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Physics of GW generated by Tokamak, for strain h ~ 10^-25 at Center of Tokamak & Mukhanov's Mistake , Corrected

How Plasma Fusion Burning makes possible GW analysis in place of only using Electric Fields in Plasma's

Plan of lecture

- 1: First we demonstrate how a strain of h ~ 10^ -25 is obtained in the toroidal Tokamak, as given by analysis of Plasma fusion burning in Tokamak
- 2: Next, we bring up a mistake made by V. Mukhanov in the Marcel Grossman meeing, number 14 , improperly assuming Heisenberg Uncertainty principle (flat space) in start of universe $\Delta E \Delta t \geq \hbar$
- 3. Correction in HUP to non flat space conditions
- 4. Punchline, non singular Universe, no singularity has similar behavior as TOKAMAK FOR GW strain

Beginning How a Tokamak can give us GW which can be measured , High Frequency, 10- ^ 10 Hertz or higher

TOKAMAK MATERIAL FOR GW STRAIN IN CENTER OF TOKAMAK, 10^-25

Basics of our work with Tokamak's

- In the original Griskchuk model, we would have very small strain values, which will comment upon but which require the following relationship between GW wavelength and resultant amplitude

Change we created as to applied E field

For Grischkuck model it is applying Ohm's law

For our re done model with a second term in the strain, we have E field according to Ohm's law plus an additional term.

We take the square of the E field

Basics Grishchuk formula

$$\mathrm{A(amplitude-GW)} = \mathrm{h} \sim \frac{\mathrm{G}}{c^4} \cdot E^2 \cdot \lambda_{GW}^2$$

Two strain terms, not one

- First we do the first strain term

$$h_{First-term} \sim \frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2 \sim \frac{G}{c^4} \cdot \left[\frac{J}{\sigma} \right]^2 \cdot \lambda_{GW}^2$$

Then we obtain the 2nd strain term

$$h_{Second-term} \sim \frac{G}{c^4} \cdot E^2 \cdot \lambda_{GW}^2 \sim \frac{G}{c^4} \cdot \left[\frac{J_b}{n \cdot e} + v_R \right]^2 \cdot \lambda_{GW}^2$$

- Since the velocity is not perpendicular to the B field:
-

Difference between the two strain terms

- First strain term is dependent upon Ohm's law and it does not have a temperature dependence on it built in. If the plasma is hot in it will not affect the basic behavior a lot.

- Second strain term has a temperature term in it, and if there is plasma fusion burning in it, the 2nd term is far bigger than the first term

First term will have 10^-32 in strain value, i.e. this cannot be measured

$$h_{2nd-term} \sim$$

$$\frac{\mathrm{G}}{c^4} \cdot B_\theta{}^2 \cdot \left(j_b / n_j \cdot e_j \right)^2 \cdot \lambda_{GW}^2$$

$$\sim \frac{\mathrm{G}}{c^4} \cdot \frac{\xi^{1/4} \tilde{\alpha}^2 T_{Temp}^2}{e_j{}^2} \cdot \lambda_{GW}^2 \sim 10^{-25}$$

- Second term is due to Plasma fusion burning about 10^7 times larger, about 10 million.

Significance ?

- IF one has a detector 5 meters above the center of the Tokamak, the 10 ^ - 25 becomes then 10^ - 27 in strain value. This strain value is still detectable by Dr. Li's gravitational wave detector.

So, we have a detector which may be able to measure 10^{-27} strain GW . How does this affect anything?

Basic claim. Non neligible strain in the early universe is also due to temperature, as well, and if we have a quantum bounce, (i.e. a non singular beginning, i.e. we avoid having a point in space with no volume) then we have initial strain values due to temperature which are not infinitesimally small

Bridging to the early universe

Key point is as follows, namely the strain value in the early universe is also affected by initial temperatures, just as in the Tokamak GW generation problem

In recent work done by the author, the strain h in terms of GW in the early universe is due to

h ~A *vacuum density/ (mass (graviton))^2

vacuum density ALSO affected by temperature
A is a constant which is put in to non dimensionalize h, and for initial values of vacuum density has h ~ 10^-10 during inflation, which is red shifted to h ~ 10^-27 today

Note that the particular value of the initial graviton mass (heavy gravity) will be affected if the initial Graviton is Kaluza Klien in characterisetics, as postulated by Dr. Wen Hao, Dr. Li Fangyu and Dr. Fan or if it is the 10^-62 gram creation as specified by Dr. Goldbauer. Dr. Beckwith also in to be published work has postulated that the initial mass of a graviton may be 10^-54 grams in pre big bang conditions

Now how to possibly link gravity/ gravitons to entropy, in the early universe

- Try this for a start. I.e. what if the holographic suggestion as to entropy, Hogan, is combined with the Beckwith Modification of Y.J. Ng's infinite quantum statistics

$$S_{\max - initially} = \pi / H^2 \sim 10^5 \sim \Delta S_{gravitons} \propto N_{Jack-Ng}$$

Different Scenarios for Entropy Growth Depending Upon if or Not We Have Low to High Frequency GW from the Big Bang

- This means that we have to assume, initially, for a maximum transfer of entropy and also information from a prior universe, that *H* is extremely small. From Hogan, note that if we look at Hogan's holographic model, this is consistent with a non finite event horizon for black holes

$$r_0 = H^{-1} \quad \Leftrightarrow T_{black-hole} = \left(2\pi \cdot r_0\right)^{-1}$$

We assume an early universe generalization

$$H_{early-universe} \sim r_{early-universe}^{-1}$$

$$\sim \left[T_{early-universe} / 2\pi\right] \approx T_{early-universe}$$

Large or small initial Temperature? Answers dependent upon large higher dimensions?

- Number of "holographically induced states" is

$$N = \exp\left(\pi H^{-2}\right)_{early-universe} \sim (?)\Delta N_{gravitons} \sim 10^5 - 10^{20}$$

Question, how does this relate to temperature ?

IF the temperature of start of pre –to present universe

before expansion is nearly zero, and the following holds

$$r_{starting}(very - l\arg e) \propto H_{starting}^{-1} \propto T_{starting}^{-1} \sim \varepsilon^{-1}$$

Does this mean we have large higher dimensions? Very low initial Temp?

Why issue is so relevant? Temperature dependence in GW frequency? If HFGW are dominant?

- From Grishchuck , M = mass of 'universe' initially, and R = radius of initial dimensions, T=initial temperature. (What if the T is initially low ?)

$$f_{Peak} \approx \left(10^{-3}\ \mathrm{Hz}\right) \cdot \left[\frac{T}{T\mathrm{eV}}\right] \sim 10^{10}\,\mathrm{Hz}$$

$$\approx \sqrt{\frac{M}{M_{solar-mass}}} \cdot \sqrt{\frac{90\ \mathrm{km}}{R}}$$

What if the T is initially low ?

- This means that the initial temperature leads to string theory values of the GW

$$f_{Peak} \approx \left(10^{-3}\ \mathrm{Hz}\right) \cdot \left[\frac{T \sim T_{Very-Low}}{T\mathrm{eV}} \right] \sim 10^{-18}\text{-}10^{-10}\mathrm{Hz}$$

- Question we ask the audience, can we go from initially almost absolute zero temperature to much higher temperatures? What would allow up to even entertain such a notion ?

Low temperature for Holographic Treatment of N being non zero, if H ~ T, while High Temperature for high frequency GW ? How can this be possibly justified ?

- Claim # 1, If the above happens, it argues in favor of Tegmarks Multiverse as a ‘container’ of the present universe. I.e. the dim of the Multiverse container which could be a setting for initially low temperatures for N forming, especially if the Multiverse container is very ‘large’

Claim # 2, If the above happens, Grishchuck’s $10^{10}\,\mathrm{Hz}$ arises later in 4 dimensions for very small initial 4 Dim .

Claim # 3 : To answer Claim 2, we need to consider the minimum grid size (?) $\Delta x \approx h_{rms} \sim 10^{-39} / \sqrt{\mathrm{Hz}}$

Optimal Quantum Estimation for Gravitation. True so long as a metric exists

- The standard time-energy uncertainty relation and the Heisenberg uncertainty relation are special cases of the uncertainty relation for the space-time metric. The uncertainty relation takes a particularly simple and revealing form when the measurement region is made sufficiently small **.**
  From :
- Optimal Quantum Estimation for Gravitation
- T. G. Downes, G. J. Milburn
- http://xxx.lanl.gov/abs/1108.5220

$$\left\langle \left(\delta g_{uv}\right)^2 \left(\hat{T}^{uv}\right)^2 \right\rangle \geq \frac{\hbar^2}{V_{vol}{}^2}$$

Upshot, for small volume

- Almost no initial energy density via means enormous metric fluctuations, and vice versa i.e. very large energy density then means vanishingly small metric perturbations δg_{00} using

$\hbar \equiv \mathrm{c} \equiv l_p = 1$

$$\Rightarrow \left\langle \left(\hat{T}^{00} \right)^2 \right\rangle \geq \left[\left(\delta g_{00} \right)^{-2} \right]$$

Notes on the vacuum energy idea and also the cosmological constant (Quintessence)

- Penrose (2010) writes as of p163 of his book that:

$$\Lambda\big|_{Today}\,[vacuum-energy]$$

$$\sim \frac{c^3}{N^6 G\hbar} \equiv N^{-6}\big|_{Today} \approx 10^{-90} - 10^{-120}$$

$$\sim 1/S_{Today}$$

One can perhaps write as of the beginning that

$$\Lambda\big|_{initial-Planck\,time}\,[vacuum-energy]$$

$$\sim \frac{c^3}{N^6 G\hbar} \equiv N^{-6}\big|_{Planck-time} \approx 10^{-6} - 10^{-24}$$

$$\sim 1/S_{initial-Planck-time}$$

$M.\,Giovannini,$ "$A\ Primer\ on\ the\ Physics$
$of\ the\ Cosmic\ Microwave\ Background$",
$World\ Press\ Scientific,\ Singapore,$
$Republic\ of\ Singapore,\ 2008$

$$S(Entrophy - Gravitons) \sim V_{space-time.volume} \cdot \int_{10\wedge-19Hz}^{10\wedge 11Hz} r(\omega)\omega^2 d\omega$$

$$\approx ({}^{10^{30}})^3 \doteq 10^{90}(graviton - entropy) << 10^{120}(BH - entropy)$$

Notes on the vacuum energy idea and also the cosmological constant (Not Quintessence); Continued.

- Super massive black holes in more than one million galaxies, have vastly more entropy than total entropy generated by gravitons

$$S_{universe} \approx \sum_{i=1}^{10^6} S_{Super-massive-Black-Holes-center-of-galaxies}$$

$$\sim \frac{1}{4}\sum_{i=1}^{10^6} A_i \propto 10^{120} - 10^{124}$$

Main assertion is that black holes may be in 5 D, whereas our observable universe is 4 D

What does this say about a source for a gravitational field ?

- From Penrose, Page 130 (his 2010 book)

$$E = 8\pi \cdot T + \Lambda \cdot g$$

$$E = source \quad for \quad gravitational \quad field$$

$$T = mass \quad energy \quad density$$

$$g = gravitational \quad metric$$

$$\Lambda = vacuum \quad energy, rescaled \quad as \quad follows$$

- From cyclic conformal cyclic cosmology cycle per cycle

$$g \xrightarrow[ccc]{} \hat{g} = \Omega^2 g$$

Conformal invariance of Maxwell's theory

- Write, generally

$$\nabla F = 4\pi J$$

$$F = Field$$

$$J = Current \xrightarrow[set-to]{} 0$$

If a field is massless, Then for the Maxwell Field (with no current)

- Set a 'field' as $\phi_{ABC..E}$
- Then the following holds. True for almost massless fields as well (i.e. the ultra light graviton)

$$\hat{\phi}_{ABC..E} = \Omega^{-1}\phi_{ABC..E}$$

$$\hat{\nabla}^{AA'}\hat{\phi}_{ABC..E} = \Omega^{-3}\nabla^{AA'}\phi_{ABC..E}$$

$$Ideally, we \quad have$$

$$\hat{\nabla}\hat{F} = 0 \Leftrightarrow \nabla F = 0$$

For CCC theory, Penrose(2010) the cross over from Cycle to Cycle is given by mapping $\Omega \xrightarrow[CCC]{} \Omega^{-1}$

- If C is the Weyl tensor, then one has from Penrose, page 159 (2010 Penrose book). And we see figure 3.6 of Penrose book what if $\Omega \xrightarrow[CCC]{} \Omega^{-1}$

Cross over to a new universe zone, if we use the Penrose $\Omega \xrightarrow[CCC]{} \Omega^{-1}$

$$\hat{K} = \Omega^{-1}\hat{C}$$

$$\hat{\nabla}\hat{K} = 0,$$

and before crossover to new universe zone

$C \to 0$ *just before crossover*, $\Omega \to tiny$, """", *and*

K *remains finite just before crossover*,

as well as

$$\Pi = \frac{d\Omega}{\Omega^2 - 1} \xrightarrow[\Omega \xrightarrow[CCC]{} \Omega^{-1}]{} SAME \quad \frac{d\Omega}{\Omega^2 - 1}$$

Difference of opinion with Penrose. I.e. 5th dimension inevitable, containing black holes, and there are many , not just one universe undergoing collection of material into black holes for recycling of Matter-energy material

- Penrose has ' large Ω' become small
- This information is fed into $\hat{g} = \Omega^2 g$
- The following transformation would happen for many universes, not just our own. And Ω changes

$$\Pi = \frac{d\Omega}{\Omega^2 - 1} \xrightarrow[\Omega \xrightarrow[CCC]{} \Omega^{-1}]{} SAME \quad \frac{d\Omega}{\Omega^2 - 1}$$

Experimentally tracking the GW and Gravitons from other 'universes'? As input into our own? This appears impossible; i.e. Causal discontinuities? And what is means of information transfer ? From other universes?

- Claim that an elaboration of the mapping across the boundary as given by $\Omega \xrightarrow[CCC]{} \Omega^{-1}$

becomes more nuanced, and complex. i.e. not just inverting a large Ω to become small for

$$\hat{g} = \Omega^2 g$$

What still remains the same, what changes

- The mapping $\Omega \xrightarrow[CCC]{} \Omega^{-1}$ should be refined from cycle to cycle, not just being one universe

- The mapping $\hat{g} = \Omega^2 g$ does not change

- The gravitational source E 'mapping' as given
- $E = 8\pi T + g\Lambda$ does not really change

Classical representation of Gravitons? Is it possible ?

- Now what could be said about forming states close to classical representations of gravitons?
- Venkatartnam, and Suresh [39], built up a coherent state via use of a displacement operator , applied to a vacuum state , where α is a complex number, and
- a, a^{+} as annihilation & creation operations , $\left[a, a^{+}\right] = 1$ where one has the displacement operator as set by $D(\alpha) \equiv \exp\left(\alpha \cdot a^{+} - \alpha^{*} \cdot a\right)$

So that $$\left|\alpha\right\rangle = D(\alpha) \cdot \left|0\right\rangle$$

<u>Have a situation where a vacuum state as a template for graviton nucleation is built out of an initial 'vacuum state' (The initial 'vacuum state' is not necessarily purely quantum mechanical, if it has a tiny rest mass)</u>

- To do this though, as Venkatartnam, and Suresh [39] did, involved using a squeezing operator as given by

$$Z[r,\vartheta] = \exp\left[\frac{r}{2}\cdot\left(\left[\exp(-i\vartheta)\right]\cdot a^{2} - \left[\exp(i\vartheta)\right]\cdot a^{+2}\right)\right]$$

Furthermore, the squeezing operator hits a ground state , presumably classical for a graviton via $\left|\varsigma\right\rangle =$

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

$$\left|\varsigma\right\rangle \xrightarrow[\alpha\to 0]{} Z[r,\vartheta]\cdot\left|0\right\rangle \quad 0 \le r \le \infty, -\pi \le \vartheta \le \pi$$

Could Final form of Graviton as squeezed vacuum states start off with semi classical representation for graviton?

- Begin looking at super position of states given as

$$\left|\varsigma\right\rangle \xrightarrow[\alpha \to 0]{} Z\left[r, \vartheta\right] \cdot \left|0\right\rangle$$

t'Hooft and others as to a future embedding/ expansion of QM and Quantum Gravity

- http://arxiv.org/PS_cache/gr-qc/pdf/9903/9903084v3.pdf
- **QUANTUM GRAVITY AS A DISSIPATIVE DETERMINISTIC SYSTEM**
- **Gerard 't Hooft**
- **Institute for Theoretical Physics**
- **University of Utrecht, Princetonplein 5**
- **3508 TD Utrecht, the Netherlands**
- **e-mail: g.thooft@phys.uu.nl**
- **internet: http://www.phys.uu.nl/~thooft/**

http://arxiv.org/PS_cache/gr-qc/pdf/9903/9903084v3.pdf

- Abstract
- **It is argued that the so-called holographic principle will obstruct attempts to produce physically realistic models for the unification of general relativity with quantum mechanics, unless determinism in the latter is restored**
- **<< S N I P >>;** Beckwith is in full agreement!

Final comment from L. Crowell

http://www.fqxi.org/community/forum/topic/979

- Quote:
- *In a hypothetical universe devoid of the Higgs field, all particles would have zero rest mass; the universe would be space-time and energy. That's odd enough to picture—14 billion light years with nothing massive in it, from neutrons to neutron stars. But something weirder seems to follow. It strikes me that, without the Higgs, there would be no perspective by which time is moving*. < **PUNCH LINE, do we understand TIME ?** > >

- My answer : NO ! Not at all !

Explanation as to comment on Time

- *Time evolution is usually connected with the "Arrow of time" hypothesis. i.e. that changes in Entropy are directly linked to time flow. I.e. the usual idea is that entropy dramatically increases with the evolution of the universe.*

Bluntly stated, as put in this talk, we do NOT understand at all Entropy in cosmology Until we do, it is misleading to say we understand time evolution.

Here is an attempt by the author, and L. Glinka to talk about the issue of unidirectionality of time flow. ***It needs considerable elaboration and improvement. But it gets a start in the right direction. For your enjoyment.***

http://www.scribd.com/doc/44438498/PSTJ-Focus-Issue-V1-9-Cosmology-Gravity-Part-II

- **Prespacetime Journal | November 2010 | Vol. 1 | Issue 9 | pp. 1358-1454**
- **Table of Contents**
- **ISSN: 2153-8301 Prespacetime Journal Published by QuantumDream, Inc.www.prespacetime.com**
- ***The Arrow of Time Problem: Answering if Time Flow Initially Favouritizes One Direction Blatantly*** **by Andrew W. Beckwith & Lukasz A. Glinka, pp 1358-1375**

Beckwith reference as to if gravitons can be considered semi-classical

- Website: http://www.scirp.org/journal/jmp
- JMP >> Vol.2 No.7, July 2011
- Detailing Coherent, Minimum Uncertainty States of Gravitons, as Semi Classical Components of Gravity Waves, and How Squeezed States Affect Upper Limits To Graviton Mass
- Full Text(PDF, 399KB) PP.730-751
- DOI: 10.4236/jmp.2011.27086
- Author(s)Andrew Beckwith
- KEYWORDS Squeezed State, Graviton, GW, Pilot Model
- ABSTRACT We present what is relevant to squeezed states of initial space time and how that affects both the composition of relic GW, and also gravitons. A side issue to consider is if gravitons can be configured as semi classical "particles", which is akin to the Pilot model of Quantum Mechanics as embedded in a larger non linear "deterministic" background.