How can one look at if GW generation has semi classical features, and what this implies about compression of vacuum wave states, and coherence/de coherence? Also, what about High Versus Low frequencies as to relic GW?

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Abstract.

We argue in this document that initial vacuum state values possibly responsible for GW generation in relic conditions in the initial onset of inflation may have a temporary un squeezed , possibly even coherent initial value, which would permit in certain models classical coherent initial gravitational wave states. The coherent states would be amendable to nucleation by classical/ highly non linear processes which would be almost immediately eliminated by compression and squeezing. Even though that the general background of incoherency for relic GW is a given. Furthermore, several arguments pro and con as to if or not initial relic GW should be high frequency will be presented, with the reason given why earlier string models did NOT favor low relic GW from the big bang..

Introduction

The author finds that the supposition as to the inevitability of low frequency GW from the big bang is supported only by the conclusion that large spatial dimensions above our four dimensions are conduits as to dumping cyclical universe matter-energy into. Numerous articles, i.e. one 'dumping inflation' "out of this world" , as well as the multiple universes popularized by Arkani-Hamid , among others, with most of the energy of relic inflation dumped into higher dimensions, than our present 4 dimensional space time. But notice the assumptions made to back up this claim. I.e. very large scale higher dimensions. The Calabi Yau manifold used as an initial embedding space for dimensions above our space time was for a long time thought of as having compact, almost undetectable small higher dimensions. The initial smallness of the higher dimensions was the reason why Gasperini and others as of (1995) wrote well received string theory articles predicting no favoring of low frequency GW as the primary relic GW signature from the big bang. The author believes that physics fashion has, in this matter, been driving researchers into more and more extreme suppositions, and that it is time for either QUIET and/or the Li-Baker detector systems to parse the actual circumstances of relic GW conditions , and to ask seriously, what is a sensible set of suppositions as to measurable physics signals from the big bang which can be measured. Doing so, also, will lead to another item repeatedly not faced by current physics research fashion. Facing up to if or not initial generations of GW/ gravity was due to either classical processes, in highly non linear subsequent evolution, or if the processes must be quantum . And how much squeezing of states in initial conditions for inflation(super inflation in the LQG) scenario is listed by no less that Bojowald (2008) as an open problem, which will be brought up toward the end of this document, as part of what Beckwith views as important future goals as to cosmology research .The relative role of classical processes in initial vacuum states from emergent fields, versus quantum has implications far beyond the initial spectrum of GW from relic conditions. One of the current unsolved problems in cosmology is in if or not the initial physical constants , i.e. $\hbar$, G, and the fine structure constant is invariant from before the big bang, to the present era. The author's preference is that in the present cosmos that whatever initial variations as to $\hbar$, G, and the fine structure constant were almost non existent from the big bang itself. Which brings up the question of if or not enough information content from a prior universe to today was transferred to our present universe to keep $\hbar$, G, and the fine structure constant the same from cosmological cycle to cycle.

In order to begin that line of inquiry, the author begins this document with a generalization as to what is known about the evolution of photons in the aftermath of t he big bang.

Invariance of photon equations of state to preserve black body radiation profiles, and the aftermath

Before 380 thousand years after the big bang, there was still photon related cosmological evolutions as defined by J. A. S. Lima (1996), which can be summarized, for temperature related behavior as photons having number and energy densities specified as $n_r|_{Photons} \sim T^3, \rho_r|_{Photons} \sim T^4$, so that for an instantaneous co moving number of photons, Lima write $N_r|_{Photons} = n_r|_{Photons} \cdot T$, where T is for background temperature and states that this value $N_r|_{Photons}$ must be a constant. Lima quotes a researcher, Steigman in saying that "Unless the number of co moving photons in a co moving volume is constant, a blackbody distribution (of photons) is destroyed as the universe evolves". In addition, Lima's key result which can be summarized as follows, that even if $N_r|_{Photons}$ has a changing time component that there exists entropy associated with photons , $S_r|_{Photons}$ so that the following relationship holds for any Friedman style cosmology, namely $\dot{S}_r|_{Photons} \big/ S_r|_{Photons} = \dot{N}_r|_{Photons} \big/ N_r|_{Photons}$, where the dot is time . If what is suggested by Beckwith (2009), with respect to his revision of Y.J. Ng's counting algorithm is correct, with respect to early universe conditions is correct, i.e. $\dot{S}_r|_{gravitons} \big/ S_r|_{gravitons} = \dot{N}_r|_{gravitons} \big/ N_r|_{gravitons}$ is also equal to a ratio of the time derivative of the number of gravitons, over the number of gravitons, and this in term is equal to the time derivative of entropy of graviton production, over entropy of graviton production at the onset of the universe, then in fact what one is working with is, de facto, one is looking at , then for initial conditions of

$$\dot{S}_r|_{Photons} \big/ S_r|_{Photons} = \dot{N}_r|_{Photons} \big/ N_r|_{Photons} \sim \dot{S}_r|_{gravitons} \big/ S_r|_{gravitons} = \dot{N}_r|_{gravitons} \big/ N_r|_{gravitons} \quad (0)$$

This should be a starting point to the analysis which proceeds in this paper, I.e. Eqn. (.0) as compared with the $S_{\max} = \pi / H^2 \sim 10^5$ or larger at the origins of the big bang will be a starting point in information /data comparison.

So, what can be said about the Y.J. Ng paradigm of entropy generation, which Beckwith has modified and looked at ? For a start, consider if the counting algorithm , which is a string theory result , can have any common results with a quantum gas result, which comes from the WDW equation, whose solution is WKB, semi classical in nature?

The question of relative over lap of classical and quantum processes in terms of wave functions for the evolution of the universe will be crucially important in determining coherency issues as far as relic GW, and gravitons from relic conditions, which the author will return to repeatedly during this presentation.

Review of simple models as to gravitons as produced either by (Quantum gravity) strings , LQG,(or by processes which may not be Quantum Gravity based?)

We wish now to review what may be some of the counting algorithms appropriate for entropy generation, and which may contribute to answering if or not GW are mandated to be, from the beginning either a classical versus a quantum processes. IN part this next page is due to concepts A.Beckwith presented in Rencontres De Blois, 2009, and is a starting point for our inquiry as to the necessity, or lack of , of modeling Gravity as either classical / quantum based in relic conditions.

Introduction w.r.t. the NG paradigm

We wish to present two alternative routes to generation of entropy. The first, is a counting algorithm, is an adaptation of Y.J. Ng's infinite quantum (modified Boltzmann's) statistics; the second references A. Glinka's research presentation on "graviton gas" as a way to provide a perspective? as to how to get a partition function for gravitons that is congruent with the Wheeler De Witt equation. Here are a few questions which are posed for the reader.

1. Is each “particle count unit” as suggested by Ng equivalent to a brane-antibrane unit in brane treatments of entropy?
2. Is the change of entropy $\Delta S \approx \Delta N_{gravitons}$?
3. Is this graviton production scheme comparable to Glinka’s quantum gas , from the Wheeler De Witt equation?

Entropy generation via Ng’s infinite quantum statistics (short review)

This discussion is motivated to show a purely string theory approach and to see if its predictions may over lap with semi classical WDM (semi classical) treatments of cosmology.. The contention being advanced is that if there is an over lap between these two methods, that it may aid in obtaining experimentally falsifiable data sets for GW from relic conditions.

We wish to understand the linkage between dark matter and gravitons. how relic gravitational waves relate to relic gravitons”?, To consider just that, we look at the “size” of the nucleation space, V for dark matter, DM. V for nucleation is HUGE. Graviton space V for nucleation is tiny , well inside inflation. Therefore, the log factor drops OUT of entropy S if V chosen properly for both eqn 1 and eqn 2. Ng’s result begins with a modification of the entropy/ partition function Ng used the following approximation of temperature and its variation with respect to a spatial parameter, starting with temperature $T \approx R_H^{-1}$ (R_H can be thought of as a representation of the region of space where we take statistics of the particles in question). Furthermore, assume that the volume of space to be analyzed is of the form $V \approx R_H^3$ and look at a preliminary numerical factor we shall call $N \sim (R_H / l_P)^2$, where the denominator is Planck’s length (on the order of 10^{-35} centimeters). We also specify a “wavelength” parameter $\lambda \approx T^{-1}$. So the value of $\lambda \approx T^{-1}$ and of R_H are approximately the same order of magnitude. Now this is how Jack Ng changes conventional statistics: he outlines how to get $S \approx N$, which with additional arguments we refine to be $S \approx < n >$ (where <n> is graviton density). Begin with a partition function

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

This, according to Ng, leads to entropy of the limiting value of, if $S = (\log[Z_N])$

$$S \approx N \cdot \left(\log\left[V/N\lambda^3\right] + 5/2\right) \xrightarrow[Ng-\inf inite-Quantum-Statistics]{} N \cdot \left(\log\left[V/\lambda^3\right] + 5/2\right) \approx N \tag{2}$$

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. (0.2) above. The modification of Ng’s entropy expression is in the region of space time for which the general temperature dependent entropy Kolb and Turner expression breaks down. In particular, the evaluation of entropy we do via the modified Ng argument above is in regions of space time where g before re heat is an unknown, unmeasurable number of degrees of freedom The Kolb and Turner entropy expression (1991) has a temperature T related entropy density which leads to that we are able to state total entropy as the entropy density time’s space time volume V_4 with $g_{re-heat} \approx 1000$, according to De Vega, while dropping to $g_{electro-weakt} \approx 100$ in the electro weak era. This value of the space time degrees of freedom, according to de Vega has reached a low of $g_{today} \approx 2-3$ today. We assert that Eqn (2) above occurs in a region of space time before $g_{re-heat} \approx 1000$, so after re heating Eqn (2) no longer holds, and we instead can look at

$$S_{total} \equiv s_{Density} \cdot V_4 = \frac{2\pi^2}{45} \cdot g_{\bullet} \cdot T^3 \cdot V_4 \tag{3}$$

Where $T < 10^{32} K$. We can compare eqn (1) and (2) , as how they stack up with Glinka's (2007) quantum gas, if we identify $\Omega = \frac{1}{2|u|^2 - 1}$ as a partition function (with u part of a Bogoliubov transformation) due to a graviton-quintessence gas, to get information theory based entropy

$$S \equiv \ln \Omega \tag{4}$$

Such a linkage would open up the possibility that the density of primordial gravitational waves could be examined, and linked to modeling gravity as an effective theory. The details of linking what is done with (0.2) and bridging it to (0.3) await additional theoretical development , and are probably conceptually understandable if the following is used to link the two regimes. I.e. we can use the number of space time operations used to create (0.2), via Seth Lloyds

$$I = S_{total} / k_B \ln 2 = [\#operations]^{3/4} = [\rho \cdot c^5 \cdot t^4 / \hbar]^{3/4} \tag{5}$$

Essentially, what will be done is to use 5 to show linkage between a largely thermally based production of entropy, as implied by (3) and a particle counting algorithm, as given by (0.2). This due to the problems inherent in making connections between a particle count generation of entropy, and thermal contributions. I.e two different processes are involved. The big news is though that the WKB is semi classical , whereas anything from string theory is, well, QFT, plus.

Where there is an over lap between a classical wave function, and its quantum mechanical analog, that means there is a minimization of spreading of a wave functional. i.e. see Roy Glauber (1963)

One can say the following. That if there is an over lap between the Wheeler De Witt equation derived quantum gas which was brought up by Glinka (2007) , where the WDW can have WKB semi classical solutions, and the string theory counting algorithm, Then, if the end results are similar, the fact is that the quantum procedure , i.e . brane theory, is over lapping with WKB, means that there is a minimization of uncertainty. Note that the supposition of how classical and quantum processes can give similar answers is presented in rich detail by Roy Glauber(1963) and the example talked about here is its GW analog.

Gravitons are stated conceptually to be akin to photons in light waves. In simple physics analogies. But this simple quantum generalization breaks down, since gravitons are spin two particles with a complex set of interactions not only with themselves, but with evolving space time geometry. We mention that gravitons may be important to initial entropy generation. Entropy generation and entropy perturbations affect the gaussianity of evolving wave functions of matter and energy evolving in space time. If there is a large deviation of the initially Gaussian states of space time wave functions , there is likely a break from classical physics due to the complexity of evolving wave function states influenced increasingly by non Gaussian perturbations. This non Gaussian process is reflected by marked deviation from planar wave state approximations used in the evolution of wave functions Hence the issue of apparently combined sources of planar wave generation of gravitational waves is a precursor to what would happen if squeezed states occurred at the onset of the big bang. I.e., what would happen with multiple superpositions of different coherent states?. A good reference as to coherent states in cosmology, as in this example, Bianchi I universes, was given by Brett Bolen, Luca Bombelli, Alejandro Corichi (2004) In particular, look at their equation **3.1**. If states are largely coherent, such a small variation/ smoothness of observables will have observational consequences as to relic gravitational wave signals seen in the onset of inflation.

In the case of gravitons, as coherent states, once squeezing of coherent states occurs, the ,mere act of squeezing of the initial states destroys the initial classical super position of graviton states which would contribute to a GW. How and what particular mix of squeezed versus un squeezed relic states one can expect is important for determining frequencies to look for which are from relic conditions.

The basic reason for making such an examination of the relative importance of squeezing/ lack of squeezing is to determine if or not relic GW are due to classical versus quantum Gravitational processes. The answer to if or not relic GW are due to classical versus quantum processes has huge consequences as to the dominant GW harmonics in terms of what are the most important frequencies researchers need to look for , for relic GW identification, with instrumentation. The problem facing GW researchers is how to find dominant sub harmonics, in GW signals, i.e. how to use pattern recognition , and updated advanced fourier analysis in order to identify dominant frequency ranges of GW signals which are of interest and which carry the most relevant physics information for cosmologists to review and learn from. Relic GW are messy , and the most dominant/ important frequencies identified can if properly analyzed confirm/ falsify many of our early universe cosmology theories as far as relic conditions. How does one actually know about first or second order phase transitions, due to GW. Does one see , as an example classically based non linear super position of GW, which have consequences as to admissible spectrum of GW frequencies to detect ?

Since it has been brought up, let us now review, briefly the issue of coherence, versus de coherence of initial vacuum states, and its relevance as to classical versus quantum factors as to generation of GWs

Issues about Coherent state of Gravitons (linking gravitons with GW)

In the quantum theory of light (quantum electrodynamics) and other bosonic quantum field theories , coherent states were introduced by the work of Roy J. Glauber in 1963 Now, it is well appreciated that Gravitons are NOT similar to light. So what is appropriate for presenting gravitons as coherent states ? Coherent states , to first approximation are retrievable as minimum uncertainty states. If one takes string theory as a reference, the minimum value of uncertainty becomes part of a minimum uncertainty which can be written as given by Venziano (1993), where $l_S \cong 10^{\alpha} \cdot l_{Planck}$, with $\alpha > 0$, and $l_{Planck} \approx 10^{-33}$ centimeters

$$\Delta x > \frac{\hbar}{\Delta p} + \frac{l_S^2}{\hbar} \cdot [\Delta p] \qquad (6)$$

To put it mildly, if we are looking at a solution to minimize graviton position uncertainty, we will likely be out of luck if string theory is the only tool we have for early universe conditions. Mainly, the momentum will not be small, and uncertainty in momentum will not be small either. Either way, most likely, $\Delta x > l_S \cong 10^{\alpha} \cdot l_{Planck}$ In addition, it is likely, as Klaus Kieffer in the book " Quantum Gravity" on page 290 of that book that if gravitons are excitations of closed strings, then one will have to look for conditions for which a coherent state of gravitons, as stated by Mohaupt (2003) occurs. What Mohaupt is referring to is a string theory way to re produce what Ford gave in 1995, i.e. conditions for how Gravitons in a squeezed vacuum state, the natural result of quantum creation in the early universe will introduce metric fluctuations. Ford's (1995) treatment is to have a metric averaged retarded Green's function for a massless field becoming a Gaussian. The condition of Gaussianity is how to obtain semi classical , minimal uncertainty wave states, in this case de rigor for coherent wave function states to form. Ford uses gravitons in a so called 'squeezed vacuum state' as a natural template for relic gravitons. I.e. the squeezed vacuum state (a **squeezed coherent state**) is any state such that the uncertainty principle is saturated.: In QM coherence would be when $\Delta x \Delta p = \hbar/2$. In the case of string theory it would have to be

$$\Delta x \Delta p = \frac{\hbar}{2} + \frac{l_S^2}{2 \cdot \hbar} \cdot [\Delta p]^2 \qquad (7)$$

Begin with noting t hat if one is not using string theory, we merely set the term $l_S \xrightarrow[non-string]{} 0$, but that we are still considering Roy Glauber(1963) with string theory replacing his stated example.

However, what one sees in string theory, is a situation where a vacuum state as a template for graviton nucleation is built out of an initial vacuum state, $|0\rangle$. To do this though, as Venkatartnam, and Suresh did, involved using a squeezing operator $Z[r,\vartheta]$ defining via use of a squeezing parameter r as a strength of squeezing interaction term , with $0 \leq r \leq \infty$, and also an angle of squeezing, $-\pi \leq \vartheta \leq \pi$ as used in $Z[r,\vartheta] = \exp\left[\frac{r}{2} \cdot \left([\exp(-i\vartheta)] \cdot a^2 - [\exp(i\vartheta)] \cdot a^{+^2}\right)\right]$, where combining the $Z[r,\vartheta]$ with

$$|\alpha\rangle = D(\alpha) \cdot |0\rangle \tag{8}$$

(8) leads to a single mode squeezed coherent state, as they define it via

$$|\varsigma\rangle = Z[r,\vartheta]|\alpha\rangle = Z[r,\vartheta]D(\alpha) \cdot |0\rangle \xrightarrow[\alpha \to 0]{} Z[r,\vartheta] \cdot |0\rangle \tag{9}$$

The right hand side . of eqn. (1.16) given above becomes a highly non classical operator, i.e. in the limit that the super position of states $|\varsigma\rangle \xrightarrow[\alpha \to 0]{} Z[r,\vartheta] \cdot |0\rangle$ occurs, there is a many particle version of a 'vacuum state' which has highly non classical properties. Squeezed states, for what it is worth, are thought to occur at the onset of vacuum nucleation , but what is noted for $|\varsigma\rangle \xrightarrow[\alpha \to 0]{} Z[r,\vartheta] \cdot |0\rangle$ being a super position of vacuum states, means that classical analog is extremely difficult to recover in the case of squeezing, and general non classical behavior of squeezed states. Can one, in any case, faced with $|\alpha\rangle = D(\alpha) \cdot |0\rangle \neq Z[r,\vartheta] \cdot |0\rangle$ do a better job of constructing coherent graviton states, in relic conditions, which may not involve squeezing ?. Note L. Grishchuk wrote in (1989) in "On the quantum state of relic gravitons", where he claimed in his abstract that 'It is shown that relic gravitons created from zero-point quantum fluctuations in the course of cosmological expansion should now exist in the squeezed quantum state. The authors have determined the parameters of the squeezed state generated in a simple cosmological model which includes a stage of inflationary expansion. It is pointed out that, in principle, these parameters can be measured experimentally'. Grishchuk , et al, (1989) reference their version of a cosmological perturbation h_{nlm} via the following argument. How we work with the argument will affect what is said about the necessity, or lack of, of squeezed states in early universe cosmology. From Class. Quantum Gravity: 6 (1989), L 161-L165, where h_{nlm} has a component $\mu_{nlm}(\eta)$ obeying a parametric oscillator equation, where K is a measure of curvature which is $= \pm 1, 0$, $a(\eta)$ is a scale factor of a FRW metric, and $n = 2\pi \cdot [a(\eta)/\lambda]$ is a way to scale a wavelength, λ , with n, and with $a(\eta)$

$$h_{nlm} \equiv \frac{l_{Planck}}{a(\eta)} \cdot \mu_{nlm}(\eta) \cdot G_{nlm}(x) \tag{10}$$

$$\mu''_{nlm}(\eta) + \left(n^2 - K - \frac{a''}{a}\right) \cdot \mu_{nlm}(\eta) \equiv 0 \tag{11}$$

If $y(\eta) = \frac{\mu(\eta)}{a(\eta)}$ is picked, and a Schrodinger equation is made out of the Lagrangian used to formulate (11) above, with $\hat{P}_y = \frac{-i}{\partial y}$, and $M = a^3(\eta)$, $\Omega = \frac{\sqrt{n^2 - K^2}}{a(\eta)}$, $\breve{a} = [a(\eta)/l_{Planck}] \cdot \sigma$, and $F(\eta)$ an arbitrary function. $y' = \partial y / \partial \eta$. Also, we have a finite volume $V_{finite} = \int \sqrt{^{(3)}g}\, d^3x$

Then the Lagrangian for deriving (11) is (and leads to a Hamiltonian which can be **<u>also</u>** derived from the Wheeler De Witt equation), with $\varsigma = 1$ for zero point subtraction of energy

$$L = \frac{M \cdot y'^2}{2a(\eta)} - \frac{M^2 \cdot \Omega^2 a \cdot y^2}{2} + a \cdot F(\eta) \tag{12}$$

$$\frac{-1}{i}\cdot\frac{\partial\psi}{a\cdot\partial\eta}\equiv\hat{H}\psi\equiv\left[\frac{\hat{P}^{2}{}_{y}}{2M}+\frac{1}{2}\cdot M\Omega^{2}\hat{y}^{2}-\frac{1}{2}\cdot\varsigma\cdot\Omega\right]\cdot\psi \tag{13}$$

then there are two possible solutions to the S.E. Grushchuk created in 1989, one a non squeezed state, and another a squeezed state. So in general we work with

$$y(\eta)=\frac{\mu(\eta)}{a(\eta)}\equiv C(\eta)\cdot\exp(-B\cdot y) \tag{14}$$

The **non squeezed state** has a parameter $B\big|_{\eta}\xrightarrow[\eta\to\eta_b]{}B(\eta_b)\equiv\omega_b/2$ where η_b is an initial time, for which the Hamiltonian given in (14) in terms of raising/ lowering operators is 'diagnonal', and then the rest of the time for $\eta\neq\eta_b$, the **squeezed state** for $y(\eta)$ is given via a parameter B for squeezing which when looking at a squeeze parameter r, for which $0\leq r\leq\infty$, then (14) has, instead of $B(\eta_b)\equiv\omega_b/2$

$$B\big|_{\eta}\xrightarrow[\eta\neq\eta_b]{}B(\omega,\eta\neq\eta_b)\equiv\frac{i}{2}\cdot\frac{(\mu/a(\eta))'}{(\mu/a(\eta))}\equiv\frac{\omega}{2}\cdot\frac{\cosh r+[\exp(2i\vartheta)]\cdot\sinh r}{\cosh r-[\exp(2i\vartheta)]\cdot\sinh r} \tag{15}$$

Taking Grishchuck's formalism literally, a state for a graviton/ GW is not affected by squeezing when we are looking at an initial frequency, so that $\omega\equiv\omega_b$ initially corresponds to a non squeezed state which may have coherence, but then right afterwards, if $\omega\neq\omega_b$ which appears to occur whenever the time evolution, $\eta\neq\eta_b\Rightarrow\omega\neq\omega_b\Rightarrow B(\omega,\eta\neq\eta_b)\equiv\frac{i}{2}\cdot\frac{(\mu/a(\eta))'}{(\mu/a(\eta))}\neq\frac{\omega_b}{2}$ A reasonable research task would be to determine, whether or not $B(\omega,\eta\neq\eta_b)\neq\frac{\omega_b}{2}$ would correspond to a vacuum state being initially formed right after the point of nucleation, with $\omega\equiv\omega_b$ at time $\eta\equiv\eta_b$ with an initial cosmological time some order of magnitude of a Planck interval of time $t\approx t_{Planck}\propto 10^{-44}$ seconds

Open questions. Turbulence in initial GW production and how to model it ? Either classically or quantum mechanically

What happens if there is a switch over from an initially uncompressed state, to one which has compression? Several things could happen. First of all, one may be able to see colliding plane wave representations of GW, i.e the geometry of the colliding wave space time becomes amendable to analysis, as was presented by Vladimir Belinski, and Enric Venrauger (2001) in their book on Gravitational solitons, starting on page 202. In particular, their equation (7.60) has parameters which represent gravitational shock waves in collision, followed by trailing gravitational radiation. If one believes that relic GW processes can be largely preserved in the onset of the big bang in a 'frozen' profile then the interactive region for generation of GW signals from GW shock waves in collision could account for the datum represented by Fangyu Li et al (2009) as far as the alleged random back ground as far as GW processes. Secondly is the issue which Bojowald (2008) talked to the author, Beckwith, about in the 12 Marcel Grossman conference , mainly what is known, and what is not know about the geometry of space time , presumably in the aftermath of the big bounce (LQG). Bojowald's (2008) paper leaves the relative degree of squeezing mandated by the big bounce as a 'to be solved' datum .

For the sake of comparison, Furthermore, Abhay Ashtekar (2006) wrote a simple treatment of the Bounce causing Wheeler De Witt equation along the lines of , for $\rho_{*}\approx const\cdot(1/8\pi G\Delta)$ as a critical density, and Δ the eignvalue of a minimum area operator. Small values of Δ imply that gravity is a repulsive force, leading to a bounce effect.

$$\left(\frac{\dot{a}}{a}\right)^2 \equiv \frac{8\pi G}{3}\cdot\rho\cdot\left(1-\left(\rho/\rho_*\right)\right)+H.O.T. \tag{16}$$

Furthermore, Bojowald (2008) specified a criteria as to how to use an updated version of Δ and $\rho_* \approx const\cdot\left(1/8\pi G\Delta\right)$ in his GRG manuscript on what could constitute grounds for the existence of generalized squeezed initial (graviton ?) states. Bojowald (2008) was referring to the existence of squeezed states, as either being necessarily, or NOT necessarily a consequence of the quantum bounce. As Bojowald (2008) wrote it up, in both his equation (26) which has a quantum Hamiltonian $\left\langle\hat{V}\right\rangle \approx H$,with

$$\left.\frac{d\left\langle\hat{V}\right\rangle}{d\phi}\right|_{\phi\,\approx\,0} \xrightarrow[existence-of-un-squeezed-states\;\Leftrightarrow\;\phi\;\approx\;0]{} 0 \tag{17}$$

, and $\hat{V}$ is a 'volume' operator where the ' volume' is set as V , Note also, that Bojowald has , in his initial Friedman equation, density values $\rho\equiv\frac{H_{matter}(a)}{a^3}$, so that when the Friedman equation is quantized, with an initial internal time given by ϕ , with ϕ becoming a more general evolution of state variable than 'internal time'. If so, Bojowald (2008) writes, when there are squeezed states

$$\left.\frac{d\left\langle\hat{V}\right\rangle}{d\phi}\right|_{\phi\neq0} \xrightarrow[existence-of-squeezed-states]{} N(value)\neq 0 \tag{18}$$

for his equation (26), which is incidently when links to classical behavior break down , and when the bounce from a universe contracting goes to an expanding present universe,. Bojowald also writes that if one is looking at an isotropic universe, that as the large matter 'H' increases, that in certain cases, one observes more classical behavior, and a reduction in the strength of a quantum bounce.. Bojowalds states that "Especially the role of squeezed states is highlighted. The presence of a bounce is proven for uncorrelated states, but as squeezing is a dynamical property and may change in time"

I claim that what Bojowald (2008) is leading up to, is specifying a parameter space in initial conditions which one may be able to do a semi classical analysis of the sort referenced by Vladimir Belinski, and Enric Venrauger (2001) in their book on Gravitational solitons, starting on page 202 of their text.. As stated earlier, their equation (7.60) has parameters which represent gravitational shock waves in collision, followed by trailing gravitational radiation. Not only that, but initial un squeezed states may be, in part represented/ presentable as due to the worm hole analysis of initially introduced from a prior universe, to today's universe by the WdM pseudo time representation of an initial vacuum state, as has been brought up by Beckwith, in 2008, 2009, and in two of his Vixra (2009) articles.

Last, but not least, would be to also examine, from first principles, what Christian Corda raised as a distinct possibility Namely using " investigation of the transverse effect of gravitational waves (GW's) could constitute a further tool to discriminate among several relativistic theories of gravity on the ground. After a review of the TT gauge, the transverse effect of GW's arising by standard general relativity (called Einstein's GW's in this paper) is reanalyzed with a different choice of coordinates." . I.e. using transverse effects as another further tool to distinguish on the foundations of what Li et al (2009) listed as random background for the processes in which relic GW are generate in early space time conditions.

Table 1: magnitude, sources, and top frequency values for HFGW (from Li et al. 2009)

Sources	Amplitude	frequency	Characteristics
HFGW in Quintessence inflationary models	$h_{rms} \sim 10^{-30} - 10^{-32} \big/ \sqrt{Hz}$	$\nu \sim 10^{9} - 10^{10}\, Hz$	**Random background**
HFGW in some string theory scenarios	$h_{rms} \sim 10^{-30} - 10^{-34} \big/ \sqrt{Hz}$	$\nu \sim 10^{8} - 10^{11}\, Hz$	**Random background**
Solar Plasma	$h_{rms} \sim 10^{-39} \big/ \sqrt{Hz}$	$\nu \sim 10^{15}\, Hz$	**On the Earth**
High energy particles, e.g. Fermi Ring	$h_{rms} \sim 10^{-39} - 10^{-41} \big/ \sqrt{Hz}$	$\nu \sim 10^{4} - 10^{5}\, Hz$	**On the center the frequency depends upon the rotational frequency of particles in the Fermi Ring**
Stanford Linear Accelerator	$h_{rms} \sim 10^{-39} \big/ \sqrt{Hz}$	$\nu \sim 10^{23}\, Hz$	**On the collision center, the frequency depends upon the self energy and the Lorentz factor of high energy $e^{+}e^{-}$ beams**
LHC- Large Hadron collider			**Spectra of high energy gravitons**
Nano-piezo electric crystal array, with size of about 100 nanometers	$h_{rms} \sim 10^{-28} - 10^{-31} \big/ \sqrt{Hz}$	$\nu \sim 10^{9} - 10^{10}\, Hz$	**On the wave zone with an effective cross section of or less than .01 meters squared, for gravitational radiation**

CONCLUSION: Investigating fundamentals of generation of GW in relic conditions. Time to re set GW physics to empirical foundations.

The author, Beckwith, is fully aware of how unpopular his conclusions will be with respect to current string theory proponents, who have managed to move string theory from its initial Calibi Yau compact higher dimensions focus, as Giovannini, and others used successfully (1995) to argue for almost unlimited higher frequencies as to relic GW, to the unlimited higher dimensions specified by Arkani-Hamid, and others. It is time for the GW and the GR community to cease being intimidated by some of these practitioners and to re focus and re set the discussion on relic conditions to becoming once again an empirical science, one whose focus should be data analysis, and not post modern physics.

The author, also views as potentially revolutionary the implications as argued by t'Hooft, Corda, and others that Gravity is essentially classical in its origins. A datum which can be investigated by determining if or not Vladimir Belunski , and Enric Vergaguer are right about their interaction region for shock waves, as could be modeled for initial conditions. I.e. this modeling of Vladimir Belunski , and Enric Vergaguer 's modeling of the collision of GW is under way right now by the author, and the results will be mapped onto possible relic GW spectra, once numerical protocol for doing so are fully developed by the author, Beckwith.

The final pay off, of moving beyond post modern physics, and re-setting the discussion back to laboratory science, will be in investigating a supposition t'Hooft advanced as to Quantum mechanics, which has never been satisfactorily investigated. The reconstruction of generation of GW in initial conditions may be allowing us **to illustrate *'t Hooft's proposal to reconstruct quantum mechanics*** as an emergent theory. It does not get any better than this, in terms of learning reality as we know it. The author, Beckwith, will in a subsequent publication, elaborate upon why early generation of GW could be the **perfect template** as to investigating T'Hoofs supposition in proper detail, and what that could mean with respect to physics.

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