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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. We look at if Mach's 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, which we restate as $\frac{GM}{R_0 c^2} \approx const$. Mach's principle was used by Mishra, and we use this work to come up with conditions for a stable overall mass M, contributing to GW generation / entropy of the universe. The composition of M as gravitons changes over time from initial beginnings to the present day, but the final invariant gravitional 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. This relates to the number of Gravitinos, the super-partners to Gravitons, as contibutions to N, initially, and dying out as up to the present day values. Seen from the present, we have the Machian scenario setting the present condition, given by Mishra as $\frac{GM}{R_0 c^2} \approx const$, 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. with the total mass of the electro weak era being about the same as today's mass, but if we look directly at the influence of SUSY physics super-partners, we see that $M_{electro-weak}\big|_{Super-partner} \neq M_{electro-weak}\big|_{Not-Super-Partner}$ where there is then an equivalence between SUSY dominated early conditions and non SUSY $\frac{GM_{electro-weak}\big|_{Super-partner}}{R_{electro-weak}c^2} \approx \frac{G\,M_{today}\big|_{Not-Super-Partner}}{R_0 c^2}$ as equal to a constant value . I.e. if Machian physics held from early times up to the present, ***and*** if there is a conversion from gravitinos to gravitons over time, it would have implications for entropy, as given by Y. J. Ng in $S_{entropy}\big|_{Ng-QM-\infty-statistics} \sim N_{Particle-count}$, helping us to explain why it would be so much lower as of, or before, the electro-weak regime than today. This construction leads to derived h_{ij} values to be detected by appropriate GW detectors.

Key words: gravitons, gravitinos, entropy, Machian universe, electro-weak, supersymmetry, super-partners

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Introduction: Using Machs principle as a way of making sense out of information continuity between a prior to a present universe. Justifying Uniform cosmological constants in space – time evolution?

What is the physical nature of gravitinos? If supersymmetry makes them inside out gravitons, does that make them antigravity particles? Or is this line of reasoning totally off-base, as there is no such simple relation between common sub-atomic particles and their super-partners - should they exist? Since the Machian principle basically uplevels some common notions about how we determine the properties of a space - replacing them with a heuristic or constructivist rather than absolute definitions - there must be some treatment of the benefits of doing so.

Well here are the benefits. So far, in terms of evolution of the universe, the Machs principle as unveiled in this paper is really a statement as to information conservation, with Gravtions and Gravitinos being information carriers. In models going back to Dirac as to evolution of the fine structure constant , there has been no real statement as to why physical constants , such as Planck's constant, or the fine structure constant would remain invariant in cosmological expansion. The motivation of using two types of Machs principle, one for the Gravitinos in the electro weak era, and then the 2^{nd} modern day Mach's principle, as organized by the author are as seen in

$$\frac{GM_{electro-weak}\Big|_{Super-partner}}{R_{electro-weak}c^{2}} \approx \frac{G\,M_{today}\Big|_{Not-Super-Partner}}{R_{0}c^{2}} \tag{1}$$

are really a statement of information conservation. I.e. the amount of information stored in the left hand side of Eq. (1) is the same as the information as in the right hand side of Eq. (1) above. Here, M as in the electro weak era refers to M = N times m, where M is the total ' mass' of the gravitinos, N the number of Gravitinos, and R for the electro weak as an infinitely small spatial radius. Where as the Right hand side is for M for gravitons (not super partner objects) = N (number of gravitons) and m (the ulltra low mass of the graviton) in the right hand side of Eq. (1) . We argue that this setting of an equivilance of information in both the left and right hand sides of Eq. (1) states that the amount of seed information as contained for maintaining the uniformity of values of say, h bar, is expressed in this above equation.

Furthermore, the author will use a variant of cyclic conformal cosmology, as thought of by Penrose to argue that the constitution of the left hand side of Eq. (1) comes from conformal mapping matter and energy from an 'infinite' expansion in the far future, back to the left hand side of Eq. (1). I.e. there is no LOSS of essential physical information from conformal cycle to cycle in cosmology. Hence solving the problem of constant information needed to keep Plancks constant uniform from cycle to cycle of cosmological expansion and rebirth.

Needless to say though, the masses of the Graviton and the Gravitino are very different and this document next address's the role of different life times and ranges of masses next in order to make sense out of the data that gravitinos are extremely short lived, as opposed to the almost infinite life time of an almost massless Graviton.

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

$$1TeV < m_{3/2} \equiv m_{Gravitino} < 5TeV \tag{1a}$$

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.

$$\tau_{Gravitino} = Life - time = 1/\Gamma\left(\psi_{3/2} \to all\right) \tag{2}$$

On page 10, Kori et al. [2] has that $\tau_{Gravitino} = Life - time = 1/\Gamma\left(\psi_{3/2} \to all\right) < 10^{4} \sec$ 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 Califorina institue 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 proabably 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. $10^{-6} H_{ew}^{-1}$

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

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

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

$$m_n \to m_{graviton} \sim 10^{-26} eV \tag{4}$$

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]

$$\tau_{KK-Graviton} \sim 10^{31} years \cdot \left[\frac{1eV}{m_n}\right]^3 \to 10^{31} years \cdot \left[\frac{1eV}{10^{-26} eV}\right]^3 \sim 10^{57} years \tag{5}$$

Ususally the lifetime of the universe is considered to be $3.4 \times 10^{10} years$ [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 $1.422 \times 10^{27} meters$ 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. Thaf for each gravition, 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

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

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 Gravitions 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 ~ N.

Why include in Machs principel at all. Mistra's use of Machs principle to have a quantum big bang.

Mishra in [6] came up with a Fermionic particle description of the number of particles in the universe, and since Gravitons have spin 2, we are lead to Gravitino's of spin 3/2, a super partner description many times larger in mass than the super partner Graviton . The Mistra approximation was for a fermionic treatment of kinetic energy as given by $\rho\left(\vec{X}\right)$ as a single particle distribution function, such that $\rho\left(\vec{X}\right) \equiv A \cdot e^{-x} / x^3$, where $x = \sqrt{r/\lambda}$, and $r = \left|\vec{X}\right|$, with λ a variational parameter, and KE is

$$\left\langle KE \right\rangle = \left(\frac{3\hbar^2}{10m}\right) \cdot \left(3\pi^2\right)^{3/2} \cdot \int d\vec{X} \cdot \left[\rho\left(\vec{X}\right)\right]^{5/3} \quad (12)$$

This $\rho\left(\vec{X}\right)$ has a normalization such that

$$\int d\vec{X}\cdot\left[\rho\left(\vec{X}\right)\right]=N \tag{13}$$

Furthermore, the potential energy is modeled via a Hartree – Fock approximation given by

$$\left\langle PE\right\rangle=-\left(\frac{g^2}{2}\right)\cdot\int d\vec{X}\cdot d\vec{X}'\left(\left[\rho\left(\vec{X}\right)\cdot\rho\left(\vec{X}'\right)\right]\Big/\left|\vec{X}-\vec{X}'\right|\right) \tag{14}$$

These two were combined together by Mistra to reflect the self gravitating fictitious particle Hamiltonian

$$H=-\sum_{i=1}^{N}\left(\frac{\hbar^2}{2m}\right)\cdot\nabla_i^2-g^2\sum_{i=1,i\neq j}^{N}\sum_{j=1}^{N}\frac{1}{\left|\vec{X}_i-\vec{X}'_j\right|} \tag{15}$$

So then a proper spatial averaging of the Hamiltonian will lead, for $\left\langle H\right\rangle=E$ a quantum energy of the universe given by

$$\left\langle H\right\rangle=E(\lambda)=\left(\frac{12}{25\pi}\right)\cdot\left(\frac{\hbar^2}{m}\right)\cdot\left(\frac{3\pi N}{16}\right)^{5/3}\cdot\frac{1}{\lambda^2}-\left(\frac{g^2N^2}{16}\right)\cdot\frac{1}{\lambda} \tag{16}$$

'Note that the value m, is the mass of the fermionic particle, and that Eq. (16) when minimized leads to a minimum energy value of the variational parameter , which at the minimum energy has $\lambda=\lambda_0$ for which Eq.(16) becomes

$$E(\lambda=\lambda_0)=E_0=-(.015442)N^{7/3}\cdot\left(\frac{mg^4}{\hbar^2}\right) \tag{17}$$

The tie in with Machs principle comes as follows, i.e. Mistra sets a net radius value

$$r=R_0=2\cdot\lambda_0=\frac{\hbar^2}{mg^2}\times\left(4.0147528\right)\Big/N^{1/3} \tag{18}$$

This spatial value is picked so that the Potential energy of the system becomes equal to the total energy, and note that a total mass, M of the system is computed as follows, i.e. having a mass as given by $M=M_{total}=N\cdot m$

Mistra then next assumes that then, there is due to this averaging a tie in , with M being the gravitational mass a linkage to inertial mass so as to write, using Eq. (17) and Eq. (18) a way to have inertial mass the same as gravitational mass via

$$E_{gr}=\frac{G\cdot M\cdot m_{grav}}{R_0}=m_{inertial}\cdot c^2\equiv m_{grav}\cdot c^2\Leftrightarrow\frac{GM}{R_0c^2}\approx 1 \tag{19}$$

This is for total mass M of the universe, and so if we wish to work with a sub system as what we did with Gravitinos, in the electro weak era, we will then change Eq. (19) to read instead as a sub set of this Machs principle, i.e. an electro weak version, i.e. a sub set of the Machs principle.

$$\frac{GM_{gravitinos}}{R_{EW}c^2} \approx const \tag{20}$$

Note that the idea then, later, is to use the electro weak version of Machs principle, and we can identify Eq (20) with information carry over from a prior to the present universe , and then to , after the present expansion of the universe to make the following connections with Gravitons, as given above. Namely for gravitons and Gravitinos

$$\frac{GM_{electro-weak}\Big|_{Super-partner}}{R_{electro-weak}c^2} \approx \frac{G\,M_{today}\Big|_{Not-Super-Partner}}{R_0 c^2} \tag{21}$$

The value of the radius of the electro weak is tiny, whereas the right hand side, with $R_0 \sim 10^{28}\,centimeters$, but that in the left hand side and right hand side of Eq. (21) we still use $M = M_{total} = N \cdot m$

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

$$m_n^{\,2} \sim \mu^2 + \frac{n^2}{r^2} \xrightarrow[\mu \to \varepsilon^+]{} \frac{n^2}{r^2} + \varepsilon^+ \approx \frac{n^2}{r^2} \tag{22}$$

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

$$1/\hat{r} \sim m_{graviton} \propto 10^{-26}\,eV \Rightarrow \hat{r} \sim 10^{20}\,m \tag{23}$$

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

$$R_0 \sim 10^{27}\,meters \approx 10^7\,\hat{r} \tag{24}$$

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 $\widehat{r} \sim 10^{20} m$ 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 connectiosn 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 evapoorate) to the higher temperatures associated with a new big bang. We provide such a driver via use of an addition fo the Einstein energy stress tensor with an electro magnetic addition to it.[9]

$$\begin{aligned}&\Lambda\Big|_{initial-Planck\,time}[vacuum-energy] \\ &\sim \frac{c^3}{N^6 G\hbar} \approx 10^{-6} - 10^{-24} \\ &\sim 1/S_{initial-Planck-time}\end{aligned} \tag{25}$$

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

$$H_{Early-Universe} \sim 1.66 \cdot \sqrt{g^*} \cdot \frac{T_{Early-Universe}}{M_{mass-scale}} \tag{26}$$

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]

$$g^*_{i+1} = \exp\left[-\alpha g_i^*\right] + [\left(vacuum - thermal - energy\right)_i] \tag{27}$$

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

$$\begin{aligned}&\Lambda\left[Park, 2002\right] \equiv \\ &\Lambda_{General-Value} T^{\beta}_{Temperature} \sim \\ &\frac{10^{-120} \cdot T^{\beta=115/31}_{Temperature}}{\left[2.73 Kelvin\right]}\end{aligned} \tag{28}$$

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

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

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

(29)

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

$$\rho_{E\&M-contribution} \sim 8\pi G \cdot \left(E^2 + B^2 \right) \tag{30}$$

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]

$$\Lambda_+ = \Lambda + \rho_{E\&M-contribution} \tag{31}$$

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 transiton to the form of a perfect ‘graviton’ gas looking with initial volume

$$V_{electro-weak} \sim R^3_{H(electro-weak)} \tag{32}$$

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

$$T_{Electro-weak} \sim R^{-1}_{H(electro-weak)} \propto \lambda^{-1}_{Electro-weak} \tag{33}$$

And a numerical count we can give as

$$N_{electro-weak} \sim \left[R_{H(electro-weak)} / l_{Planck} \propto 10^{25} \right]^2 \equiv 10^{49} - 10^{50} \tag{34}$$

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

$$R_H \propto H^{-1} \Rightarrow R_{H(Electro-Weak)} \propto H^{-1}_{(Electro-Weak)} \tag{35}$$

We submit that the Electro weak regime, wlll be where Gravitinos form, as of having mass of about 1 TeV, with $10^{50} TeV$ ~ 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

$$N_{Today}\cdot m_{graviton}\equiv 10^{88}\cdot m_{graviton}=N_{electro-weak}\cdot m_{gravitino}\equiv 10^{50}\cdot m_{gravitino} \tag{36}$$

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

$$\begin{aligned}&S_{Graviton-Today's.era}\propto V\int_{10^{-19}\,Hertz}^{10^{11}\,Hertz} r\left(v\right)\cdot v^{2}dv\\&\cong\left(10^{30}\right)^{3}\cdot\left(\frac{H_{1}}{M_{Planck-mass}}\right)\propto 10^{88}-10^{90}\\&\sim(difference\quad of\quad 10^{11}\quad to\quad 10^{-19}\,Hertz)^{3}\end{aligned} \tag{37}$$

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

$$\begin{aligned}&10^{10^{90}}\approx 10^{Final-entropy-Gravitons=S_{FINAL-GRAVITONS}}\\&\sim Phase\quad space\quad due\quad to\quad Gravitons\end{aligned} \tag{38}$$

The Penrose conjecure 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]

$$\begin{aligned}&10^{10^{124}}\approx 10^{Final-entropy-Galactic-Black-Holes=S_{FINAL-BL}}\\&\sim Phase\quad space\quad Super-Massive-BH-in-Galaxies\end{aligned} \tag{39}$$

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]

$$\begin{aligned}&E=8\pi\cdot T+\Lambda\cdot g\\&E=source\quad for\quad gravitational\quad field\\&T=mass\quad energy\quad density\\&g=gravitational\quad metric\\&\Lambda=vacuum\quad energy, rescaled\quad as\quad follows\end{aligned}$$

$$g \xrightarrow[ccc]{} \hat{g} = \Omega^2 g \qquad (40)$$

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

$$\begin{aligned} &\nabla F = 4\pi J \\ &F = Field \\ &J = Current \xrightarrow[set-to]{} 0 \end{aligned} \qquad (41)$$

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)

$$\begin{aligned} &\hat{\phi}_{ABC..E} = \Omega^{-1}\phi_{ABC..E} \\ &\hat{\nabla}^{AA'}\hat{\phi}_{ABC..E} = \Omega^{-3}\nabla^{AA'}\phi_{ABC..E} \\ &Ideally, we \quad have \\ &\hat{\nabla}\hat{F} = 0 \Leftrightarrow \nabla F = 0 \end{aligned} \qquad (42)$$

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

$$\Omega \xrightarrow[CCC]{} \Omega^{-1} \qquad \textbf{(43)}$$

the cross over from Cycle to Cycle is given by mapping in Eq. (33) above. And the invariance, as in Eq. (42)

$$\begin{aligned} &\hat{K} = \Omega^{-1}\hat{C} \\ &\hat{\nabla}\hat{K} = 0, \\ &and \quad before \quad crossover \quad to \quad new \\ &universe \quad zone \\ &C \to \varepsilon^{+} \approx 0^{+} \quad just \quad before \quad crossover, \\ &\Omega \to tiny \quad value \\ &K \quad remains \quad finite \\ &\Pi = \frac{d\Omega}{\Omega^2 - 1} \xrightarrow[\Omega \xrightarrow[CCC]{} \Omega^{-1}]{} SAME \quad \frac{d\Omega}{\Omega^2 - 1} \end{aligned} \qquad (44)$$

Key hyothesis in this presentation, i.e. a graviton can obtain effective mass in the regime before the start of a new map;ping. I.e. one can have no issues as to forming a fifth dimensional value of $\widehat{r} \sim 10^{20} m$ 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 $\widehat{r} \sim 10^{20} m$ 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.

$$m_n(Graviton) = \sqrt{\frac{n^2}{L^2} + \left(m_{graviton-rest-mass} = 10^{-65} grams\right)^2} \tag{45}$$

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

The zeroth order KK mode would then be super parterned with a gravitino, and then Eq. (35), assuming that Gravitinos would not last long, would be mapped into the invariance relationship given by Eq. (35). 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 $|\vec{B}| \sim 10^{22}$ G [3] at the EW epoch would be crucial in the formulation of Eq. (35), 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 Gravititino-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. As was given in Eq. (21) Namely

$$\frac{GM_{electro-weak}\big|_{Super-partner}}{R_{electro-weak}c^2} \approx \frac{G\,M_{today}\big|_{Not-Super-Partner}}{R_0 c^2} \quad \text{as having a constant ratio value} \tag{21}$$

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 gravitions.

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

$$h_{00}(x) = \frac{2M}{3M_{Planck}} \cdot \frac{\exp(-m \cdot r)}{4\pi \cdot r} \tag{46}$$

$$h_{0i}(x) = 0 \tag{47}$$

$$h_{ij}(x) = \left[\frac{M}{3M_{Planck}} \cdot \frac{\exp(-m \cdot r)}{4\pi \cdot r} \right] \cdot \left(\frac{1 + m \cdot r + m^2 \cdot r^2}{m^2 \cdot r^2} \cdot \delta_{ij} - \left[\frac{3 + 3m \cdot r + m^2 \cdot r^2}{m^2 \cdot r^4} \right] \cdot x_i \cdot x_j \right) \tag{48}$$

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

$$\left(\partial^2 - m^2 \right) h_{\mu\nu} = -\kappa \cdot \left[T_{uv} - \frac{1}{D-1} \cdot \left(\eta_{uv} - \frac{\partial_\mu \partial_\nu}{m^2} \right) \cdot T \right] \tag{49}$$

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

$$\begin{aligned} M &= 10^{50} \cdot 10^{-27} g \equiv 10^{23} g \propto 10^{61} - 10^{62} eV \\ M_{Plank} &= 1.22 \times 10^{28} eV \end{aligned} \tag{50}$$

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

We argue that the rigorous application of Machs principle permit h_{ij} to be calucluated in ways which a magnetic field 3DSR detector can obtain.

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APPENDIX :

Graviton mass problem re stated in terms of gravitons in terms of chains of gluons. I.e. to look at what happens if we are examining if we extend our analysis of [21] to try to understand the full spectrum of the variable length spin Chain model. This spin chain model has a Hamiltonian given by [22]

$$H_{Spin-Chain-Model} = 2\lambda \sum_{l=1}^{L} \hat{a}_l^{\dagger} \hat{a}_l - \lambda \sum_{l=1}^{L-1} (\hat{a}_l^{\dagger} \hat{a}_{l+1} + \hat{a}_l \hat{a}_{l+1}^{\dagger}) + 2\lambda\alpha^2 + \lambda\alpha \cdot \left(\hat{a}_1^{\dagger} + \hat{a}_1\right) + \lambda\alpha \cdot \left(\hat{a}_L^{\dagger} + \hat{a}_L\right) \quad \text{(A1)}$$

Here

$$\begin{aligned} \hat{a}_l^{\dagger} a_l &= I - |0\rangle\langle 0| \\ \hat{a}_l \, \hat{a}_l^{\dagger} &= I \end{aligned} \quad \text{(A2)}$$

The idea is to note, as quoted in the article “ *The one loop spectrum of anomalous dimensions for strings attached to a maximal giant graviton was described in [23], were it was found that the one loop planar anomalous* (*given*) *dimensions correspond to an ordinary spin chain model with integrable Dirichlet-like boundary conditions. This work was extended to study what spin chain corresponds to a more general giant graviton in [21], where we found that the spin chain in question has a variable number of sites and therefore it is not an ordinary spin chain model anymore. After a bosonization transformation, we found that the spin chain model could be also understood in terms of a system of a Cuntz oscillator chain model (a boson chain, where each spin corresponds to a single boson Fock space) with non-diagonal boundary conditions*”. I.e. one has then, eventually, that there is also a further mathematics generalization [24] As written by Crowell:

I wrote a paper on f(R) gravity with a massive graviton sector. The graviton can become massive under various (*given*) *circumstances --- in theory of course. The scalar curvature in the Hilbert-Palatini action has in a string*

$$L = R + \alpha' R^{abcd}R_{abcd} + O(\alpha'^2) \qquad \text{(A3)}$$

which defines a mass-gap for the graviton. This may have played some role in the early universe, in particular during the inflationary phase. An article by Bern, Dixon and Kosower appeared in Scientific American that is interesting. I read a paper in 2010 or so by the first two authors on computing graviton propagators up to 7 loops. These guys are making a bit of news with these developments (according to L. Crowell)

The article in SciAm talks about gravitons as pair of gluons. This makes in a string theory sense. For a closed string there are two sets of mode operators $a^\dagger_n$, a_n and $b^\dagger_n$, b_n for modes propagating left and right polarized directions in space. Along the string though modes travel along a σ and $-\sigma$ direction on the string according to whether the n subscript is positive or negative. We then write these modes as $a^\dagger_n$, a_n and $a^\dagger_{-n}$, a_{-n} (ditto for b operators), and we ignore the zero mode for technical reasons. There is a result which says the Hamiltonian operator must have equal levels in operator products, such as $a^\dagger_n a^\dagger_{-n}$, that act on the string ground state. The reason for this is there is no preferred direction along the string with parameter σ, and this level matching result is a Noether theorem result from this. Each $a^\dagger_n$ or $b^\dagger_n$ is a raising operator for a spin 1 boson field, and the product of the two is a spin 2 field, with no m = 0 or 1 component. So the graviton can be thought of as a pair of Yang-Mills gauge bosons..The operators can be given a spacetime index μ so that we have $(a^\mu)^\dagger_n$ and $(a^\mu)^\dagger_{-n}$. We then consider this index extended to $\mu = \{0, 1, 2, 3\}$ for spacetime and $q = \{4, 5, \ldots, 9\}$. (As a consequence one then finds) A gauge boson operator in standard QFT is is then of the form

$$(A^\mu)^\dagger = (a^\mu)^\dagger_n (a^q)^\dagger_{-n} \qquad \text{(A4)}$$

Suppose we have a gauge boson operator(as written up by L. Crowell is then) of the form

$$(A'^\mu)^\dagger = (a^q)^\dagger_n (a^\mu)^\dagger_{-n} \qquad \text{(A5)}$$

The interaction (as given by L. Crowell) of the two is of the form $(A^\mu)^\dagger (A'^\mu)^\dagger$ and this is then

$$(A^\mu)^\dagger (A'^\mu)^\dagger = (a^\mu)^\dagger_n (a^q)^\dagger_{-n} (a^q)^\dagger_n (a^\mu)^\dagger_{-n} \qquad \text{(A6)}$$

Graphically one has that

http://f1602.mail.yahoo.com/ya/download?mid=2%5f0%5f0%5f1%5f51009%5fAHLai2IAAU4jT5ZSdgFM1RGPHm0&pid=1.2.2&fid=Inbox&inline=1&appid=YahooMailClassic

where the red part that involves the creation of internal space bosons with opposite mode directions on the string. This is equivalent to opposite gauge charges (opposite colors) and so this is a type of glueball, and the annihilation of the opposite charges leaves a product of two operators which recovers a graviton, or two photons.

This is a way of looking at how gravitation is a form of QCD, or that gluon chains are equivalent to a graviton. The diagram in the paper by Bern, Dixon and Kosower of the form below depicts the graviton as a pair of gluons, and in general a gluon chain on the boundary of an anti-de Sitter spacetime has the same symmetries as a graviton in the interior of an anti-de Sitter spacetime The graviton with a mass gap for a spin $s = 2$, then has $m = 2, 1, 0, -1, -2$, where the 0 states are the dilaton and axion. The $s = 1, -1$ state then corresponds to a massive form of the graviton which may then have a form

$$(A'^\mu)^\dagger = (a^q)^\dagger_n (a^\mu)^\dagger_{-n} \qquad \text{(A7)}$$

(*as written above*) *which may be a* ***massive gauge boson, such as the Z and $W^{+/-}$ particle.*** *The axion particle is the gadget which involves QCD and takes up the CP violation of QCD --- leaving QCD CP symmetric. This might also form a component of dark matter as well.*