

Modeling GW Generation at Start of the Electro Weak Regime and its tie in to the Machian Universe with falsifiable h_{ij} Values

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Abstract

The early Electro weak regime as of 10^{-32} seconds after the big bang is where we could see the initial formation of gravitons, gravitinos and GW. What we intend to do is to look at if Machs principle, and a statement of overall quantized energy state behaviour of the universe can help us get h_{ij} , using initial conditions as initially presented by Mishra in 2012 we restate as

$\frac{GM}{R_0 c^2} \approx const$. Mach's principle was used by Mishra, and we use it to come up with conditions for a stable overall mass M

contributing to GW generation / entropy of the universe. The composition of M for gravitons would changes over time from initial beginnings to the present day, but the final invariant graviton mass M we work with is a way to state initial and final numbers, N, of the constituent particles contributing to entropy of our universe. By the way of comparison this also is tied into Gravitinos, as super partners to Gravitons, as counted by N, initially, and dying out as up to the present day values. From the

present, we have the Machian condition of setting , the present condition , as given by Mishra $\frac{GM}{R_0 c^2} \approx const$, with

$M = Nm$ being the mass of a sub system inside the universe, with N being the number of 'particles' , and m being the net particle mass. We examine the consequences of Mach's principle for the case of the mass M, contributing to GW and entropy with a case of $M_{electro-weak} \approx M_{today}$, i.e. the total mass of the electro weak era is about the same as todays mass, but that if we look directly at the influence of SUSY physics super partners, in such a way that $M_{electro-weak} |_{Super-partner} \neq M_{electro-weak} |_{Not-Super-Partner}$ and there is then an equivalence between SUSY dominated early

conditions and non SUSY $\frac{GM_{electro-weak} |_{Super-partner}}{R_{electro-weak} c^2} \approx \frac{GM_{today} |_{Not-Super-Partner}}{R_0 c^2}$ as equal to a constant value . I.e. if

Machian physics held from early times, up to the present, it would have implications for explaining entropy, as given in $S_{entropy} |_{Ng-QM-\infty-statistics} \sim N_{Particle-count}$, as to why it would be so much lower as of about and before the electro-weak

regime than today. This leads to Eq. (37), Eq.(38), and Eq. (39) as h_{ij} values to be detected by appropriate GW detectors.

Key words: Gravitons,Gravitinos, Entropy, Machian Universe, Electro – Weak, SUSY physics, Super Partners

PACS: 98.80.-k , 98.80.Cq, 98.80.Jk, 98.80.Qc

INTRODUCTION: Ranges of Masses Considered and Lifetimes

We are giving support to the idea that a Gravitino would be, as a much more massive particle than even a massive graviton have a far shorter life time than a graviton, even in the case of Massive gravitons. This will have implications in terms

We will work with a seemingly naive interpretation of looking at gravitons, and gravitinos, as given by Sarkar [1] the mass of a rest Gravitino would be for a temperature about $10^{12} K \leq T_{\text{inf}} \leq 10^{12+\beta} K$ up to 10^{-32} seconds

$$1\text{TeV} < m_{3/2} \equiv m_{\text{Gravitino}} < 5\text{TeV} \quad (1)$$

Note that gravitinos have a very short life time, and KORI et al [2] stating that the lifetime of the Gravitino goes down as its mass goes up, i.e.

$$\tau_{\text{Gravitino}} = \text{Life-time} = 1/\Gamma(\psi_{3/2} \rightarrow \text{all}) \quad (2)$$

On page 10, Kori et al. [2] has that $\tau_{\text{Gravitino}} = \text{Life-time} = 1/\Gamma(\psi_{3/2} \rightarrow \text{all}) < 10^4$ sec with frequent values for the Gravitino life time down to as low as 1 second, i.e. not lasting long in the neighborhood of the electro weak regime. The Electro weak phase would be for .3 meters in diameter according to Giovanni [3] in a California institute of technology web site, and graviton production as well as gravitino production would start as early as $10^{-35} - 10^{-32}$ seconds according to [1] and also confirmed by a u. of Oregon web site in physics [4]

Note that in the vicinity of the electro weak regime, the magnetic field was probably enormous, i.e. [The obtained magnetic fields were rather strong](#) (i.e. $|\vec{B}| \sim 10^{22}$ G at the EW epoch) [3] but over a small scale, i.e. $10^{-6} H_{\text{ew}}^{-1}$

The lime time of a graviton if it is a spin two zero mass boson is effectively infinite. For KK gravitons, as given by Sarkar [1], the way to get the life time is to make use of, for mode m_n is to look at

$$\tau_{\text{KK-Graviton}} \sim 10^{31} \text{years} \cdot \left[\frac{1\text{eV}}{m_n} \right]^3 \quad (3)$$

If one is not using KK gravitons, but assuming massive gravitons, then [5] gives the hint, in stating "In conclusion, only the complete non perturbative quantum theory can fix the lifetime of the graviton:

If we made the substitution

$$m_n \rightarrow m_{\text{graviton}} \sim 10^{-26} \text{eV} \quad (4)$$

A good non perturbative effect may be to go to Eq(3) and to look at m_n as for a graviton life time [1]

$$\tau_{\text{KK-Graviton}} \sim 10^{31} \text{years} \cdot \left[\frac{1\text{eV}}{m_n} \right]^3 \rightarrow 10^{31} \text{years} \cdot \left[\frac{1\text{eV}}{10^{-26} \text{eV}} \right]^3 \sim 10^{57} \text{years} \quad (5)$$

Usually the lifetime of the universe is considered to be 3.4×10^{10} years [6] (Big rip scenario) os Eq. 5 is considerably longer than the expected lifetime of the universe, which is not suprising.

Applying the Machian principle to Gravitinos at 10^{-32} seconds, and a .3 meter radius, of a universe, versus a present universe radius of about 1.422×10^{27} meters after 4.41796×10^{17} seconds [6], i.e. a difference in radius we can write as

$$\frac{R_0}{R_{Electro-Weak}} = \frac{1.422 \times 10^{27}}{3 \times 10^{-1}} \sim .47 \times 10^{28} \quad (6)$$

Now let us make the following assumption. That for each graviton, there is a counter part Gravitino in the electro weak regime, i.e. up to a point we have the following, i.e. an early universe version of Machs principle as to Gravitons we can expression as follows

$$\frac{GM_{electro-weak} \Big|_{Super-partner}}{R_{electro-weak} c^2} \approx \frac{.47 \times 10^{28} \times GM_{electro-weak} \Big|_{Super-partner}}{R_0 c^2} \approx \frac{GM_{today} \Big|_{Not-Super-Partner}}{R_0 c^2} \approx const \quad (7)$$

This implies then,

$$.47 \times 10^{28} \times M_{electro-weak} \Big|_{Super-partner} \approx M_{today} \Big|_{Not-Super-Partner} \quad (8)$$

If so, then the number of super partner Gravitons equals the number of gravitinos in the Electro weak era, and one has

$$M_{electro-weak} = N_{electro-weak} \cdot m_{3/2} = N_{electro-weak} \times 10^{38} \cdot m_{graviton} \quad (9)$$

So

$$M_{electro-weak} = N_{electro-weak} \cdot m_{3/2} = N_{electro-weak} \times 10^{38} \cdot m_{graviton} = N_{today} \cdot m_{graviton} \approx 10^{88} \cdot m_{graviton} \quad (10)$$

Then the electro weak regime would have

$$N_{electro-weak} \sim 10^{50} \quad (11)$$

Using quantum infinite stastics, this is a way of fixing the early electro weak entropy as $\sim 10^{50}$ vs. 10^{88} today

i.e. this uses Ng's quantum infinite statistics, to get $S \sim N$.

We have concluded a proof, that Entropy, according to Machs Principle grows 10^{38} times from the electro weak era. From $\sim 10^{50}$ to 10^{88} . What else? How do we get to having the entropy figure of 10^{50} ?

Note that for a KK graviton that there is a mass, which we can call as follows, traditionally one has, then

$$m_n^2 \sim \mu^2 + \frac{n^2}{r^2} \xrightarrow{\mu \rightarrow \varepsilon^+} \frac{n^2}{r^2} + \varepsilon^+ \approx \frac{n^2}{r^2} \quad (12)$$

Note that as of the Planck scale we would be working with the following. Start off with Planck mass, with $M_{Planck} \sim \frac{1}{\sqrt{G_N}} \sim 10^{19} GeV$, then Planck length $L_{Planck} \sim \sqrt{G_N} \sim 10^{-33} cm = 10^{-34} m$ and also Planck time as $t_{Planck} \sim 10^{-44} sec$

The question we can ask is then, what would a spatial distance would correspond to a graviton mass, the surprising answer is

$$1/\hat{r} \sim m_{graviton} \propto 10^{-26} eV \Rightarrow \hat{r} \sim 10^{20} m \quad (13)$$

Note that the radi of the present universe, in four dimensions is usually thought to be of the order of, as given by Mishra [6] of the value $R_0 \sim 10^{27} meters$, so then the

$$R_0 \sim 10^{27} meters \approx 10^7 \hat{r} \quad (14)$$

Here a non standard version of KK theory is that in space time, one usually thinks of higher dimensions as of Planck sized spatial contributions, and Arkani Hamid [7], [8] still was very conservative in this matter.

But if there is a prior universe, and that due to cyclic conformal cosmology [9], and a meta structure containing the 4 dimensional structure, then $\hat{r} \sim 10^{20} m$ as far as an embedding structure is not so fantastic after all. Using Penroses formulation from his 2010 book [9], we will report on vacuum energy and its connection to entropy. The rub in all of this though is that Penrose never explained how to go from his cyclic conformal cosmology collection of matter from a million or so black holes, to a new universe, a process with initially low temperatures (Black holes eventually evaporate) to the higher temperatures associated with a new big bang. We provide such a driver via use of an addition to the Einstein energy stress tensor with an electro magnetic addition to it.[9]

$$\begin{aligned} \Lambda|_{initial-Planck\ time} [vacuum - energy] \\ \sim \frac{c^3}{N^6 G \hbar} \approx 10^{-6} - 10^{-24} \\ \sim 1/S_{initial-Planck-time} \end{aligned} \quad (15)$$

Take in mind that the above Eq.(15) is assuming a Quintessence set of conditions, i.e that the vacuum space time changes from initial conditions to the Electro weak era and then to today. The question though is when would the electro weak era actually begin. We can reference a treatment of Hubble time, as follows with the Hubble parameter set, Sarkar [1], as to early universe Hubble parameters

$$H_{Early-Universe} \sim 1.66 \cdot \sqrt{g^*} \cdot \frac{T_{Early-Universe}}{M_{mass-scale}} \quad (16)$$

The electro weak regime, depending upon the evolving values of g^* could vary between 10^{-35} seconds to as “large “ as 10^{-32} seconds.

Making use of what was done by Beckwith [10] at DICE, 2010 , as to g^* rising to at or above 1000, instead of the commonly accepted figure of 100 or so given by Kolb and Turner in 1991 [11] , a a chaotic map driven increase in degrees of freedom from a low point to a high point. With vacuum thermal energy intially tied to [10]

$$g^*_{i+1} = \exp[-\alpha g^*_i] + [(vacuum - thermal - energy)_i] \quad (17)$$

The vacuum thermal energy in this case given by quinessent behavior in the vicinity of the electro weak regime would be given by [12] and subsequently modified by Beckwith

$$\Lambda [Park, 2002] \equiv \Lambda_{General-Value} T_{Temperature}^\beta \sim \frac{10^{-120} \cdot T_{Temperature}^{\beta=115/31}}{[2.73 Kelvin]} \quad (18)$$

The upshot in terms of entropy would be a vacuum energy evolving as follows. Namely [12]

$$\Lambda [Park, 2002] \Big|_{T_{temp}=10^{32} Kelvin}^{Planck-Time} \sim 10^{-5} \propto \frac{1}{S_{initial}} \quad (19)$$

$$\Lambda [Park, 2002] \Big|_{T_{temp}=2.73 Kelvin}^{Today} \sim 10^{-120} - 10^{-124} \propto \frac{1}{S_{Today}}$$

There are two questions this raises. What would be the driving impetus to go from a low temperature pre space time temperature, then to Planck time entropy, then to the entropy of today as given in Eq. (19). This is similar to what would lead to the Electro weak era behavior, as far as an increase to the degrees of freedom. The way to do it would be to have an energy “driver” of inflation. One way to look at it would be to suggest that as done by H. Kadlecova [13] in the 12 Marcel Grossman meeting that the typical energy stress tensor, using, instead, Gyratons, with an electro-magnetic energy density addition to effective Electro magenetic cosmological value as given by

$$\rho_{E\&M-contribution} \sim 8\pi G \cdot (E^2 + B^2) \quad (20)$$

I.e. that there be, due to effective E and M fields a boost from an initially low vacuum energy to a higher ones, as given by Kadlecova [13], [14]

$$\Lambda_+ = \Lambda + \rho_{E\&M-contribution} \quad (21)$$

Using the prinicple that ones E field is really another mans B field, and a magnetic field of about $|\vec{B}| \sim 10^{22}$ G at the pre planckian to EW epoch, we could then have a low temperature initial starting point for pre Planckian physics and then by both Eq. (19) to Eq. (20) go to dramatically increased temperatues, while leading eventually to conditions of Electro Weak space time physics which would be predicted by Ng infinite quantum

statistics, which was given by Ng at the 12 Marcel Grossman conference [15] , after a phase transition to the form of a perfect 'graviton' gas looking with initial volume

$$V_{electro-weak} \sim R_{H(electro-weak)}^3 \quad (22)$$

With a temperature of the order of $10^{12} K \leq T_{inf} \leq 10^{12+\beta} K$, for a net contribution of temperature due to

$$T_{Electro-weak} \sim R_{H(electro-weak)}^{-1} \propto \lambda_{Electro-weak}^{-1} \quad (23)$$

And a numerical count we can give as

$$N_{electro-weak} \sim \left[R_{H(electro-weak)} / l_{Planck} \propto 10^{25} \right]^2 \equiv 10^{49} - 10^{50} \quad (24)$$

Note that Ng [15, 16] , also has that the Hubble radius leading to an effective contribution due to the Electro Weak regime which would be about .3-.4 meters in length

$$R_H \propto H^{-1} \Rightarrow R_{H(Electro-Weak)} \propto H_{(Electro-Weak)}^{-1} \quad (25)$$

We submit that the Electro weak regime, will be where Gravitinos form, as of having mass of about 1 TeV, with $10^{50} TeV \sim$ net mass M contributing to GW from the electro weak regime which will be part of the h_{ij} calculations in the next section. About $10^{50} TeV = 10^{23} grams$. The universe has a 'mass' quantified regime of much greater value of , according to Mishra [6] $10^{56} grams$, with the following conservation law, of sorts to be worked with as far as information, namely for preserving the cosmological constant information, we would have

$$N_{Today} \cdot m_{graviton} \equiv 10^{88} \cdot m_{graviton} = N_{electro-weak} \cdot m_{gravitino} \equiv 10^{50} \cdot m_{gravitino} \quad (26)$$

Next , note that as given by Giovanni, the figure of 10^{88} as due to gravitons can be seen to come from [17] , page 156 as

$$\begin{aligned} S_{Graviton-Today's.era} &\propto V \int_{10^{-19} Hertz}^{10^{11} Hertz} r(v) \cdot v^2 dv \\ &\equiv (10^{30})^3 \cdot \left(\frac{H_1}{M_{Planck-mass}} \right) \propto 10^{88} - 10^{90} \\ &\sim (difference\ of\ 10^{11}\ to\ 10^{-19}\ Hertz)^3 \end{aligned} \quad (27)$$

Review of the Penrose Cyclic cosmology conjecture in 4 Dimensions, plus what can be said about Black holes and fifth dimensions, etc.

As given by Penrose [9] , the phase space for gravitons in four dimensions can be seen to be

$$\begin{aligned} 10^{10^{90}} &\approx 10^{Final-entropy-Gravitons=S_{FINAL-GRAVITONS}} \\ &\sim Phase\ space\ due\ to\ Gravitons \end{aligned} \quad (28)$$

The Penrose conjecture is that there is no big crunch, that the universe continues to expand, with matter-energy trapped in black holes. Our hypothesis, is that Black holes are actually 5 dimensional space time entities. I.e. then look at a much bigger phase space for containment of our 4 dimensional universe[9]

$$10^{10^{24}} \approx 10^{Final-entropy-Galactic-Black-Holes=S_{FINAL-BL}}$$

~ Phase space Super – Massive – BH – in – Galaxies (29)

The matter-energy trapped in black holes is assumed to be conformally mapped back in cyclic conformal cosmology to a new big bang, in so many words, gravitational ‘energy’ is collected and re cycled. This is what Penrose wrote: From page 130 of his reference. Namely look at [9]

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

E = source for gravitational field

T = mass energy density

g = gravitational metric

Λ = vacuum energy, rescaled as follows

$$g \xrightarrow{ccc} \hat{g} = \Omega^2 g \quad (30)$$

Note that the idea is conformal invariance, and this is similar to what is done in electromagnetism, as seen by Penrose’s [9]

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

F = Field

$$J = Current \xrightarrow{set-to} 0 \quad (31)$$

For cyclic conformal cosmology the basic construction is as follows. Namely look at

- 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 have (32)

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

For CCC theory, Penrose(2010) makes the following mapping.

$$\Omega \xrightarrow{ccc} \Omega^{-1} \quad \underline{\hspace{10em}} \quad (33)$$

the cross over from Cycle to Cycle is given by mapping in Eq. (33) above. And the invariance, as in Eq. (32)

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

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

and before crossover to new

universe zone

$$C \rightarrow \varepsilon^+ \approx 0^+ \text{ just before crossover,} \quad (34)$$

$\Omega \rightarrow$ tiny value

K remains finite

$$\Pi = \frac{d\Omega}{\Omega^2 - 1} \xrightarrow{\Omega \xrightarrow{ccc} \Omega^{-1}} \text{SAME} \frac{d\Omega}{\Omega^2 - 1}$$

Key hypothesis in this presentation, i.e. a graviton can obtain effective mass in the regime before the start of a new mapping. I.e. one can have no issues as to forming a fifth dimensional value of $\hat{r} \sim 10^{20} m$ as far as an embedding structure for the first tier of a KK graviton is not so fantastic after all. This would be shoe horned into the four dimensional space time continuum, and be carried through to the electro weak regime, and each graviton super partnered with a gravitino.

Shifting the pre CCC regime first KK mass for a graviton to the zeroth order KK mode , giving a Graviton a tiny effective mass.

Hypothesis. Pre CCC has a $1/r$ 1st excited KK state for the graviton with $\hat{r} \sim 10^{20} m$ which then gets shifted to the zeroth order mass in the following formulation. So, let us review the idea of a MASSIVE graviton in terms of KK theory.

We would get, then . as was given in Beckwith's 2011 Journal of Cosmology article [18] , assuming that the prior ccc cycle first KK spatial radius r was huge in pre cyclic conformal cosmology , and then the $1/r$ value shifted to a zeroth order mode contribution of [18] and making use of Sarkar [1] as well, i.e.

$$m_n(\text{Graviton}) = \sqrt{\frac{n^2}{L^2} + (m_{\text{graviton-rest-mass}} = 10^{-65} \text{ grams})^2} \quad (35)$$

$$= \frac{n}{L} + 10^{-65} \text{ grams}$$

The zeroth order KK mode would then be super partnered with a gravitino, and then Eq. (25), assuming that Gravitinos would not last long, would be mapped into the invariance relationship given by Eq. (25). We furthermore state that the electro magnetic energy as given in Eq. (20) as put into the electro weak phase transition due to a magnetic field $|\vec{B}| \sim 10^{22} \text{ G}$ [3] at the EW epoch would be crucial in the formulation of Eq. (25),

i.e. hastening the demise of gravitinos (NOT long lived objects) and the invariance of information in keeping fidelity with respect to the cosmological parameters during cosmological evolution.

CONCLUSION.SEVERAL INVARIANCES,due to MACHS principle and its impact upon massive graviton detection

The main theme, aside from applying conformal cyclic cosmology in a different way, is Eq. (25), as well as re scaling of Machs principle. According to Gravitino-Graviton machian ratio invariance. Here $M_{electro-weak} \Big|_{Super-partner}$ is for gravitinos, and $M_{today} \Big|_{Not-Super-Partner}$ is for the total mass of all of the gravitons in the present universe . This uses a variant of Mistra' s [6] Mach's principle value.

$$\frac{GM_{electro-weak} \Big|_{Super-partner}}{R_{electro-weak} c^2} \approx \frac{GM_{today} \Big|_{Not-Super-Partner}}{R_0 c^2} \text{ as having a constant ratio value} \quad (36)$$

The benefits from such rescaling is that the evolution of entropy, as seen in using N times m (early universe) to N times m (today) can be written in terms of gravitational physics as to the linkage between super partners, SUSY representation of gravitinos and gravitons.

We can use this Machian relationship to understand the h_{ij} values as influenced by massive gravitons. As read from Kurt Hinterbichler [19] , if $r = \sqrt{x_i x_i}$, and we look at a mass induced h_{ij} suppression factor put in of $\exp(-m \cdot r)$, then if

$$h_{00}(x) = \frac{2M}{3M_{Planck}} \cdot \frac{\exp(-m \cdot r)}{4\pi \cdot r} \quad (37)$$

$$h_{0i}(x) = 0 \quad (38)$$

$$h_{ij}(x) = \left[\frac{M}{3M_{Planck}} \cdot \frac{\exp(-m \cdot r)}{4\pi \cdot r} \right] \cdot \left(\frac{1 + m \cdot r + m^2 \cdot r^2}{m^2 \cdot r^2} \cdot \delta_{ij} - \left[\frac{3 + 3m \cdot r + m^2 \cdot r^2}{m^2 \cdot r^4} \right] \cdot x_i \cdot x_j \right) \quad (39)$$

Here, we have that these are solutions to the following equation, as given by [19], [20]

$$\left(\partial^2 - m^2 \right) h_{\mu\nu} = -\kappa \cdot \left[T_{\mu\nu} - \frac{1}{D-1} \cdot \left(\eta_{\mu\nu} - \frac{\partial_\mu \partial_\nu}{m^2} \right) \cdot T \right] \quad (40)$$

To understand the import of the above equations, and the influence of the Machian hypothesis, for GW and massive Graviton signatures from the electro weak regime, set

$$M = 10^{50} \cdot 10^{-27} g \equiv 10^{23} g \propto 10^{61} - 10^{62} eV \quad (41)$$

$$M_{Plank} = 1.22 \times 10^{28} eV$$

And use the value of the radius of the universe, as given by $r = 1.422 \times 10^{27} \text{ meters}$, and rather than a super partner Gravitino, use the $m_{massive-graviton} \sim 10^{-26} eV$.

We argue that the rigorous application of Mach's principle and Eq (20) and Eq. (25) permit h_{ij} to be calculated in ways which a magnetic field 3DSR detector can obtain.

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