Creating a (Quantum?) constraint, in Pre Planckian space-time early universe via the Einstein Cosmological Constant in a One to One and onto comparison between two Action Integrals.

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Abstract

**** NOTE, this is a "30 minute" Communications talk approved by Jesus, of FFP15 For November 30, 2017. Presumably for the conference proceedings****

We are looking at comparison of two action integrals and we identify the Lagrangian multiplier as setting up a constraint equation (on cosmological expansion). Two action integrals, one which is connected with quantum gravity is called equivalent to another action integral, and the 2nd action integral has a Lagrangian multiplier in it. Using the idea of a Lagrangian multiplier as a constraint equation, we draw our conclusions in a 1 to 1 and onto assumed equivalence between the two action integrals. The viability of the 1 to 1 and onto linkage between the two action integrals is open to question, but if this procedure is legitimate , the conclusions so assumed are fundamentally important. We also state this procedure should be streamed toward giving substance to the paper entitled "Fast optimization algorithms and the cosmological constant", by Ning Bao, et.al.2017 , as a way to find conditions for restricting the size of the cosmological constant to be of 10^ - 120 for reasons we discuss as a future works project. We come up with relic GW which are after 65 e folds of inflationary expansion leading to 10 ^ 36 GHz high frequency GW being possible at the site of formation of the 10^-120 sized cosmological constant, for 10 GHz HFGW today. After 65 e folds of inflationary expansion

Key words, Ricci Scalar, inflaton physics.

1. Basic idea, can two First Integrals give equivalent information?

Our supposition is that if we wish to make an equivalence between two action integrals, i.e., first integrals that we need to have a 1 to 1 and onto linkage between the integrands, in the two cases so referenced.

To do this, we are making several assumptions.

a. That the two mentioned integrals are evaluated from a Pre Planckian to Planckian space-time domain. i.e. in the same specified integral of space-time.

b. That in doing so, the Universe is assumed to avoid the so called cosmic singularity. In doing so assuming a finite "Pre Planckian to Planckian" regime of space time similar to that given in [1,2].

c. The Integrands in the two integrals are assumed to have a 1-1 and onto relationship to one another.

We will be identifying the components of the two integrands which are assumed to be Inter related to each other. This idea is the foundation of our approach. The two references, [1,2] have in their own formulation specific Lagrangian formulations and a criticism our approach, is that the references we are using for first integrals, namely [3,4] are not giving action integrals identical as to [1,2]. Our answer is that we reference [1, 2] specifically as to how to avoid the Penrose singularity theorem [5] , and that not enough is known as to rule out the nonsingular starting point of the universe as having the same content for Lagrangians as given in [3,4]. I.e., for Pre Planckian space time, so long as [5] is avoided, that presumably our three assumptions for comparison can be made, so long as we adhere to the 'path integral' idea as represented by [6] as equivalent to what is stated in [1,2] .

2. Specifying the particulars of the two First integrals in Pre-Planckian to Planckian space-time

Before proceeding, it is advisable to define some of the symbols which will be used in the integrals and the integrands in our document.

First of all, we have what is known as a scale factor $a(t)$. Which is nearly zero, in the Pre Planckian regime of space-time if we assume [5] does not hold, and that $a(t)$ is 1 in the present era. A good reference as to the physics behind how we set up $a(t)$ is [7] . In addition we will define, for the purpose of analysis, of the integrals, the following symbols as given in [1], for the Quantum paths sensitive first integral, with

$$\begin{aligned} &\int dt\sqrt{g_{tt}}V_3(t)=V_4(t)\sim 8\pi^2 r^4/3 \\ &\&V_3(t)=2\pi^2 a(t)^3/3 \\ &\&k_2=9\left(2\pi^2\right)^{2/3} \end{aligned} \tag{1}$$

These are the purported volume elements of the [3] first integral. The second first integral is using the usual GR inputs as defined by Padmanbhan in [4]. To review what is meant by first integrals we refer the readers to [6, 8,9, 10]

Roughly put, according to [8,9, 10] a Lagrangian multiplier invokes a constraint of how a "minimal surface" is obtained by constraining a physical process so as to use the idea of [8, 9, 10] which invokes the idea of minimization of a physical processes. In the case of [3], the minimization process is implicitly that, if $a(t)$ were a scale factor as defined by Roos, [7] and if g_{tt} were a time component of a metric tensor, which we will later define via [11, 12]

Here, the subscripts 3 and 4 in the volume refer to 3 and 4 dimensional spatial dimensions, and this will lead to us writing, via [3] a 1st integral as defined by [3, 8], in the form , if G is the gravitational constant, that if we have following [3], a first integral defined by

$$S_1 = \frac{1}{24\pi G} \cdot \left(\int dt \sqrt{g_{tt}} \left(\frac{g_{tt} \dot{V}_3^2}{V_3(t)} + k_2 V_3^{1/3}(t) - \lambda V_3(t) \right) \right) \tag{2}$$

This should be compared against the Padmabhan 1st integral [4] of the form , with the third entry of Eq. (3) having a Ricci scalar defined via [13] and usually the curvature $\aleph$ set as extremely small, with the general relativity version of

$$\begin{aligned} & S_2 = \frac{1}{2\kappa} \int \sqrt{-g} \cdot d^4 x \cdot (\Re - 2\Lambda) \\ & \& - g = -\det g_{uv} \\ & \& \Re = 6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a} \right)^2 + \frac{\aleph}{a^2} \right) \end{aligned} \tag{3}$$

Also, the variation of $\delta g_{tt} \approx a_{\min}^2 \phi$ as given by [11, 12] will have an inflaton, ϕ given by [4]

$$\begin{aligned} & a \approx a_{\min} t^{\gamma} \\ & \Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln \left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right\} \\ & \Leftrightarrow V \approx V_0 \cdot \exp \left\{ -\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t) \right\} \end{aligned} \tag{4}$$

Leading to [2]

$$\phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln \left\{ \sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t \right\} \tag{5}$$

Here, we have that $a_{\min}$ is a minimum value of the scale factor presumably given by [2] as a tiny but non zero value. Or at least a quantum bounce as given by [1]

The innovation we will be looking at will be in comparing a 1-1 and onto equivalence, i.e. an information based isomorphism between 1st integrals with a nod to [14]

$$S_1 \cong S_2 \tag{6}$$

We will be making a simple equivalence between the two first integrals via Eq. (6) assuming that even in the Pre Planck-Planck regime that curvature $\aleph$ will be a very small part of Ricci scalar $\Re$ and that to first approximation even in the Plank time regime, that to first order [13] has a value altered to be

$$\Re = 6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a} \right)^2 + \frac{\aleph}{a^2} \right) \sim 6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a} \right)^2 \right) \tag{7}$$

This last approximation will make a statement as to applying Eq. (6) far easier may not be defensible, but we will use it for the time being.

3. Comparison between Eq. (2) and Eq. (3) with Eq.(5), Eq. (6) and Eq. (7)

In order to obtain maximum results, we will be stating that the following will be assumed to be equivalent.

$$\sqrt{g_{tt}} \left(\frac{g_{tt} \dot{V}_3^2}{V_3(t)} + k_2 V_3^{1/3}(t) - \lambda V_3(t) \right) \sim \frac{1}{2\kappa} \int \sqrt{-g} \cdot d^3 x \cdot \left(6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a} \right)^2 \right) - 2\Lambda \right) \tag{8}$$

i.e.

$$\sqrt{g_{tt}} \left(\frac{g_{tt} \dot{V}_3^2}{V_3(t)} + k_2 V_3^{1/3}(t) \right) \sim \frac{1}{2\kappa} \int \sqrt{-g} \cdot d^3 x \cdot \left(6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a} \right)^2 \right) \right) \tag{9}$$

And

$$\sqrt{g_{tt}} \left(\lambda V_3(t) \right) \sim \frac{1}{2\kappa} \int \sqrt{-g} \cdot d^3 x \cdot (2\Lambda) \tag{10}$$

If the term Λ is indeed a constant (.i.e. we avoid Quinessence, and the vacuum energy is invariant), then Eq. (10) puts a profound restriction upon g_{tt} which will be elaborated upon in the next section. I.e. for the sake of Argument we will make the following assumptions which may be debatable, i.e.

$$\sqrt{-g} \text{ is approximately a constant} \tag{11}$$

For extremely small time intervals (in the boundary between Pre Planckian to Planckian physics boundary regime).

$$g_{tt} \sim \delta g_{tt} \approx a_{\min}^2 \phi \tag{12}$$

The next section will be investigating the physical implications of such assumptions.

4. What we can extract in physics, if Eq. (9), Eq. (10), Eq. (11) and Eq.(12) hold ?

Simply put a relationship of the Lagrangian multiplier giving us the following:

$$\lambda \sim \frac{1}{\kappa}\sqrt{\frac{-g}{\left(\delta g_{tt} \approx a_{\min}^{2}\phi\right)}} \cdot \Lambda \tag{13}$$

If the following is true, i.e. in a Pre Plankian to Planckian regime of space-time

$$\sqrt{\frac{-g}{\left(\delta g_{tt} \approx a_{\min}^{2}\phi\right)}} \approx \text{ constant} \tag{14}$$

Then what has been done is to conflate the Lagrangian as equivalent to Λ which if Λ is also a constant is implying that the cosmological constant is obtaining for us the consomological constant value chosen as a precursor for (DE ?) expansion of the universe, as given in the scale factors as of Eq. (9) and Eq. (8). i.e. what we are inferring then is similar to a result assumed by Padmanabhan, in [15]

But what is noticeable, is that the inflaton equation as given by Padmanabhan [4] hopefully will not be incommensurate with the physics of the Corda Criteria given in the Gravity's breath document [16]. Keep in mind the importance of the result from reference [17] below which forms the core of Eq. (15) below

$$N_{e-foldings} = -\frac{8\pi}{m_{Planck}^{2}} \cdot \int_{\phi 1}^{\phi 2} \frac{V(\phi)}{\left(\frac{\partial V(\phi)}{\partial \phi}\right)} d\phi \geq 65 \tag{15}$$

Furthermore, we should keep in mind the physics incorporated in [18,19], i.e. as to the work of LIGO. i.e. it is important to keep in mind that in addition, that [20] has confirmed that a subsequent analysis of the event GW150914 by the LSC constrained the graviton Compton wavelength of those alternative theories of gravity in which the graviton is massive and placed a level of 90\%
confidence on the lower bound of 10^{13} km for a Compton wavelength of the graviton. Doing these sort of vetting protocols in in line with being consistent with investigation as to a real investigation as to the fundamental nature of gravity. This is a way of also look I.e. is this a way to show if general relativity is the final theory of gravitation. I.e., if massive gravity is confirmed, as given in [21], then GR is perhaps to be replaced by a scalar-tensor theory, as has been shown by Corda.

We can say though that if we do confirm Eq. (13) and Eq. (14) that such observations may enable a more precise rendering of settling the issues brought up by references [16], and [21]. As well as the appropriate use of the structures, algebraically given in [22, 23] for our comparison of the first integrals.

5. Future projects. Restricting the size of the Cosmological constant., I.e. what our project should be aimed at vetting and confirming the following hypothesis

Since we are discussing a regime of space-time for which Eq. (6) holds, we wish to make reference to both [24] and [25], for computational information based construction of the cosmological constant used in our problem.

In [24] We have the following quote (abstract)

Denef and Douglas have observed that in certain landscape models the problem of finding small values of the cosmological constant is a large instance of an NP-hard problem. The number of elementary operations (quantum gates) needed to solve this problem by brute force search exceeds the estimated computational capacity of the observable universe. Here we describe a way out of this puzzling circumstance: despite being NP-hard, the problem of finding a small cosmological constant can be attacked by more sophisticated algorithms whose performance vastly exceeds brute force search. In fact, in some parameter regimes the average-case complexity is polynomial. We demonstrate this by explicitly finding a cosmological constant of order 10^ −120 in a randomly generated 10 ^ 9 dimensional ADK landscape.

End of quote (of the abstract)

In particular what is most relevant is given in page 14 of [24] is given via

Quote

A. Karmarkar-Karp

To empirically test the Karmarkar-Karp algorithm in a regime relevant to the cosmological constant problem, we generated random instances of the number partitioning problem, at various values of n in which each of the n numbers are independently sampled uniformly from {0, 1, 2, . . . , (2^430) − 1}. In figure 4, we plot the fraction of instances on which the Karmarkar-Karp algorithm was successful with n numbers, where we defined success as achieving residue less than 2^ 30. In the context of finding small cosmological constant within the ADK model, one starts with real numbers of order 1, and seeks to find a residue of order 10^−122. Here we have scaled up the numbers by a factor of 2^430 and represented them as integers. This use of fixed-point arithmetic is strictly for computational convenience. Our definition of success corresponds to achieving a residue which is smaller than the magnitude of the initial numbers by a factor of 2^400 ≃ 10^120 and thus corresponds to finding a cosmological constant close to that observed for our universe4. The extra 30 bits of precision are to ensure that "numerical noise" should be small.

What we state is that the conditions as to the Kammakar-Karp algorithm being relevant to the cosmological constant problem, as given above is in fact almost identical to what we did when we wrote in Eq. (6), i.e. when we made a statement as to making a statement of the equivalence of the two first integrals via $S_1 \cong S_2$, in a 1-1 and onto relationship.

We should work toward obtaining conditions for which this is verified, and furthermore proceed to investigate if this is true, with no quinessence, i.e. variation of the cosmological "constant", from beginning of space – time. . i.e. if this is true, then indeed, in the beginning we have taken a step toward confirming that then the information based treatment of [24], with an early universe invariant cosmological constant, is then an admissible candidate for Dark Energy.

I.e. the idea is that an invariant DE, which may be formed by Gravitons, as given by [25] , and that the initial graviton count, will be related to initial formation of *cosmological constant of order 10^ -120 by confirming conditions so that [24] is true, which we then say is also linked toward* $S_1 \cong S_2$ in Eq. (6) above.

Doing so provides us with another bonus, i.e. that the earlier we confirm conditions as to [24] holding, and presuming that this is due to Graviton physics, we are if this happens say at conditions for which GW have wave length of the order of Planck Length so then we can state the following, i.e. We have spatial conditions for [24] holding, with the resulting DE (linked to the Cosmological constant) linked by [25], so then that we have the spatial conditions for [24] and [25] holding when we also take into consideration Eq. (6) above, so that

$$\begin{aligned}&\lambda_{graviton}(initial) \sim l_P \sim Planck-length \\ &\approx \omega^{-1}_{graviton}(initial) \approx 1/\omega^{-1}_{graviton}(initial) \\ &\Leftrightarrow S_1 \cong S_2 \Leftrightarrow \omega^{+1}_{graviton}(Today-after-\inf) \approx 1GH\end{aligned} \tag{16}$$

I.e. the early universe condition for [24] holding which we also state is similar to initial ultra high frequency GW waves forming. i.e. we are also employing Eq. (5) above, in our rendition of Eq. (16), i.e. 65 e foldings of inflationary expansion.

The earlier we can employ [24] , and we say it can be done in a space commensurate to having spatial dimensions for which $\lambda_{graviton}(initial) \sim l_P \sim Planck-length$, for setting the cosmological constant, which we link to Dark Energy and Graviton production by [25] , the more likely after 10^26 expansion of the initial wave function of GW, then we move closer to

$$\begin{aligned}&e-folds = 65 \\ &\Leftrightarrow \omega^{+1}_{GW}(Today) \approx (1-10)GH\end{aligned} \tag{17}$$

We wish to also, in doing this make use of the Seth Lloyd paper, i.e. given in [26] below for more insights.

The end result is that we have We come up with relic GW which are after 65 e folds of inflationary expansion leading to 10 ^ 36 GHz high frequency GW being possible at the site of formation of the 10^-120 sized cosmological constant, for 10 GHz HFGW today. After 65 e folds of inflationary expansion

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