perspectives on Quantum Gravity" in April 2008 and has been told that no one really understands what entropy really is in cosmology. As has been said to the author in conversations, this is avoidance behavior on the part of the physics community, and it is time to end it, and to understand, first, the origins of increasing entropy, and secondly to come up with consistent criteria for explaining and measuring entropy.

It is important to note that an article in Scientific American, written by Cliff Burgess and Fernando Quevedo claims that the universe, if embedded in a vaster realm, as the author views as likely, that there will be essentially non existent traces of relic gravitational waves. If or not gravitional waves/ gravitons from the big bang are detectable is crucial to the development of initial increases in entropy, for reasons the author will delineate in the manuscript The author will discuss this issue in an appendix and discuss why he thinks the claim that relic gravitons are virtually undetectable is in error. But the forecoming discussions of entropy are leading to what may be experimentally falsifiable criteria for answering such questions for the first time. Note also that Seth Lloyd and George Smoot have tried in different ways to conflate bits, operations of a computer and the like, with constructing entropy, and that is a problem in itself. An operation in the sense of quantum computing and the measurement of entropy are two different things entirely, and can be only linked together if the quantum computing mechanism is carefully delineated.

The author is convinced 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. Will that be easy to do ? No. But for reasons stated below, it appears to be a necessary start to addressing formalistic chaos

AN ALTERNATIVE QCD MODEL

Dr. Jaeckel, met with the author in ISEG2009 in Kochi, India during January 2009 and stated that due to the chaotic , and at times mutually exclusionary nature of different entropy definitions, that it would probably be better to use the QCD formulation of entropy as a 'jet' process. A jet in Quantum Chromodynamics is a narrow cone of hadrons and other particles produced by the hadronization of a quark or gluon in a particle physics or heavy ion experiment. Because of QCD confinement, particles carrying a color charge, such as quarks, cannot exist in free form. Therefore they fragment into hadrons before they can be directly detected, becoming jets. These jets must be measured in a particle detector and studied in order to determine the properties of the original quark. Jets are produced in QCD hard scattering processes, creating high transverse momentum quarks or gluons, or collectively called partons in the partonic picture

Jaeckel told the author that a 'particle count' algorithm akin to measurements in the parton picture would be the only fundamental measurement protocol for entropy which he could accept.

How to compare entropy of the universe vs. entropy due to a mega black hole at the center of a major spiral galaxy structure

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In trying to understand how to reconcile how there could be little difference in the entropy of a black hole in the center of the milky way with the entropy of the universe, the author suggests starting with relic graviton production as the driving force in delineating increase in entropy, from a low point at the start of the universe to the value of at least 10^{88} today. The author claims that appropriate measurements of graviton production/ gravity wave physics from relic nucleation of our present universe conditions may help in gaining falsifiable criteria for comparing entropy of black holes in the center of our galaxy and to with entropy of the universe as a whole, answer the outstanding question brought to the fore above.

A second question about entropy was given to the author by Abhas Mitra, Bhabha Atomic Research Centre in the Tata Physics organized ISEG meeting in Kochi India, January 2009 which can be stated as follows. At the EXTREMA of any function: $dx/dt = 0$, but for the initial conditions of the Big-Bang there is a value of $dS/dt = \infty$ at $S=0$. Clearly, the resolution of this second question will impact answering the first question. I.e. to reconcile how entropy would be produced at the beginning of a universe, and to see if the resolution of the above question impacts the comparison between the black hole at the center of a galaxy and how it generate entropy vs entropy for the entire universe.

Seth Lloyd's linking of information to 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

$$|S_{Total}| \sim |k_B \cdot \ln 2| \cdot [\#operations]^{3/4} \qquad (1)$$

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 1 is accepted, which is debatable, then the issue is what is the unit of operation, i.e. the mechanism involved for an operation and can it in any way be linkable to solving the problem which Mithras gave the author, that of dS/dt =∞ at S=0 in Kochi, India, in the experimental gravity conference ?

Frankly, the author sees what Seth Lloyd has done as a clever construct , a black box, and until the mechanism for an operation is delineated , that it cannot be accepted by people working in cosmology. I.e. a mechanism for making a cosmological 'operation' via physical processes needs to be found.

Does this mean that quantum computing as an algorithm for defining the evolution of entropy in the universe is not usable ? NO. Here is a head start as to how to present a working set of parameters to define an operation for equation 1 above.

PARTICLE PRODUCTION AS AN ENTROPY MODEL

Fortunately, if the reader thinks of particle detection as stated above, we can conflate entropy with a 'particle count'. Dr. Jack Ng has done just this with his quantum infinite statistics. Ng manages to show how a change in entropy ΔS could be linked to an increase ΔN in partonic 'fundamental particles'.

The issue which can be addressed, if the reader accept a particle count (i.e. a partonic model for units of entropy) is what 'unit' or partonic contribution to entropy should be used.

The uses that Jack Ng has for it is to use dark matter 'particles' as a way to gain entropy. The author intends to use relic graviton production as a 'driver' to obtain increases in entropy, while assuming that Jack Ng is correct in his accessment of dark matter 'particles' for initial base line entropy values. A base line calculation as to entropy increase due to relic gravitons yielded $\Delta S \approx \Delta N_{gravitons} \cong 10^{20}$ in the initial phases of graviton production in the early universe , and the remainder of a set up of entropy for the early universe can probably be ascertained by Jack Ng's reading of formulating entropy production from 'long wave length' dark matter particles.

To understand what Jack Ng's is getting at, the relic graviton production would be done with short wave length 'gravitons' corresponding to high frequency gravitational waves. I.e. a correspondence between graviton production and relic gravitational waves is assumed. Furthermore, since the wave length for the gravitons would be short, this allows for the possibility that the emergent quantum field space for the emergence of graviton production is .

As Ng writes, the analogous dark matter contribution to entropy would be with considerably longer length dark matter particles. This is in tandem with his presentation at "The Dark side of the Universe" in Cairo, in 2008 as well as his earlier arXiv and Entropy magazine presentations of the subject One can take Ng's entropy production algorithm as a good start, albeit not the final word as to what initiated entropy in the early universe. Needless to say though that it presents a good start as to how to address the conundrum which Mithra brought up to the author in January 2009, i.e. how to reconcile and solve the following EXTREMA of any function: dx/dt =0, but for the initial conditions of the Big-Bang there is a value of dS/dt =∞ at S=0. That last statement appears not to make any sense, and it needs to be addressed. So what is a start as to feeding structure/ input

Is the dark energy flow mega structure feeding information to a quantum computing device -- our present universe?

The present paper's main focus on entropy generation was in part stimulated by a paper by A. Kashlinsky, F. Atrio-Barandela, D. Kocevski, and H. Ebeling (2008), purporting to show that there exists dark energy flows. Beckwith (2008) uses the dark energy flow to explain the source of an introduction of vacuum energy in the onset of inflation, as a driver for initial vacuum energy / relic graviton, and entropy production To explain the presence of dark energy flow, as one hypothesis, a "dark flow" toward a mega structure in which the present universe is embedded has been suggested. As stated by Clara Moskowitz "Patches of matter in the universe seem to be moving at very high speeds and in a uniform direction that can't be explained by any of the known gravitational forces in the observable universe…The stuff that's pulling this matter must be *outside* the observable universe, researchers conclude." So, if this is the case, how can one speak of putting in a sufficient amount of information into the structure of our present evolving universe? This putting of information into our universe would be the first step toward getting an idea as to how to initiate relic graviton production.

Is the conduit of information for Dark flow, a wormhole from a prior universe to the present universe?

Beckwith in both 2007 and 2008 advanced at STAIF meeting presentations the idea that the present universe is obtaining quantum 'information' via a worm hole from either a prior universe, or from a super structure which the present universe is embedded within. The embedding is implied via the dark flow hypothesis,which compliments the idea of either vacuum energy and/or information being transferred via a prior universe's 'information'. The embedding information is using formalism which was obtained via Crowell's (2005) hypothesis of adapting a pseudo time dependent version of the Wheeler De Witt equation. For those who wish to check what the Wheeler De Witt equation implies, it is the basis of a hypothesis often referred to in cosmology as the Wave Funcition of the Universe, which is normally time independent. In simplest presentation, the Wheeler De Witt wave function of the universe was given as a quantum schrodinger equation with the time componet equal to zero. Barvinsky(1986) gave this, as a way of obtaining initial configuration data for how the universe began right after the cosmic singularity. Crowell's (2005) treatment, which Beckwith adopted in part uses a pseudo WKB solution of the extended version of the Wheeler De Witt equation, taking into account the worm hole structure itself. Pseudo time componets using Crowell's version of a solution to the Wheeler De Witt equation are justifiable since the worm hole construction involved a cosmic discontinuity of prior universe information in the main part, so what was represented in the present universe had much the time independent solution of the original Wheeler De Witt wavefunction of the universe. This point will later be addressed as far as an introduction of data compression from a prior universe , to the present , in terms of modeling computational information/ entropy as Shannon type entropy . The embedding structure which Beckwith (2007, 2008) in both STAIF conferences referred to for the worm hole assumed embedding in a Nordstrom metric similar to what was given in Misner, Thorne, and Wheeler's (1973) work on Gravitation.

How to work with Gravitons in terms of kink-anti kink structure: the rise of structure in terms of breaking and reformulation of gauge symmetries.

The first relatively rapid rise in entropy in terms of information from a low point of 10^{8} units of entropy as units of information was due to relic gravition production, and the subsequent rise in bits of information from about 10^{20} to todays value 10^{88} lmay have started due to what seems to be an esoteric treatment of torsion. Bob Mc Eirath (2008) for both relic neutrino and relic graviton production to occur, as $S0(3,1)_{space} \times S0(3,1)_{spin}$. This paper asserts that a generalization of what Mc Eirath is referencing in the above can be made, with some difficulty overlapping with the quark – gluon phase transition dynamics which Torrieri, Giorgio, and Mishustin, Igor (2008) wrote about and which Giorgio Torrieri presented in the Erice school of Nuclear physics, September 2008.

Worm holes, quantum nucleation, low entropy and relic graviton production

Having said that, it is appropriate to talk about the formation of low entropy states , with conditions leading to increasing complexity/ entropy generation as the universe evolved from the big bang, itself to the present era. But for reasons which the author will state later, the worm hole picture leads to a natural set of initial conditions which effectively mandate low entropy, and low bits of information in the initial stages of the big bang. Furthermore, the worm hole picture allows treatment of gravity as an emergent physical phenomenon, as suggested by Matt Visser (1999), and others . We will next talk about quantum nucleation as a start to talk about low entropy and the relic graviton production conditions. .

Information and gravitons; Four-dimensional instanton structure in a five-dimensional version of the Weiner-Nordstrom metric, Wheeler-De-Witt wormhole bridge between two universes, and resulting entropy fluctuations

However, since $\Delta S \approx \Delta N_{gravitons}$, with $\Delta N_{gravitons} \propto N1 \rightarrow N3$. Since $\Delta S \approx \Delta N_{gravitons}$, there is an eventual increase in information / entropy terms, from 10^7 to 10^{88}, due to the boost $\Delta N_{gravitons} \propto N1 \rightarrow N3 \propto boosting$ in overall entropy due to a measurable graviton burst starting the entropy buildup. **Appendix I** describes an embedding of a four-dimensional instanton structure in a five-dimensional version of the Weiner-Nordstrom metric. This is important, because it uses the same metric that could be used to construct a time-dependent wormhole bridge between two universes, as cited by Lawrence Crowell in his 2005 reference on quantum fluctuations. This pseudo-time-dependent Wheeler-De-Witt equation-generated bridge is discussed in **Appendix J**, and the contribution to entropy fluctuations due to the input of energy due to the wormhole in **Appendix K**.

INSTANTON STRUCTURE, ENTROPY, INFORMATION, DATA COMPRESSION, AND GUAGE THEORY

While assuming the relatively narrow spectrum of graviton frequencies in the onset of inflation, it is necessary to examine how this could tie into instanton-anti-instanton production. The instanton structure is actually broken up due to information compression as a prior universe collapses to a near singularity. Models of compression of physical states for cosmological singularities date back to 1973 as can be gleaned via an article written by Novikov and Zeldovitch (1973) .

For the sake of adding in an information flow/ computational bit version of this above cosmological problem, the reader can consult Shannon's (1948) result which gives a consistent mathematical treatment about data compression. As was written up by Shannon in 1948, Shannon established that there is a fundamental limit to lossless data compression. "This limit, called the entropy rate, is denoted by *H*. The exact value of *H* depends on the information source --- more specifically, the statistical nature of the source. It is possible to compress the source, in a lossless manner, with compression rate close to *H*. It is mathematically impossible to do better than *H*".

The abrupt reformulation of a near-constant cosmological constant, i.e., more stable vacuum energy conditions right after the big bang itself, would allow for reformulation of SO(4) gauge theory conditions. This would happen right after the breakup of the initial instanton due to extreme conditions. It would then lead to gravitons, which, as stated, appear as the mode describing the propagation of the gauge field, which strongly interacts with the oriented instantons that reappear shortly after a Planck time t_P

The initial breakup of instanton structure during a squeeze to a near-cosmological singularity would lead to a release of energy. Also, reformulation of suitable conditions of SO(4) gauge theory would lead to brane-antibrane construction of generalized entropy. And massive production of entropy as implied by the formulation of a one to one relationship between the cube of wave lengths of HFGW, and an initial volume of space for the nucleation of relic gravitons would lead to an increase in gravitons, for the reason stated in Appendix E**.** The gravitons are composed of kink-anti kink structures which would be formulated within a small region of space, subject to intial break up due to thermal excitation, and then a re formulation after a 2^{nd} order phase transformation . And this would be in a very small region of space, comparatively speaking due to the ultra high frequency requirement as indicated by Jack Ng's (2008a,2008b) infinite quantum statistics.

Furthermore, gravitons may be composed of kinks and anti kinks, the brane – anti brane structure used to indicate kinks and anti kinks is also duplicated in string theory , as we have discussed above. A Dp brane paired with a Dp anti brane is also in almost a one to one information bit , so not only is the graviton in early universe conditions equivalent to an information bit, so is entropy itself.

A point to investigate critically is that Giovannini's (1993,2008) calculation implies, that the total entropy of the entire universe is due to gravitons, I.e. Giovannini asserts that up to 10^{88} non dimensional entropy 'units' are due to graviton production from the onset of the big bang up to present day sources of graviton production.

To put it mildly, the author, after counting no fewer than seven methodologies for entropy contribution in cosmology thinks that Giovannini's calculation is preposterous. .But there is a very good likelihood that graviton production may have, in a relic sense played a decisive role in early universe increases of initial entropy.

Realistically brane-antibranes forming, may per appropriate for setting initial conditions for Eqn. (1) above, and then a massive increase of $\Delta S\big|_{graviton-production} \approx \Delta N\big|_{graviton-production}$, leading to entropy/information increases exemplified in G. Smoot's information increase figures, which we reproduce again below. For what it is worth, the author, Andrew Beckwith is assuming that the tally is equivalent to number of operations in equation 1 on page 2 of this document.

0) Holographic principle-allowed states in the evolution/development of the Universe: 10^{120}
1) Initially available states given to us to work with at the onset of the inflationary era: 10^{10}
2) Observable (computation) operations present due to quantum/statistical fluctuations: 10^{8}

Assuming that the above is a labeling of number of operations, this is all equivalent to having entropy as then equivalent to re writing the above as approximately

0) Holographic states in present universe $\Leftrightarrow Entropy \approx 10^{88} - 10^{90}$
1) Initially available states to work with at onset of inflation $\Leftrightarrow Entropy \approx 10^{7} - 10^{8}$
2) Observable (computation) operations due to quantum/ stat fluctuations $\Leftrightarrow Entropy \approx 10^{5}$

We need to find a way to experimentally verify this tally of results. And to find conditions under which the abrupt reformulation of a near-constant cosmological constant, i.e., more stable vacuum energy conditions right after the big bang itself, would allow for reformulation of SO(4) gauge-theory conditions.

What is the bridge between low entropy of the early universe and its rapid build up later ? Penrose in a contribution to a conference, (2006) on page two of the Penrose conference (2006) document refers to the necessity of reconciling a tiny initial starting entropy of the beginnings of the universe with a much larger increased value of entropy substancially later. As can be read from the article by Penrose (2006) "A seeming paradox arises from the fact that our best evidence for the existence of the big bang arises from observations of the microwave background radiation-"….. " This corresponds to maximum entropy so we reasonably ask:how can this be consistent with the Second law, according to which the universe started with a tiny amount of entropy" . Penrose then goes on to state that " The answer lies in the fact that the high entropy of the microwave background only refers to the matter content of the universe, and not the gravitational field, as would be enclosed by its space-time background in accordance to Einstein's theory of general relativity". Penrose then goes on to state that the initial pre red shift equals 1100 background would be remarkably homogeneous. I.e. for red shift values far greater than 1100 the more homogeneous the universe would become according to the dictum that " gravitational degrees of freedom would not be excited at all"

Beckwith (2008) then asks the question of how much of a contribution the baryonic matter contribution would be expected to make to entropy production. Figure that one would have at most 5 % of the 'matter-energy" of the universe as baryonic, and thereby easily viewed by the CMBR. If so, then what is the physical mechanism for having an increase of say 10^5 in initial entropy, corresponding to 10^8 entropy units for the start of inflation move in an arrow of time presentation for enhanced entropy to at least 10^{30} bits right after the big bang, as calculated by Beckwith(2008) . The question should be asked in terms of the time line as to how the universe evolved, as specified by both Steinhardt and Turok (2007) on pages 20-21 of their book, as well as by NASA . In addition, Beckwith also says that a major jump in entropy after the initial big bang would be at, and then after the electro weak transition of the universe. But to start the intial jump in entropy, that relic gravition production would be a good candidate for starting a jump in computational complexity from 10^8 entropy units to say 10^{20} entropy units , as stated by . Beckwith(2008). Furthermore , this jump in entropy for reasons which will be explained later would be in a small region of expanding space in the onset of the big bang. The short wave length of GW this would allow would force HFGW production.

Why consider HFGW in the first place. Why look for them rather than low frequency GW?

If one accepts what Jack Ng writes, and what A.W. Beckwith states about the wave length of 'unit particles' being commensurate with the radii of a creation space of new particles contributing to the expression $\Delta S \approx \Delta N|_{relic-gravitons}$, then high frequency gravitational waves have to be assumed . This assumption is due to HFGW having their wave lengths being very short, and the initial volume of the big bang small. So only HFGW would be created at the onset of the big bang, if the 'infinite quantum statistics Jack Ng writes up are applied .

It is now appropriate to consider how one compares the genesis of HFGW with conditions for low frequency gravitational waves. The most frequently stated example of such is with black hole physics, and in particular the interaction of binary star black hole pairs.

The main event generating low frequency GW as would be ascertained via direct experimental measurements is the phenomenon known as ringdown. Ringdown as noted in the 11th Gravitational Wave Data Analysis Workshop as written up by James Clark oscillations are rapidly damped away by gravitational wave emission, leading to a distinctive 'ring –down' (i.e., a damped sinusoid) signal. Bayesian model selection was used to evaluate the relative probabilities of various models describing gravitational wave interferometer data. So, ringdown is a well developed technology. There are other useful ways to use Black holes to get GW from black holes, as outlined by Clifford Will (2006) in his classic work, about the collision between GR and experiment in living reviews of relativity , and Beckwith (2008) merely asserts that ringdown is the most useful technology for obtaining GW from black holes, i.e. the most mature currently developed technology.

How often could one realistically expect to observe ringdown ? F Acernese, P Amico, et al, in 2007 presented a well done evaluation as to up to which level the so called Virgo detector would be able to constrain the amplitude of the gravitational wave signal from a typical long gamma-ray burst.This with regards to the Virgo detector being aimed to search for bursts of gravitational waves associated with the long GRB 050915a. Despite, all the expectations, no positive results, and as Dr. Beckwith confirmed with discussions with researchers in Texas in Vancouver, December 2008, the GW community, despite multi billion dollar technology plat forms may have to wait decades, or longer for ringdown to occur . And this phenomenon, ringdown for black holes is very rare. Enough so that Arnaud et al, noted (2004) that even for supernova, GW would be extremely weak.

In addition to the problems associated with low frequency GW, in terms not of the technical feasibility of the measurement platforms, like LISA, LIGO, and PLANCK, which are superb instruments in their own right, but of the relative frequency of occurance of black hole phenomenon like ringdown, is the probability that relic graviton production, as specified as a way to boost initial low entropy levels of 10^{8} would be far more likely to occur. Even Krauss and his associates in Case Western Reserve (2008) in the PRL article written by Jones-Smith, K., Krauss, L., Mathur, H. (2008) give credence to the likely hood of large scale graviton/ GW production in early universe conditions. Furthermore, the production levels of early universe GW production conditions as predicted by both Jones-Smith, Krauss, and Mathur (2008) as well as Beckwith (2008) enables the possibility of detection of gravitons as physical objects, contravening Tony Rothman's (2006) assertions that detectors the size of Jupiter would be needed to observe a single graviton. The main point is as follows. Ringdown and the like would for low frequency GW would not create enough gravitons, partly due to the admitted weakness of low frequency GW. Proper analysis of HFGW would , if early universe conditions at or before electro weak transitions down to the big bang create an almost continual production of HFGW which would enhance the likelihood of detection of gravitons. **Appendix A** as given outlines what may be an experimental way to evaluate HFGW with a far higher chance of success than what is assumed via traditional methods.

Change in entropy = change in nucleated states and HFGWs

Furthermore, as will be explained in applying Y. Jack Ng. (2007, 2008) results as to making an equivalence between change in entropy, and change in the number of nucleated states, See **Appendix C** for the relevant details, and pay attention to how short wave length implies high frequencies for vacuum nucleated in relic conditions GWs.

Topological implications of the informational increase in complexity

The topological implications of the informational increase in complexity has similarities with the topological dynamics discussed in Altman C, Pykacz J and Zapatrin R (2007).

The entire Hartle- Hawkings treatment of wave functions which Beckwith asserted as of both (2007) and (2008) is closely linked to Beckwith's (2008) treatment of causal discontinuity. The treatment of causal discontinuity is in this matter actually a space time enabler of Shannon data compression, a point both Beckwith and Altman appear to be fully conversant upon.

An analogy with black hole physics is informative and instructive . Manschott (2008) specifically modeled for four dimensions a way of calling black hole entropy as directly linked to the absolute magnitude, squared, of a central charge, Z . Here Z is constructed from electric charges, q_A and magnetic charges p^A contributions, so then the treatment of mass-energy equivalence can be given 'at an infinite distance' as mass $M = |Z|_{r=\infty}$ and it is possible to write as given by Ceresole , et al (1995)

$$S_{black-hole} = \pi |Z|^2 \qquad (2)$$

Discontinuity comes with a vengeance when ascertaining necessary and sufficient conditions for forming sufficient conditions for formation of electric and magnetic charge. I.e. a threshold for formation of the charges, both magnetic and electric has to be crossed. How is this related to the Hartle-Hawking state ? Again, threshold effects are the key. Here is why this threshold monikor is brought up. Equation 2 is, in its own way closely tied into the so called BPS model of black hole entropy models. As can be noted, suppose we have a box filled with gas of some type of molecule called M. The temperature of that gas in that box tells us the average kinetic energy of those vibrating molecules of gas. Each molecule as a quantum particle has quantized energy states, and if we understand the quantum theory of those molecules, theorists can count up the available quantum microstates of those molecules and get some number**.** The entropy **is** the logarithm of that number**.** When it was discovered that black holes can decay by quantum processes**,** it was also discovered that black holes seem to have the thermodynamic properties of temperature and entropy. The temperature of the black hole is inversely proportional to its mass, so the black hole gets hotter and hotter as it decays.

The entropy of a black hole is one fourth of the area of the event horizon, so the entropy gets smaller and smaller as the black hole decays and the event horizon area becomes smaller and smaller.

BLACK HOLES AND BRANES IN STRING THEORY

A black hole is an object that is described by a spacetime geometry that is a solution to the Einstein equation. In string theory at large distance scales, solutions to the Einstein equation are only modified by very small corrections. But it has been discovered through string duality relations that spacetime geometry is not a fundamental concept in string theory, and at small distance scales or when the forces are very strong, there is an alternate description of the same physical system that appears to be very different. A special type of black hole that is very important in string theory is called a BPS black hole. A BPS black hole has both charge (electric and/or magnetic) and mass, and the mass and the charges satisfy an equality that leads to unbroken supersymmetry in the spacetime near the black hole.

But there's also a relationship between black p-branes and D-branes. At large values of the charge, spacetime geometry is a good description of of a black p-brane system. But when the charge is small, the system can be described by a bunch of weakly interacting D-branes. Now for the punch line.

But when the charge is small, the system can be described by a bunch of weakly interacting D-branes. In this weakly coupled D-brane limit, with the BPS condition satisfied, it is possible to calculate the number of available quantum states. This answer depends on the charges of the D-branes in the system.When we go back to the geometrical limit of the equivalent black hole of p-brane system with the same charges and masses, we find that the entropy of the D-brane system matches the entropy as calculated from the black hole or p-brane event horizon area .I.e. there is a near one to one equivalence i.e. it is possible to calculate the number of available quantum states. . In a word, there is equivalence between the number of quantum states, from D branes, and area of p brane event horizon. I.e. a linkage between quantum states, i.e. quantum 'information' and entropy exists. One of the latest re statement of this idea is given by Gunadyn, Neitzke, Pioline, and Waldron(2007). We categorically state that a similar equivalence exist between information, and entropy at the start of nucleation of a new universe, which breaks down just before inflation, and is re formulated after inflation commences. The re formulation of this equivalence is at the heart of 'arrow of time' models of entropy

Steinhardt's treatment of reconstruction of tensorial contributions of gravitational waves; Ng: analysis of data from the Li-Baker detector; entropy and gravitons; entropy and information; cutoff of information from a prior universe

Appendix B shows a derivation of inputs from Steinhardt's treatment of reconstruction of tensorial contributions of gravitational waves. In **Appendix C**, Jack Ng's derivation is cited, and in **Appendix D**, an analysis of data from the Li-Baker detector is presented. It is asserted that these inputs will show how $\Delta S \approx \Delta N_{gravitons}$ is so important for the growth of entropy. That leads to the main point of this paper: entropy is a measurement of "information," i.e., the relative informational content of the universe, as Seth

Lloyd has asserted, then the growth of entropy indicates that Abhay Ashtekar is wrong in saying that there is a cutoff of a lot of prior information from the older universe to matter-energy input to the new universe.

Gauge field invariance, universe nucleation, and cosmological constant, loss of information from a prior universe and HFGW evidence of entropy growth: main focus on this paper

Appendix E deals with a very important idea discussed with Tigran Tchrakian (2008)at the Models of Gravity in Higher dimensions conference in Bremen: that gauge field invariance, so important to the formation of instanton structure, is broken at the onset of early cosmological universe nucleation. I.e., a cosmological constant for four dimensions no longer holds for times $t \le t_P$ (Planck's interval of time), within an order of magnitude of 10^{-35} seconds. If instanton structure is a packet of moving enclosed "information," and if the gauge invariance is broken, as assumed in this paper, for times $t \le t_P$, then there is an excellent chance there is a significant loss of information from a prior universe to the present universe. This is the main focus of this paper.

Breakdown in causal ordering

Appendix F will also look at older work presented purporting to show the same thing, i.e., a breakdown in causal ordering, a.k.a. Fay Dowker causal set ordering -- a temporary reversal of causal set ordering in the evolution of the scale factor at or about times $t \le t_P$. This is equivalent to the breakup of gauge invariance for times $t \le t_P$.

Buildup of temperature from energy-matter transfer from a prior universe, Wheeler-De-Witt wormhole, graviton burst, leading to entropy growth; Smoot's cosmological information theory

- As stated in __Beckwith (2008)_ , a rapid buildup of temperature from energy-matter transfer from a prior universe involves a rapid thermal buildup by matter-energy transfer, per the Wheeler-De-Witt wormhole model presented in **Appendix H** . So by the time $Temp = 5T^*$, the graviton burst has occurred within an order of magnitude of the value $t_{Planck} \sim 10^{-35}$ seconds, and the frequency range can be set to $\nu_{Maximum}\big|_{graviton-production} \propto 10^{10}\,Hz$, assuming that $Temp = 5T^* \approx 10^{-32}\,Kelvin$ as a point where quantum nucleation effects become dominant in quantum gravity, as predicted by Stephen Weinberg in 1972. Note that the graviton burst effect, leading to entropy growth is seen in the expansion of information bits from 10^8 to almost 10^{88} in a relatively short period of time.

This build up of information from 10^{10} to higher values is outlined in Table 1, below

TABLE 1. Graviton burst

Numerical values of graviton production	Temp	Scaled Power values
$N1 = 1.794 \times 10^{-6}$	T^*	0
$N2 = 1.133 \times 10^{-4}$	$2T^*$	0
$N3 = 7.872 \times 10^{21}$	$3T^*$	1.058×10^{16}
$N4 = 3.612 \times 10^{16}$	$4T^*$	~ 1
$N5 = 4.205 \times 10^{-3}$	$5T^*$	0

The numerical peak of graviton burst at N3 in table 1 is consistent with a peak of gravition energy , as a function of input vacuum energy. i. Consider Eqn. (1) below and how iEqn (1) peaks in value at $\nu_{Maximum}\Big|_{graviton-production} \sim 10^{10}\,Hz$. Beckwith (2008) asserted that this peak value for graviton energy , and input vacuum energy is consistent with the rapid growth in entropy and the change in bits of "information" from a low value of entropy of $10^{7}\;to\;\;10^{88}$.

$$\Omega_{gw}(\nu) = \frac{\pi^2}{3} h^2(\nu) \left(\frac{\nu}{\nu_H}\right)^2 \qquad (3)$$

Entropy relationship to relic graviton bursts; decrease of information bits sent from a prior universe vs. Loop Quantum gravity; 10^{10} Hertz peak;

Figure 1, presented at a meeting of HFGW researchers in the Institute of Advanced Study at Austin, will assist in the subsequent parameterization of our investigation of entropy and its relationship to relic graviton bursts. The key point to be made here is: there is a very pronounced decrease of information bits sent from a prior universe to today's universe. This contradicts what many theorists of Loop Quantum gravity suppose: that much of the universe's prior memory is needed to keep values of key physical parameters such as G and η the same between different cycles. So it will be necessary to find a different mechanism to preserve continuity of physical parameters such as G and η , if they are assumed to be essentially the same between different cycles of creation and destruction. Entropy is a measure of informational complexity. At $\sim 10^{10}$ Hertz, , there a huge influx of energy from a prior universe into the inflationary era of the present universe. As we be discussed later, this will lead to both depression, then a rebirth of both relic graviton production and entropy. It is asserted that the presence of the peak in gravity wave frequency at about 10^{10} Hertz (shown in figure 1) has significant consequences for observational cosmology.

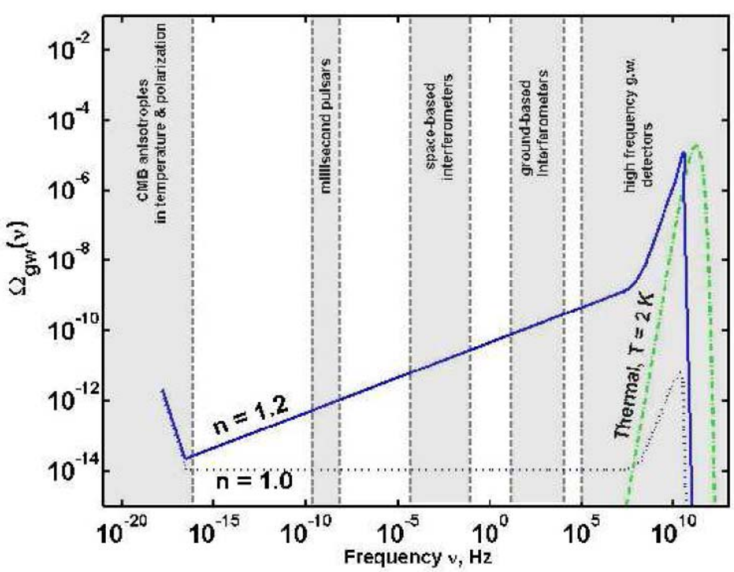

FIGURE 1 Where HFGWs come from: Grishchuk found the maximum energy density (at a peak frequency) of relic gravitational waves (Grishchuk, 2007).

It should be noted that the relic graviton burst alluded to in Figure 1 is due in part to a second-order phase transition, which will be explained in **Appendix H**

HFGWs, NEUTINOS, AND BOUNDS FOR THE GRAVITON MASS

Finally, there is an inter relationship which is notable between HFGW, and neutrino physics, which can further aid in getting data, namely in the following identification of neutrino data sets, which has a counter part in the LHC graviton production schemes within the ring of the LHC, as initially noted by Pisen Chen in 1993.Traditionally, the assumption of graviton mass has lead to limits as to the unbounded nature of gravitational interaction. The usual way this is stated is via

$$r_g \sim \frac{\eta}{m_g c} \qquad (4.)$$

As stated by Valev (2006), and which is readily apparent, Eqn. (4) becomes unbounded as $m_g \to 0$, and Valev (2006) bench marks upper limits as to the gravitational mass, as traditionally calculated by claiming that phenomenology arguments lead to upper bond values of

$$m_g \sim 1.2 \times 10^{-37} eV / c^2 \qquad (5)$$

As well as phenomenology arguments specifying

$$m_{\nu_{e^-}} \sim 0.0002 eV / c^2 \qquad (6.)$$

Furthermore, in recent communication with Dr. Beckwith, Dr. Steinhardt claimed a ratio of about 10^5 neutrinos to each graviton, most likely referring to relic production of both of them, and this, plus the Li-Baker predictions (Baker, 2001; Li et al., 2008; Baker, Stephenson and Li, 2008; Stephenson, 2009) as to electric and magnetic field production can permit a comparison between graviton / gravitational wave detection as specified by the Li-Baker detector, and Neutrino data sets by the ICECUBE south pole detector.

The reference as to the LHC can be made by assuming Beckwith's article presented as of Neutrino 2008 as accepted in the IOP conference proceedings for Neutrino 2008 give the correct branching ratios for Neutrino physics, and that Steinhardts value of 10^5 neutrinos per graviton is correct. If so, the additional assumption is that equation (2) and equation (3) values are correct. Furthermore, the author wishes to point out that the Li Baker detector , after having a graviton mass ascertained, can have its values of graviton mass checked via the following procedure, which does have the LHC as its center piece

Detection of relic HFGWs; Instanton-anti-instanton structures contributing to both entropy production and gravitons; graviton flux; gauge theory

This computation will lead to detection of relic HFGW, provided frequency values for $\omega_g \leq 10^{10} Hz$ are found experimentally. Such a high frequency, resulting from energy inputs from a prior universe, ensures that there is both a breakdown, then a reconstitution of instanton-anti-instanton structures contributing to both entropy production and gravitons. In the paper by Dr. Li, Dr. Baker et al., the authors set an incident relic graviton flux of $N_g \cong 2.89 \times 10^{14} / \sec$ at a detector site. This is different from a graviton flux due to the reformulation of instanton-anti-instanton structure of gravitons. It is assumed from Figure 1 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. An invariant ratio of viscosity over entropy, even as the entropy changes and the viscosity becomes enormous, is also assumed. In part, this is shown in the phase-transition dynamics of Fig 1 and Appendix G Initially, ultra-high temperatures would break up the instanton-anti- instanton structure, while the falloff to lower temperatures would lead to the reconstitution of instanton-anti-instanton structures.

Comparing different models of inputting thermal-radiation energy

Begin first with looking at different value of the cosmological vacuum energy parameters, in four and five dimensions,as given by Park (2003), and re duplicated by Beckwith(2008) at the last STAIF meeting

$$\left|\Lambda_{5-\dim}\right| \approx c_1 \cdot \left(1/T^{\alpha}\right) \qquad (8)$$

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

$$\Lambda_{4-\dim} \approx c_2 \cdot T^{\beta} \qquad (9)$$

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

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

Right after the gravitons are released, one still sees a drop-off of temperature contributions to the cosmological constant .Then one can write, for small time values $t \approx \delta^1 \cdot t_P$, $0 < \delta^1 \leq 1$ and for temperatures sharply lower than $T \approx 10^{12}\, Kelvin$, Beckwith (2007, 2008), where for a positive integer n

$$\frac{\Lambda_{4-\dim}}{\left|\Lambda_{5-\dim}\right|} - 1 \approx \frac{1}{n} \qquad (11)$$

If there is an order of magnitude equivalence between such representations, there is a quantum regime of gravity that is consistent with fluctuations in energy and growth of entropy. An order-of-magnitude estimate will be used to present what the value of the vacuum energy should be in the neighborhood of Planck time in the advent of nucleation of a new universe. The significance of Eqn (11) is that at very high temperatures, it completely breaks from what the author brought up with Tigran Tchrakian, in Bremen,

Uniform value of the cosmological constant in the gravitating Yang-Mills fields in quantum gravity

August 29th, 2008. I.e., one would like to have a uniform value of the cosmological constant in the gravitating Yang-Mills fields in quantum gravity in order to keep the gauges associated with instantons from changing. When one has, especially for times $t_1, t_2 <$ Planck time t_P and $t_1 \neq t_2$, with temperature $T(t_1) \neq T(t_2)$, then $\Lambda_4(t_1) \neq \Lambda_4(t_2)$. I.e., in the regime of high temperatures, one has $T(t_1) \neq T(t_2)$ for times $t_1, t_2 <$ Planck time t_P and $t_1 \neq t_2$, such that gauge invariance necessary for soliton (instanton) stability is broken. Note that Jason Kumar (2002) speculated on the existence of instantons for quantum gravity in 2002, largely based upon this gauge invariance, and that the easiest way to break gauge invariance is to have $\Lambda_4(t_1) \neq \Lambda_4(t_2)$ especially, since Tchrakian established that invariance of a cosmological constant in his gravitating Yang-Mills fields is necessary for the gauge conditions for instanton formation and stability.

TABLE 2

Cosmological Λ in 5 and 4 dimensions

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

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

HOW BRANE THEORY TALKS ABOUT ENTROPY

One can look at the research results of Samir Mathur The supposition is that branes and antibranes form the working component of an instanton. This is part of what has been developed in the case of massless radiation, where for D space-time dimensions, and E, the general energy is

$$S \sim E^{(D-1/D)} \qquad (12)$$

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

$$\frac{\Lambda_{Max} V_4}{8 \cdot \pi \cdot G} \sim T^{00} V_4 \equiv \rho \cdot V_4 = E_{total} \qquad (13)$$

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 $l_P \sim 10^{-33}\,cm \xrightarrow[\text{Quantum-Gravity-threshold}]{} \tilde{N}^{\alpha} \cdot l_P$. 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. Density wave physics would require a one- to-one relationship between the instanton as an electronic charge and the anti-instanton as a positron charge. In CDW, this is a way to get a thin-wall approximation of CDW dynamics. First, a similar pairing in both black hole models and models of the early universe is examined, and a counting regime for the number of instanton and anti-instanton structures in both black holes and in early universe models is employed as a way to get a net entropy-information count value. One can observe this in the work of Gilad Lifschytz in 2004. Lifschyztz codified thermalization equations of the black hole, which were recovered from the model of branes and antibranes and a contribution to total vacuum energy. In lieu of assuming an antibrane is merely the charge conjugate of say a Dp brane in this situation, one can write an entropy value as shown in Eqn. (12) above as a numerical average value of winding numbers of brane and antibrane contributions to entropy. Here, $M_{p\,j,0}$ is the number of branes in an early universe configuration, while $M_{\bar{p}\,j,0}$ is anti-brane number . I.e., there is a kink in the given $brane \sim M_{p\ \ j,0} \leftrightarrow CDW\ \ e^{-}$ electron charge and for the corresponding anti-kink $anti-brane \sim M_{\bar{p}\ \ j,0} \leftrightarrow CDW\ \ e^{+}$ positron charge. Here, in the bottom expression, $\breve{N}$ is the number of kink-anti-kink charge pairs, which is analogous to the simpler CDW structure.

$$S_{Total} \sim \breve{a} \cdot \left[\frac{E_{Total}}{2^{n}}\right]^{\lambda} \cdot \prod_{j=1}^{\breve{N}} \left(\sqrt{M_{p\,j,0}} + \sqrt{M_{\bar{p}\,j,0}}\right) \qquad (14)$$

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 (13) above, where E_{Total} is proportional to the cosmological vacuum energy parameter; in string theory, E_{Total} is also defined via

$$E_{Total} = 4\lambda \cdot \sqrt{M_{p\,j,0} \cdot M_{\bar{p}\,j,0}} \qquad (15)$$

This can be changed and rescaled to treating the mass and the energy of the brane contribution along the lines of Mathur's CQG article (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

$$E_{Total} = 2\sum_{i} m_i n_i \qquad (16)$$

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. (17) 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:

$$S_{Total} = A \cdot \prod_{i}^{\breve{N}} \sqrt{n_i} \tag{17}$$

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

1. Modeling gravitons as a kink-anti-kink combination
2. Modeling of entropy, generally, as kink-anti-kinks pairs with $\breve{N}$ the number of the kink-anti=kink pairs. This value of $\breve{N}$ directly contributes to the value of entropy, as given in Eqn. (17)
3. The tie in with entropy and gravitons is this: The two structures are related to each other in terms of kinks and antikinks. It is asserted that how they form and break up is due to the same phenomenon: a large insertion of vacuum energy leads to an initial breakup of both entropy levels and gravitons. When a second-order phase transition occurs, there is a burst of relic gravitons. Similarly, there is an initial breakup of net entropy levels, and after a second-order phase transition, another rapid increase in entropy.

The growth of entropy starts from a low point given by Smoot (initial values in the range of about 10^7 to 10^8), which then radically expands. The task in Eqn. (18) below is to configure the initial starting point for entropy.The main assertion is that if gravitons and entropy are interrelated, and due to kinks and antikinks, a low point of entropy and graviton production is due to kink-antikinks being broken up, and then reformulated for a radical boost in entropy. The assertion is that the breakdown of entropy and information from a prior universe will lead to a surviving structure of Dp branes and antibranes and in a Planck interval of time at the very beginning of the inflationary era, leads to

$$\left| \left[S_{Total} = A \cdot \prod_{i}^{N} \sqrt{n_i} \right] \Big/ k_B \ln 2 \right| \approx [\#operations]^{3/4} \approx 10^8 \tag{18}$$

It is also claimed that the interaction of the branes and antibranes will form an instanton structure, which is implicit in the treatment outlined in Eqn. (18), and that the numerical counts given in Eqn (18) merely reflect that branes and antibranes -- even if charge conjugates of each other -- have the same "wrapping number" n_i .It should be noted that this sort of treatment of entropy has to be reconciled with the standard radiation era, i.e., right after the big bang value of entropy, usually written as

$$s_{Density} = \frac{2 \cdot \pi^2}{45} \cdot g_* \cdot T^3 \tag{19}$$

Competing Cosmology models. Can entropy production help falsify cyclic models of cosmology, or variants along the lines discussed by Roger Penrose at the ICG conference in Penn State, 2007 ?

In the inaugural ICG meeting, on August 11, 2007 at Penn State, Roger Penrose gave a resentation which the author saw in person about an alternative to cyclic cosmological models, which has many good point, but which needs experimental tests for falsifiabity. As discussed by Beckwith, (2008), in a EJTP particle, Penrose brought up how a De Albertain wave equation, as simplified in flat space could lead to a rising vacuum nucleation field which would engender the pop up behavior as sought in most emergent field models of gravity. The scalar field pop up with certain qualifications is not so startling in itself. Now for the radical extension Penrose brought to bear. Penrose asserted in his ICG lecture that there was a good chance that there was no collapse in future events, but that matter would be eventually sucked up by 'millions' of black holes, creating a clean up of most interstellar matter.

Next, Penrose asserted that the 'millions of black holes' would eventually undergo Hawking's evaporation, i.e. that in some fashion that there would be a release of the matter- energy For those who wish to look it up, Hawking's evaporation of black holes, involves subtle quantum arguments and tries to reconcile black hole physics with known thermodynamics. ,eg. As an example the 2nd law of Black hole dynamics. Traschen (2000) states the basic assumptions involved, while Hawkings (1992) stated evaporation as to ways which may tie in with typical entropy / area calculations as given by Bernstein and other writers. Needless to state though, equation 1 above, and the issue of if or not there is a well defined threshold bulk electric and magnetic charge contribution to energy. If there is , indeed an evaporation effect of black hole physics, at what juncture does one have a collapse of a threshold effect for calculations about the minimum entropy based upon black hole models involving electric and magnetic charges ?

Assuming then, that the relevant Black holes evaporate, Penrose next presented the question of an undetermined mapping of the evaporated Hawking radiation back to the nexus point for a new big bang.

The author, Beckwith, asked Penrose repeatedly at the ICG about the nature of the mapping of released Hawking radiation back to a new big bang. Penrose threw the question back to Beckwith, as Beckwith's research problem, not his. And with the addition of the dark flow/ mega structure of larger structures than our universe containing our present cosmos idea (2008) as given in the beginning of this article, in part the solution partly suggests itself to the author as follows.Assume, if one will that there are N number of universes under going Penrose style expansion and then black hole clean up of matter- energy as these N universes expand. Each universe contains roughly 10^{88} entropy units of computational information as embedded in say 10^{10} spiral galaxies. If each spiral galaxy has an entropy reading of about 10^{90} entropy 'units', this leads to an over hang of about 10^{100} entropy units, as opposed to an observable 10^{88} entropy units for the universe as can be accessed by instrumentation. Which leads to the question of what is the significance of that entropy gap ?

Secondly, and most important to this discussion, there is a strange attractor suck up of bits of information from each of the N expanding universes, and the Hawking radiation is, within a mega structure mapped back to the locus point of another sent of N big bangs via typical phase space strange attractor dynamics.How to verify this wild supposition experimentally ? See the conclusion of this article for Beckwith's guess as to what to try to do experimentally to indirectly infer the existence of this mega structure and of strange attractor collapse of Hawkings radiation back to N locus points for N number of big bangs.

Conclusion: What is needed to be experimentally falsified: relic graviton production involves HFGWs, indicated by a rapid drop off of graviton creation after the onset of the big bang

We should first look at the key assumption of the Jack Ng (2008a,2008b) approach to entropy : the wavelength of the "particles" contributing to entropy are ultra-long, i.e., there is an order of magnitude difference between the cube of the wavelengths of the particles and of the containing volume of space, V, which is analyzed to obtain the entropy figure Ng (2008a, 2008b) uses to get his infinite quantum statistics.The same methodology of comparing the cube of wavelengths with the expected spacetime volume is used to get Ng's infinite quantum statistics, assuming that relic graviton production involves HFGWs and that there is an extremely short wavelength for the ultra high frequency gravity waves. Then one analyzes entropy production what Ng did with DM and wavelengths, and the volume of space V,. But instead of DM, this involves gravitons, with an ultra-short wavelength, necessitating a small volume of space in the beginning of graviton production. So the same infinite quantum statistics procedure Ng used for DM can be used for gravitons, except that the gravitons are produced in the very *beginning* of the inflationary era. So the creation of gravitons is enhanced in the beginning of cosmological nucleation by the requirement of a one-to-one relationship between shortwave lengths of HFGW and a small space time volume for relic graviton creation .Then it's likely that the data sets observed in the Li-Baker detector could indicate a rapid drop off of graviton creation after the onset of the big bang. This should be investigated by falsifiable experimental procedures.

Prediction: a relatively narrow range of GW frequencies for relic graviton production

Appendix N examines this assumption and compares it directly with another assumption made by Giovannini in 1993, which is reformulated to assert that if all frequency ranges for GW radiation were permissible, one would see a total value of entropy of nearly 10^{90}. This is done while not assuming as we did HFGW conditions.

Therefore, Giovannini's (1993) prediction is assumed to be indefensible, and that a relatively narrow range of GW frequencies for relic graviton production is what should be looked for via either the Li-Baker HFGW detector or by the Planck satellite mission.

Implication: How an inflaton could arise and fall from thermal inputs from a prior universe

Here are some additional possible spinoffs of these sorts of ideas, if they are experimentally verified. The author, A.W. Beckwith, attended the inaugural lectures of the Penn State gravitational center in 2007. **Appendix K** shows a to-the-point presentation of how an inflaton could arise and fall from thermal inputs from a prior universe. These are notes adapted from a presentation by Dr. Penrose regarding his alternatives to typical cyclic-universe cosmologies. We do not agree with Penrose's startling conclusions, but his first part of his presentation is useful, since it fits very closely with the author's methodologies for thermal inputs from a prior universe.

Are irregularities in the CMBR spectra related to entropy production?

If this can be verified experimentally, the biggest payoff would be to address an issue that the author discussed with Subir Sarkar of Oxford. **Appendix L** gives the basic idea: are the irregularities in the CMBR spectra, due to non-standard physics, which are an extension of the standard inflaton model, used to justify entropy production? We think that there is merit to this idea and that it should be investigated. At the minimum, understanding entropy production would allow us to analyze if the structure formation methodology experimentally presented by Rtuu ties in with models of entropy production, and if not, what about verifying the standard model for CMBR production, as G. Hingsaw and others promote? Or what if Subir Sarkaris right? A summary of what A.W. Beckwith (2008) , thinks of these issues may be found in this summary of a presentation made at IDM 2008 (the author is amendable to changing this, with verification of the experimental issues).

STRUCTURE FORMATION FROM ENTROPY GENERATION

Aiding in the development of confirming/falsifying Eqn. (24) above are structure formation questions that we leave as open questions to be addressed by the CMBR/astrophysics community: This would be aligned with the question of how structure formation could arise as a result of entropy generation. Subir Sarkar and others, with their race track models of inflation, have done useful pioneering work in defining coupled fields undergoing symmetry breaking that are coupled to the inflaton. The author, A.W. Beckwith, thinks that such suppositions need experimental verification, and that the boost of total entropy by the relic graviton value given in $\Delta S_{graviton-production} \propto 10^{21}$ could lead to additional insights into whether or not Subir Sarkar (2008) or Gary Hingsaw is right about the origins of irregularities in the CMBR spectra.

How initially huge vacuum energy and its rapid collapse in space-time to a much smaller cosmological constant value aids in the breakup and reformulation of entropy production ????

The author, A.W. Beckwith, wishes to close with what will be future projects to address some of the above issues. As discussed with Tigran Tchrakian, in Bremen, August 29th, 2008, the author wishes to determine if or not the dichotomy between an initially huge vacuum energy, as specified above in this manuscript, and its rapid collapse in space-time to a much smaller cosmological constant value, aids in the breakup and reformulation of entropy production. The author's supposition is that it is relevant to two areas. First, the author assume that there is a breakup of the initial instanton structure from a prior universe. Since the author also views gravitons as a kink-antikink structure, the supposition is that initially, from a prior to a present universe, there would be a similar phenomenon: initial lack of numerical density of gravitons just before a second-order phase transition, which is discussed in part in **Appendix M.** Secondly if, after a second-order phase transition we see evidence of astrophysical data supporting the rebirth of both entropy and graviton production, we should take this hypothesis seriously. Should the cosmological constant/vacuum energy linkage be proved to be consistent with the breakup and then reformulation of graviton production in a phase transition, then the author, A.W. Beckwith, thinks that researchers could be on track for new experimentally falsifiable criteria, to be developed for CMBR physics.

Relationship between Dark Matter, Neutrino physics, and the production of HFGW in relic conditions; WIMP-less DM and a shadow world

Furthermore the use of a HFGW detector leads open the question of if or not WIMPS are the best way to model Dark Matter. The author, Beckwith, as of 2008 is for many reasons convinced that there is an inter relationship between Dark Matter, Neutrino physics, and the production of HFGW in relic conditions. As stated by Feng (2008) , the idea of WIMP-less dark matter gets a little more interesting than simply considering weaker or stronger dark matter candidates. Feng says that WIMP-less dark matter could provide some support for the idea of a hidden sector – a so-called shadow world. "There are theories that there is a shadow world behind ours. It is a mirror world that is like ours, but doesn't interact with ours. With WIMP dark matter, that possibility is remote." Next , "WIMP-less dark matter requires new forces that we don't really know much about. If you could have evidence of this type of dark matter, it might be a hint that this shadow world exists."

Finally, Relic graviton produced entropy at the onset of the big bang . Why starting entropy would be so small while CMBR entropy would be so large

As a closing remark, Beckwith wishes to suggest a solution to Dr. Penrose's implied question about entropy as raised in in Edingborough , Scotland (2006) conference proceedings. Penrose talks about the 2nd law, and its implied requirements as to the small initial value of early universe entropy, and then states that gravitational entropy would not be so major, whiereas CMBR matter contributed entropy would be much larger. Beckwith is convinced that relic graviton production at the onset of the big bang, i.e. before the contribution of entropy from matter itself would be necessary to boost entropy from its small 10^8 value at the onset of the big bang, to a much higher level , and that entropy would be initially dramatically boosted by that process. I.e. the uniformity requirement Penrose talks about in structure would be actually as of up to the Electro weak transition , and far after the initial onset of inflation itself.

And the punch line ? A wild new idea extending Penrose's suggestion of cyclic universes, black hole evaporation, and the embedding structure our universe is contained within

'

Beckwith (2008) strongly suspects that there are no fewer than N (a large number) of universes under going Penrose 'infinite expansion' and all these are contained within a mega universe structure. Furthermore, that each of the N universes has black hole evaporation commencing, with the Hawking radiation from decaying black holes.

If each of the N universes is definable by a partition function, we can call $\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}$, then there exist an information minimum ensemble of mixed minimum information roughly correlated as about 10^{10} bits of information per each partition function in the set $\left.\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}\right|_{before}$, so minimum information is concerved between a set of partition functions per each universe

$$\left.\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}\right|_{before} \equiv \left.\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}\right|_{after} \qquad (25)\ '$$

However, that there is non uniqueness of information put into each partition function $\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}$.

Furthermore that within the mega structure, that Hawking radiation from the black holes is collated via a strange attractor collection in the mega universe structure to form a new big bang for each of the N universes as represented by $\left\{\Xi_i\right\}_{i\equiv N}^{i\equiv 1}$. Verification of this mega structure compression and expansion of information with a non unique venue of information placed in each of the N universes would strongly favor Ergodic mixing treatments of initial values for each of the N universes expanding from a quasi singularity beginning.If this idea is in any way confirmable, it would lend credence as to the formation of the dark flow hypothesis, and of how anharmonic perturbative contributions to initial inflationary expansion may occur , within a partially random ergotic background. Beckwith claims that such a process would inheriently favor the small 10^{10} bits of information per each partition function representing the 'start' of expansion of a new universe.

Appendix A:

Complementarity between Li-Baker detector data, LHC graviton detection, ICECUBE neutrino data

Eric Davis, quoting Pisen Chen's article written in 1994 estimates that a typical storage ring for an accelerator will be able to give approximately $10^{-6} - 10^{3}$ gravitons per second. Quoting Pisen Chen's 1994 article, the following for graviton emission values for a circular accelerator system, with m the mass of a graviton, and M_P being Planck mass. N as mentioned below is the number of 'particles' in a ring for an accelerator system, and n_b is an accelerator physics parameter for bunches of particles which for the LHC is set by Pisen Chen as of the value 2800, and N for the LHC is about 10^{11}. And, for the LHC Pisen Chen sets γ as $.88 \times 10^{2}$, with $\rho[m] \approx 4300$. Here, $m \sim m_{graviton}$ acts as a mass charge.

$$N_{GSR} \sim 5.6 \cdot n_b^2 \cdot N^2 \cdot \frac{m^2}{M_P^2} \cdot \frac{c \cdot \gamma^4}{\rho} \qquad (1)$$

The immediate consequence of the prior discussion would be to obtain a more realistic set of bounds for the graviton mass, which could considerably refine the estimate of 10^{11} gravitons produced per year at the LHC, with realistically 365 x 86400 *seconds* = 31536000 *seconds* in a year, leading to 3.171×10^{3} gravitons produced per second. Refining an actual permitted value of bounds for the accepted graviton mass, m, as given above, while keeping $M_P \sim 1.2209 \times 10^{19}$ *GeV*/c^2 would allow for a more precise set of gravitons per second which would significantly enhance the chance of actual detection, since right now for the LHC there is too much general uncertainty as to the likelihood of where to place a detector for actually capturing / detecting a graviton.Both the outlined procedures , involving both the Li-Baker detector, and the LHC, involving neutrino physics, gravitons, and the like would, with additional vetting be part of an active research program which would be useful experimentally in obtaining conditions for giant gravitons.

A suitable goal of a reasonable HFGW detector system, and detection of gravitons would be to get complementarity between data taken by the Li – Baker detector and LHC graviton detection at the center of a major accelerator ring. Furthermore, if entropy build up is largely determined by relic graviton production as asserted by Beckwith (2008) , then complimentarity, if established in neutrino physics data sets from ICECUBE experiments and HFGW data

Appendix A1 : Bounds upon Graviton mass, and making use of the difference between Graviton propagation speed and HFGW transit speed to observe post Newtonian corrections to Gravitational potential fields.

The author presents a post Newtonian approximation based upon an earlier argument / paper by Clifford Will as to Yukawa revisions of gravitational potentials in part initiated by gravitons with explicit mass dependence in their Compton wave length. The Li- Baker HFGW detector, with its ultra refined capacity to obtain relic HFGW signals is able to experimentally determine for HFGW empirical data sets which could determine upper bounds as to the existence of a graviton mass. Prior work with Clifford Will's idea was stymied by the application to binary stars and other such astro-physical objects with non useful frequencies topping off as up to 100 Hertz, thereby rendering Yukawa modifications of Gravity due to gravitons effectively an experimental curiosity which was not testable with any known physics equipment. The appearance of HFGW data sets as could be measured by the Li Baker detector gives a real chance as to experimentally obtain a measurable upper bound to the Compton wave length of Gravitons, which leads to other tests as to Gravitons existence as a measurable quantity, contradicting Tony Rothman's (2006) assertion that a detector the size of Jupiter would be needed to obtain measurements of a single graviton.

Introduction

Post Newtonian approximations to General relativity have given physicists a view as to how and why inflationary dynamics can be measured via deviation from simple gravitational potentials. One of the simplest deviations from the Newtonian inverse power law gravitational potential being a Yukawa potential modification of gravitational potentials. So happens that the mass of a graviton would factor directly into the Yukawa exponential term modification of gravity . This present paper tries to indicate how a smart experimentalist could use the Li-Baker detector as a way to obtain more realistic upper bounds as to the mass of a graviton and to use it as a template to investigate modifications of gravity along the lines of a Yukawa potential modification as given by Clifford Will.

Secondly, this paper will address an issue Eric Davis raised in his AIAA book on Frontiers of Propulsion Science, Progress in Astronautics and Aeronautics Series, Vol. 227 .Namely, if an upper mass to the graviton mass is identified, can an accelerator physicist use the theoretical construction Eric Davis raised in his book in the section "producing Gravitons via Quantization of the coupled Maxwell- Einstein fields" as to how an experimental bound to the graviton mass as considered in this document can aid in refinement of graviton Synchrotron radiation . A brief review of Chen and Chen and Nobles application of the Gersenshetein effect will be made as to potentially improve their statistical estimates as to the range of graviton production.

Giving an upper bound to the mass of a graviton.

The easiest way to ascertain the mass of a graviton is to investigate if or not there is a slight difference in the speed of graviton 'particle' propagation and of HFGW in transit from a 'source' to the detector. Visser's (1998) mass of a graviton paper presents a theory which passes the equivalence test, but which has problem with depending upon a non-dynamical background metric. I.e. gravitons are assumed by both him, and also Clifford Will's (2006) write up of experimental G.R. to have mass This document accepts that there is a small graviton mass, which the author has estimated to be on the order of 10^{-60} kilograms. Small enough so the following approximation is valid. Here, v_g is the speed of graviton 'propagation', λ_g is the Compton wavelength of a graviton with $\lambda_g = h/m_g c$, and $f \approx 10^{10}$ Hertz in line with L. Grischuck's (2007) treatment of relic HFGW's . In addition, the high value of relic HFGW's leads to naturally fulfilling $hf >> m_g c^2$ so that

$$\left(v_g/c\right)^2 \approx 1 - \left(c/\lambda_g f\right)^2 \qquad (1)$$

But equation (1) above is an approximation of a much more general result which may be rendered as

$$\left(v_g/c\right)^2 \equiv 1 - \left(m_g c^2/E\right)^2 \qquad (2)$$

The terms m_g and E refers to the graviton rest mass and energy, respectively. Now specifically in line with applying the Li Baker detector, physics researchers can ascertain what E is, with experimental data from the Li Baker detector, and then the next question needs to be addressed, namely if D is the distance between a detector, and the source of a HFGW/ Graviton emitter source

$$1 - v_g/c = 5 \times 10^{-17} \cdot \left[\frac{200Mpc}{D}\right] \cdot \left(\frac{\Delta t}{1\sec}\right) \qquad (3)$$

The above formula depends upon $\Delta t \equiv \Delta t_a - (1+Z)\Delta t_e$, with where Δt_a and Δt_e are the differences in arrival time and emission time of the two signals (HFGW and Graviton propagation), respectively, and Z is the redshift of the source. Z is meant to be the red shift. Specifically, the situation for HFGW is that for early universe conditions, that $Z \geq 1100$, in fact for very early universe conditions in the first few mili seconds after the big bang, that $Z \sim 10^{25}$. An enormous number.

The first question which needs to be asked is, if or not the Visser (1998) non-dynamical background metric correct, for early universe conditions so as to avoid the problem of the limit of small graviton mass does not coincide with pure GR, and the predicted perihelion advance, for example, violates experiment . A way forward would be to configure data sets so in the case of early universe conditions that one is examining appropriate $Z >> 1100$ but with extremely small Δt_e times, which would reflect upon generation of HFGW before the electro weak transition, and after the INITIAL onset of inflation.

I.e. the Li – Baker detector system should be employed as to pin point experimental conditions so to high accuracy , the following is an adequate presentation of the difference in times, Δt. I.e.

$$\Delta t \equiv \Delta t_a - (1+Z)\Delta t_e \quad \to \Delta t_a - \varepsilon^+ \approx \Delta t_a \tag{4}$$

The closer the emission times for production of the HFGW and Gravitons are to the time of the initial nucleation of vacuum energy of the big bang, the closer we can be to experimentally using equation (4) above as to give experimental criteria for stating to very high accuracy the following.

$$1 - v_g / c \cong 5 \times 10^{-17} \cdot \left[\frac{200Mpc}{D}\right] \cdot \left(\frac{\Delta t_a}{1\sec}\right) \tag{5}$$

More exactly this will lead to the following relationship which will be used to ascertain a value for the mass of a graviton. By necessity, this will push the speed of graviton propagation very close to the speed of light. In this, we are assuming an enormous value for D

$$v_g / c \cong 1 - 5 \times 10^{-17} \cdot \left[\frac{200Mpc}{D}\right] \cdot \left(\frac{\Delta t_a}{1\sec}\right) \tag{6}$$

This equation (6) relationship should be placed into $\lambda_g = h / m_g c$ with a way to relate this above value of $\left(v_g / c\right)^2 \equiv 1 - \left(m_g c^2 / E\right)^2$, with an estimated value of E coming from the Li- Baker detector and field theory calculations, as well as to make the following argument rigorous, namely

$$\left[1 - 5 \times 10^{-17} \cdot \frac{200Mpc}{D} \cdot \frac{\Delta t_a}{1\sec}\right]^2 \cong 1 - \left(\frac{m_g c^2}{E}\right)^2 \tag{7}$$

A suitable numerical treatment of this above equation, with data sets could lead to a range of bounds for m_g, as a refinement of the result given by Clifford Will for graviton Compton wavelength bounded behavior for a lower bound to the graviton mass, assuming that h is the Planck's constant.

$$\lambda_g \equiv \frac{h}{m_g c} > 3\times10^{12} km \cdot \left(\frac{D}{200Mpc} \cdot \frac{100Hz}{f} \right)^{1/2} \cdot \left(\frac{1}{f\Delta t} \right)^{1/2}$$
$$\cong 3\times10^{12} km \cdot \left(\frac{D}{200Mpc} \cdot \frac{100Hz}{f} \right)^{1/2} \cdot \left(\frac{1}{f\Delta t_a} \right)^{1/2} \quad (8)$$

The above equation (8) gives an upper bound to the mass m_g as given by

$$m_g < \left(\frac{c}{h}\right) \Big/ 3\times10^{12}\ km \cdot \left(\frac{D}{200Mpc} \cdot \frac{100Hz}{f} \right)^{1/2} \cdot \left(\frac{1}{f\cdot\Delta t_a} \right)^{1/2} \quad (9)$$

Needless to say that an estimation of the bound for the graviton mass m_g, and the resulting Compton wavelength λ_g would be important to get values of the following formula, namely

$$V(r)_{gravity} \cong \frac{MG}{r} \exp(r/\lambda_g) \quad (10)$$

Clifford Will (2006) gave for values of frequency $f \equiv 100$ Hertz enormous values for the Compton wave length , i.e. values like $\lambda_g > 6\times10^{19}$ kilometers . Such enormous values for the Compton wave length make experimental tests of equation (10) practically infeasible. Values of $\lambda_g \approx 10^{-5}$ centimeters or less for very high HFGW data makes investigation of equation (10) above far more tractable.

Application to Gravitational Synchrotron radiation , in accelerator physics

Eric Davis (2009), quoting Pisen Chen's article written in 1994 estimates that a typical storage ring for an accelerator will be able to give approximately $10^{-6} - 10^{3}$ gravitons per second. Quoting Pisen Chen's 1994 article, the following for graviton emission values for a circular accelerator system, with m the mass of a graviton, and M_P being Planck mass. N as mentioned below is the number of 'particles' in a ring for an accelerator system, and n_b is an accelerator physics parameter for bunches of particles which for the LHC is set by Pisen Chen (1994) as of the value 2800, and N for the LHC is about 10^{11}. And, for the LHC Pisen Chen (1994) sets γ as $.88\times10^{2}$, with $\rho[m]\approx 4300$. Here, $m \sim m_{graviton}$ acts as a mass charge.

$$N_{GSR} \sim 5.6 \cdot n_b^2 \cdot N^2 \cdot \frac{m^2}{M_P^2} \cdot \frac{c\cdot\gamma^4}{\rho} \quad (11)$$

The immediate consequence of the prior discussion would be to obtain a more realistic set of bounds for the graviton mass, which could considerably refine the estimate of 10^{11} gravitons produced per year at the LHC, with realistically 365 x 86400 *seconds* = 31536000 *seconds* in a year, leading to 3.171×10^{3} gravitons produced per second. Refining an actual permitted value of bounds for the accepted graviton mass, m, as given above, while keeping $M_P \sim 1.2209 \times 10^{19}$ *GeV*/c^2 would allow for a more precise set of gravitons per second which would significantly enhance the chance of actual detection, since right now for the LHC there is too much general uncertainty as to the likelihood of where to place a detector for actually capturing / detecting a graviton.

Conclusion, falsifiable tests for the Graviton are closer than the physics community thinks

The physics community now has an opportunity to experimentally infer the existence of gravitons as a knowable and verifiable experimental datum with the onset of the LHC as an operating system. Even if the LHC is not used, Pisen Chens (1994) parameterization of inputs from his table right after his equation (8) as inputs into equation (11) above will permit the physics community to make progress as to detection of Gravitons for , say the Brookhaven site circular ring accelerator system. Tony Rothman's (2006) predictions as to needing a detector the size of Jupiter to obtain a single experimentally falsifiable set of procedures is defensible only if the wave- particle duality induces so much uncertainty as to the mass of the purported graviton, that worst case model building and extraordinarily robust parameters for a Rothman style graviton detector have to be put in place.

The Li- Baker detector can help with bracketing a range of masses for the graviton, as a physical entity subject to measurements. Such an effort requires obtaining rigorous verification of the approximation used to the effect that $\Delta t \equiv \Delta t_a - (1+Z)\Delta t_e \quad \to \Delta t_a - \varepsilon^+ \approx \Delta t_a$ is a defensible approximation. Furthermore, obtaining realistic inputs for distance D for inputs into equation (9) above is essential

The expected pay offs of making such an investment would be to determine the range of validity of equation (10) , i.e. to what degree is gravitation as a force is amendable to post Newtonian approximations.The author asserts that equation (10) can only be realistically be tested and vetted for sub atomic systems, and that with the massive Compton wavelength specified by Clifford Will cannot be done with low frequency gravitational waves.Furthermore, a realistic bounding of the graviton mass would permit a far more precise calibration of equation (11) as given by Pisen Chen in his 1994 article.

Appendix B:

Summarizing inputs into tensorial representation of GWs and their Fourier transform scalar value

B1) Computing the polarization values of relic gravitational waves, and transferring to appropriate Fourier components for HFGW density

We will essentially be using Daniel Baumann, Kiyotomo Ichiki, Paul J. Steinhardt, Keitaro Takahashi,(2007). very complete treatment of rank-two tensorial contributions to the evolution of the gravitational wave contributions to entropy that we are talking about. That will be helped further by using HFGW as a template to simplify a search for appropriate h_{ij} behavior, which will be simplified further after Steinhardt's reduction of h_{ij} to a scalar field value. This is in contrast to the simplified model given by many cosmologists, an example of which is in a dissertation The main centerpiece of Daniel Baumann, Kiyotomo Ichiki, Paul J. Steinhardt, Keitaro Takahashi, (2007) derivation is to take into account a right-hand-side contribution of stress and strain to the conformal time evolution of h_{ij} which in a scalar-field-contributed reduction of complexity leads to the Fourier transform $\Im h_{ij} \equiv \hat{h}$ having an equation, in conformal time of,

$$\hat{h} \equiv \frac{A_1(k)}{a(\tau)}\exp\left(i\left[\vec{k}\cdot\vec{x}-k\tau\right]\right)+\frac{A_2(k)}{a(\tau)}\exp\left(i\left[\vec{k}\cdot\vec{x}+k\tau\right]\right) \qquad (1)$$

As Fangyi Li writes in Li, Baker, Stevenson et al (2008), this is in response to a metric we can write as

$$g_{\mu\nu} \equiv \begin{pmatrix} -a^2 & 0 & 0 & 0 \\ 0 & a^2(1+h_\oplus) & a^2 h_\otimes & 0 \\ 0 & a^2 h_\otimes & a^2(1-h_\oplus) & 0 \\ 0 & 0 & 0 & a^2 \end{pmatrix} \qquad (2)$$

We have to make a change in the treatment of Eqn (1) if we are considering scalar expansion at the onset of the big bang, which would entail looking at stress and strain contributions to the evolution of the scalar field contribution to gravitational radiation from the onset of the big bang. After stress and strain processes, as Steinhardt states, this leads to an evolution equation -- Eqn. (3) below. This assumes that the pressure p is a constant and T^i_j is a stress term. We further note that $k^2 \propto$ energy and $\left|\frac{a''}{a}\right| \propto$ potential energy so that

$$\hat{h}'' + 2\frac{a'}{a}\cdot\hat{h}' + k^2\hat{h} = 16\pi\cdot G\cdot a^2\cdot\left[\Pi_k(\tau) = \Im\left(T^i_j - p\delta^i_j\right)\right] \qquad (3)$$

Eqn (3) after we make the substitution of $a(\tau)\cdot\hat{h} = \mu(k)$ leads to a non-homogeneous perturbed Schrodinger-like equation that we can write as

$$\mu'' + \left(k^2 - \frac{a''}{a}\right)\mu = a\cdot\left[16\pi\cdot a^2\cdot\Pi_k(\tau)\right] \qquad (4)$$

Numerous solutions combining Bessel and Hankel Equations exist when we look at the homogeneous part of Eqn. (4) above. If we wish to take into account stress and strain forces associated with the onset of the big bang, we have to look at particular and general solutions that would use combinations of Eqn. (3) and Eqn. (4) above. To do so, we will look at what Steinhardt and others developed in 2007 to deal with relic inflationary contributions to gravitational waves.

B2) General and specific solutions to Eqn. (3) taking into account simplification due to HFGW in relic inflationary conditions

We wish now to look at a homogeneous and particular solution for Eqn (8) above, and to comment upon HFGW modifications we claim simplify matters enormously. This will be pertinent to what we bring up in particular about the Li-Baker HFGW detector system. We claim that before the onset of the CMBR formation 280-300 thousand years after the big bang, the uniform magnetic field of relic inflationary conditions was impinged upon by incident HFGW (from signatures of phase transitions we can model appropriately).

The particular solution to Eqn. (3) we will write out as

$$\hat{h}_{Particular} = \frac{1}{a(\tau)} \cdot \int d\tilde{\tau} \cdot g_k(\tau, \tilde{\tau}) \cdot \left(16\pi \cdot G \cdot \Pi_k(\tilde{\tau})\right) \qquad (5)$$

The kernel in Eqn. (5), namely $g_k(\tau, \tilde{\tau})$, obeys Eqn (6) below. We also simplify matters by using HFGW explicitly. If $\frac{a''}{a} << k^2$, then for

$$g''_k + \left(k^2 - \frac{a''}{a}\right) \cdot g_k \equiv \delta(\tau - \tilde{\tau}) \qquad (6)$$

We get a Greens function of the form

$$g_k(\tau, \tilde{\tau}) = \frac{1}{k}\left[\sin(k\tau) \cdot \cos(k\tilde{\tau}) - \sin(k\tilde{\tau}) \cdot \cos(k\tau)\right] \qquad (7)$$

So a particular solution may be written as:

$$\hat{h}_{Particular} = \frac{1}{a(\tau)k} \cdot \int d\tilde{\tau} \cdot [\sin(k\tau)\cos(k\tilde{\tau}) - \sin(k\tilde{\tau})\cos(k\tau)] \cdot \left(16\pi \cdot G \cdot \Pi_k(\tilde{\tau})\right) \qquad (8)$$

We will fill in the details of the $\left(16\pi \cdot G \cdot \Pi_k(\tilde{\tau})\right)$ part of this particular solution in the next section. But now, we should pay attention to the general solution. The main dynamics of the $\left(16\pi \cdot G \cdot \Pi_k(\tilde{\tau})\right)$ are in part linked to quantum fluctuation, and also the stress and strain of the initial nucleation of the present universe from the vacuum template of space-time itself. Here is the equation of the following homogeneous part of evolution equation we write as, as in Diego Pavon's (2006)dissertation

$$\hat{h}'' + 2\frac{a'}{a} \cdot \hat{h}' + k^2 \hat{h} = 0 \qquad (9)$$

In the initial phases of nucleation of a new universe, this can be simplified to:

$$\hat{h}'' + 2H_{initial} \cdot \hat{h}' + k^2 \hat{h} = 0 \qquad (10)$$

Traditional treatments of both Eqn (9) and Eqn. (10) make use of a dynamical changing value of $\frac{a'}{a}$,

leading in many cases to Bessel/Hankel equation solutions . By setting $\frac{a'}{a} \sim H_{Initial}$, we obtain

$$\hat{h}_{Total} = \hat{h}_{Initial-Value} \cdot [\exp(-H_{Initial}\tau)] \cdot \cos(k\tau + c_1) + \hat{h}_{Particular} \qquad (11)$$

I.e., in later times, the dynamics are largely dominated by the particular, specialized solution. We will now put in an HFGW evaluation of what $(16\pi \cdot G \cdot \Pi_k(\tilde{\tau}))$ should be, at the site of a detector.

B3) Stress and strain contributions to space-time due to early universe production of HFGWs

From now on, we will be dealing with an HFGW contribution to forming the $(16\pi \cdot G \cdot \Pi_k(\tilde{\tau}))$ stress and strain contribution, using much of what Baumann, Steinhardt, Takahasi, and Ichiki (2007)set for the simplest case of how to evaluate $(16\pi \cdot G \cdot \Pi_k(\tilde{\tau}))$, taking into account a simplified treatment of the Bardeen potential for times $\tau < \tau_{Threshold}$. I.e., we will effectively confine $\tau < \tau_{Threshold}$ to within a few orders of magnitude of the Planck's time interval after big bang nucleation of the present universe.

This means working with the following template for the stress-strain-vacuum nucleation problem:

$$(16\pi \cdot G \cdot \Pi_k(\tilde{\tau})) \equiv S_k(source) = \int d^3\tilde{k} \cdot e(k,\tilde{k}) \cdot f(k,\tilde{k},\tau) \cdot \psi_{k-\tilde{k}} \cdot \psi_{\tilde{k}} \qquad (12)$$

$\psi_{\tilde{k}}$ is a quantum fluctuation which we will offer a simplified model for, and the term $e(k,\tilde{k})$ is equal to $\tilde{k}^2 \cdot \left(1 - \frac{\vec{k} \cdot \vec{\tilde{k}}}{k\tilde{k}}\right)$. The main result of this section will be to present $f(k,\tilde{k},\tau)$, where we use $w \propto 1/3$

$$f(k,\tilde{k},\tau) \equiv \frac{4}{3\cdot(1+w)} \left\{ \begin{array}{l} \frac{2\cdot(5+3w)}{\left(1+\left|k-\tilde{k}\right|^2\tau^2\right)} \cdot \frac{1}{\left(1+\left|\tilde{k}\right|^2\tau^2\right)} \\ +4\cdot\left[\frac{2\tau}{1+\left|k-\tilde{k}\right|^2\tau^2} + \tau^2 \cdot \frac{\partial}{\partial\tau}\left(\frac{1}{1+\left|k-\tilde{k}\right|^2\tau^2}\right)\right] \cdot \frac{\partial}{\partial\tau}\left(\frac{1}{1+\left|\tilde{k}\right|^2\tau^2}\right) \end{array} \right\} \qquad (13)$$

What we should take note of is that this is using the Bardeen potential in early times which is

$$\Phi = \frac{1}{1+k^2\tau^2} \qquad (14)$$

We should note here that the derived quantity of $\hat{h}$, which is a FT, with quantum raising and lowering operator considerations thrown in, will have to be inverse FT backwards to be used in the $h_{\oplus}^2 + h_{\otimes}^2$ expression of t_0^0 for the Li-Baker applications we will talk about later.

B4) A simplified quantum fluctuation model to use for now

We are explicitly using the ideas of V. P. Mukhanov, and S. Wintizki (2007), where they give a quantum fluctuation in k space along the lines of:

$$\psi_k'' + (k^2 + m^2)\psi_k \cong 0 \qquad (15)$$

This in the limit of low mass will lead to

$$\psi_k \sim \exp(ik\tau) \qquad (16)$$

What we will be assuming is that with additional data feedback, the nucleation quantum fluctuation formula as outlined in Eqn (13) will be given considerable more structure.

Appendix C :

Jack Ng's derivation of how entropy is linked to numerical density of a species of 'particles'

We will reproduce Jack Ng's treatment (2008a,2008b)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

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

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

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

But $V \approx R_H^3 \approx \lambda^3$, so unless N in Eqn (2) 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. (2) above. This is a way to obtain what Ng refers to as Quantum Boltzmann statistics, so then we obtain for sufficiently large N

$$S \approx N \qquad (3)$$

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>.

Appendix D:

Our analysis of our inputs of data from the Li-Baker detector

D1) Weinberg's 1972 numerical estimate of the number of Gravitons per frequency range

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 $\bar{k} = 1.38 \times 10^{-16} erg/{}^{0}K$, where ${}^{0}K$ denotes Kelvin temperatures and Gravitons have two independent polarization states), as given by Weinberg (1972).

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

The hypothesis presented here is that 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 $T_{dS}\big|_{t \le t_P} \sim H_0 \approx 10^{-33} eV$. Interested readers can see what Kolb and Turner wrote up about axions as a wall phenomena (1991) We will do this calculation assuming that $E_{graviton} \equiv \eta\omega_{graviton} \propto (volume) \cdot \left[energy \quad density \equiv t_0^0 \right]$ where the energy density term will come straight from GR formulas.

D2) Giving frequency/energy value inputs into Weinberg's numerical value of gravitons, from GR energy density equations

At this juncture, we are referring to Dr. Fangyu Li's derivation/formula for energy density of gravitational waves as given by Li, Baker, Stevenson et al (2008) which we will refer to here as

$$t_0^0 \equiv \frac{c^4 k^2}{4\pi G a^3} \cdot \left[h_{\oplus}^2 + h_{\otimes}^2 \right] \tag{2}$$

We will compute, via a method discussed by the author earlier, an input into this above formula , and use it to get order-of-magnitude estimates of physical processes linked to entropy and entropy generation. From here on, we will attempt to fill in a detailed recommended volume, and also what the $h_{\oplus}^2 + h_{\otimes}^2$ terms are in value and in importance. We should also state that $a \approx a_{initial} \cdot \exp(H_{initial}\tau)$ where $H_{initial}$ is the initial value of the Hubble expansion parameter, and τ is a conformal time value. This value for an exponentially expanding scale factor will be crucially important in what we calculate later.

Appendix G:

Inputs into the Relic Graviton burst

We shall reference what the AW. Beckwith (2008) presented in 2008 STAIF, which we think still has current validity for reasons we will elucidate upon in this document. We use a power law relationship first presented by Fontana (2005), who used Park's earlier (1955) derivation: when $E_{eff} \equiv \langle n(\omega) \rangle \cdot \omega \equiv \omega_{eff}$

$$P(power) = 2 \cdot \frac{m_{graviton}{}^{2} \cdot \vec{L}^{4} \cdot \omega_{net}{}^{6}}{45 \cdot \left(c^{5} \cdot G\right)} \qquad (1)$$

This expression of power should be compared with the one presented by Massimo Giovannini (2008) on averaging of the energy-momentum pseudo tensor to get his version of a gravitational power energy density expression, namely

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

Giovannini states that should the mass scale be picked such that $M \sim m_{Planck} >> m_{graviton}$, that there are doubts that we could even have inflation. However, it is clear that gravitational wave density is faint, even if we make the approximation that $H \equiv \frac{\dot{a}}{a} \cong \frac{m\phi}{\sqrt{6}}$ as stated by Linde (2008), where we are following $\dot{\phi} = -m\sqrt{2/3}$ in evolution, so we have to use different procedures to come up with relic gravitational wave detection schemes to get quantifiable experimental measurements so we can start predicting relic gravitational waves. This is especially true if we make use of the following formula for gravitational radiation, as given by L. Kofman (2008), with $M = V^{1/4}$ as the energy scale, with a stated initial inflationary potential V. This leads to an initial approximation of the emission frequency, using present-day gravitational wave detectors.

$$f \cong \frac{(M = V^{1/4})}{10^{7}\, GeV} Hz \qquad (3)$$

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

Appendix H:

Wheeler-De-Witt wormhole model

H1) Details as to forming Crowell's time dependent Wheeler-De-Witt equation, and its links to Wormholes

.. This will be to show some things about the wormhole we assert the instanton traverses en route to our present universe. This is the Wheeler-De-Witt equation with a pseudo time component added. From Crowell

$$-\frac{1}{\eta r}\frac{\partial^2\Psi}{\partial r^2}+\frac{1}{\eta r^2}\cdot\frac{\partial\Psi}{\partial r}+rR^{(3)}\Psi=\left(r\eta\phi-r\dot{\phi}\right)\cdot\Psi \qquad (1)$$

This has when we do it $\phi\approx\cos(\omega\cdot t)$, and frequently $R^{(3)}\approx$ constant, so then we can consider

$$\phi\cong\int_0^\infty d\omega\left[a(\omega)\cdot e^{ik_\varpi x^\mu}-a^+(\omega)\cdot e^{-ik_\varpi x^\mu}\right] \qquad (2)$$

In order to do this, we can write out the following for the solutions to Eqn (1) above.

$$C_1=\eta^2\cdot\left(4\cdot\sqrt{\pi}\cdot\frac{t}{2\omega^5}\cdot J_1(\omega\cdot r)+\frac{4}{\omega^5}\cdot\sin(\omega\cdot r)+(\omega\cdot r)\cdot\cos(\omega\cdot r)\right)$$
$$+\frac{15}{\omega^5}\cos(\omega\cdot r)-\frac{6}{\omega^5}Si(\omega\cdot r) \qquad (3)$$

And

$$C_2=\frac{3}{2\cdot\omega^4}\cdot(1-\cos(\omega\cdot r))-4e^{-\omega\cdot r}+\frac{6}{\omega^4}\cdot Ci(\omega\cdot r) \qquad (4)$$

This is where $Si(\omega\cdot r)$ and $Ci(\omega\cdot r)$ refer to integrals of the form $\int_{-\infty}^{x}\frac{\sin(x')}{x'}dx'$ and $\int_{-\infty}^{x}\frac{\cos(x')}{x'}dx'$. It so happens that this is for forming the wave functional that permits an instanton to form. Next, we should consider whether or not the instanton so formed is stable under evolution of space-time leading up to inflation.

H2) Wormhole transition from a prior to the present universe

To model this, we use results from Crowell (2005) on quantum fluctuations in space-time, which gives a model from a pseudo time component version of the Wheeler-De-Witt equation, with use of the Reinssner-

Nordstrom metric to help us obtain a solution that passes through a thin shell separating two space-times. The radius of the shell $r_0(t)$ separating the two space-times is of length l_P in approximate magnitude, leading to a domination of the time component for the Reissner – Nordstrom metric

$$dS^2 = -F(r)\cdot dt^2 + \frac{dr^2}{F(r)} + d\Omega^2 \qquad (5)$$

This has:

$$F(r) = 1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3}\cdot r^2 \xrightarrow[T \to 10^{32}\,Kelvin \sim \infty]{} -\frac{\Lambda}{3}\cdot (r = l_P)^2 \qquad (6)$$

This assumes that the cosmological vacuum energy parameter has a temperature dependence as outlined by Park (2003), leading to

$$\frac{\partial F}{\partial r} \sim -2\cdot\frac{\Lambda}{3}\cdot (r \approx l_P) \equiv \eta(T)\cdot (r \approx l_P) \qquad (7)$$

as a wave functional solution to a Wheeler-De-Witt equation bridging two space-times. This solution is similar to that being made between these two space-times with "instantaneous" transfer of thermal heat ,as given by Crowell (2005)

$$\Psi(T) \propto -A\cdot\{\eta^2 \cdot C_1\} + A\cdot\eta\cdot\omega^2\cdot C_2 \qquad (8)$$

This has $C_1 = C_1(\omega, t, r)$ as a pseudo cyclic and evolving function in terms of frequency, time, and spatial function. This also applies to the second cyclical wave function $C_2 = C_2(\omega, t, r)$, where we have $C_1 =$ Eqn (3) above, and $C_2 =$ Eqn. (4) above. Eqn. (8) is an approximate solution to the pseudo time dependent Wheeler-De-Witt equation. The advantage of Eqn. (8) is that it represents to good first approximation of gravitational squeezing of the vacuum state. In Appendix, XII, Eqn. (8) will be compared in part to more rigorous procedures involving first-order approximations to a GUT wave function.

Appendix I :

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

We will attempt to build up a radiation-based instanton of a Reissner-Nordstrom metric embedded in a five-dimensional space- time metric, and see if this satisfies conditions for an instanton. This allows us to determine, using the Risessner-Nordstrom metric as given, by Kip Thorne, Wheeler, and Misner (1973), an added cosmological 'constant' Λ and 'charge' Q. This will be shown to lead to, partly copying Wesson's (1999) treatment of instantons and GR

$$M_g(r) = \int \left[T_0^0 - (T_1^2 + 2 \cdot T_2^2)\right] \cdot \sqrt{-g_4}\, dV_3 \qquad (1)$$

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

To do this, we start off with the following space-time line metric in five dimensions. This is a modification of Wesson's book(1999).

$$dS_{5-\dim} = \left[\exp(i\pi/2)\right] \cdot \left\{ \begin{aligned} & e^{2\Phi(r)} dt^2 \\ & + e^{2\tilde{\Lambda}(r)} dr^2 + R^2 d\Omega^2 \end{aligned} \right\} + (-1) \cdot e^{\mu} dl^2 \qquad (3)$$

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

$$e^{2\Phi(r)} = \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right) \qquad (4)$$

And

$$e^{2\tilde{\Lambda}(r)} = \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right)^{-1} \qquad (5)$$

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

$$T_0^0 = \left(\frac{-1}{8\pi}\right)\cdot\left(1-\frac{2M}{r}+\frac{Q^2}{r^2}-\frac{\Lambda}{3}r^2\right)\cdot\left(\frac{c_1^2}{4}+\frac{c_1}{r}+\frac{c_1}{4}\cdot\left[\frac{\frac{2M}{r^2}-\frac{2Q}{r^3}-\frac{2\Lambda r^2}{3}}{1-\frac{2M}{r}+\frac{Q^2}{r^2}-\frac{\Lambda}{3}r^2}\right]\right) \quad (6)$$

$$T_1^1 = \left(\frac{-1}{8\pi}\right)\cdot\left(1-\frac{2M}{r}+\frac{Q^2}{r^2}-\frac{\Lambda}{3}r^2\right)\cdot\left(\frac{c_1}{r}+\frac{c_1}{4}\cdot\left[\frac{\frac{2M}{r^2}-\frac{2Q}{r^3}-\frac{2\Lambda r^2}{3}}{1-\frac{2M}{r}+\frac{Q^2}{r^2}-\frac{\Lambda}{3}r^2}\right]\right) \quad (7)$$

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

Furthermore, we get the following determinant value

$$\sqrt{-g_4} = \left(1-\frac{2M}{r}+\frac{Q^2}{r^2}-\frac{\Lambda}{3}r^2\right) \quad (9)$$

All these together satisty Eqn (2). Let us now see how this same geometry contributes to a wormhole bridge and a solution for forming the instanton flux wave functional between a prior and present universe. The Reissner-Nordstrom metric permits us to have a radiation-dominated “matter” solution whose matter “contribution” drops off rapidly as the spatial component of geometry goes to zero. This is in tandem with radiation pressure and density falling off rapidly, as we leave the center of such a purported soliton/instanton. This is extremely useful because it ties in with the notion of fractional branes contributing to entropy calculations. In fact, it is useful to state that these two notions dovetail with each other quite closely. The only difference is that the construction above does not in itself lend to the complexity of what we would observe, which is in itself a multiple-joined network of charge centers and shifting geometry.

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

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

Appendix J:

Energy fluctuations due to the wormhole and their link to entropy fluctuations

We argue that the existence of the wormhole and an instanton formation in the throat of the wormhole will lead to a constant energy flux through the wormhole. This is equivalent to work, with an expression given by Mukhanov are energy density fluctuations and entropy. In position space, it is for energy density $\rho(x)$, and entropy $S(x)$

$$\frac{\partial^2 \delta\,\rho(x)}{\partial t^2} - c_s^2 \Delta \cdot \delta\rho(x) - 4\pi \cdot G\rho_0 \cdot \delta\rho(x) = \sigma \cdot \Delta\delta\, S(x) \qquad (1)$$

This is Fourier transformed into

$$\frac{\partial^2 \delta\,\rho(k)}{\partial t^2} + k^2 c_s^2 \cdot \delta\rho(k) - 4\pi \cdot G\rho_0 \cdot \delta\rho(k) = -\sigma \cdot k^2 \delta\, S(k) \qquad (2)$$

This has a time-independent solution of the form (assuming small spatial dimensions)

$$\delta\rho(k) \equiv -\frac{\sigma\, k^2\ \delta\, S(k)}{\left(k^2 c_s^2 - 4\pi G\rho_0\right)} \xrightarrow[k\to big]{} -\frac{\sigma\delta\, S(k)}{\left(c_s^2\right)} \qquad (3)$$

This may be Fourier-transformed, assuming near-constant values of k and position x, to be in x position space

$$\delta\rho(x) \cong -\frac{8\sigma}{c_s^2}\,\delta\, S(x) \qquad (4)$$

Here, c_s^2 is the square of the speed of sound, which is, in early universe conditions, close to unity. We also have that $\sigma \equiv \left(\partial p/\partial S\right)_\rho$. Then we can state that when we have $\delta\rho(x) \propto \Lambda_{initial} \to \Lambda_{\max}$ due to increasing temperature,

$$\left|\delta\rho(x)\right| \cong 8\sigma \cdot \delta\, S(x) \qquad (5)$$

We claim that the increase in entropy is connected with breaking of the instanton structure of a packet of energy transferred from a prior space-time to our own.

Appendix K:

Emergent inflaton 'field' due to thermal input from a prior universe (The D'Albembertain operation in an equation of motion for emergent scalar fields)

This was presented at the IUCAA meeting in India by the author, A.W. Beckwith, in December 2007 and is part of an article in print, Beckwith(2008).

We begin with the D'Albertain operator as part of an equation of motion for an emergent scalar field. We refer to the Penrose potential (with an initial assumption of Euclidian flat space for computational simplicity) to account for, in a high temperature regime, an emergent non-zero value for the scalar field ϕ due to a zero effective mass at high temperatures.

When the mass approaches far lower values is when a non-zero scalar field reappears.

Let us now begin to model the Penrose quintessence scalar field evolution equation. Look at the flat space version of the evolution equation

$$\ddot{\phi} - \nabla^2 \phi + \frac{\partial V}{\partial \phi} = 0 \qquad (1)$$

In the Friedman-Walker metric, this uses the following as a potential system to work with, namely:

$$V(\phi) \sim -\left[\frac{1}{2}\cdot\left(M(T)+\frac{\Re}{6}\right)\phi^2 + \frac{\tilde{a}}{4}\phi^4\right] \equiv$$
$$-\left[\frac{1}{2}\cdot\left(M(T)+\frac{\kappa}{6a^2(t)}\right)\phi^2 + \frac{\tilde{a}}{4}\phi^4\right] \qquad (2)$$

This assumes $\kappa \equiv \pm 1,0$, and a curvature signature compatible with an open universe.

That means $\kappa = -1,0$ as possibilities. So we will look at the $\kappa = -1,0$ values, beginning with

$$\ddot{\phi} - \nabla^2 \phi + \frac{\partial V}{\partial \phi} = 0 \Rightarrow$$
$$\phi^2 = \frac{1}{\tilde{a}}\cdot\left\{c_1^2 - \left[\alpha^2 + \frac{\kappa}{6a^2(t)} + M(T)\right]\right\} \qquad (3)$$
$$\Leftrightarrow \phi \equiv e^{-\alpha\cdot r}\exp(c_1 t)$$

We find the following basic phenomena, namely

$$\phi^2 = \frac{1}{\tilde{a}}\cdot\left\{c_1^2 - \left[\alpha^2 + \frac{\kappa}{6a^2(t)} + \left(M(T)\approx\varepsilon^+\right)\right]\right\} \qquad (4)$$
$$\xrightarrow[M(T\sim high)\to 0]{} \phi^2 \neq 0$$

$$\phi^2 = \frac{1}{\widetilde{a}} \cdot \left\{ c_1^2 - \left[\alpha^2 + \frac{\kappa}{6a^2(t)} + \left(M(T) \neq \varepsilon^+ \right) \right] \right\} \qquad (5)$$

$$\xrightarrow[M(T\sim Low)\neq 0]{} \phi^2 \approx 0$$

The difference is due to the behavior of $M(T)$. We use $M(T) \sim$ axion mass $m_a(T)$ in asymptotic limits with Kolb's

$$m_a(T) \cong 0.1 \cdot m_a(T=0) \cdot (\Lambda_{QCD}/T)^{3.7} \qquad (6)$$

Appendix L:

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

Our guess is as follows: the thermal flux implied by the existence of a wormhole accounts for perhaps 10^{10} bits of information. These could be transferred via a wormhole solution from a prior universe to our present , and there could be perhaps 10^{120} minus 10^{10} bits of information temporarily suppressed during the initial bozonification phase of matter right at the onset of the big bang itself .

Then we predict that there is a dramatic drop in the degrees of freedom during the beginning of the descent of temperature from about $T \approx 10^{32}\,Kelvin$ to at least three orders of magnitude less. The drop in degrees of freedom happens as we move out in time from an initial red shift, $z \approx 10^{25}$, to something lower, which is when the temperature drops from about $T \approx 10^{32}\,Kelvin$ to a significantly lower value of

$$T \approx \sqrt{\varepsilon_V} \times 10^{28}\,Kelvin \sim T_{Hawkings} \cong \frac{\eta \cdot H_{initial}}{2\pi \cdot k_B} \qquad (1)$$

Whichever model we can come up with that does this is the one we need to follow, experimentally. And it gives us hope of confirming whether or not we can eventually analyze the growth of structure in the initial phases of quantum nucleation of emergent space-time. We also need to consider the datum so referenced for the irregularities of the cooling-down phase of inflation, as mentioned by Sakar in a private e mail to the author, Beckwith, (2008),"Quasi-DeSitter space-time during inflation has no "lumpiness" -- it is necessarily very smooth. Nevertheless one can generate structure in the spectrum of quantum fluctuations originating from inflation by disturbing the slow-roll of the inflaton -- in our model this happens because other fields to which the inflaton couples through gravity undergo symmetry breaking phase transitions as the universe cools during inflation.”. The race track models, after the inflaton begins to decline, would be ideal in obtaining the necessary couplings between the inflaton, and fields which undergo a symmetry breaking transformation . We will refer to this topic in a future publication. We can make a few observations though about the assumed coupling. First, there is a question of whether there is a finite or infinite fifth dimension. String theorists have argued for a brane world with a warped, infinite extra dimension, allowing for the inflaton to decay into the bulk so that after inflation, the effective dark energy disappears from our brane. This is achieved by shifting away the decay products into the infinity of the 5th dimension. Nice hypothesis, but it presumes CMB density perturbations could have their origin in the decay of a MSSM flat direction. It would reduce the dynamics of the inflaton if there were separation between a Dp brane and $\overline{D}p$ antibrane via a moduli argument.What if we do not have an infinite fifth dimension? What if it is compacted only ? We then have to change our analysis.

Another thing. We place limits on inflationary models; for example, a minimally coupled $\lambda\phi^4$ is disfavored at more than 3 σ. Result? Forget quartic inflationary fields , as has been shown by H. V. Peiris, G. Hingshaw et al.(2003) We can realistically hope that WMAP will be able to parse through the race track models to distinguish between the different candidates. So far, “First-Year Wilkinson Microwave Anisotropy Probe (WMAP)1 Observations: Implications For Inflation” is giving chaotic inflation a run for its money. We shall endeavor for numerical work using some of the tools brought up in this present discussion to falsify or confirm figures 1 and 2 of this appendix I that imply variance in the CMBR spectrum.

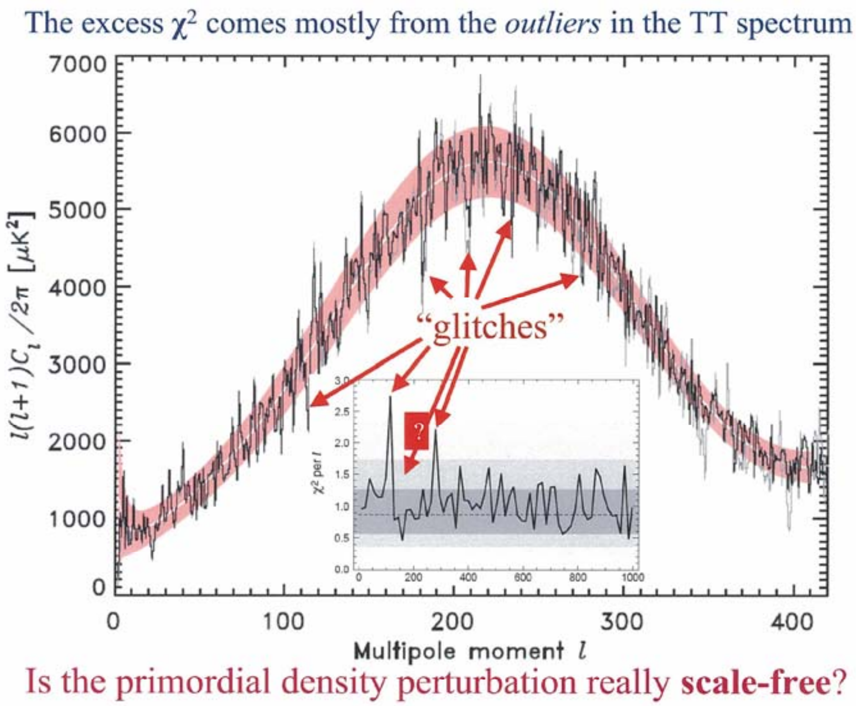

Figure 1 by Subir Sarkar shows the glitches that need to be addressed in order to make a CMBR data set congruent with an extension of the standard model of cosmology.

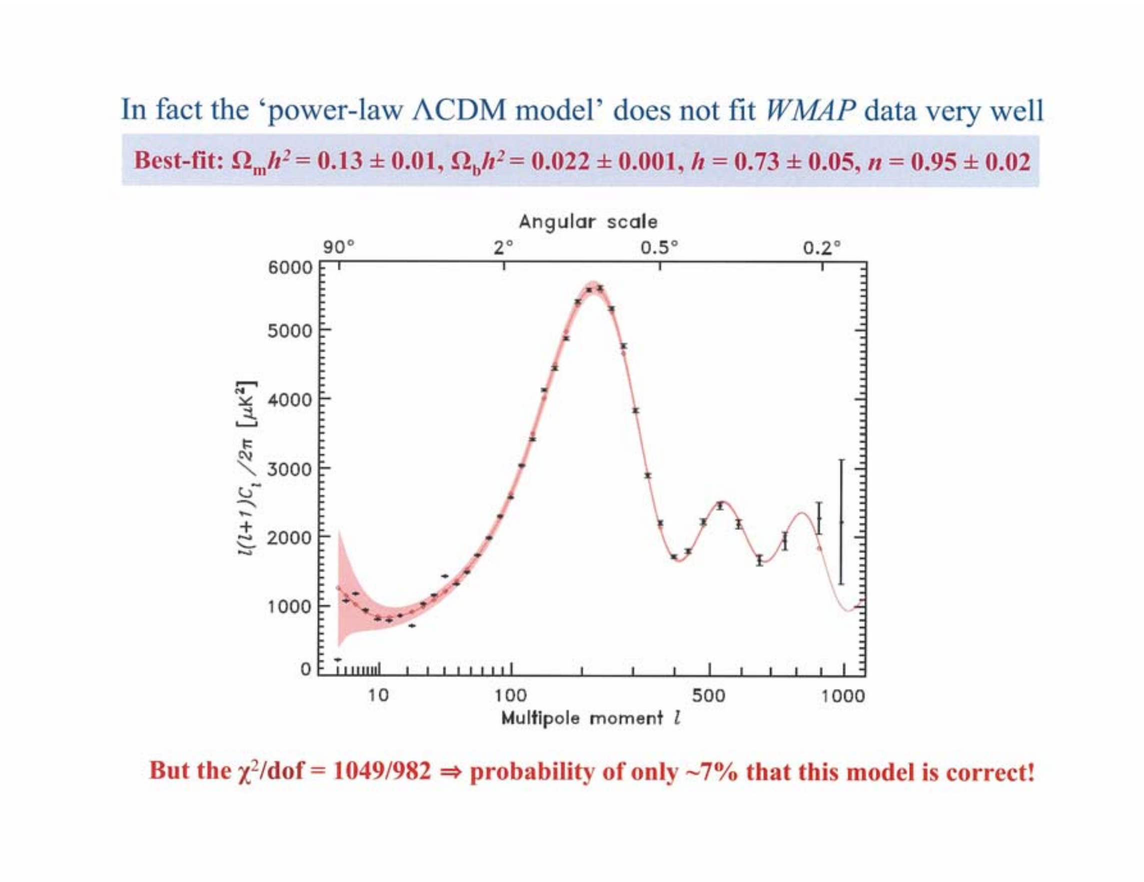

Figure 2 . Self explanatory Can be explained via Subir Sarkar Bad Honnef talk, (2007)

Appendix M: Formulation of criteria for a second-order phase transition at the onset of nucleation of a new universe

Let us first review Gigorio Torrieri's and Igor Mushuntin's (2008) contribution to stability analysis of a wave functional treatment of a QCD bulk viscosity-over-entropy constant-ratio state equation. The idea is that we have initially a super hot plasma reaching a peak value of viscosity for a given temperature T, which is less than or equal to a critical temperature, T_C reflecting the QCD plasma having a peak value for viscosity. For those who wish to understand how this may work out, we can refer to a paper by M. Asakawa et al of (2006), which specified a sheer bulk viscosity approximated by a viscosity value with $d_f \approx O(100)$, which weakly depends upon the number of quark flavors n_f in the quark-gluon plasma

$$\eta_C = \left[d_f \cdot T^3 \big/ g^4 \ln g^{-1} \right] \qquad (1)$$

Here, g is fixed by the number of degrees of freedom of the system. M. Asakawa et al.(2006) also specify that in a quark-gluon plasma, frequently there is an additional anomalous contribution to viscosity , η_A caused by turbulent fields within the quark-gluon plasma. M Asakawa et al. (2006) concluded in their document that frequently we have

$$\eta_{Total}^{-1} = \eta_C^{=1} + \eta_A^{-1} \qquad (2)$$

Frequently we also have for extremely high temperatures to a good first approximation,

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

Where $g_* \cdot$ is the net degrees of freedom of the plasma gas that we can model as an ultra-relativistic fluid. For high temperatures, if $g_* \cdot$ is on the order of 100, i.e., reflecting many initial degrees of freedom,

$$\eta_{Total} / s_{Density} \approx const \sim [1/4\pi] \qquad (4)$$

With classical fluid models, even for quark-gluon plasmas, this assumes we are working with η_A^{-1} as not a very strong contributing factor to Eqn (2) , leading to almost infinite viscosity if we have viscosity almost entirely dependent upon temperature, as the temperature climbs.With the model of entropy so offered above, we have if the temperature is not elevated and the two terms in Eqn. (2) contribute , trouble in obtaining a stable value for Eqn. (4) above as a constant. It so happens that Gigorio Torrieri's and Igor Mushuntin's (2008) idea is to incorporate a modification of the Bjorken equation for cosmology applications,

$$\tau^{-3} \frac{d[\tau^3 s]}{d\tau} = \frac{3s}{R\tau} \qquad (5)$$

where τ is conformal time, and R is the Reynolds number, and s is entropy density. This Eqn. (5) is well above the complexity level of what one expects from the simple linearized models, where we look at, say, if y represents space time "length," etc., with

$$s(\tau) = s_0(\tau) + \delta \cdot s(\tau, y) \exp[iky] \qquad (6)$$

And a velocity $v \propto x/t$ so that eventually we look at $x_1 = \delta \cdot s/s$ and $x_2 \equiv y - y_{space-time}$. So the stability analysis we have is

$$\tau \frac{\partial}{\partial \tau} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \equiv \begin{bmatrix} \mathrm{A}_{11} & \mathrm{A}_{12} \\ \mathrm{A}_{21} & \mathrm{A}_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \qquad (7)$$

This is when we have at high temperatures a major simplification of the A_{ij} terms in the matrix in the right hand side of Eqn. (7) .This simplification of the right hand side of Eqn. (7) happens when we write $\eta \approx T^3$ and $s \propto T^3$. We obtain with this simplification of entropy and viscosity a relatively constant Reynolds number R_0, and a relatively constant speed of "sound" in the viscous media c_s^0. The resulting simplification and drop out of terms in the evolution equation allows us to write

$$A_{11} = c_s^{02} R_0^{-1} \qquad (8)$$

and

$$A_{12} = -k \cdot \left(1 - 2R_0^{-1}\right) \qquad (9)$$

and

$$A_{21} = kc_s^{02} \cdot \left(1 - 3R_0^{-1}\right) / (1 - R_0^{-1}) \qquad (10)$$

and

$$A_{22} = -[\left(1 - c_s^{02}\right) + c_s^{02} R_0^{-1} + 3c_s^{02} R_0^{-1}\left(1 - R_0^{-1}\right) + k^2 \cdot R_0^{-1}] / \left(1 - R_0^{-1}\right) \qquad (11)$$

In this limit we have a stability analysis performed for the eigenvalues of

$$A + A^T \qquad (11)$$

Where we are using $A \equiv \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix}$, and with the summarized results that for $\{\lambda_{\min}, \lambda_{\max}\}$ of Eqn (11) are such that , if

$\lambda_{\min} > 0$ we always have instability (12)
$\lambda_{\max} < 0$ we always have stability (13)
$\lambda_{\min} < 0, \lambda_{\max} > 0$, we some times have stability, (14)
and sometimes we do not have stability.

The forms of Eqn (12) to Eqn (14) remain the same, but we assert that if we deviate from strict adherence to $\eta \approx T^3$ and $s \propto T^3$ due to marked initial conditions, i.e., unusual contributions due to the anharmonic contribution to viscosity η_A we will have increasingly involved criteria for forming the matrix for Eqn. (11) and Eqn. (7) to Eqn. (10). We are looking into what these criteria should be for very unstable initial GUT criteria, with the proviso that we are not able to use simple linearization in GUT initial conditions, but that the ratio of $\eta_{Total} / s_{Density} \sim [1/4\pi]$ holds.

Appendix N:

Comparing implementation of Jack Ng's $\Delta S \approx \Delta N$ for wavelengths cubed, of the order of magnitude of an entropy generating volume of space, with Giovannini's calculation of entropy for all permissible ranges of frequencies.

As stated above, our implementation of the $\Delta S \approx \Delta N$ rule for HFGW assumes we are able to make a direct comparison between the wavelength of HFGWs and the region of space in which they are evaluated. This comparison yields an interpretation of a growth of entropy due to an infusion of vacuum energy at the onset of inflation, which we think needs to be falsified experimentally. We are suggesting that the Li-Baker detector will be an optimal platform for making such a set of measurements. Recapitulating what was said at the beginning of this paper, we make the following time line. Our basic assumption is that the Li-Baker detector is a platform to investigate the following buildup of information bits in the early universe. I.e., that in the beginning of quantum nucleation, there were perhaps 10^{10} bits of information present. That the production of relic gravitons in a HFGW early universe nucleation environment perhaps added up to 10^{30} bits of information in 10^{-10} seconds -- perhaps closer to an order of magnitude of 10^{-35} seconds in the boost effects of entropy from information transferred from a prior universe to our present universe. The analysis for how this could happen depends upon the verification of a supposition that HFGWs have a wavelength whose value cubed would be within an order of magnitude of the initial volume of space-time in which the HFGW are nucleated in relic inflationary conditions. Saying this though leads us to consider: do all frequencies contribute to the generation of gravitational waves equally? (This has implications for the generation of entropy, for reasons we will get to next.)

On the face of it, this question is nonsense. LISA and LIGO, two very well engineered detectors, are superb detectors of low frequency gravitational waves , as was given by the Amaldi 5 (2007) meeting . In addition, the betting is that allegedly that signal/noise issues will make detection of HFGWs, especially from relic conditions, exceptionally difficult. The Li-Baker design effort, with its emphasis on a static magnetic field that can be impinged upon by HFGWs has a ready answer to this alleged difficulty. However, the sheer number of contributions to entropy if all ranges of frequencies contribute to GW production in the universe should be considered.Fortunately, there is a calculation authored by Giovannini (2008) and others that does count to entropy generation in total from the entire spectrum of GW generated, with a startling conclusion: that the present high level of entropy today can be effectively generated by GW production ! This calculation reads as follows. If we set V as the space-time volume, then look at $\nu_0 \sim 10^{-18}$ Hz, and $\nu_1 \sim 10^{11}\left(H_1/M_P\right)^{3/2} \sim 10^{11}$ Hz as an upper bound, assuming no relationship like the GW wavelength cubed, as proportional to early universe volume, which leads to $r(\nu) \equiv \ln \bar{n}_{gravitons}$, where $\bar{n}_{gravitons}$ refers to the number of produced gravitons over a very wide spectral range of frequencies. This assumes that we are working with $H_1 \propto M_P$

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

This should be compared with HFGW production in relic conditions $\Delta S\big|_{relic-HFGW} \approx \Delta N \sim 10^{21}$ right after the onset of nucleation of a new universe. I.e. there is have relic gravitational production, as occurring after the 2nd order initial phase transition referenced in Appendix XII above, for a GUT, with information/entropy for universe which Dr. Smoot pegs as less than or equal to 10^{10} $-$ information / 10^{8} $-$ entropy $\xrightarrow[2nd-order-phase-transition]{}$ 10^{120} $-$ information / 10^{88} $-$ entropy in our present universe, which will be explained more fully in future publications.

This should be compared with the result that Sean Carroll (2004) came up with: that for the universe as a whole

$$S_{Total} \sim 10^{88} \tag{2}$$

This Eqn. (2) should be compared with the even odder result that the author discussed in a question and answer period in the Bad Honnef perspectives in quantum gravity (2008) meeting, April 2008 to reconcile Eqn. (2) with the odd prediction given in Eqn. (3), namely , as presented by Carroll, (2004)

$$S_{Black-Hole} \sim 10^{90} \cdot \left[\frac{M}{10^{6} \cdot M_{Solar-Mass}} \right]^{2} \tag{3}$$

I.e. the black hole in the center of our galaxy may have purportedly more entropy than the entropy of the entire KNOWN universe.Our hierarchy of how to generate entropy from initial conditions present in the initial cosmological evolution is an attempt to make sense of the inherent weirdness present in Eqn. (1), Eqn. (2), and Eqn. (3). The three equations together do not fit as a consistent whole. We assert that there is no way that we can meaningfully justify the conclusions of Eqn. (1). And while we view graviton production as crucially important for the rise in entropy, as outlined by Dr. Smoot (2007), graviton production is most likely to be concentrated as narrow relic graviton production as an onset to entropy generation.We hope that the articles following this manuscript will enable us to handle the frankly physically absurd implications inherent in all three of the basic equations written in this document and permit us to develop an experimentally falsifiable set of experimental procedures to reasonably investigate entropy creation from first principles.

BIBLIOGRAPHY

Acernese, F., Amico, P., Alshourbagy, et al. **"**Gravitational waves by gamma-ray bursts and the Virgo detector: the case of GRB 050915a**"***Class. Quantum Grav.* **24** S671-S679 doi: 10.1088/0264-9381/24/19/S29

Arnaud., Nicolas, Barsuglia, Matteo, Bizouard, Marie-Anne , Brisson, Violette, Cavalier, Fabien, Davier, Michel, Hello, Patrice, Kreckelbergh , Stephane, and E Porter Edward K., ." Detection of a close supernova gravitational wave burst in a network of interferometers, neutrino and optical detectors", Astroparticle physics, Volume 21, Issue 2, May 2004, pages 201-221.

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

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. "Symmetries in evolving spacetime from prior to present universes", arXIV math-ph/0501028 (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., "Hypothetical Dark Matter/Axion rockets: What can be said about Dark Matter in terms of space physics propulsion"**,**Contributed to SPESIF - 2009, Huntsville, Alabama, 24-27 Feb 2009.
e-Print: arXiv:0810.1493 [physics.gen-ph]; http://arxiv.org/abs/0810.1493

Beckwith, A. W. talk given in IDM 2008, Sweden, **"**Toward a viable dark matter candidate without invoking SUSY" http://agenda.albanova.se/contributionDisplay.py?contribId=369&sessionId=254&confId=355

Beckwith, A. W. "Relic High Frequency Gravitational waves from the Big Bang, and How to Detect Them", http://arxiv.org/abs/0809.1454

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

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

Crowell, L., "Quantum Fluctuations of Space Time ", World Scientific Series in Contemporary Chemical Physics, Vol 25, World Scientific, PTE, LTD, 2005, Singapore

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

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.

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

P. Frampton, Peter, and Baum, L. “Turnaround in Cyclic Cosmology “,Phys.Rev.Lett. 98 (2007) 071301 , arXiv:hep-th/0610213v2

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

Gasperini, M., Maharana, J. and Veneziano, G.,”Graceful exit in String cosmology,” *Nucl. Phys. B*, **472**, (1996), pp. 349-356

Gertsenshtein, M.E. “ Wave Resonance of Light and Gravitational Waves”, J. Exptl. Theoret. Phys (USSR) pp 13-14 (1961)

Giovannini, Massimo, ” A Primer on the Physics of the Cosmic Microwave Background”, World Press Scientific, 2008, Singapore, Republic of Singapore, (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

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.

Hooper, Dan, and Baltz, Edward A.,” Strategies for Determining the Nature of Dark Matter”, pp 293-314, Annual Reviews of Nuclear and Particle physics, Volume 58, 2009, with editors Kayser, Holstein, Jawahery

Hunt P., and Sakar Subir , “ Multiple Inflation and the WMAP “glitches” “, *Phys Rev D* Volume 70**,** 103518

Invitees to 2007 HFGW Workshop

Jones-Smith, K., Krauss, L., and Mathur, H., ” *A Nearly Scale Invariant Spectrum of Gravitational Radiation from Global Phase Transitions*", Phys. Rev. Letters, 100, 131302 (2008), http://arxiv.org/abs/0712.0778

Kashlinsky, A., Atrio-Barandela , F. Kocevski, , D and Ebeling, H. “A Measurement of Large-Scale Peculiar Velocities of Clusters of Galaxies: Results and Cosmological Implications”, The Astrophysical Journal Letters - 686(2):pp. L49-L52

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

Kumar, Jason , “A Brief Comment on Instanton-like Singularities and Cosmological Horizons”, JHEP 0301 (2003) 010, arXiv arXiv:hep-th/0204119v2, 27 Apr 2002

L.D. Landau , L.D., Lifshitz, E.M., The Classical Theory of Fields (Course of Theoretical Physics, Volume 2), Butterworth-Heinemann; 4th Rev edition (June 1987)

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," *International Journal of Modern Physics D* **15**

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

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

Manschot, Jan ; " Partition functions for Super symmetric Black Holes", Amsterdam University Press, (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).

Misner, C., Thorne, K., and Wheeler, J.," Gravitation", W.H. Freeman, and Company, San Francisco, USA, 1973;

Moskowitz , Clara ," Mysterious New 'Dark Flow' Discovered in Space", http://www.space.com/scienceastronomy/080923-dark-flows.html

Mukhanov, V., "Physical foundations of Cosmology", Cambridge University Press, Cambridge, UK, 2005

Mukhanov, V. P., and Wintizki, S. " Introduction to Quantum Effects in Gravity", Cambridge University Press, 2007, New York , New York, USA

Muramaya, H., "Physics beyond the Standard Model and Dark matter," Lectures at Les Houches Summer School, Session 86, Particle Physics and Cosmology: the Fabric of Spacetime, July 31- August 25, (2006)

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

Novikov, I.D. and Zeldovitch, Ya., B. , " Physical Properties of Cosmological Singularities", Annual Review of Astronomy and Astrophysics, Vol. 11: 387-412 (Volume publication date September 1973)
(doi:10.1146/annurev.aa.11.090173.002131)

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*. **B**535 (2002) pp. 5-10

Pavon D, " Relic gravitational waves in the Expanding Universe", arXIV gr-qc/ 0601050 v1, 12 Jan 2006

Peebles, J.E.," Principles of Physical Cosmology", Princeton University press, USA (1993)

Peiris, H. V., Komatsu, E.L. Verde, L , Spergel, D ,Bennett, C. Halpern, M. Hinshaw, G., Jarosik, N. Kogut, A., Limon, M., Meyer, S., Page, L. Tucker, G. Wollack E., and Wright, E. " First-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Implications For Inflation", The Astrophysical Journal Supplement Series, 148:213–231, 2003 September

Penrose, Roger; " Before the Big Bang: An Outrageous New Perspective and Its Implications for Particle Physics", Proceedings of EPAC 2006, Edinburgh, Scotland, pp 2759-2763

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*.

Private communications with Subir Sarkar received as of January 2008 via e mail

Radu, E., Tchrakian, D.H.,Yang: Y., " Spherically symmetric self dual Yang – Mills instantons on Curved Backgrounds in all Even Dimensions", Phys Rev D 77,044017 (2008), arXiv 0 707.1270 [hep-th]

Robson, David, "US investigation into gravity weapons 'nonsense' ",http://www.newscientist.com/article/dn16306-us-investigation-into-gravity-weapons-nonsense.html?full=true&print=true

Rothman, Tony and Boughnm S., "Can Gravitons be Detected?" *Foundations of Physics*, **36**(12), December (2006), pp. 1801-1825.

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 ^{3}He as an analog of cosmological defect formation," *Nature* **382**, 334-336 (25 July

Sanchez, N. 11th Paris Cosmology Colloquium, August 18th, 2007 with respect to Sanchez, N., "Understanding Inflation and Dark Energy in the Standard Model of the Universe", 'D.Chalonge' school

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

Smoot, George , 11th Paris Cosmology Colloquium, August 18th , 2007 with respect to Smoot, G, " CMB Observations and the Standard Model of the Universe" 'D.Chalonge' school, http://chalonge.obspm.fr/Programme2007.html

Smoot, George**,** Personal communication to Amara D. Angelica, Sept. 21, 2008

Song, Seong-Yong, **Doré**, Olivier , "Testing gravity using weak gravitational lensing and redshift surveys", http://arxiv.org/abs/0812.0002 , December 2008

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

Tcharkian, D. H. presentation "Gravitating Yang-Mills fields" at Bremen, August 29th, 2008, at the "Models of Gravity in Higher Dimensions", August25- 29th, 2008 418 WE- Heraeus – Seminar (to appear in proceedings which the seminar will put out in later 2008-2009.

Torrieri, Giorgio, and Mishustin, Igor, "Instability of Boost-invariant hydrodynamics with a QCD inspired bulk viscosity", http://arxiv.org/abs/0805.0442, (2008)

Traschen, Jennie, " An introduction to Black Hole Evaporation", http://arxiv.org/abs/gr-qc/0010055, 3 pages, latex. Published in Mathematical Methods of Physics, proceedings of the 1999 Londrina Winter School, editors A. Bytsenko and F. Williams, World Scientific (2000)

Tremaine , S., and Gunn, J. E.; "Dynamical Role of Light Neutral Leptons in Cosmology," *PRL* 42, (1979), p. 407.

Weinberg , Stephen, "*Gravitation and Cosmology: Principles and Applications of the General theory of Relativity"*, John Wiley & Sons, Inc. New York, 1972

Wesson, P., " Space-Time-Matter, Modern Kaluza Klein Theory", World Scientific , Singapore, Republic of Singapore, 1999

What the author , A.W. Beckwith brought up with Tigran Tchrakian, in Bremen, August 29th, 2008, at the "Models of Gravity in Higher Dimensions", August 29th, 2008;

Yeo,Ye, Lim, Zhi Han Ching, Chee Leong Chong, J. , Chua, Wee Kang and Dewanto, A., "Detection of gravitational waves —An application of relativistic quantum information theory", 2007 *EPL* **78** 20006 (5pp), arXIV quantum-Ph/0605135 v1, 16 May 2006