Emergent Cosmological Constant from a Holographic Mass/Energy Distribution

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Abstract

A new methodology is introduced suggesting that an exact cosmological constant is theoretically and numerically derived and described as the squared ratio of Planck length and the particle horizon radius. Additionally, equations relating the sterile neutrino mass, Planck mass and mass of the universe are established. Furthermore, the mass of the universe can be derived as encoded information located on the cosmic horizon. Finally, a relationship of the Hubble radius and comoving radius is reviewed. This hypothesis is tested for convergence for an overall flat curvature using the Friedmann equations.

Keywords: cosmological constant, dark energy, friedmann equations, hubble radius, comoving radius, hubble constant

1 Introduction

A new model is introduced which satisfies the Friedmann equations for a flat universe without the contribution of dark matter. Recent researches such as MOND [12] and quantized inertia [10] suggest dark matter is an effect and not an actual substance (material, real particle). Therefore, the contribution of the dark matter particle as part of the deSitter models (matter dominated fields) for the universe curvature might be relevant. The standard approach considers dark energy as compensating for a matter dominated deSitter dictated curvature of the universe. This results in a theoretically flat cosmos by adjusting the relevant density parameter. From the standard model in recent years, it has been found that the cosmological constant has an actual value and is not a theoretical artifact [13] [14]. The present value of the cosmological constant is significantly small and only slightly contributes in addition to the expansion effect of the Hubble parameter. In this paper the cosmological constant is suggested to be correlated to the smallest quantized energy oscillation (longest wavelength) that could span the particle horizon. This is a similar situation to the confinement situation of an electron in a box. Investigated by both Hawking and Unruh, the model(s) under discussion include the consideration that the particle horizon is an information boundary

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which influences the conditions of virtual particles due to effects at the horizon. With regards to the cosmic particle horizon with equivalent or similiar properties of an event horizon due to a mass effect or acceleration, certain aspects may influence the field as described by the concept of virtual particles. With the concept of an information boundary, the particle horizon coordinate is suggested to be a carrier of mass/energy (as similar to a black hole entropy is available at that coordinate). Here, the mass equivalence allocation by a holographic energy encoding which is similar to the concept that correlates entropy to and event horizon surface influences the confinement within the information boundary and establishes a holographic energy allocation. This is equivalent to a gravity field with an effect which is suggested to be associated to the cosmological constant. This could be interpreted as a dark energy contribution since the direction of this energy, as a property of the information boundary, exerts a gravitational effect outwards (with respect to an observer particle in the middle of the particle horizon span). This also suggests that the interpreted curvature of space by a matter equivalence at the information horizon is an inverse slope compared to the curvature of a gravitational field centered inside the cosmic confinement. By Gauss's law of gravity, matter is allocated to the center. This results in two mass coordinates, one at the observer particle and the other at the information horizon, with two opposing force vectors. This is caused by the field density which influences the curvature of spacetime. This simplified hypothetical scenario might be seen as an anti DeSitter (AdS) curvature which would be by Gauss's law located at the horizon coordinate and a DeSitter matter curvature where both resulting fields are in superposition and overlay onto each other as proposed by Dungworth and Sheppeard [6].

2 Method

2.1 Computation of Informational Mass & Cosmological Constant

The mass of the Universe can be thought of as encoded in the horizon as conjectured by holographic principle [18]. First consider the energy of the fundamental wavelength which spans between the center observer coordinate and the edge of the particle horizon in terms of compton energy.

$$E_\Theta = \frac{\hbar c}{\Theta/2} = \frac{2\hbar c}{\Theta} \tag{1}$$

Next, consider the ratio of the surface area of the observable universe divided by the minimum area that can contain a qubit of information using the Schwarzschild radius, $2l_p$.

$$R_{SA} = \frac{4\pi\left(\frac{\Theta}{2}\right)^2}{4\pi l_p^2} \tag{2}$$

Now surmise that each qubit (represented as an entropy surface element) is associated to the minimum fundamental energy. Multiply the fundamental energy by the ratio factor to compute the total energy located on the horizon.

$$E_\mathrm{H} = \frac{2\hbar c}{\Theta} \cdot \frac{4\pi\left(\frac{\Theta}{2}\right)^2}{4\pi l_p^2} \tag{3}$$

Finally use $E = mc^2$ to convert into mass.

$$M_{\mathrm{H}} = \frac{2\hbar c}{\Theta} \cdot \frac{4\pi \left(\frac{\Theta}{2}\right)^2}{4\pi l_p^2} \cdot \frac{1}{c^2} \tag{4}$$

Note: This concept can be also used to find the ordinary mass of the universe using the Hubble radius R_H to obtain the following.

$$M_{\mathrm{O}} = \frac{\hbar c}{R_H} \cdot \frac{4\pi {R_H}^2}{4\pi l_p^2} \cdot \frac{1}{c^2} \tag{5}$$

Further reduce (4) and cancel like terms to find the following.

$$M_{\mathrm{H}} = \frac{\hbar}{l_p c} \cdot \frac{\Theta}{2 l_p} \tag{6}$$

This concept can be also used to find the ordinary mass of the universe using the hubble radius to obtain the following. Notice this coincides exactly to Riofrio's ordinary mass calculation [15].

$$M_{\mathrm{H}} = \frac{\hbar}{l_p c} \cdot \frac{R_{\mathrm{hubble}}}{l_p} \tag{7}$$

Finally use the definition of Planck mass $m_p = \frac{\hbar}{l_p c}$ and to obtain the following cosmological constant relation. The left hand side is what Sheppeard predicted [16] and right side similar to McCulloch [11].

$$\boldsymbol{\sqrt{\Lambda} = \frac{m_p}{M_H} = \frac{2 l_p}{\Theta}} \tag{8}$$

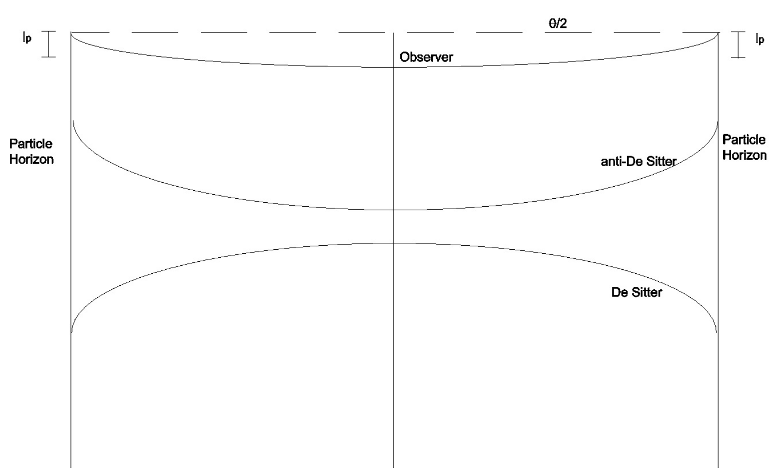

Figure 1: CC

2.2 Cosmological Constant using Mass-Energy & Compton energy

Consider the energy for two different masses, namely Planck mass, m_p, and horizon mass, M_H.

$$E_{m_p} = m_p c^2 \tag{9}$$

$$E_{M_H} = M_H c^2 \tag{10}$$

Take the ratio of the two equations to yield the following.

$$\frac{E_{m_p}}{E_{M_H}} = \frac{m_p}{M_H} \tag{11}$$

Similarily find the maximum and minimum compton energy wave values from the center of the universe to its edge namely, l_p and $\Theta/2$.

$$\frac{E_\Theta}{E_{l_p}} = \frac{\frac{2\hbar c}{\Theta}}{\frac{\hbar c}{l_p}} \tag{12}$$

Reduce this equation to yield the following.

$$\frac{E_\Theta}{E_{l_p}} = \frac{2l_p}{\Theta} \tag{13}$$

Equate (11) and (13) and notice they are equivalent. This may describe a the mass equivalence formula and appears to equal the cosmological constant.

$$\sqrt{\Lambda} = \frac{m_p}{M_H} = \frac{2l_p}{\Theta} \tag{14}$$

The equation can also be squared to obtain a form more equivalent to an energy conversion ratio.

$$\Lambda = \frac{m_p^2}{M_H^2} = \frac{(2l_p)^2}{\Theta^2} \tag{15}$$

Planck time and the adjusted age of the universe can also indicate the cosmological constant where p_t is Planck time and $t_{0,\mathrm{adj}}$ is age of universe adjusted for inflation.

$$\sqrt{\Lambda} = \frac{m_p}{M_H} = \frac{2l_p}{\Theta} = \frac{p_t}{t_{0,\mathrm{adj}}} \tag{16}$$

2.3 Cosmological Constant using Newton's Gravity Law

Consider Newton's Gravity Force Law

$$F = \frac{GMm}{r^2} \tag{17}$$

Now consider the following thought experiment where two Planck masses, m_p, are at a minimum distance from each other namely the Planck length, l_p.

$$F_{m_p} = \frac{Gm_p^2}{l_p^2} \tag{18}$$

Now consider another thought experiment where two total Universe masses, M_H, are at a distance, $\Theta/2$ from each other. Note: This is the maximum distance two mass objects can be apart due to the information boundary of the horizon as denoted by a minimum quantized acceleration. This has been defined by MOND (Modified Newtonian Dynamics) and by quantized inertia [10]. Considering the superposition of allowed waves as part of the theorized vacuum fluctuations [5], the probability of position would be at the side of the confined space of wave (mode) propagation regarding the superposition of the accumulated energy state. Here the individual modes of radiation/fluctuations would be distributed homogenously throughout space. Furthermore, the lowest energy state of the aforementioned superposition would follow the overall probablity where this energy may localize as a mass equivalence in accordance to the superposition concept. Additionally, since the force direction is outwards which opposes the matter gravity field, per Gauss's Law in this model is assumed to be centered, the concentrated effect of the mass/energy of the vacuum would be allocated at the information horizon coordinate. This could act as ring of negative gravity equivalent in spacetime distorsion.

$$F_{M_H} = \frac{GM_H^2}{(\Theta/2)^2} \tag{19}$$

Consider the concept that these minimum and maximum conditions could be equivalent due to symmetry.

$$F_{m_p} = F_{M_H} \tag{20}$$

Subsitute in for both force equations.

$$\frac{Gm_p^2}{l_p^2} = \frac{GM_H^2}{(\Theta/2)^2} \tag{21}$$

Rewrite and simplify.

$$\frac{m_p^2}{M_H^2} = \frac{(2l_p)^2}{\Theta^2} \tag{22}$$

2.4 Neutrino mass equivalence principle

The neutrino/CMB coupling factor was found to be the following [16] [17] [3].

$$\frac{2m_{\nu,\mathrm{sterile}}}{m_p} = \sqrt{\frac{2l_p}{\Theta}} \tag{23}$$

Replace m_p in (22) using (13).

$$\boldsymbol{\frac{2m_{\nu,\mathrm{sterile}}}{M_H} = \left(\frac{2l_p}{\Theta}\right)^{3/2}} \tag{24}$$

2.5 Equivalence Principle to solve for Planck's constant

Consider Newton's Gravity Force Law

$$F = \frac{GMm}{r^2} \tag{25}$$

Now consider the following thought experiment where one mass, m, is located at the center of the observable universe and the other is the full holographic mass/energy at the horizon , M_H, located at the edge of the universe at location $\Theta/2$ away.

$$F_G = \frac{GmM_H}{(\Theta/2)^2} \tag{26}$$

Next use Newton's force law, $F = ma$ and equate to see the acceleration on the test mass, m.

$$ma = \frac{4GmM_H}{\Theta^2} \tag{27}$$

Substitute in the minimum acceleration, $a = 2c^2/\Theta$ using quantized inertia since the test mass is at its maximum distance away from M_H. Cancel out the test mass, m.

$$\frac{2c^2}{\Theta} = \frac{4GM_H}{\Theta^2} \tag{28}$$

Simplify and notice that this has full convergence [11].

$$\boldsymbol{\frac{c^2}{G} = \frac{M_H}{\Theta/2}} \tag{29}$$

Next substitute in for $G = \frac{c^3 l_p^2}{\hbar}$.

$$\frac{c^2 \hbar}{c^3 l_p^2} = \frac{M_H}{\Theta/2} \tag{30}$$

Solve for $\hbar$ which results in the following.

$$\hbar = \frac{\mathbf{2 l_p^2 M_H c}}{\mathbf{\Theta}} \tag{31}$$

Rewrite the equation using the relation $\Theta/2 = ct_0$ where t_0 is time from beginning of the universe.

$$\boldsymbol{h} = \boldsymbol{\left(\frac{M_H/t_0}{4\pi l_p^2}\right)^{-1}} \tag{32}$$

2.6 Hawking Radiation energy connection to Cosmological constant

Consider the radiation energy for a Planck sized mass black hole.

$$E_{H,l_p} = \frac{\hbar c^3}{8\pi G m_p} \tag{33}$$

Replace both $G = \frac{c^3 l_p^2}{\hbar}$ and $m_p = \frac{\hbar}{l_p c}$ using composite gravitational constant and Planck mass defintion formula. Consider the radiation energy for a Planck sized mass black hole [7].

$$E_{H,l_p} = \frac{\hbar c^3}{8\pi} \cdot \frac{\hbar}{c^3 l_p^2} \cdot \frac{l_p c}{\hbar} \tag{34}$$

Simplify to obtain the following.

$$E_{H,l_p} = \frac{c^2}{8\pi} \cdot \frac{\hbar}{l_p c} \tag{35}$$

Identify the Planck mass term to obtain the following.

$$E_{H,l_p} = \frac{1}{8\pi} \cdot m_p c^2 \tag{36}$$

This can also be written as the Compton energy of the shortest wavelength l_p.

$$E_{H,l_p} = \frac{1}{8\pi} \cdot \frac{\hbar c}{l_p} \tag{37}$$

Therefore define $E_{l_p} = \frac{\hbar c}{l_p}$ which results in the following relation.

$$E_{H,l_p} = \frac{1}{8\pi} E_{l_p} \tag{38}$$

This relation could be linked to the high energy Compton mode of the wavelength l_p by a factor of 8π. This may denote a specific model of the energy is established and measured from the observer so it is halved and the total volume integral of 4π is divided to normalize the radiation to one dimension. An alternative hypothesis for the cause of this parameter could be that Hawking Radiation uses traditional Newton's Gravity law to compute gravity $g = \frac{GM}{r_s^2}$ where r_s is the Schwarzschild radius. It is was discovered that a factor of 4 appears at the limit of Newton's adjusted gravity formula [2]. Also Hawking uses $\hbar$ instead of h which is traditionally used for radiation energy when mass is converted to energy. This could account for the 8π factor. In general it seems the 8π (also found as a factor in Einstein's constant) could be a quantum correlation factor from relativity to the quantum realm.

This methodology can be furth extended to discover the relationship to the mass at the horizon and Planck mass.

$$E_{H,M_H} = \frac{\hbar c^3}{8\pi G M_H} \tag{39}$$

Rewrite using the Einstein's constant $\kappa = \frac{8\pi G}{c^2}$ to suggest this may represent a conversion factor between the compton energy of the horizon mass and Hawking radiation energy. The equation (39) employs two mass energy conversion factors in combination. As already pointed out by Haug [7] the c^2 bridges energy to mass, but a deeper look into the actual reasons to apply c^2 are essential. In (39) the square of the velocity of light had been replaced with a parameter which resembles Einstein's constant which could be of interest for future review.

$$E_{H,M_H} = \frac{1}{\kappa} \frac{\hbar c}{M_H} \tag{40}$$

Replace both $G = \frac{c^3 l_p^2}{\hbar}$ in (39).

$$E_{H,M_H} = \frac{1}{8\pi M_H} \cdot \frac{\hbar^2}{l_p^2} \tag{41}$$

The above equation can also be rewritten by substituting (31) into (40).

$$E_{H,M_H} = \frac{M_H c^2}{8\pi} \cdot \left(\frac{2l_p}{\Theta}\right)^2 = \frac{\Lambda}{8\pi} M_H c^2 \tag{42}$$

Next consider the Compton energy of the longest wavelength that fits between the observer and horizon namely $\Theta/2$.

$$E_{\Theta/2} = \frac{2\hbar c}{\Theta} \tag{43}$$

Using the concepts above it can be suggested that the following could hold true.

$$E_{H,M_H} = \frac{1}{8\pi} \cdot E_{\Theta/2} \tag{44}$$

Plug into both energy values to obtain the following.

$$\frac{1}{8\pi M_H} \cdot \frac{\hbar^2}{l_p^2} = \frac{1}{8\pi} \cdot \frac{2\hbar c}{\Theta} \tag{45}$$

This equation reduces down to the familiar Cosmological Constant relation after substituting in for $m_p = \frac{\hbar}{l_p c}$

$$\sqrt{\Lambda} = \frac{m_p}{M_H} = \frac{2l_p}{\Theta} \tag{46}$$

2.7 Friedmann Equation Convergence

Here is a compilation of various Hubble constant values. The average value integral was performed on the logarithmic function to obtain $H_{0,\text{avg}} = 70.85$. This value is closely converging to the value of 70.95 which was used for calculations to provide conformity to the Friedmann Equations with a flat universe curvature.

	LY	H0	
Planck (CMB)	1.38E+10	67.8	
Hubble #1 (NGC4258) 2011	2.37E+08	72.25	(+/-) 2.51
Hubble #2 (LMC) 2011	163000	71.02	(+/-) 2.67
Hubble #3 (M31) 2011	2.50E+07	74.5	(+/-) 3.27
Spitzer (LMC)	163000	74.1	
Hubble 2019 (LMC)	1.63E+05	74.03	
Hubble & Gaia (MW)	100000	73.52	(+/-) 1.62
Cosmic Flow (normalized VIRGO)	5.40E+07	75	(+/-) 2
HE0435-1223 (z=1.689)	2.3E+10	71.9	
Holicow Quasar SDSS1206+4332 (B)	1.03E+10	68.8	(+/-) 5
Hubble 2018 (MW cepheids)	9.00E+03	73.25	(+/-) 2.3

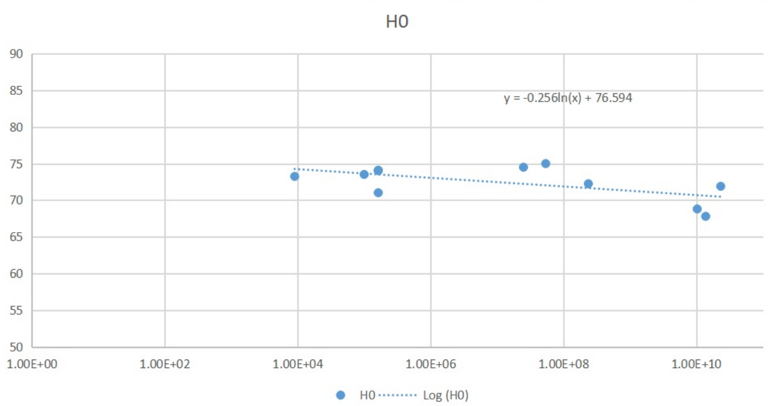

Figure 2: Logarithmic fit of Hubble Constant

$H_0 = 70.95 \quad$ [km/(s mpc)]
$\rho_c = 9.4557 \cdot 10^{-27} \quad$ [kg/m^3]

$\Theta = 8.8 \cdot 10^{26}$ [m]
$\Omega_{vac} = 0.7355$
$\Omega_M = 0.2634$
$\Omega_r = 0.000231$
$\Omega_K = 0$
$M_{tot} = \rho_c \Omega_M = \frac{3}{2} M_H = 8.8878 \cdot 10^{53}$ [kg]

Below is the Friedmann equation where ρ is the total density.

$$H^2 = \frac{8\pi G\rho}{3} + \frac{\Lambda_{DE} c^2}{3} - \frac{kc^2}{a^2} \tag{47}$$

For a flat universe $k = 0$ and next compute for conformal time. Notice the conformal time has a special form that might have some special geometrical significance.

$$\eta H_0 = \int_0^\infty \frac{dz}{\sqrt{\Omega_\Lambda + \Omega_M (1+z)^3 + \Omega_K (1+z)^2 + \Omega_r (1+z)^4}} = 3.375 = \left(\frac{3}{2}\right)^3 \tag{48}$$

$$\frac{\Theta}{2} = \frac{c}{H_0} \left(\frac{3}{2}\right)^3 = 4.40 \cdot 10^{26} \quad \text{[m]} \tag{49}$$

The value of Θ seems the most logical convergence as previous data outliine.

Additionally, using H_0 as indicated above correlates the age of the universe to 13.781 billion years within the accepted range.

$$t_0 = \frac{1}{H_0} = 13.781 \cdot 10^9 \quad \text{light years} \tag{50}$$

The cosmic diameter is considered to be $8.80 \cdot 10^{26}$ [m]. Some additional errors could come from the available data measurements related to the critical energy density.

The computed Cosmological Constant value is. Additionally, a flat universe is used assumed to be consistent with recent findings.

$$\Lambda_{\text{meas}} = \frac{3 H_0^2 p_T^2}{8\pi} \Omega_{vac} = 1.3491 \cdot 10^{-123} \tag{51}$$

The cosmological constant using the mass from the Friedmann Equations are the following. It could be that the AdS and DS universes overlayed creates this relationship.

$$\Lambda = \frac{m_p}{M_H} = 1.3495 \cdot 10^{-123} \quad \text{[m]} \tag{52}$$

Here the factor of 3/2 could suggest the overlap of an AdS and dS universe segmented universe. In order to overlay different energy related curvature aspects to combine into the observable universe, the same time progression of the matter dominated universe would be 2/3 younger than the vacuum dominated universe. Therefore, A factor of 3/2 is incorportated to extend the mass coordinates in a vacuum universe to allow the accumulation of curvature without complicating standard physical aspects [4].

$$M_{tot} = 3/2M_H \tag{53}$$

Finally is interesting to note that the relationship between the hubble radius and comoving radius is the following. Specifically, it can be obtained by a matter dominated universe only where $D = 8/27R_H$ [4]. In order to satisfy the AdS and dS universe overlay a factor of 27/8 would need to be added because the hubble radius is equivalent to comoving radius in a vacuum dominated universe. Future research may suggest a qutrit-qubit relationship of 27 to 8 [9] [11] and some conversion factor from 3 dimensions to 2 dimensions.

$$\boldsymbol{R_\Theta = (3/2)^3 R_H} \tag{54}$$

3 Discussion

Below are the explicit values used to compute the cosmological constant. Following is a summary of the important equations that link mass from the neutrino scale to mass of the universe.

Table 1: Cosmological Constant & Neutrino, Planck and Universe Masses

Equation	**LHS Value**	**RHS Value**	**Error %**
$\frac{m_p^2}{(M_H)^2} = \frac{(2l_p)^2}{\Theta^2}$	$1.3475 \cdot 10^{-123}$	$1.3493 \cdot 10^{-123}$	0.131
$\frac{2m_{\nu,\text{sterile}}}{M_H} = \left(\frac{2l_p}{\Theta}\right)^{3/2}$	$7.0356 \cdot 10^{-93}$	$7.0400 \cdot 10^{-93}$	0.064
$\frac{2m_{\nu,\text{sterile}}}{m_p} = \sqrt{\frac{2l_p}{\Theta}}$	$1.9166 \cdot 10^{-31}$	$1.9166 \cdot 10^{-31}$	0.0016
$\hbar = \frac{2l_p^2 M_H c}{\Theta}$	$1.0546 \cdot 10^{-34}$[J s]	$1.0553 \cdot 10^{-34}$[J s]	0.066
$E_{H,M_H} = \frac{\Lambda}{8\pi} M_H c^2 = \frac{1}{8\pi} \cdot \frac{\hbar c}{\Theta/2}$	$2.8571 \cdot 10^{-34}$ [J]	$2.8589 \cdot 10^{-34}$ [J]	0.066
Λ_{meas}	$1.3477 \cdot 10^{-123}$	—	—

The models discussed include the consideration that the longest wave, which can span the observable universe, is disallowed for natural oscillations by the observer particle in the center. The next allowed wave would confine the distance between the particle horizon and a (probe) particle allocated in it's own center of information boundary. The concerned wave per mode probability in position is typically distributed within the confinement but looking into a momentum space may contribute according to the field direction with force effects. This effect could be understood as being correlated to the cosmological constant. The cosmological constant is of low numerical value and the associated fundamental wave from the universe span is also of lowest energy level with regards to an allowed discrete energy and momentum spectrum in the zero point field (ZPF). One hypothesis could be that smaller distortions in between the maximum extent of observation distance may provide in low gravity environment sufficient momentum to extent distance between particles in direction where the gravity field is acting less. Considering the vacuum is filled with vacuum fluctuations, this could be described by the method of virtual particles as an application of inhomogeneity of surrounding energy that might shift relative position to provide momentum. The observer particle is inherently pushed around by alternations influencing the probability in position of localization of the longest wavelength allowed in the span of observation. According to the theory of quantized inertia this may provide also the cause to consider a minimum discrete acceleration. Hence a situation is established where, between two particles, the space increases (see the Hubble effect). A minimum acceleration adds to the effect to the Hubble parameter and, as result, a minimized cosmological constant is established.

Alternatively another model could be considered which provides equivalent results but considers a different viewpoint with respect to the acting wavelength. As outlined already in the comments of (1), the longest wave without a node at the observer position would be formally disallowed. By conservation laws, similar to entropy on an event horizon, the longest wave would become a property of a mass/energy equivalent at the horizon coordinate. Essentially, either scenario could lead to the same relevant conditions to satisfy the Friedmann equations. Also it would results in the same theoretical cosmological constant which acts with a small (AdS) curvature to further expand the observable cosmos. The results of this paper may support the view that in a balance perspective the lowest possible energy in the observable cosmos (similar to the minimum quantized acceleration) contributes a mass equivalent at the information horizon and is therefore adds a small element to the effect which is perceived as dark energy.

4 Appendix

Consider the energy outside of electron an electron. Notice only the unshared waves are accounted for outside using the logarithmic ratio technique [1].

$$E_{\text{out},e} = \frac{\ln\left(\frac{R_H}{r_e}\right)}{\ln\left(\frac{R_H}{2l_p}\right)} = \frac{2}{3} \tag{55}$$

Likewise, consider the energy outside of proton.

$$E_{\text{out},p} = \frac{\ln\left(\frac{R_H}{r_p}\right)}{\ln\left(\frac{R_H}{2l_p}\right)} \approx \frac{2}{3} \tag{56}$$

It seems there is a special relationship in quantum mechanics with the number 2/3 as also discovered by Koide [8]. It is seen in the conformal time factor as well.

References

[1] A. S. Bhatt and F. M. Becker. Electrostatic accelerated electrons within information horizons exert bidirectional propellant-less thrust. *vixra.org*, page 34, 2018.

[2] A. S. Bhatt and F. M. Becker. An introduction to the theory of everything using energy gradients and information horizons. *vixra.org*, page 11, 2019.

[3] A. S. Bhatt and F. M. Becker. Neutrino mass replaces planck mass as fundamental particle. *vixra.org*, page 7, 2019.

[4] Y. L. Bolotin and I. V. Tanatarov. A thousand problems in cosmology: Horizons, 2013.

[5] H. B. G. Casimir and D. Polder. The influence of retardation on the london-van der waals forces. *Phys. Rev.*, 73:360–372, Feb 1948.

[6] G. Dungworth and M. Sheppeard. Non local neutrinos with r = ct. *vixra.org*, page 10, 2017.

[7] E. G. Haug. The hawking temperature intensive crisis and a possible solution that leads to an intensive schwarzschild surface temperature. *Applied Physics Research*, 11(3):56, May 2019.

[8] Y. Koide. New view of quark and lepton mass hierarchy. *Phys. Rev. D*, 28:252–254, Jul 1983.

[9] M. Malik, M. Mirhosseini, M. P. J. Lavery, J. Leach, M. J. Padgett, and R. W. Boyd. Direct measurement of a 27-dimensional orbital-angular-momentum state vector. *Nature Communications*, 5:3115 EP –, Jan 2014. Article.

[10] M. E. McCulloch. Minimum accelerations from quantised inertia. *EPL (Europhysics Letters)*, 90(2):29001, 2010.

[11] M. E. McCulloch and J. Giné. Modified inertial mass from information loss. *Modern Physics Letters A*, 32(28):1750148, 2017.

[12] M. Milgrom. A modification of the Newtonian dynamics as a possible alternative to the hidden mass hypothesis. *apj*, 270:365–370, July 1983.

[13] S. Perlmutter, G. Aldering, G. Goldhaber, R. A. Knop, P. Nugent, P. G. Castro, S. Deustua, S. Fabbro, A. Goobar, D. E. Groom, I. M. Hook, A. G. Kim, M. Y. Kim, J. C. Lee, N. J. Nunes, R. Pain, C. R. Pennypacker, R. Quimby, C. Lidman, R. S. Ellis, M. Irwin, R. G. McMahon, P. Ruiz-Lapuente, N. Walton, B. Schaefer, B. J. Boyle, A. V. Filippenko, T. Matheson, A. S. Fruchter, N. Panagia, H. J. M. Newberg, W. J. Couch, and T. S. C. Project. 517(2):565–586, jun 1999.

[14] A. G. Riess, A. V. Filippenko, P. Challis, A. Clocchiatti, A. Diercks, P. M. Garnavich, R. L. Gilliland, C. J. Hogan, S. Jha, R. P. Kirshner, B. Leibundgut, M. M. Phillips, D. Reiss, B. P. Schmidt, R. A. Schommer, R. C. Smith, J. Spyromilio, C. Stubbs, N. B. Suntzeff, and J. Tonry. Observational evidence from supernovae for an accelerating universe and a cosmological constant. *The Astronomical Journal*, 116(3):1009–1038, sep 1998.

[15] L. Riofrio. Space/Time Explanation of Supernova Data kernel description, 2004.

[16] M. Sheppeard. The algebra of non local neutrino gravity. 01 2018.

[17] M. D. Sheppeard. Constraining the standard model in motivic quantum gravity. *Journal of Physics: Conference Series*, 1194:012097, apr 2019.

[18] L. Susskind. The world as a hologram. *Journal of Mathematical Physics*, 36:6377–6396, Nov. 1995.