Does Causal Discontinuity as postulated in the pre Planckian State affect / create conditions for the break down of non commutative geometry necessary for quantum effects?

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Abstract: Linking a shrinking prior universe via a wormhole solution for a pseudo time dependent Wheeler-De Witt equation[1] permits the formation of a short-term quintessence scalar field [2]. As both Beckwith and Glinka[3] postulated the existence of at least a brief period of causal discontinuity in the vicinity of Pre Planckian physics space time, the question is does the construction as given by Crowell[1] for an Octonionic non associator which leads to the commutation relations between position x and momentum p of quantum mechanics still hold up? Crowell's derivation heavily depends upon a value of the path integral of the $\left[x_i , p_j\right]$ over spatial variation equal to $-\beta \cdot l_P T_{ijk}$. Here, T_{ijk} is a structure constant, which we claim would go to zero if a discontinuity exists, leading to x . p = p . x in the neighborhood of pre Planckian space time.

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INTRODUCTION

By necessity we repeat some of the first parts of the last paper done by the authors, since it sets the template as to what will be done as to implementing the idea of causal discontinuity. Doing so makes the paper self contained. We argue this is important as to the issue of the initial failure of QM operators in pre Planckian space time, and their success right afterwards. We begin first with a restatement of the physics that leads to a wormhole solution for early-universe transfer of vacuum energy from a prior universe to today's expanding universe. The main contention of this paper is that we need to go back to early universe conditions to determine optimal conditions for graviton production. Having stated this initial value for graviton production touches upon the issue as to if QM commutation relations break down due to pre Planckian physics. We summarize background in part, as from a prior paper, and lead to a very unexpected conclusion, partly due to the causal discontinuity [3] , and also upon the concept that perhaps gravitons, via the pilot theory of embedding QM in a non linear super structure, that a non zero tiny mass of a graviton in four dimensions may be due to this embedding of QM within a larger non linear classical super structure [4], [5] .

HOW A WORMHOLE FORMS

We referenced the Reinssner-Nordstrom metric [1] to help obtain a solution that passes through a thin shell separating two space-times. The radius of the shell, $r_0(t)$ separating the two space-times is of length l_P in approximate magnitude, leading to a multiplication of the time component for the Reissner-Nordstrom metric:

$$dS^2 = -F(r) \cdot dt^2 + \frac{dr^2}{F(r)} + d\Omega^2 \quad . \tag{1}$$

This has:

$$F(r) = 1 - \frac{2M}{r} + \frac{Q^2}{r^2} - \frac{\Lambda}{3}\cdot r^2 \xrightarrow[T\to 10^{32}\,Kelvin\sim\infty]{} -\frac{\Lambda}{3}\cdot\left(r = l_P\right)^2 \quad . \tag{2}$$

Note that Equation (2) referenced above is a way to link this metric to space-times[1], [6]

$$\Psi(T) \propto -A\cdot\left\{\eta^2\cdot C_1\right\} + A\cdot\eta\cdot\omega^2\cdot C_2 \quad . \tag{3}$$

This equation has $C_1 = C_1(\omega,t,r)$ as a cyclic and evolving function of frequency, time, and spatial function, also applicable to $C_2 = C_2(\omega,t,r)$ with, $C_1 = C_1(\omega,t,r) \neq C_2(\omega,t,r)$ It is asserted here that a thermal bridge in wormhole form exists as a bridge between a prior and present universe. Furthermore, it is asserted that the existence of this bridge is part of a necessary condition for thermal energy transfer between a prior and present universe. The prior universe shrinks to a singularity at the time that thermal energy is transferred to our present universe, thereby helping to initiate cosmological inflation. dominated This is due in part to the absolute value of the five-dimensional "vacuum state" parameter varying with temperature T, as Beckwith writes [1], [6]:

$$\left|\Lambda_{5-\dim}\right| \approx c_1\cdot\left(1/T^{\alpha}\right) \quad . \tag{4}$$

This contrasts with the more traditional four-dimensional version of the same, without the minus sign of the brane world theory version (i.e., the four-dimensional cosmological constant grows large and is a positive valued expression at the same time that the five- dimensional vacuum energy expression shrinks in value and has a negative value). The five-dimensional version is based on brane theory and higher dimensions, whereas the four-dimensional version is linked to more traditional De Sitter space-time geometry, as given by Park [7] :

$$\Lambda_{4-\dim} \approx c_2\cdot T^{\beta}. \tag{5}$$

Looking at the range of allowed upper bounds of the cosmological constant, one can note the difference between what Park [7] predicted (a nearly infinite four-dimensional cosmological constant) and Barvinsky [8], who specified an upper limit of 360 times the square of Planck's mass m. This indicates that a phase transition is occurring within a Planck interval of time.. This allows for a brief interlude of quintessence. This assumes m_P as the Planck mass, i.e. the mass of a black hole of "radius" on the order of magnitude of Planck length $l_P \sim 10^{-35}$ m. This leads to Planck's mass $m_P \approx 2.17645\times 10^{-8}$ kilograms, as alluded to by Barvinsky [1], [6], [8].

$$\Lambda_{4-\dim} \propto c_2\cdot T \xrightarrow[graviton-production]{} 360\cdot m_P^2 << c_2\cdot\left[T \approx 10^{32}K\right] \quad . \tag{6}$$

Right after the gravitons are released, there is still a drop off of temperature contributions to the cosmological constant.

Connection with the directionality of time issue, for Planckian space – time

We are re duplicating part of the argument used [3], in order to make a point if there is, in a four dimensional representation of Λ, with a temperature component, as given by Park [7] , that it is then necessary for a semi classical treatment of the wavefunction of the universe, to assume, initially that the TEMPERATURE of the pre Planckian space time state, would have to be zero. The argument as presented by Beckwith and Glinka [3] is as follows.

1. Beckwith and Glinka [3] noted in a recent publication have argued that the wave function of the universe interpretation of the Wheeler-DeWitt equation depends upon a WKB airy function, which has its argument dependent upon z. When z ~ $\left(\frac{3\pi\cdot\tilde{a}_0^2}{4G}\right)^{2/3}\cdot\left[1-\left[\frac{\tilde{a}^2}{\tilde{a}_0^2}\right]\right] \xrightarrow[\tilde{a}\to 0]{} \left(\frac{3\pi\cdot\tilde{a}_0^2}{4G}\right)^{2/3}$ right at the start of the big bang, the wave function of the universe is a small positive value, as given by Kolb and Turner [9]. Having

$\tilde{a} \to 0$ corresponds to a classically forbidden region, with a Schrödinger equation of the form (assuming a vacuum energy $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$ initially), with Λ part of a closed FRW Friedman equation solution [3], [9], [10]

$$a(t) = \frac{1}{\sqrt{\Lambda/3}} \cosh\left[\sqrt{\Lambda/3} \cdot t\right] \tag{7}$$

to a flat space FRW equation of the form [3], [9] , [10]

$$\left[\frac{\dot{a}}{a}\right]^2 + \frac{1}{a^2} = \frac{\Lambda}{3} \tag{8}$$

Which is so one forms a 1-dimensional Schrödinger equation to mimic the Wheeler-DeWitt equation[3], [9], [10]

$$\left[\frac{\partial^2}{\partial \cdot \tilde{a}^2} - \frac{9\pi^2}{4G^2}\left[\tilde{a}^2 - \frac{\Lambda}{3}\tilde{a}^4\right]\right]\psi = 0 \tag{9}$$

with $\tilde{a}_0$ a turning point to potential

$$U(a) = \frac{9\pi^2}{4G^2}\left[\tilde{a}^2 - \frac{\Lambda}{3}\tilde{a}^4\right]. \tag{10}$$

Note that as $\tilde{a} \to 0$, the wave function in a classical sense would never leave a potential system defined by U(a) and that much more seriously, the definition of a vacuum energy, as set by the 1-dimensional Schrödinger equation is not defined, properly for a FRW classical Friedman equation. .The vacuum energy, is for $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$, for definition of the Λ FRW metric, and is undefined for the regime $0 < \tilde{a} < 1/\sqrt{\Lambda/3}$. I.e. the classically undefined regions for evolution of Eq. (8) and Eq (9) are the same. The problem is this, having $\tilde{a} \to 0$ makes a statement about the existence, quantum mechanically about having a (semi classical) approximation for ψ , when in fact the key part of the solution for ψ , namely $\rho_{Vacuum} = [\Lambda/8\pi \cdot G]$ is not definable if $0 < \tilde{a} < 1/\sqrt{\Lambda/3}$, whereas the classically forbidden region for Eq. (8) depends upon $0 < \tilde{a} < \tilde{a}_0$ where $\tilde{a}_0$ is a turning point for Eq. (10) above. Λ is undefined classically, and is a free parameter, of sorts especially in the regime $0 < \tilde{a} < 1/\sqrt{\Lambda/3}$. As $\tilde{a} \to 0$, unless $\Lambda \to 0$, there is no "classical" way to justify the WKB [3] as $\tilde{a} \to 0$.

Causal discontinuity, and Dowkers axiomatic approach to space time physics time in the aftermath of the pre Planckian space time discontinuity

The existence of a nonlinear equation for early universe scale factor evolution introduces a de facto "information" barrier between a prior universe, which can only include thermal bounce input to the new nucleation phase of our present universe. To see this, refer to Dr. Dowker's [6], [11] paper on causal sets. These require the following ordering with a relation $\prec$, where we assume that initial relic space-time is replaced by an assembly of discrete elements, so as to create, initially, a partially ordered set C :

(1) If $x \prec y,$ and $y \prec z,$ then $x \prec z$

(2) If $x \prec y,$ and $y \prec x,$ then $x = y$ for $x, y \;\; \varepsilon \;\; C$

(3) For any pair of fixed elements x and z of elements in C , the set $\{y \mid x \prec y \prec z\}$ of elements lying in between x and z is always assumed to be a finite valued set.

Items (1) and (2) show that C is a partially ordered set, and the third statement permits local finiteness. Now for some claims to consider [3]

CLAIM 1 : The Friedmann equation for the evolution of a scale factor $a(t)$, suggests a non partially ordered set evolution of the scale factor with evolving time, thereby implying a causal discontinuity. The validity of this formalism is established by rewriting the Friedman equation as follows: in 5 dimensions looking at Λ_{5-Dim} going to infinity as time goes to zero. I.e. if $\delta \cdot t$ is vanishingly small, then…

$$\left[\frac{a(t^* + \delta t)}{a(t^*)}\right] - 1 < \frac{\left(\delta t \cdot l_P\right)}{\sqrt{\Lambda_{5-Dim}/3}} \cdot \left[1 + \frac{8\pi}{\Lambda_{5-Dim}} \cdot \left[(\rho_{rel})_0 \cdot 10^{4\alpha} + (\rho_m)_0 \cdot 10^{3\alpha}\right]\right]^{1/2} \xrightarrow[\Lambda 5-\dim \to \infty]{} 0 \quad . \tag{11}$$

So in the initial phases before the big bang, with a very large 5 dimensional vacuum energy and a vanishing 4 dimensional vacuum energy , the following relation, which violates (signal) causality, is obtained for any given fluctuation of time in the "positive" direction within the confines of time evolution within the pre Planckian regime :

$$\left[\frac{a(t^* + \delta \cdot t)}{a(t^*)}\right] < 1 \quad . \tag{12}$$

The existence of such a violation of a causal set arrangement in the evolution of a scale factor argues for a break in information above a minimal level of complexity being propagated from a prior universe to our present universe. This has just proved non-partially ordered set evolution, by deriving a contradiction from the partially ordered set assumption. Doing this, means that in order to cement having uni directionality of the time flow itself, we would need to define a starting flow for time flow, in one direction starting at the instant of space time created by the Planckian unit of time, and not just before it.

Relevance to Octonian Quantum gravity constructions? Where does non commutative geometry come into play ?

We argue that Eq. (11) and Eq. (12) are essential ingredients for starting a non commuting geometry construction of space time. Crowell [1] wrote on page 309 that in his Eq. (8.141) , namely if one is far away from a causal break in space time ordering, and geometry that.

$$\left[x_j, p_i\right] \cong -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar T_{ijk} x_k \to i\hbar \delta_{i,j} \tag{13}$$

Here, β is a scaling factor, while we have, above, after a certain spatial distance, a Kroniker function so that at a small distance from the confines of Planck time, we recover our quantum mechanical behavior. Here, this, as Crowell[1] describes it, is a linkage between Planck scale physics, and the recovery at Planck scale of quantum geometry. His page 308 builds up Eq. (13) as a consequence of a supposed octonionic non association relation, and and an Octonionic product rule. Our contention is, that since Eq. (13) depends upon Energy- momentum being conserved as an average about quantum fluctuations, that if energy-momentum is violated, in part, that Eq. (13) falls apart .Our construction VIOLATES energy – momentum conservation, at least as far as an embedding of a Friedman Equation in 5 dimensions, making use of [6] $|\Lambda_{5-\dim}| \approx c_1 \cdot \left(1/T^{\alpha}\right)$ .and .

$$\frac{\Lambda_{4-\dim}}{|\Lambda_{5-\dim}|} - 1 \approx \frac{1}{n} \quad . \tag{14}$$

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The situation developing if a causal discontinuity is included, in. Break down of QM

As of Eq. (8.140) of Crowell [1] , what is used explicitly, in coming up with Eq. (13). Specifically, what we claim is that the statement of a loop integration, with respect to the De Broglie relation will not hold if we have Eq. (11) in the pre Planckian regime of space time, up to Planck length. I.e. the following will not hold as before.

$$\oint p_i \, dx_k = \hbar \delta_{i,k} \tag{15}$$

no longer holds.

Eq. (8.40) of the Crowell manuscript makes the assumption is true, namely

$$\left[x_j, x_k\right] = \beta \cdot l_P \cdot T_{j,k,l} \cdot x_l \tag{16}$$

The problem is not with Eq. (16), i.e. Crowell's [1] (8.139), it lies with Eq. (8.140) of Crowell with the final equality not necessarily holding. If one were integrating across a causal barrier,

$$\oint [x_j, p_i] dx_k \approx -\oint p_i [x_j, dx_k] = -\beta \cdot l_P \cdot T_{j,k,l} \oint p_i dx_l \neq -\hbar \beta \cdot l_P \cdot T_{i,j,k} \tag{17}$$

Very likely, across a causal boundary, between $\pm l_P$ across the boundary due to the causal barrier, one would have

$$\oint p_i \, dx_k \neq \hbar \delta_{i,k}, \oint p_i \, dx_k \equiv 0 \tag{18}$$

I.e.

$$\left. \oint_{\pm l_P} p_i dx_k \right|_{i=k} \rightarrow 0 \tag{19}$$

If so, then [1]

$$\left[x_j, p_i\right] \neq -\beta \cdot \left(l_{Planck} / l\right) \cdot \hbar T_{ijk} x_k \quad and \quad does \quad not \rightarrow i\hbar \delta_{i,j} \tag{20}$$

Eq. (20) in itself would mean that in the pre Planckian physics regime, and in between $\pm l_P$, QM no longer applies.

Analogue of this sort of break down via string theory language

In Dp brane dynamics, a Dp brane action from a reduced field theory, as given by Szabo, on page 103 of his manuscript is a super symmetric Yang Mills theory on a Dp world volume, involving a Yang-Mills potential as given by [12]

$$V(\Phi) = \sum_{m \neq n} Tr\left[\Phi^m, \Phi^n\right]^2 \tag{21}$$

Here, the $N \times N$ Hermitian matrix fields can be written as, with x_i^m co ordinates giving positions of N distinct D branes in the m-th transverse dimension.

$$\Phi^m = U \cdot \ Diag\left[x_1^m, x_2^m, ..., x_N^m\right] \cdot U^{-1} \tag{22}$$

The Dp branes, we argue, would have no chance of survival in a causal discontinuity regime, i.e. our next paper will discuss the break down of this sort of structure as cited by Szabo [12] . I.e. in the case of p=0, the matrices as given by Eq. (22) are giving a geometrical interpretation in terms of a necessary non commutative geometry, of the sort which breaks down, as implied by Eq. (20) above.

CONCLUSIONS

Our conclusion is that if Eq. (20) is true, that even in the case super symmetric matrix mechanics, that a break down down of the matrix representation of the Yang-Mills potential in terms of Eq. 22 will be to essentially invalidate the structure of instanton D0 branes (points) so one is looking at a situation where , even with super symmetry that there will be no structure duplicating non commutative geometry. Without that geometry, there is no chance, in the regime Pre Plankian space time holds that QM can be utilized. The authors are aware that even, at times, the cosmological parameters used and identified with the cosmological constant are very controversial [13], but we are confident that there is much to explore and learn from, especially about the inter relationship of classical and quantum fields, and a space time linkage between the which we expect will be better understood in the future [5] . This document is a step in that direction. The issues brought up [14] by N.E. Mavromatos_and R.J. Szabo are well done but we view them as \incomplete for the reasons brought up above.

REFERENCES

[1] L. Crowell, "Quantum Fluctuations of Space-time, ," in World Scientific Series in Contemporary Chemical Physics, Volume 25, Singapore, Republic of Singapore, 2005.

[2] L. Kofman, *physics of the early universe, and inflation*, pp 165-232, Les Houches, session Lxxxvi, , 'Particle physics and cosmology, the fabric of space time', editor F. Bernadeau, C. Grojean, J. Dalibard, editors, Elsevier, 2007, Oxford, UK.

[3] A.W. Beckwith, L. Glinka, http://vixra.org/abs/1010.0032, submitted to prespacetime for possible publication

[4] A. W. Beckwith, http://vixra.org/abs/1010.0031, as contribution to the DICE 2010 , Italy proceedings

[5] A. Yu. Kiennikov, Invited lecture, **DICE 2010**, "Quantum mechanics as classical signal theory on noisy background";A. Yu. Kiennikov "Bell's inequality: Physics meets Probability", Information Science **179, N. 5**, 492-504 (2009)

[6] A. W. Beckwith, arXiv:0804.0196 [physics.gen-ph], AIP Conf.Proc.969:1018-1026,2008

[7] Park, D.K., Kim, H., and Tamarayan, S., "Nonvanishing Cosmological Constant of Flat Universe in Brane world Senarios," *Phys. Lett. B* **535**, 5-10 (2002).

[8] Barvinsky, A., Kamenschick, A., and Yu, A., "Thermodynamics from Nothing: Limiting the Cosmological Constant Landscape," *Phy Rev D* **74** 121502, Rapid communications (19 December 2006)

[9] E. Kolb, and S. Turner "The Early Universe", Westview Press, Chicago, USA, 1994

[10] Dalarsson, M., Dalarsson, N., "Tensors, Relativity and Cosmology," Elsevier Academic Press, (2005), Burlington, Massachusetts, USA

[11] F. Dowker , "Causal sets and the deep structure of space-time," in *100 Years of Relativity, Space-Time Structure: Einstein and Beyond*, with Abhay Akshtekar, editor, World Press Scientific, P.T.E., Republic of Singapore, Singapore, 2005, pp. 445-464, arXIV gr-qc/0508109v1 (26 Aug 2005).

[12] R. Szabo, " An Introduction to String Theory and D-brane Dynamics", Imperial College Press, London, UK, 2005

[13] E.B., C. Rovelli, ``*Why all these prejudices against a constant?''* arXiv:1002.3966[astro-ph.CO]

E.B., C. Rovelli & R. Kolb, ``*Is dark energy really a mystery?'' Nature***466**, 321-322 (2010)

[14] N.E. Mavromatos_and R.J. Szabo; *D-branes and the Non-Commutative Structure of Quantum Space Time*, JHEP conference proceedings Corfu Summer Institute on Elementary Particle Physics, 1998