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Does a Restricted Quintic Polynomial in Minimum Time Step (Planck Time Interval) Being Solvable in a Galois Theory Sense Affect the Closing of a Wormhole Throat if (Kaluza Klein Theory) Is Assumed and Impact Admissible Gravitational Wave Polarization?

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Abstract

In a prior paper, the $d = 1$ to $d = 7$ sense of AdS/CFT solutions were described in general whereas we did not introduce commentary as to GW polarization of gravitational radiation from a worm hole. We will discuss GW polarization, for $d = 1$ and in addition say concrete facts as to the strength of the GW radiation, and admissible frequencies. First off, the term Δt is for the smallest unit of time step. Note that in the small Δt limit for $d = 1$ we avoid any imaginary time no matter what the sign of T_{temp} is. And when $d = 1$ in order to have any solvability one would need $X = \Delta t$ assumed to be infinitesimal. To first approximation, we set $X = \Delta t$ as being of Planck time, 10^{-31} or so seconds, in duration.

Keywords

Kerr Newman Black Hole, High-Frequency Gravitational Waves (HGW), Solvable Quintic Equations Wormholes

1. Set up of the Problem: Precursor to Answering Innumerable Issues

We assert that due to the fact that abbreviated math tech approximations to the derived quintic [1] [2] yield incommensurate very different physics answers to the delta *t*, Δt, problem, Note that the 2nd entry into Equation (1) below comes from applying the Gauss-Lucas theorem [3] [4]. In the end, the three different would be general solutions to Δt in these three equations look very different from each other. This is using manipulations of the original quintic as given by the author in [5]

$$\begin{aligned}&(\Delta t)^3 + \frac{2A_1}{5} = 0\\ &\text{different } \Delta t \text{ answer from}\\ &A_1 \cdot (\Delta t)^2 + A_2 = 0\\ &\text{versus needing Galois solution to}\\ &(\Delta t)^5 + A_1 \cdot (\Delta t)^2 + A_2 = 0\end{aligned} \tag{1}$$

We urge readers, from this point on, to skim over the references given in [6]-[14] before going the main point of the paper as given below.

This document will address the problem of a worm hole, as to the question of if its throat is opened or closed [9]. When $d = 1$, we have Kaluza Klein type physics, and so it goes. The Kaluza Klein [15] situation with $d = 1$ is by far and away the easiest situation to work with, and with the least.

2. Two Cases to Consider

The paper confused a prior reviewer who did not understand the references as to negative temperature. Hence, the first main part of the document is with regards to negative temperature [15]. Then the idea of a general solution to a polynomial equation, the quintic [2] [5].

Case 1:

The first one, is for when we have an effective quadratic equation for Δt due to Δt being infinitesimally small. And we are avoiding at all costs having imaginary Δt. *Note that for extra dimensions* $d = 1, 3, 5, 7$, *the coefficient* A_1 *is always less than zero, leading to no requirement for* T_{temp} *to be* < 0.. *If* $d = 0, 2, 4, 6$, *need* $T_{\text{temp}} < 0$ *for coefficient* A_1 *to be less than zero. This conflicts with conditions for general Galois solvability of* $(\Delta t)^5 + A_1 \cdot (\Delta t)^2 + A_2 = 0$. *Note, that special solutions for* $(\Delta t)^5 + A_1 \cdot (\Delta t)^2 + A_2 = 0$ *are easy to obtain, but we are referring to completely general solutions, not specific special case solutions.*

Now for the sign of T_{temp}, in terms of if we have $A_1 < 0$, and we claim this is also convenient as to obtain an easily determined value of, for $d = 1, 2, 3, 4, 5, 6, 7$, and a very small value of Δt

$$(\Delta t)^2 = \frac{16\pi \cdot (\hbar)^2}{\frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3} \cdot \left(\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1} \cdot \frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3} \right)^{-1} \tag{2}$$

Note then that if $d = 1$, as in Kaluza Klein theory, then there are no questions of imaginary time, and also no T_{temp} restrictions. In answer to one of the reviewer's questions, we avoid having imaginary time, hence, this puts restrictions as to the choice of T_{temp}. Ironically, in the case of very small Δt, if d = 1, 3, 5, 7, we have Δt always real valued and setting $T_{\text{temp}} > 0$ is not necessary. *i.e.* negative temperature $T_{\text{temp}} < 0$ may occur. It means, as given in [16] [17] [18] that if we have negative temperature, that we will have positive entropy for black holes. If our worm hole is an extension of a linkage to two black holes, or a black hole and a white hole, then the negative temperature at the "mouth" of the worm hole implies the existence of positive entropy.

Case 2, infinitesimal Δt and d = 1 the Kaluza Klein case.

We then have Δt real valued, and no restrictions on T_{temp}

This is putting a preference in for d = 1 as the Kaluza Klein case avoids multiple pathologies, but in the case that Δt to the fifth power is neglected.

$$(\Delta t)^2 = \frac{16\pi\cdot(\hbar)^2}{\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\cdot\left(\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\right)^{-1}$$
$$\xrightarrow[d=2,4,6\text{ and }T_{\text{temp}}<0]{} -\frac{16\pi\cdot(\hbar)^2}{\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\cdot\left(\frac{n_{\text{graviton count}}}{\left(\frac{4\pi\left|T_{\text{temp}}\right|}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\right)^{-1} \tag{3}$$

i.e. imaginary time, for $d = 2,4,6,\cdots$

Note this cannot happen, *i.e.* imaginary time, for d = 1, 3, 5, 7

Note that in the small Δt limit for d = 1, 3, 5, 7 we avoid imaginary time no matter what the sign of T_{temp} is. And this, plus the connection to the discussion on page 639 about coupling constant, if d = 3, reference [19], page 639 may for infinitesimal Δt lend toward supporting d = 3. This arises because of the AdS/CFT correspondence bought up in [20] [21] which we use. Note also that this makes explicit use of [22] [23] as far as t'Hooft coupling as well.

3. How to Reconcile String Theory Which Is a Quantum Gravity Regime, with Results Which Seem to Be Inconsistent with Quantum Gravity

The author refers the readers to [19], go to page 639 as to the coupling constants used in super Yang Mills theory. *i.e.* in the section "the Coupling constants", [24] write that

Quote, from [19], page 639

"The dimensional effective coupling of super Yang Mills theory in d + 1 dimension is scale dependent. At an energy scale E, it is determined by dimensional analysis to be

$$g_{eff}^2(E) \sim g_{YM}^2 N E^{d-3} \tag{4}$$

This coupling is small, so that perturbation theory applies for large E (the UV) for $d < 3$, and for small E (the IR). The special case of $d = 3$ corresponds to $\mathbb{N} = 4$ super Yang Mills theory in four dimensions, which is known to be a UV finite, conformally invariant theory. In that case, $g_{eff}^2(E)$ is independent of the scale E and corresponds to the t'Hooft coupling constant [22]

$$\lambda \sim g_{YM}^2 N \tag{5}$$

This is the constant which is held constant in the large-N expansion of the gauge theory discussed below.

End of quote from page 639 of [19].

This also insures we need to reference [25] [26] [27] [28] [29] and eventually the infinite quantum statistics by Ng, as given in [30] below.

i.e. in our work, the question of d dependence will be crucial in the application of the T_{temp} to the question of if we have adherence to quantum gravity, via if we need a negative temperature, will show up as follows, namely

However, in our derivation of the quintic polynomial, in [2] we are dependent upon an entropy count based upon infinite statistics counting algorithm based upon entropy being based upon an admitted particle count, *i.e.* $S \sim$ particle count n, as given in [30]. In this sense, our results in terms of removal of the importance of the sign of the temperature, and by extension statistical energy, given in Equation (5) below may make a partial linkage between Equation (5) below, and Equation (4) if we can write $E_{\text{statistical}} = \frac{k_B T_{\text{applied temperature}}}{2} = E$, as an input into Equation (4), with the applied temperature $T_{\text{applied temperature}} = T_{\text{temp}}$

Theorem 1

$$(\Delta t)^5 - \frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1} \cdot \frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3}(\Delta t)^2 + \frac{16\pi \cdot (\hbar)^2}{\frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3} \equiv 0$$

$$\Rightarrow A_1 = -\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1} \cdot \frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3}$$

$$A_2 = \frac{16\pi \cdot (\hbar)^2}{\frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3}$$

$\Rightarrow T_{\text{temp}}$ should be negative if $d = 2,4,6,\cdots$ for $A_1 > 0$

$\Rightarrow T_{\text{temp}}$ does not have to be negative if $d = 1,3,5,7,\cdots$ for $A_1 < 0$

but the solvability requirement for a Galois solution, by [5]

is impossible. And $A_1 < 0$ all the time $A_1 > 0$ (6)

If the removal of the sign of the temperature, as given in T_{temp}, is similar to reducing the importance of the sign of energy, as an input using

$E_{\text{statistical}} = \frac{k_B T_{\text{applied temperature}}}{2} = E$, with E used in Equation (4), we then have a connection with string theory which is in a sense answering the referees objections. This is different from when we have sensitivity as to the sign When $d = 1, 3, 5, \cdots$ we claim then that Equation (5) is in sync with Equation (4) and that especially when $d = 3$ we have the tie in with Equation (5) and Equation (4). And most telling the $d = 3$ case appears to superimpose directly with Equation (5) and the discussion as to what that implies given on page 639 but we rule out $d = 3$, if we are looking at a generalized Galois solution given through Equation (5). This also leads us to examine [31] as well.

Doing this is also equivalent to making use of the infinite quantum statistics quantum counting algorithms as given in [30] and [32].

References [30]-[53] should now be read as far as giving background as to the characteristics of black hole entropy, negative temperatures, and weird quantum and quantum gravity effects which may show up in a full investigation as to if or not quantum effects in particular are relevant to if a $d = 1$ 5 dimensional worm hole, let alone 5 dimensional black hole, as considered may indeed have either classical or quantum gravity characteristics. After doing this long read, and I recommend it, then go to Section 4 and 5 which goes into if we have positive and negative temperatures. Spoilers alert. Negative temperatures have been identified with having an avoidance of negative entropy. If one is using a counting algorithm as to entropy, and one is counting gravitons, as output, then this is a way to keep fidelity with measurable gravitational physics phenomenon. Having said that, on with the rest of this paper. See the next section. This also means issues brought up in [54]-[60] should also be consulted, as well as [61].

4. Answering a Mis Understanding to the Mathematical Solution of a Quintic Polynomial, Which Is Used to Ascertain if $T_{\text{temperature}}$ Is Positive or Negative

First of all, we ask the readers to review Equation (9), and this will be to determine if $T_{\text{temperature}}$ **or positive and this comes from use of [2], *i.e.* we will look at the following Equations (5), Equation (6) and then if Equation (8) holds, Equation (9) below which mandates having $A_1 > 0$** in Equation (5) which then leads to the reviewer finding a trivial solution for

Note that for reasons which will be discussed in terms of its attendant physics in the later part of the manuscript, that for extremely small $(\Delta t)^5$ that in that situation where we have a simple quadratic, that instead of having $A_1 > 0$ we have, instead

Theorem 2

$$A_1 = -\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1} \cdot \frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3} < 0 \quad \text{when we have } (\Delta t)^5 \text{ about zero} \tag{7}$$

This is reflected in a simple general physics solution to

$$-\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}(\Delta t)^2+\frac{16\pi\cdot(\hbar)^2}{\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\equiv 0 \quad (8)$$

If we have non-vanishing $(\Delta t)^5$ the situation changes, and we have then

$$(\Delta t)^5-\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}(\Delta t)^2+\frac{16\pi\cdot(\hbar)^2}{\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\equiv 0 \quad (9)$$

We will avoid the specialized solution, use a general solution, and then state

$$A_1=-\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}>0 \quad (10)$$

when we have $(\Delta t)^5$ still contributing

If Equation (8) no longer holds due to the fact we no longer have a quadratic equation due to $(\Delta t)^5$ not vanishing, we will have to go to, *i.e.* Equation (10), and then the odd situation of what is given below. Let *a* and *b* be nonzero rational numbers. We show that there are an **infinite number of essentially different**, irreducible, solvable, quintic trinomials X^5+ax+b. On the other hand, **we** show that there are only five **essentially different, irreducible, solvable, quintic trinomials** x^5+ax^2+b, namely, by [2] [11]

$$x^5+5x^2+3,$$
$$X^5+5x^2-15,$$
$$X^5+25x^2+300,$$
$$X^5+100X^2+1000, \quad (11)$$
$$\text{and } X^5+250X^2+625.$$

here, $X=\Delta t$, and we change the dimensional scaling of A_1 and A_2, so as to be consistent with Equation (11), and in addition, the *d* in Equation (5) can range in size from *d* = 2, 4, 6 so as to keep our construction consistent with String theory.

If *d* = 1, 3, 5, 7 we have then that we could have then, with T_{temp} either greater than or less than zero, with the odd situation that at *d* = 1, a situation where the sign, and the value of T_{temp} could even be zero itself, *i.e.* as an artifact of Kaluza Klein theory, but then all connection then to Equation (11) would be lost and the following, at *d* = 1 A_1 would always be negative. *i.e.* If *d* = 1, then the following would always be true, (Kaluza Klein theory) and then we would be having

$$A_1=-\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}<0 \quad (12)$$

5. Applying the Gauss-Lucas Theorem

Gauss-Lucas theorem gives a geometrical relation between the roots of a polynomial P and the roots of its derivative P'. *i.e* … If P is a (nonconstant) polynomial with complex coefficients, all zeros of P' belong to the convex hull of the set of zeros of P. [61], and [62] give a good general introduction as to the geometric considerations of the polynomials we are generating here.

Theorem 3, applying Gauss-Lucas theorem to quintic

$$(\Delta t)^3 - \frac{2n_{\text{graviton count}}}{5\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}(\Delta t)^0 = 0$$
$$\Rightarrow (\Delta t)^3 = \frac{2n_{\text{graviton count}}}{5\left(\frac{4\pi T_{temp}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3} \quad (13)$$

Superficially, this imposes the same sort of restrictions upon Δt for d = 1, 3, 5, but then

$$(\Delta t)^2 \equiv \frac{16\pi\cdot(\hbar)^2}{\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\cdot\frac{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}{n_{\text{graviton count}}}$$
$$\Rightarrow (\Delta t) \equiv \left(\frac{16\pi\cdot(\hbar)^2\cdot\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}}{n_{\text{graviton count}}}\right)^{1/2}$$
$$(\Delta t)^3 = \frac{2n_{\text{graviton count}}}{5\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}$$
$$\Rightarrow (\Delta t) = \left(\frac{2n_{\text{graviton count}}}{5\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\right)^{1/3} \quad (14)$$

Theorem 4: Tiny time step, temperature T can either be less than or greater than zero, and no imaginary time.

Again, as indicated by Equation (1) we have that for a very small-time step, for a non-imaginary time, that no matter what the sign of Temperature, T, that

$$(\Delta t)^2 = \frac{16\pi\cdot(\hbar)^2}{\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}\cdot\left(\frac{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}\cdot\frac{4\pi}{3}\cdot\left(\frac{Jc^2}{\hbar}\right)^3}{n_{\text{graviton count}}}\right); d = 1,3,5,\cdots \quad (15)$$

We do not, in the case of very small-time step, have a situation for which temperature T is required to be either positive or negative, hence we reduce this situation to being of the form $\Delta E \Delta t \doteq \hbar$

$$i.e.\ \left(\Delta E\right)^2 = \frac{1}{4\pi} \cdot \left(\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d} \right)^{d-1}} \right); d = 1, 3, 5, \cdots \tag{16}$$

The sign T_{temp} plays no role in the determination of an energy value, other than that this conceivably be the minimum state of a graviton condensate.

Now let us consider what if $d = 1$, *i.e.* Kaluza Klein, *i.e.* then we have

$$\left(\Delta E\right)^2 = \frac{n_{\text{graviton count}}}{4\pi} \cdot \left(\frac{1}{\left(\frac{4\pi T_{\text{temp}}}{d} \right)^{d-1}} \right); d = 1, 3, 5, \cdots \xrightarrow[d=1]{} \frac{n_{\text{graviton count}}}{4\pi} \tag{17}$$

We are then leading to, if we have a distance, we call $a_{\text{gravition}}$.

$$\left[\left(\hbar / a_{\text{graviton}} \right) \cdot c \right]^2 \approx \frac{n_{\text{graviton count}}}{4\pi} \tag{18}$$

If in this situation we have $a_{\text{graviton}} \approx \lambda_{\text{graviton}} \propto 1/\omega_{\text{graviton}}$

$$\begin{aligned} &\left[\left(\hbar / a_{\text{graviton}} \right) \cdot c \right]^2 \propto \hbar \omega_{\text{graviton}} \approx \frac{n_{\text{graviton count}}}{4\pi} \cdot \left(\frac{1}{\left(\frac{4\pi T_{temp}}{d} \right)^{d-1}} \right); d = 1, 3, 5, \\ &a_{\text{graviton}} \approx \lambda_{\text{graviton}} \propto 1/\omega_{\text{graviton}} \\ &\text{if } d = 1 \\ &\left[\left(\hbar / a_{\text{graviton}} \right) \cdot c \right]^2 \propto \hbar \omega_{\text{graviton}} \approx \frac{n_{\text{graviton count}}}{4\pi} \end{aligned} \tag{19}$$

We claim that in the case of $d = 1$ in the situation for which $\left(\Delta t\right)^5 \to 0^+$, that indeed the ground state, as referred to in Equation (19) is a strong indicator of quantum gravity. *i.e.* the zero-point energy is dependent upon a graviton count, $n_{\text{graviton count}}$ We see that in the case of minimum uncertainty in quantum mechanics, Quantum mechanically, the uncertainty principle forces the electron to have non-zero momentum and non-zero expectation value of position. If a is an average distance electron-proton distance, the uncertainty principle informs us that the minimum electron momentum is on the order of $\hbar/a$. *i.e.* if we have the same situation with a presumed graviton, and give it a mass of m_{graviton} infinitesimally small but not zero, and say we have a distance we call $a_{\text{gravition}}$. So, the minimum graviton momentum is

$$p\left(\text{momentum}\right)_{\text{graviton}} \approx \hbar / a_{\text{graviton}} \tag{20}$$

Assume that gravitons are then endowed with mass, and then the mass vanishes

$$\begin{aligned}&\left(p_{\text{graviton}}c\right)^2 = E_{\text{graviton}}^2 - \left(m_{\text{graviton}}c^2\right)^2 \approx \left[\left(\hbar/a_{\text{graviton}}\right)\cdot c\right]^2 \\ &\Rightarrow E_{\text{graviton}}^2 \approx \left[\left(\hbar/a_{\text{graviton}}\right)\cdot c\right]^2 \text{ if } m_{\text{graviton}} \to 0\end{aligned} \tag{21}$$

leads to a minimum energy equation looking like

$$\left[\left(\hbar/a_{\text{graviton}}\right)\cdot c\right]^2 \approx \frac{1}{4\pi}\cdot\left(\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}}\right); d = 1,3,5, \tag{22}$$

The HUP is central to the discussion of if a minimum uncertainty exists. In any stationary state $\langle p\rangle = 0$ or at least is a constant so any system in which there is a stationary state that has a gaussian wave function will have minimum position/momentum uncertainty. One case where this occurs is the ground state of the harmonic oscillator. In the case of a graviton we have that $\lambda\left(\equiv\lambda_{\text{graviton}}\right) = \frac{h}{p}\left(\equiv\frac{h}{p_{\text{graviton}}}\right)$ from the de Broglie hypothesis, we will answer in the last part of the question the final issues of if the quantum condition is due to a minimum uncertainty principle being satisfied. Doing so means that we can, if d = 1, as in the case of Kaluza Klein theory, and 5-dimensional cosmology [5] still stick with $T_{\text{temperature}} < 0$. Other values of d will lead to different situations.

***Theorem* 5**

If we have d = 1, d = 3, d = 5, d = 7 set in AdS/CFT in dimensions, so that $T_{\text{temperature}} < 0$ changing $A_1 > 0$ is NO LONGDER POSSIBLE. We have then no solvability of Equation (2) and Equation (3) hence, then ODD values of d, as given above, lead to SEMI Classical gravity.

Corollary is that then, ODD values of d, lead to SEMI classical treatment of gravity, and we can say then that the Kaluza Klein [5] 5-dimensional treatment is at best SEMI classical.

6. Analyzing When We Have a Very Small $X = \Delta t$

***Theorem* 6**

$X = \Delta t$ very small, so that the first quintic polynomial term being ignorable, leads then to writing:

$$\begin{aligned}&\text{if } \left(\Delta t\right)^5 \approx 0^+ \\ &\left(\Delta t\right)^2 \equiv +6\pi\cdot\hbar^2\cdot\frac{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}}{n_{\text{graviton count}}}\end{aligned} \tag{23}$$

We claim that this is rather than a case of semi classical, versus quantum a case of real and imaginary time, with a preference toward have d = 1, d = 3, d = 5, d = 7 set in AdS/CFT in dimensions, so that $T_{\text{temperature}} < 0$ is not necessary, and then we have the following $d = 1$, $d = 3$, $d = 5$, $d = 7$ to work with, so that we get that small values of the sort with $(\Delta t)^5 \approx 0^+$ lead to, if $d = 1$, $d = 3$, $d = 5$, $d = 7$ then $T_{\text{temperature}} < 0$ is not necessary for real values of Δt, and then we have values of $\Delta E \Delta t \equiv \hbar$, so that ΔE is real valued. Also, then, ΔE is equivalent to *H*, with *H* a Hamiltonian system, *i.e.* a 1-1 and onto linkage then to the Hamiltonian being the same as the total energy of our system. This is in line with Abraham and Mardsen [6], Arnold [7], and Goldstein [8], as well as Spiegel [9] of a condition where the Hamiltonian is equal to the total energy of a system.

7. Conclusion, Relevance to the Problem of the Closed Throat of a Wormhole. And Small to Large Delta t Values

According to applying the criterial of [2] we have that if we look at a worm hole

***Theorem* 7**

$$\begin{aligned} &E_{\text{wormhole}} = -q/8\ell = -(2j+1)\cdot\pi\cdot T_{\text{temperature}}/8 \\ &E_{\text{wormhole}} < 0 \Rightarrow \text{Open wormhole throat} \\ &\Leftrightarrow T_{\text{temperature}} > 0 \Rightarrow \text{Semi Classical} \\ &\Leftrightarrow \text{No quantum gravity if } E_{\text{wormhole}} < 0 \end{aligned} \tag{24}$$

Keep in mind that this is making a connection with a Gravitino, of a very light mass, so as to be congruent with [2], we would have, say a gravitino of about 25 electron volts, *i.e.* see [10] whereas we make the connection to [11] as a link between gravitons and gravitinos, and Mach's theorem.

Note that the following is a generalized version of Mach's theorem which we can refer to in cosmology, *i.e.*

Dickie restatement of Mach's theorem, as given below,

The dimensionless gravitational coupling constant as given by

$\frac{Gm_p^2}{\hbar c} \approx 5\times 10^{-39}$, (1), *i.e.* as a modification of what is given in [53] with $\frac{Gm_p^2}{\hbar c}$ being a constant with m_p the mass of some elementary particle, for definiteness taken as the proton, is such a small number that its significance has long been questioned. Thus Eddington[1] considered that all the dimensionless physical constants, including this one, could be evaluated as simple mathematical expressions. Dirac[2] considered that such an odd number must be related to other numbers of similar size, characterizing the structure of the universe. However, most physicists seem to believe that a dimensionless constant, such as (1), is provided by Nature, cannot be calculated, and is not in any way related to other numbers.

Should this be fleshed out in further generality, we will have the conundrum of addressing for very small delta *t*, Equation (24) in conjunction with Equation (25) below compared to Equation (24) being compared with connections to Equation (23)

$$\text{if } (\Delta t)^5 \approx 0^+, (\Delta t)^5 + A_1\cdot(\Delta t)^2 + A_2 = 0 \Rightarrow (\Delta t)^2 + \frac{A_2}{A_1} = 0 \tag{25}$$

This would $d = 1$, $d = 3$, $d = 5$, $d = 7$ then $T_{\text{temperature}} < 0$ is not necessary for real values of Δt, and then we have values of $\Delta E \Delta t \equiv \hbar$, so that ΔE is real valued. And equal to the Hamiltonian.

***Theorem* 8**

if Equation (25) does not hold, *i.e.* for non-negligible delta t

if $d = 1$, $d = 3$, $d = 5$, $d = 7$ then $T_{\text{temperature}} < 0$, and then

1) $E_{\text{wormhole}} = -q/8\ell = -(2j+1)\cdot\pi\cdot T_{\text{temperature}}/8 > 0$, HENCE the worm hole throat is closed.
2) We also do not have classical gravity if 1) is true. *I.e.* we can have quantum gravity.
3) Open throat worm hole means we assume semi classical gravity.

Else

if Equation (25) does hold, *i.e.* for negligible delta t, then if $d = 1$, $d = 3$, $d = 5$, $d = 7$ then $T_{\text{temperature}} < 0$ IS NOT NECESSARY, for real values of Δt, and then we have values of $\Delta E \Delta t \equiv \hbar$, so that ΔE is real valued. And equal to the Hamiltonian. Note then if $T_{\text{temperature}} < 0$ IS NOT NECESSARY for quantum gravity and then $E_{\text{wormhole}} = -q/8\ell = -(2j+1)\cdot\pi\cdot T_{\text{temperature}}/8 < 0$ and we have an open worm hole throat. *I.e.* for very small Δt it is easy to come up with real values of Δt, and non-imaginary ΔE and it's easy to obtain $E_{\text{wormhole}} = -q/8\ell = -(2j+1)\cdot\pi\cdot T_{\text{temperature}}/8 < 0$ for an OPEN worm hole throat. Finally, the reference [9] by C. A. Pickett and J. D. Zunda gives an area calculation which neatly fits into [10] and [11], whereas there is in [10] a precise calculation of entropy which also has an area to volume identification for black holes and entropy calculations. We close after all of this in stating that the energy, will be part of ΔE, as in the usual Heisenberg Uncertainty relationships, $\Delta E \Delta t \geq \hbar$, whereas we take the minimum condition of uncertainty by writing $\Delta E \Delta t \equiv \hbar$ [12], and [13] confirms that indeed we have that use of minimum uncertainty in terms of data analysis has a long history if done correctly. Keep in mind that we do an abbreviation of

$$\Delta E \equiv mc^2 = \hbar/\Delta t \Rightarrow m = \hbar/c\Delta t \tag{26}$$

This will allow us to obtain, in entropy a polynomial which we identify as $(\Delta t)^5 + A_1 \cdot (\Delta t)^2 + A_2 = 0$. The exact solution of this analysis, in terms of [2] will then form the basis of our analysis of if we have classical gravity, or quantum gravity, in terms of necessary conditions. Before proceeding it is useful to read the background in [54]-[67] before we get to the several sets of conclusions which will be generated below.

8. First Level Conclusion. *i.e.* a Necessary Condition for Quantization of Induced Kerr Newman Black Hole. Assuming a Worm Hole Is a Join between Two Kerr Newman Black Holes

We first of all need to have a "negative" temperature. *I.e.* is this doable?

Both these conditions would be a NECESSARY condition for satisfying in terms of reference [5].

$(\Delta t)^5 + A_1 \cdot (\Delta t)^2 + A_2 = 0$ which we state would be due our construction a necessary condition for a complete quantum gravity analysis of gravitons being emitted from a Kerr-Newman black hole. We state that these two points have to be determined and investigated, and also that an optimal value of d, for dimensions for a problem, involving Kerr Newman black holes would have to be ascertained in future research. Finally, we refer the reader to references [66]-[72] or additional ideas which may be used in future projects. Note also that Valev wrote [73]

$$\lambda_{\text{graviton}} \sim \frac{h}{m_{\text{graviton}} \cdot c} \tag{27}$$

and Valev indicates in his article that this gives a light year, or more length GW of unimaginably low frequency. Obviously, in terms of experimental conditions, this breaks down, *i.e.* in the limit of say a simulated worm hole in a laboratory, so it would be useful to find ways to experimentally test and vet Equation (27) in our review of basics. Keep in mind, too, what is in the answer to my answer to the reviewers first question. *i.e.* S (entropy) ~ n (graviton count) is put in directly into the derivation of Equation (5). There is no way to guarantee. S (entropy) ~ n (graviton count) being positive as to two black holes at the two ends of a worm hole. *i.e.* that is one of the wormhole configurations. Unless one has NEGATIVE temperature. *I.e.* see the discussion of the text on this, and that ties in directly with the sign of A_1, as given in

$$A_1 = -\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{temp}}{d}\right)^{d-1} \cdot \frac{4\pi}{3} \cdot \left(\frac{Jc^2}{\hbar}\right)^3} < 0 \quad d \neq 1 \tag{28}$$

The $d = 1, 3, 5, \cdots$ cases have a different behavior than what is in d = 2, 4, 6… when we are looking at Equation (5) it really hits home. we have that we want a minimum energy to depend upon graviton count, with that process being inherently quantum nature of gravity.

The d = 1 case, as with having $(\Delta E)^2 = \frac{1}{4\pi} \cdot \left(\frac{n_{\text{graviton count}}}{\left(\frac{4\pi T_{\text{temp}}}{d}\right)^{d-1}} \right); d = 1, 3, 5$. *i.e.* if d = 1, our minimum uncertainty, which is solvable then will be giving us functional linkage to gravity and gravitons. As well as some of the issues in [74] and [75].

9. Looking at Polarization from Higher Level Dimensions, with *d* = 1 Kaluza Klein Representation Our Example

In [74] the authors in 2014 claim that above d = 1 that one does not have the possibility of a worm hole. *i.e.* note this in their statement

Quote:

We have observed that the wormhole solutions exist only in four and five di-

mension, however, higher than fine dimension no wormhole exists. For five dimensional spacetime, we get a wormhole for a restricted region.

End of quote

To whit, we have that [75]

Quote

In the induced-matter picture, the fluid does not satisfy the strong energy conditions, but its gravitational mass is positive.

End of quote

[76] has that

Quote, page 2,

To set some basic nomenclature, the pointwise energy conditions of general relativity are: 1, 2, 3 *Trace energy condition* (*TEC*), *now abandoned. Strong energy condition* (*SEC*), *almost abandoned. Null energy condition* (*NEC*). *Weak energy condition* (*WEC*). *Dominant energy condition* (*DEC*)

End of quote

The Strong energy condition so mentioned is given in [77] is that gravity is allegedly always positive in general relativity, *i.e.* is given, page 195 as

$$\left(T_{ab}-\frac{T}{2}g_{ab}\right)V^{a}V^{b}\geq 0 \tag{29}$$

This condition is held to, in this situation to be violated. But then we have a positive gravitational mass. *i.e.* meaning as we call it, that the gravitons will be positive mass in value, whereas we have negative energy densities. Which is commensurate with the theorems which we have brought up. *i.e.* see [78] as given in JHEPGC

Note that in [76] we have that

Quote

Many researchers simply decided to ignore quantum mechanics, relying on the classical NEC to prevent grossly weird physics in the classical regime, and hoping that the long sought for quantum theory of gravity would eventually deal with the quantum problems. This is not a fully satisfactory response in that NEC violations already show up in semiclassical quantum gravity (*where you quantize the matter fields and keep gravity classical*), *and show up at first order in ¯h. Since semiclassical quantum gravity is certainly a good approximation in our immediate neighborhood, it is somewhat disturbing to see widespread* (*albeit small*) *violations of the energy conditions in the here and now.*

We should also refer to [77] for what we will be doing next. Before all that, consider the following.

Now for polarization there are two issues to be raised here. We are arguing that the violation of the NEC is linked toward powering the following estimates as to strength of gravitational wave signals, the admissible frequency, and also the luminosity of the signal which may be created by a worm hole bridge say between a black hole and a white hole. Note that from [78], and [79] if r is the distance from a worm hole to the Earth, or the site of measurement of the signals from a GW generating object, with what we call $M(\text{total mass})$ affects the polarization state conditions as to 5 dimensions

$$\begin{aligned} & h(\text{strength of GW signal}) \\ & \sim \frac{M(\text{total mass})}{r} \cdot \frac{M(\text{total mass})}{R(\text{spatial radii of GW source})} \end{aligned} \tag{30}$$

Also

$$\omega^2(\text{GW frequency}) \sim \frac{M(\text{total mass})}{\left[R(\text{spatial radii of GW source})\right]^3} \tag{31}$$

In addition there is also a luminosity ζ of this GW source to consider, as given by

$$\zeta \sim \left(\frac{M(\text{total mass})}{\left[R(\text{spatial radii of GW source})\right]}\right)^5 \tag{32}$$

As given in [79], and [80] and [81] any given system of GW beyond just the standard polarization we will be working with will involve, among other things, looking at some of the phenomenology given in [82] which has to be compared with [83] [84], and [85]. If we have a transversable worm hole as given in [86].

Quote

We construct a nearly-AdS2 solution describing an eternal traversable wormhole. The solution contains negative null energy generated by quantum fields under the influence of an external coupling between the two boundaries.

i.e. we are referring to negative energy as to the throat regime. *i.e.* we have specified conditions as to negative energy, and done it in our theorems given above. As to negative energy, we argue that one simple way to do it, is to make the following identification, *i.e.*

$$\begin{aligned} & E(\text{wormhole throat}) \propto \frac{k_B \cdot T(\text{wormhole throat})}{2} \leq 0 \\ & \text{if } T(\text{wormhole throat}) \leq 0 \end{aligned} \tag{33}$$

Using the guise of Equation (32) we follow the following identification as given, namely from [79] the luminosity is given a luminosity signal strength of

$$\begin{aligned} \zeta & \sim \left(\frac{M(\text{total mass})}{\left[R(\text{spatial radii of GW source})\right]}\right)^5 \\ & \equiv v^{10}(\text{dynamical velocity of system}) \\ & \doteq \left(\frac{M(\text{total mass})}{\left[R(\text{spatial radii of GW source})\right]}\right)^{10/2} \end{aligned} \tag{34}$$

hence note the following from use of [87] and [88]

$$\begin{aligned} & v(\text{graviton}) = c \cdot \sqrt{1 - \frac{m(\text{graviton})^2 c^4}{\left(\hbar \cdot \omega(\text{graviton})\right)^2}} \\ & \& \ \ m(\text{graviton}) \leq 7.7 \times 10^{-23} \text{ eV}/c^2 \end{aligned} \tag{35}$$

Our big idea, is as follows, namely that we can make the following approximation,

$$\begin{aligned}
&v(\text{graviton}) = c\cdot\sqrt{1-\frac{m(\text{graviton})^2 c^4}{(\hbar\cdot\omega(\text{graviton}))^2}} \\
&\approx \left(\frac{M(\text{total mass})}{[R(\text{spatial radii of GW source})]}\right)^{1/2} \\
&\& \ m(\text{graviton}) \le 7.7\times10^{-23}\ \text{eV}/c^2 \\
&\& \ [R(\text{spatial radii of GW source})] \\
&\approx \text{bounded if total mass} = M(\text{total mass}) \\
&\text{is specified}
\end{aligned} \tag{36}$$

Keep in mind that we should have the graviton mass as commensurate with the LIGO result as given in [89] [90] and [91] with $m_{\text{graviton}} \le 5\times10^{-23}\ \text{eV}/c^2$. This should be in fidelity with the above equations.

Also keep in mind the following. If we make the following Planckian approximation, *i.e.* that $\hbar = c = k_B = l(\text{Planck}) = 1$ [88].

Given in Equation (36) we have specified a bound to the individual graviton mass, this is a way to get a specification as to the GW/Graviton frequency, for a 5 dim wormhole, a.k.a. Kaluza Klein style negative temperature for the worm hole.

$$\begin{aligned}
&v(\text{graviton}) = \sqrt{1-\frac{m(\text{graviton})^2}{(\omega(\text{graviton}))^2}} \\
&\approx \left(\frac{\left(M(\text{total mass}) = (1/2)\cdot|T(\text{wormhole throat temperature})|\right)}{[R(\text{spatial radii of GW source})]}\right)^{1/2} \\
&\Rightarrow \frac{m(\text{graviton})^2}{(\omega(\text{graviton}))^2} \approx 1-\frac{\left((1/2)\cdot|T(\text{wormhole throat temperature})|\right)}{[R(\text{spatial radii of GW source})]} \\
&\quad \text{if } T(\text{wormhole throat}) \le 0 \\
&\quad h(\text{strength of GW signal}) \\
&\quad \sim \frac{M(\text{total mass})}{r}\cdot\frac{M(\text{total mass})}{R(\text{spatial radii of GW source})} \\
&\quad \sim \frac{(1/4)\cdot|T(\text{wormhole throat temperature})|^2}{r\cdot R(\text{spatial radii of GW source})}
\end{aligned} \tag{37}$$

We then have the following form of scaling,

$$\begin{aligned}
&h(\text{strength of GW signal}) \propto 10^{-25} \sim \frac{(1/4)\cdot 10^{-2\delta}}{r\cdot R(\text{spatial radii of GW source})} \\
&\Rightarrow R(\text{spatial radii of GW source}) \approx 4\times10^{25}\,10^{2\delta}/r \\
&\text{if } r \propto 10^{\beta}\times l_{\text{Plank}} \xrightarrow[\text{Planck units}]{\text{in normalized}} 10^{\beta} \\
&\Rightarrow R(\text{spatial radii of GW source}) \approx 4\times10^{25}\times10^{2\delta-\beta}
\end{aligned} \tag{38}$$

Due to

$$\begin{aligned}&\left|T\left(\text{wormhole throat temperature}\right)\right|\propto 10^{-\delta}T\left(\text{Planck}\right)\\&\&\ T\left(\text{Planck}\right)\approx 1.416808\left(33\right)\times 10^{32}\ \text{K}\xrightarrow[\text{Planck units}]{\text{in normalized}}1\\&\&\ \left|T\left(\text{wormhole throat temperature}\right)\right|\propto 10^{-\delta}T\left(\text{Planck}\right)\xrightarrow[\text{Planck units}]{\text{in normalized}}10^{-\delta}\end{aligned} \tag{39}$$

Now how does this relate to polarization? To see this, r = distance to Earth, and also $h\left(\text{strength of GW signal}\right)\propto 10^{-25}$, and using Planck units, we have say that we review the comments made in [89] to the effect that

Quote

we find: a massless wave with an additional polarization, the breathing mode, and extra waves with high frequencies fixed by Kaluza-Klein masses. We discuss whether these two effects could be observed.'

End of quote

Our idea here is that we look at Equation (3.25) of [89]

$$h_{ij}^{k\neq 0}\left(t\right)=\begin{pmatrix}h^{+}-\dfrac{h^{l,O}}{2} & h^{\times} & h_1^l\\ h^{\times} & -h^{+}-\dfrac{h^{l,O}}{2} & h_2^l\\ h_1^l & h_2^l & h^{l,O}\end{pmatrix}_{ij}\cdot\cos\left(m_k\cdot c^2\cdot t\right) \tag{40}$$

here, h^{+} and $h^{\times}$ are standard transverse modes, seen in places like Maggiore, [87] while h_1^l and h_2^l are two purely longitudinal ones as given in [90]. Also, $h^{l,O}$ are mixed modes as described in [89] as breather modes. See [89] for a full development as given in page 17 of [89].

here, where the angular frequency is given by $m_k\cdot c^2$ which has as we relay it the following interpretation. Namely

$$m_k\cdot c^2\approx\left|T\left(\text{wormhole throat temperature}\right)\right|\propto 10^{-\delta}T\left(\text{Planck}\right)\xrightarrow[\text{Planck units}]{\text{in normalized}}10^{-\delta} \tag{41}$$

It is important to note that Corda in [90] also gave a fully developed version of polarization which is in some ways different from this above, We will return to his system, in [90] as it is very sophisticalted and complimentary and improving the suggestions given above, and its application will be part of the future works session of our manuscript. [91] also makes an appearance due to the fact that gravitons due to the fact that Gravitons have to obey the gravitational wave restraints elucidated in [91]

Having said this, we will also return to discuss in part what was raised by Dr. Wen Hao and Dr. Fangyu Li, as far as polarization [81] which is an extension of all this and get to another issue, immediately, which is how what we have been talking about which is something which is imminently solvable, if we look at what Equation (41) is taking about, namely the cosmological constant problem, which is inheriently solvable in this milieu if we consider the role of negative temperature, in it. Note that we also are looking at [92] and [93] before going to the next section.

10. Resetting the Cosmological Constant Problem, from First Principles

In, [94] and [95] we had that by using a comparison between two first integrals of initial space time that we can consider having

$$\begin{aligned} S_2 &= \int_0^T \mathrm{d}t \cdot \left[p(t)\dot{q}(t) - H_N\left(p(t), q(t)\right)\right] \\ &\approx S_1 = \frac{1}{2\kappa}\int \sqrt{-g} \cdot \mathrm{d}^4 x \cdot (\Re - 2\Lambda) \end{aligned} \tag{42}$$

That, after a certain amount of work we have in the initial phases of the universe, a cosmological constant of the following namely, Our assumption is that Λ is a constant, hence we assume then the following, *i.e.* a Pre Planckian-instant of time, say some power of Planck Time length, hence getting the following approximation. If N is the actual boundary of a potential well specifying Pre Planckian to Planckian physics, we then write [94] [95]

$$\Lambda \approx \frac{-\left[\dfrac{V_0}{3\gamma - 1} + 2N + \dfrac{\gamma \cdot (3\gamma - 1)}{8\pi G \cdot \tilde{t}^2}\right]}{\dfrac{1}{\kappa}\int \sqrt{-g} \cdot \mathrm{d}^3 x} + \left(6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a}\right)^2\right)\right)\Bigg|_{t=\tilde{t}} \tag{43}$$

In doing this, the following approximations have to be kept in mind, namely that

$$\begin{aligned} & S_1 = \frac{1}{2\kappa}\int \sqrt{-g} \cdot \mathrm{d}^4 x \cdot (\Re - 2\Lambda) \\ & \& \ -g = -\det g_{uv} \\ & \& \ \Re = 6 \cdot \left(\frac{\ddot{a}}{a} + \left(\frac{\dot{a}}{a}\right)^2 + \frac{\aleph}{a^2}\right) \end{aligned} \tag{44}$$

Also, the variation of $\delta g_{tt} \approx a_{\min}^2 \phi$ as given by [93] will have an inflaton, ϕ given by [93] [94] [95] which also has connections with issues in [96] [97], and [98]

$$\begin{aligned} & a \approx a_{\min} t^{\gamma} \\ & \Leftrightarrow \phi \approx \sqrt{\frac{\gamma}{4\pi G}} \cdot \ln\left\{-\sqrt{\frac{8\pi G V_0}{\gamma \cdot (3\gamma - 1)}} \cdot t\right\} \\ & \Leftrightarrow V \approx V_0 \cdot \exp\left\{-\sqrt{\frac{16\pi G}{\gamma}} \cdot \phi(t)\right\} \end{aligned} \tag{45}$$

This should be understood as to be for the beginning of the universe, and the comparison with worm holes and black holes can be visualized by looking at, say the entropy as given in [96], where the initial entropy of the universe is similar to the entropy of a black hole, and then also [97] which allows us using worm holes to make a conceptual linkage between a worm hole and say a black hole, whereas the usual idea is that a worm hole may connect a black hole and a white hole, as given in [98], and for starters we refer to the readers to the possibilities inherent in all those as given in [99] [100], and [101].

11. And How Torsion May Play a Role in Setting Subtraction of Negative Energy from an Enormous Cosmological Constant

In [102], and [103] there is an effective Torsion generated term for an effective cosmological constant which is written as

$$\Lambda(\alpha) = \Lambda_0 - \alpha \cdot k \cdot \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] \tag{46}$$

Here according to [102] we would be seeing

$$\rho_{\text{vacuum}} = \left[\Lambda(\alpha) \doteq \Lambda_{\text{eff}}\right]\cdot\left[c^4/8\pi G\right] \xrightarrow{?} 10^{-122}\Lambda_{\text{Planck}} \tag{47}$$

If so then the following comes up as far as scaling and the good news is that the subtraction as so indicated may be linked to the existence of negative temperature at the early phases of the worm hole as given in this document earlier.

$$\begin{aligned}
&\Lambda(\alpha) \doteq \Lambda_{\text{eff}} = \Lambda_{\text{Planck}} - \alpha \cdot k \cdot \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] = 10^{-122}\Lambda_{\text{Planck}} \\
&\Rightarrow 10^{-122}\Lambda_{\text{Planck}} = \Lambda_{\text{Planck}} - \alpha \cdot k \cdot \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] \\
&\Rightarrow \alpha \cdot k \cdot \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] \doteq \Lambda_{\text{Planck}}\cdot\left(1-10^{-122}\right) \\
&\Rightarrow \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] \doteq \Lambda_{\text{Planck}}\cdot\left(\left(1-10^{-122}\right)/\alpha\cdot k\right) \\
&\Rightarrow \left(r_{\min}/l_{\text{Planck}}\right) \doteq -\left(3\pi^2/4\right)^{-1}\cdot\log\left[\Lambda_{\text{Planck}}\cdot\left(\left(1-10^{-122}\right)/\alpha\cdot k\right)\right]
\end{aligned} \tag{48}$$

Coleman in [104] as given in [102], page 26, had an argument purportedly having instead of a scaling of $10^{-122}\Lambda_{\text{Planck}} = \Lambda(\alpha)$, of instead having $\Lambda(\alpha)$ set to zero. In our argument we will argue, instead for having a negative temperature for the wormhole throat doing the following

$$\begin{aligned}
&\Lambda_{\text{Planck}} - \alpha \cdot k \cdot \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] \doteq \Lambda_{\text{eff}} \\
&= \Lambda_{\text{Planck}} - \frac{k_B}{2l_{\text{Planck}}^3}\cdot\left|T_{\text{wormhole throat}}\right| \\
&\frac{k_B}{2l_{\text{Planck}}^3}\cdot\left|T_{\text{wormhole throat}}\right| = \alpha \cdot k \cdot \exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right]
\end{aligned} \tag{49}$$

In our situation, we will assume that the radial distance, *i.e.* an additional parameter from a form of the Kaluza Klein style metric, as given by [105] which the authors of [105] call a Cannonical metric, for which we have an effective projection of the fourth spatial component of the KK metric, and which we call this fourth dimension our effective $r_{\min} = \ell$, and for which [105] has

$$\begin{aligned}
&r_{\min} = \ell \\
&\mathrm{d}S_5 = \left(\frac{\ell}{L}\right)^2 g_{\alpha\beta}\mathrm{d}x^\alpha \mathrm{d}x^\beta \pm \mathrm{d}\ell^2 \\
&\Lambda = \mp 3/L^2
\end{aligned} \tag{50}$$

In otherwise, in Equation (49) we are in effect taking the imprint of the fourth spatial dimension, into the worm hole and setting an observable linkage of this imprint by setting $r_{\min} = \ell$ which is in effect similar to what is being done in

Equation (40), and for an analogy with our work as [91] [92], and [93], as well as thems which will be part of [94] [95], and [96].

We then lead the reader with the following set of equivalence analogies to consider. *I.e.* this is in lieu of the embedding in Equation (50)

$$\text{if } \Lambda \approx \frac{-\left[\frac{V_0}{3\gamma-1}+2N+\frac{\gamma\cdot(3\gamma-1)}{8\pi G\cdot\tilde{t}^2}\right]}{\frac{1}{\kappa}\int\sqrt{-g}\cdot \mathrm{d}^3x}+\left(6\cdot\left(\frac{\ddot{a}}{a}+\left(\frac{\dot{a}}{a}\right)^2\right)\right)\Big|_{t=\tilde{t}}$$

$$\text{and } \left(6\cdot\left(\frac{\ddot{a}}{a}+\left(\frac{\dot{a}}{a}\right)^2\right)\right)\Big|_{t=\tilde{t}} \leftrightarrow \Lambda_{\text{Planck}}$$

$$\text{and } \frac{-\left[\frac{V_0}{3\gamma-1}+2N+\frac{\gamma\cdot(3\gamma-1)}{8\pi G\cdot\tilde{t}^2}\right]}{\frac{1}{\kappa}\int\sqrt{-g}\cdot \mathrm{d}^3x} \leftrightarrow -\frac{k_B}{2l_{\text{Planck}}^3}\cdot\left|T_{\text{wormhole throat}}\right|$$

Does the following hold?

$$\frac{-\left[\frac{V_0}{3\gamma-1}+2N+\frac{\gamma\cdot(3\gamma-1)}{8\pi G\cdot\tilde{t}^2}\right]}{\frac{1}{\kappa}\int\sqrt{-g}\cdot \mathrm{d}^3x} \leftrightarrow -\alpha\cdot k\cdot\exp\left[-\left(3\pi^2/4\right)\cdot\left(r_{\min}/l_{\text{Planck}}\right)\right] \tag{51}$$

If so then does the following hold?

$\Lambda = 10^{-122}\Lambda_{\text{Planck}}$?

The answer is, MAYBE but it will take a lot more work to do to show it. If aa an example, the beginning of the universe, is, say a product of a wormhole ejection of space time matter into the present cosmos, then the identification may be very exact, pending future investigations.

12. Open Problem, How Do the Ideas of Equation (40) Tie in With Reference [81]?

For reference [81] the first equation offered is of the following form

$$h_{uv}(t)=\begin{pmatrix}0 & 0 & 0 & 0\\ 0 & A_{\oplus}+A_b & A_{\otimes} & A_x\\ 0 & A_{\otimes} & -A_{\oplus}+A_b & A_y\\ 0 & A_x & A_y & \sqrt{2}A_l\end{pmatrix}_{uv}\cdot\exp\left(ik_g z-i\omega_g t\right) \tag{52}$$

Re-statement of Equation(40)

$$h_{ij}^{k\neq0}(t)=\begin{pmatrix}h^{+}-\frac{h^{l,O}}{2} & h^{\times} & h_1^l\\ h^{\times} & -h^{+}-\frac{h^{l,O}}{2} & h_2^l\\ h_1^l & h_2^l & h^{l,O}\end{pmatrix}_{ij}\cdot\cos\left(m_k\cdot c^2\cdot t\right) \quad \text{(40) reproduced}$$

i.e. we will compare the terms in these two sets of equations and make comments as to inputs from the worm hole.

First, re set Equation (52) as a 3 by 3 matrix.

Equation (52) reduced looks like

$$h_{uv}(t)\Big|_{\text{restricted}} = \begin{pmatrix} A_{\oplus} + A_b & A_{\otimes} & A_x \\ A_{\otimes} & -A_{\oplus} + A_b & A_y \\ A_x & A_y & \sqrt{2}A_l \end{pmatrix}_{uv} \cdot \exp\left(ik_g z - i\omega_g t\right) \tag{53}$$

$\oplus$, $\otimes$, *x*, *y*, *b* and *l* represent as given by [81], *i.e.*

$\oplus$-type, $\otimes$-type polarizations (tensor-mode gravitons), [81]

x-type, *y*-type polarizations (vector-mode gravitons), [81]

b-type and *l*-type polarizations (scalar-mode gravitons), respectively. [81].

In addition we should pay attention to the physics problems brought up in [106] [107] and [108] before examining the role of gravitons with Photons which we reference in [109].

Notice that a completely independent linkage of gravitons with Photons is brought up in [109] but which may be a parallel development worth investigating, as it relates to Lorentz symmetry breaking.

For Tensor type of polarizations, the best reference is, say [80] and also [110] and the best visualization of Tensor GW polarization is in page 953, on the Figure 35.2 of [110]. Where the claim is made in [110] on page 957, that the typical carrying energy of GW via THIS representation is in

$$T_{tt}^{(GW)} \equiv T_{zz}^{(GW)} = -T_{tz}^{(GW)} = \frac{1}{32\pi} \cdot \omega_g^2 \cdot \left(A_{\oplus}^2 + A_{\otimes}^2\right) \tag{54}$$

In [109], we have that gravitons and electromagnetics may be inter related, for reasons linked to symmetry breaking

It so happens that this energy carrying presentation is given by massive gravitons, at least in how [81] views it, and this has a linkage to electromagnetic radiation which is commented upon in [81] which forms the center piece of analysis of how this GW radiation could be measured.

In [81], we have that there is a very noticeable effect as given by the final accumulation phase modification $\Delta\Phi f$ caused by the HFGWs (gravitons) and the EM signals (perturbative photon fluxes, see below) can be given by:

$$\Delta\Phi f \approx m_{\text{graviton}}^2 \Big/ \omega_{\text{graviton}} \tag{55}$$

This is the starting of the procedure given in [81] as far as how to detect the signal imprint of massive gravitons in a detector, with the graviton mass extremely small, and the frequency of at least the order of 1 Giga Hertz, or higher.

It is worth noting that in a similar fashion, [109] also discusses Gravitons and Photons, in a manner possibly linked to Lorentz symmetry breaking.

i.e. this means that we have to ascertain what is the frequency given by a worm hole, for GW, and what the upper bound for massive graviton mass is, as generated by the worm hole. We will comment upon this next, in our conclusions. This also is part of [110].

13. Conclusions and a Summary as to Where This May Be Headed

If the worm hole is not conflated as being at the start of cosmological evolution, and is not red shifted downward by 10^{-29} by 60 e folds of inflationary expansion [111] we have say a frequency of about 10 Giga Hertz, for GW and perhaps a signal strength of $h \sim 10^{-25}$ or so which would be within the observational constraints of the [109] detector scheme.

If this is in a laboratory setting as in an artificial worm hole, which the author has talked about with colleagues in Dice 2018, in Italy, the main constraint to keep in mind is [if one is constrained to an artificial simulation or worm holes in space time not within the Electroweak regime or earlier, which would avoid the problem of red shift dropping the admitted GW frequencies].

The main issue to answer is, do we have classical or Quantum effects in the case of negative temperature being positive in the regime of a worm hole throat.

The technology for a possible worm hole detection may ultimately lie in the measurement protocols as outlined by [109] in the case of astrophysical wormholes. In the case of the laboratory, a variant of [111], or maybe something even more exotic may be called for. The only sure ascertaining of the facts of this matter awaits astrophysical data sets in the future. Keep in mind that there is a stated road map as to what may allow for Quantum Gravity. This is what now needs to be discovered, via experimental inquiry. And in doing so, we may via further research benefit from the mathematical techniques which may be of some use as far as generalization of worm holes, as connecting say two black holes, or a black hole-white hole combination.

It is useful once again to go to the Corda interferometry polarization article, [90] which has also that:

Quote

Finally, if a longitudinal response function will be present, *i.e.* Equation (25) for a wave propagating parallel to one interferometer arm, or its generalization to angular dependences, we will learn that the correct theory of gravity will be massive Scalar-Tensor Gravity which is equivalent to f(R) theories. In any case, such response functions will represent the definitive test for General Relativity. This is because General Relativity is the only gravity theory which admits only the two response functions (2) and (19) [4] [7] [17] [18]. Such response functions correspond to the two "canonical" polarizations $h+$ and $h\times$. Thus, if a third polarization will be present, a third response function will be detected by GWs interferometers and this fact will rule out General Relativity like the definitive theory of gravity.

End of quote

Keep in mind that the readers are enjoined to consider that Equation (25), Equation (2), and Equation (19) are for [90] and do not correspond to equations in OUR document. Likewise, the quoted section has [4] [7] [17] [18] whereas we for completeness will be rereferred to as [112] [113] [114] [115].

Our final question, is do the addition of polarization states as given in [81] as presaged by Dr. Hao and Dr. Li reinforce the conclusion of Dr. Corda, in [90], as to additional polarization states presaging an abandonment of GR, and does our own referencing of additional polarization states do the same?

This should be solved in a future publication.

We also state for the record that the answering of this issue will be of extreme relevance as to the inquiry goals as stated in the abstract, as far as open and closed wormhole throats.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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