Electrostatic quantum dark energy in a seven-dimensional universe

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Abstract:

This paper explains the dark energy and acceleration of the universe by quantizing the space in the hidden dimensions and provides the basis and background for the gravitational force through the curvature of space-time. Space-time is considered to be made of a four-dimensional elastic grid in a seven-dimensional universe in which matter also expands along with the universe. Each cube of the grid is considered a quantum of hidden three-dimensional space of Planck volume containing Planck charge, which makes the universe seven-dimensional. The dark energy is explained by the electrostatic repulsion between the Planck charges in each quantum of the hidden space. Mathematically, this electrostatic repulsion is related to the Hubble constant to explain the accelerated expansion due to dark energy and the increase in mass of matter. Expansion of space-time is considered not due to the creation of the new space but due to the stretching of the existing space-time itself like an elastic ruler where the length remains constant. As the Hubble constant is decreasing with time, the rate of acceleration of the universe is considered to be decreasing because of the contraction force of the space-time elastic grid opposing the electrostatic repulsion between Planck charges. The apparent violation of the law of energy conservation in the cosmological redshift is properly explained to show that the mass of the matter continues to increase due to the stretching of the space-time and hence the redshift without violating the law of energy conservation. The values of the Planck constant, gravitational constant, permittivity of free space, and all the constants that depend on mass are shown to vary owing to the expansion of the space-time and hence provide falsifiable predictions for this theory. Identifies a thought experiment to prove that the expansion of the space-time causes the mass of the matter to increase but not the massless photons as they will continue to exist in the same energy state once they are emitted proving the aforementioned varying constants and the proposed theory. Overall, this theory assigns a hidden extra dimensional electrostatic background to gravity to explain the cause of curvature of space-time, dark energy, cosmological redshift, and eliminates cosmic inflation, cosmic event horizon, cosmic scale factor (a) and the cosmological constant Λ.

Introduction:

In this theory of electrostatic quantum dark energy in a seven-dimensional universe, Hubble expansion is considered to be due to the stretching of the existing space-time rather than the creation of a new space that is analogous to the markers on an elastic ruler stretching along with the expansion of the ruler, as opposed to the raisin bread model, where matter does not expand along with space. Therefore, the matter is considered to be stretching along with the space-time, or not being diluted with the expansion of the space-time. As the matter also stretches with space, the expansion is non-observable locally but can be observed through the redshift of the light coming from a far-off space of a lower stretch. At the outset, we can see that matter exists in different energy states based on the magnitude of the space-time stretch. The matter continues to move to higher energy states as space-time expands, but the energy of the photon remains the same. Therefore, in a lower stretch space-time, blue light has less energy compared to the same blue light in a higher stretch space-time. Therefore, when light travels from a lower stretch space-time to a higher stretch space-time, it becomes redshifted without violating the law of energy conservation. From this observation, we can conclude that the energy generated by converting the matter based on the mass-energy equivalence formula $E=mc^2$ is time-variant as the mass also increases along with the space-time expansion, whereas the energy of the light does not change with the space-time expansion, and it does not gravitate because the mass of the photon is zero but is affected by the gravity of the other objects, which means that the energy of a photon does not curve the space-time around it, but takes the path of the curved space around any matter.

The proper distance between any two points in space is considered to remain constant despite the stretching of the space-time, similar to the markers on an elastic ruler. Therefore, the volume of the universe does not change with expansion of space. The expansion of the space-time and matter is considered to be due to electrostatic repulsion between the Planck charges present in the Planck volumes. Space-time is considered to be made of a four-dimensional elastic grid in a seven-dimensional universe. Each cube of the grid is considered to be a quantum of the three-dimensional space of Planck volume containing Planck charge. The space-time membrane acts as a dielectric material between the Planck charges. Matter only exists as a probability wave function (Ψ) in the four-dimensional space-time grid but not in the hidden three spatial dimensions. The presence of matter in space-time would increase the force required to expand the space-time grid as the matter also expands along with space. The presence of matter also increases the permittivity of space-time and hence reduces the electrostatic repulsion inside the mass of any particle. As the expansion of the space-time surrounding the matter will be greater than the expansion of the matter itself due to the permittivity difference and the net compressing force on the matter from the surrounding Planck charges, space-time becomes naturally curved around any mass and hence the gravitational force, which is explained by the general theory of relativity.

In this theory, the electrostatic potential energy between the Planck charges in the three-dimensional space is considered to be the same as the dark energy, which causes accelerated expansion of the universe. The electrostatic dark energy in the three-dimensional space does not gravitate because this energy itself is the cause of the gravitational force in the four-dimensional space-time enveloping the three-dimensional Planck charges.

The special theory of relativity should not affect this model of the universe, as it considers it to be applicable only for objects moving through space, but not for the expansion of space-time. Matter in the universe is considered to have a negligible effect on the expansion of the universe, as the expansion is solely driven by the electrostatic repulsion force, and the resisting force from matter is considered to be negligible. Beginning with the birth of the universe, the first law of thermodynamics is strictly followed in this model of the universe to uphold the law of conservation of energy, which includes energy conservation in dark energy, cosmological redshift, and calculation of the CMB radiation temperature.

This theory proposes a flat or zero-curvature, isotropic, and homogenous universe, where the rate of acceleration will continue to decrease proportionally to the age of the universe, and its velocity only becomes zero after an infinite amount of time. However, the universe will continue to accelerate, but only at a continuously decreasing rate that asymptotes to zero. Invoking the critical density ($\Omega_0 = 1$) or cosmic inflation is not required to explain the flatness in this model of the universe, as the uniform expansion of the whole universe due to electrostatic repulsion explains why the universe is flat rather than closed or open. As there is no increase in the volume of the universe with time, big bang should be replaced with big repulsion. This theory makes the gravity electrostatic background dependent to explain the curvature of space-time, dark energy and cosmological redshift. The electrostatic background provides an additional background to the quantum fields on top of the gravitational background. This theory also eliminates the cosmic event horizon and the cosmic scale factor (a) as the proper length, and the volume remains constant despite the expansion of the space-time. Therefore, we should be able to see light from any part of the universe without any distance limit, such as a cosmic event horizon. Cosmological constant Λ in the gravitational field equations to factor in the dark energy is not required in this model of the universe as dark energy does not gravitate and is isolated to the electrostatic background which is handled independently. In addition, this new model could potentially act as a precursor to theories explaining dark matter, galaxy rotation curve, spiral shape of galaxies, black hole dynamics such as creation, evaporation and information conservation, baryogenesis, and primordial nucleosynthesis.

Acceleration of space-time:

Let us consider two points, A and B, on the space-time fabric. We calculated the apparent outward acceleration of point B when observed from point A based on the redshift of the light coming from point B.

D = Proper distance between points A and B

λ = D (let us consider the wavelength of light to be equal to D)

Thus, by the time light travels from point B to point A, its wavelength would have expanded by D(1+z) based on the cosmological redshift phenomenon. Therefore, point B would have apparently moved from its original location by D(1+z)–D, which is equal to Dz.

The apparent velocity v due to the redshift is given by $v = \frac{Distance}{time} = \frac{Dz}{t}$, where t is the time taken for the light to travel from point B to point A.

As the distance between points A and B remains constant, the real velocity of point B is zero. Thus, apparent acceleration a is given by $a = \frac{Dz}{t^2}$

As space stretches like an elastic ruler, the proper distance between points A and B should always remain the same, irrespective of the apparent acceleration. Therefore, the light should take the same amount of time t to travel the apparent distance of D(1+z), which is D owing to the constancy of the speed of light.

Therefore, time t is given by $t = D/c$

So, $v = \frac{Dz}{\left(\frac{D}{c}\right)} = zc$ **(1)**

$$and \quad a = \frac{Dz}{\left(\frac{D}{c}\right)^2} = \frac{zc^2}{D}$$

As $v = zc$ has already been established, the above derivation proves that space is stretching like an elastic ruler, where the length remains constant, as opposed to the raisin bread model, where length increases and matter is diluted with the expansion of space-time. Therefore, this theory disproves the raisin-bread model of the universe and provides a theoretical basis for $v = zc$ (1) whereas the raisin-bread model does not provide any theoretical reasoning.

Based on the equations $v = H_0 D$ *and* $v = zc$ from Hubble's law, $\frac{z}{D} = \frac{H_0}{c}$,

where v is the apparent receding velocity, H_0 is the bubble's constant, D is the distance, and z is the redshift, and c is the speed of light.

So, the apparent acceleration $a = \frac{H_0}{c} * c^2 = cH_0$

$$\boxed{a = cH_0} \quad \textbf{(2)}$$

Therefore, point B will always move from point A with an apparent acceleration equal to Hubble's constant multiplied by the speed of light, although the proper distance between the two points always remains the same. As Hubble's constant decreases over time, the rate of apparent acceleration of the universe or space-time is also considered to decrease over time. As the proper distance between the two points and the volume of the universe always remains constant, acceleration $a = cH_0$ is only considered as apparent.

As H_0 is considered to be inverse of the age of the universe in this theory, $a = cH_0$ can only be used to calculate the acceleration since the time of big repulsion.

Velocity of space-time and the cosmological redshift:

Based on the apparent acceleration of space-time $a = cH_0$, we can calculate the apparent velocity v of point B from big repulsion (point A) on the space-time fabric based on the cosmological redshift.

$$\frac{dv}{dt} = a; \quad dv = a\,dt; \quad dv = cH_0\,dt;$$

$$\int_0^v dv = \int_{t_p}^t cH_0\,dt \quad \text{or} \quad \int_0^v dv = c\int_{t_p}^t \frac{1}{T}\,dT \tag{3}$$

Planck time t_p is the minimum age of the universe at the beginning of the big repulsion owing to the quantization of space and time to Planck units. T is the age of the universe, which is considered to be Hubble's time or the inverse of Hubble's constant.

$$v = c\left[\ln(T) - \ln\left(t_p\right)\right] \quad = \quad c\left[\ln\left(\frac{1}{H_0}\right) - \ln\left(t_p\right)\right] \tag{4}$$

Equating the above formula (4) with $v = zc$, we get the cosmological redshift as

$$\boxed{z = \ln\left(\frac{1}{H_0}\right) - \ln\left(t_p\right) = \ln\left(\frac{1}{H_0 t_p}\right)} \tag{5}$$

Therefore, the maximum possible cosmological redshift z is **140.25636** for $H_0 = 70\left(km/s\right)/Mpc$, and the maximum apparent recession velocity that can be observed is 140.25636 times the speed of the light. We can see that the redshift z exponentially increases from 0 to almost 100 in the first second owing to big repulsion.

For $H_0 < H_1$, $$\boxed{z = \ln\left(\frac{1}{H_0}\right) - \ln\left(\frac{1}{H_1}\right) = \ln\left(\frac{1}{H_0}\right) - \ln\left(\frac{1}{H_0} - \frac{\mathrm{D}}{\mathrm{c}}\right) = \ln\left(\frac{c}{c - H_0 D}\right)} \tag{6}$$

where $\frac{1}{H_1} \geq t_p$ and H_1 is Hubble's constant when the light was emitted at distance D.

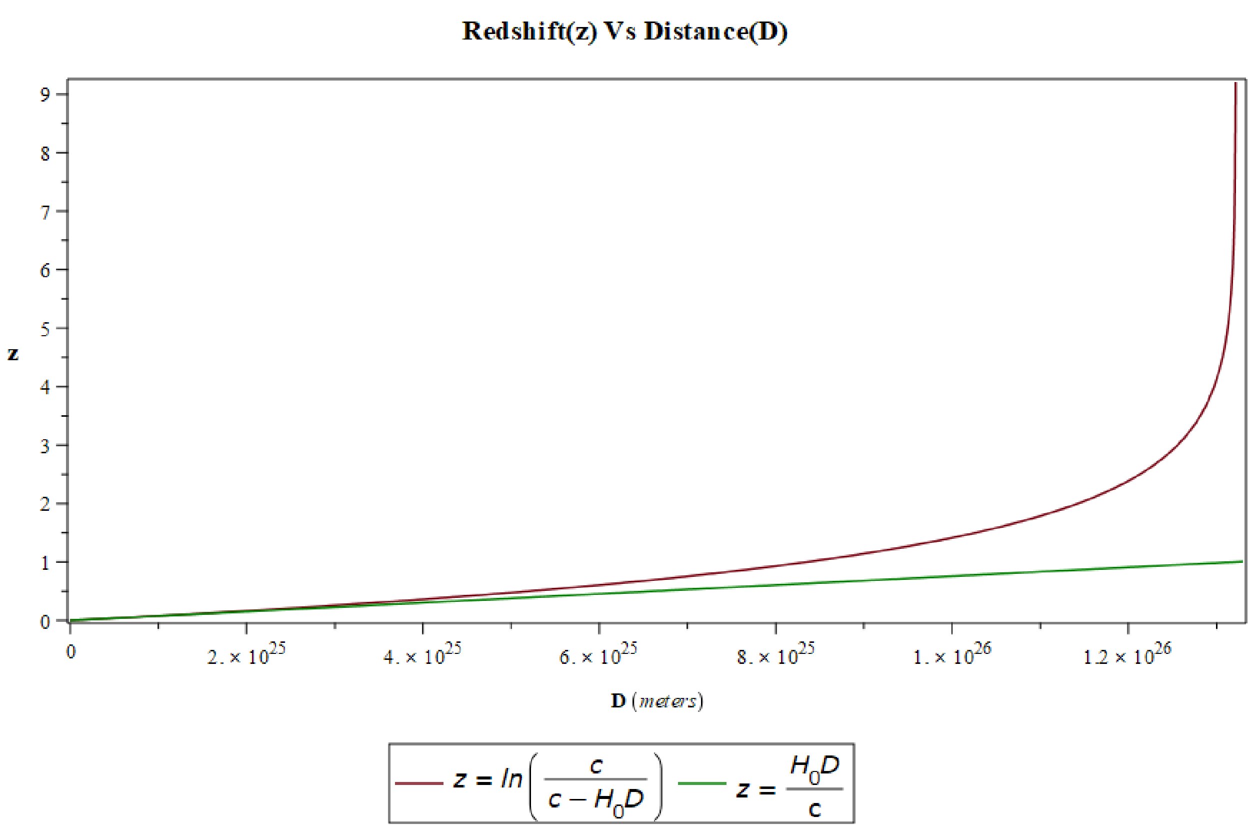
We can see in the table below that the redshift (z) values match the regular Hubble's formula and the new formula for low values of D. The new formula restricts the maximum cosmological redshift to 140.25636 owing to model of the universe being considered. As shown in the table below, the z values differ from each other as D increases or as the time traveled by the light approaches the age of the universe. Therefore, $v = H_0 D$ is only accurate up to moderate distances.

We can also see that the new z-values in Table I are in line with the accelerating model of the universe.

Table I (Cosmological redshift values)

D (meters)	$z = \dfrac{H_0 D}{c}$	$z = \ln\left(\dfrac{c}{c - H_0 D}\right)$
1×10^{10}	$7.5670532811\times10^{-17}$	$7.5670532811\times10^{-17}$
2×10^{15}	$1.5134106562\times10^{-11}$	$1.5134106562\times10^{-11}$
3×10^{20}	$2.2701159843\times10^{-6}$	$2.2701185611\times10^{-6}$
$\sim8.35358937\times10^{25}$ (New Hubble radius)	0.6321205588	1
1×10^{26}	0.7567053281	1.4134819288
$\sim1.32151838\times10^{26}$	1	140.25636 (Maximum / Big repulsion)

As the proper distance remains constant, the maximum observable universe is only 13.97 × 2 billion light years across which is 27.94 billion light years for $H_0 = 70(km/s)/Mpc$.



Graph 1

Time evolution of the constants G, h, ε_0 **and mass increase:**

As the speed of light is constant, the Planck length and Planck time are considered constants. Therefore, the product of the gravitational constant G and Planck's constant h is considered to be constant. As the Planck charge $(q_p = \frac{e}{\sqrt{\alpha}})$ is conserved, Alpha (α) or the fine-structure constant is considered to be constant. Therefore, the product of the Planck constant and permittivity of free space ε_0 is considered to be constant. Based on the above, we can calculate how constants G, h, and ε_0 vary over time. Using the law of conservation of energy, we can calculate the values of G, h, and ε_0 in the past and in the future.

Cosmological redshift $z = \frac{\lambda_{obs} - \lambda_{emit}}{\lambda_{emit}}$ or $\lambda_{obs} = \lambda_{emit}(1+z)$ **(7)**

As the energy is conserved in cosmological redshift, $E = \frac{hc}{\lambda_{obs}} = \frac{h_{t_p} c}{\lambda_{emit}}$ **(8)**

Here, h is the new or current Planck constant and h_{tp} is the old Planck constant when the age of the universe was Planck time t_p. G is the new or current gravitational constant and G_{tp} is the old gravitational constant. ε_0 is the new or current permittivity of free space and ε_{tp} is the old permittivity of free space.

$z = \ln\left(\frac{1}{H_0 t_p}\right)$ from (5)

$h = h_{t_p}(1+z)$ based on (7) and (8) **(9)**

$$\boxed{h = h_{t_p}\left(1+\ln\left(\frac{1}{H_0 t_p}\right)\right)}$$

As $hG = h_{t_p} G_{t_p}$

$$\boxed{G = \frac{G_{t_p}}{\left(1+\ln\left(\frac{1}{H_0 t_p}\right)\right)}}$$

As $h\varepsilon_0 = h_{t_p}\varepsilon_{t_p}$

$$\boxed{\varepsilon_0 = \frac{\varepsilon_{t_p}}{(1+\ln\left(\frac{1}{H_0 t_p}\right))}}$$

Below are the values of G, h, and ε_0 when the age of the universe was Planck time t_p, based on the current values of G, h, and ε_0 for H_0 = 70 in MKS units.

$$h_{t_p} = 4.69081190\times10^{-36}, \quad G_{t_p} = 9.42787323\times10^{-9}, \quad \varepsilon_{t_p} = 1.25071034\times10^{-9}$$

As the Planck constant h is directly proportional to the mass, $m_0 = m_z(1+z)$, where m_0 is the current mass and m_z is the original mass when the light was emitted in the past at cosmological redshift z. However, the change in mass cannot be observed directly because of the relative change in the standard mass with which it is compared. However, a change in mass can be observed by converting m_0 and m_z to energy, which is the observed energy difference in the cosmological redshift. Changes in mass can also be observed by observing the change in physical constants that depend on mass, such as the Planck constant, gravitational constant, permittivity of free space, and Boltzmann constant.

For example, Planck constant after 10 years (h_{+10yr}) from now would be $h\,(1+\delta z)$

$$h_{+10yr} = h\,(1+z_{+10yr} - \max z) = h\,(1+(\ln(\frac{1}{H_0}+10\times365.2425\times24\times60\times60)-\ln(t_p))-140.25636))$$

using (5), where $h = 6.62607015\times10^{-34}$ and $G = 6.67430\times10^{-11}$. The accuracy of the values given below depends on the accuracy of the current values of h, G, and H_0.

$$h_{+10yr} = 6.6260701547\times10^{-34}$$
$$h_{+50yr} = 6.6260701737\times10^{-34}$$
$$h_{+100yr} = 6.6260701974\times10^{-34}$$

$$G_{+10yr} = 6.6742999952\times10^{-11}$$
$$G_{+50yr} = 6.6742999761\times10^{-11}$$
$$G_{+100yr} = 6.6742999522\times10^{-11}$$

Therefore, this theory provides falsifiable predictions by predicting the change in Planck's constant gravitational constant, permittivity of free space, Boltzmann constant, etc.

Temperature of CMB (Cosmic microwave background) radiation:

Internal energy U of black-body photon gas is given by

$$U = \left(\frac{8\pi^5 k^4}{15h^3c^3}\right)VT^4$$

where
k = Boltzmann constant
h = Planck constant
c = Speed of light
V = Volume
T = Temperature

As $h = h_{t_p}(1+z)$, $k = k_{t_p}(1+z)$ and volume V of the universe remains constant with the apparent expansion of the universe and upholding the law of conservation of energy and CMB being a black-body radiation, the maximum possible original temperature of the radiation when the age of the universe was t_p is given by the below based on the above formula for U.

$$\boxed{T_{t_p} = T(1+z)^{1/4}} \qquad \textbf{(10)}$$

As T =2.725 K and Max z is 140.25636, T_{tp} = 9.394 K

As CMB is emitted after the initial t_p of the big repulsion, the original temperature of the CMB when it was first emitted should be less than 9.394 K. Therefore, this theory disproves the original hot CMB and Big Bang paradigm. The future temperature of CMB radiation can also be calculated using the formula above. For example, the CMB temperature after 10^8 years from now would be 2.720 K, but the CMB photon density should remain the same as the volume of the universe remains constant. The maximum possible initial temperature of 9.394 K of the big repulsion may not be enough to explain baryogenesis, primordial nucleosynthesis, and hydrogen-helium abundance. However, further research can potentially explain them based on how the initial expansion energy of the big repulsion interacted with the quantum vacuum fluctuations to create all the elementary particles and hydrogen, helium, lithium atoms, etc.

As the interaction of the electrostatic expansion energy with the quantum vacuum fluctuations at the time of big repulsion will be the same throughout the space-time, the created primordial elementary particles, atoms and its attributes like temperature, density should be uniform throughout the space-time without having the particles to interact with one another and hence eliminates the cosmic inflation, horizon problem and explains the uniformity of CMB radiation. However, minor fluctuations in the density of the created particles due to the randomness of the quantum vacuum fluctuations and the subsequent lumping of the matter due to gravity could explain the temperature anisotropy of CMB radiation.

Acceleration of the universe due to electrostatic repulsion:

In this theory of electrostatic quantum dark energy in a seven-dimensional universe, the expansion of the space-time is due to the electrostatic repulsion between the Planck charges in the Planck volumes of the seven-dimensional space. This theory proposes that the product of the net electrostatic energy density or the dark energy density of the universe in the hidden three dimensions and the gravitational constant is equal to the square of the acceleration of the universe, based on dimensional analysis.

$$\boxed{\rho G = a^2} \tag{11}$$

ρ = Energy density of the universe responsible for acceleration
G = Gravitational constant
a = Acceleration of the universe which is cH_0 from (2)

Planck energy $E_p = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{\alpha(l_p)} = \sqrt{\frac{\hbar c^5}{G}}$ where l_p is the Planck length.

When the age of the universe was Planck time t_p, the energy density of the hidden three-dimensional space ρ_{t_p} of the universe was $\frac{E_{p(t_p)}}{(l_p)^3}$.

$$\rho_{t_p} = \frac{1}{4\pi\varepsilon_{t_p}}\frac{e^2}{\alpha(l_p)^4} = \frac{\sqrt{\frac{\hbar_{t_p} c^5}{G_{t_p}}}}{(l_p)^3} \tag{12}$$

$\rho_{t_p} G_{t_p} = \frac{1}{4\pi\varepsilon_{t_p}}\frac{e^2}{\alpha(l_p)^4} G_{t_p} = \frac{c^2}{(t_p)^2} = (cH_{t_p})^2 = a^2$, which proves (11) based on (2)

As the universe accelerates due to electrostatic repulsion, the electrostatic potential energy in the hidden three-dimensional space is gradually transferred to the four-dimensional space-time grid and stored as potential energy. As the elastic space-time grid resists expansion, the rate of acceleration gradually decreases to follow $a = cH_0$ that will asymptote to zero but will never become zero.

The total energy density responsible for the acceleration is given below.

$$\rho = \rho_z - \rho_{zs} \tag{13}$$

Where, ρ_z is the Planck energy density of the hidden three-dimensional space at redshift z, and $-\rho_{zs}$ is the potential energy density of the four-dimensional space-time grid at redshift z.

As $\varepsilon_0 = \frac{\varepsilon_{t_p}}{(1+z)}$ and $G = \frac{G_{t_p}}{(1+z)}$,

$|\rho_{zs}| = \rho_{t_p}(1-\frac{1}{n^2})(1+z)$ based on (11), (12) and (13)

where $n = \frac{1}{H_0 t_p}$ (Age of the universe in the multiples of Planck time t_p).

When the age of the universe was t_p, potential energy of the space-time grid, $-\rho_{zs} = 0$.

At higher redshifts, $\frac{1}{n^2}$ becomes negligible. Therefore,

$$\boxed{|\rho_{zs}| \approx \rho_{t_p}(1+z)}$$

Therefore, potential energy density $-\rho_{zs}$ of the four-dimensional space-time grid after the initial big repulsion at cosmological redshift z is approximately equal to the potential energy density of the hidden three-dimensional space when the age of universe was t_p multiplied by the cosmological redshift factor (1+z). Therefore, the potential energy density of the four-dimensional space-time grid will continue to increase till infinity owing to the declining permittivity of free space ε_0.

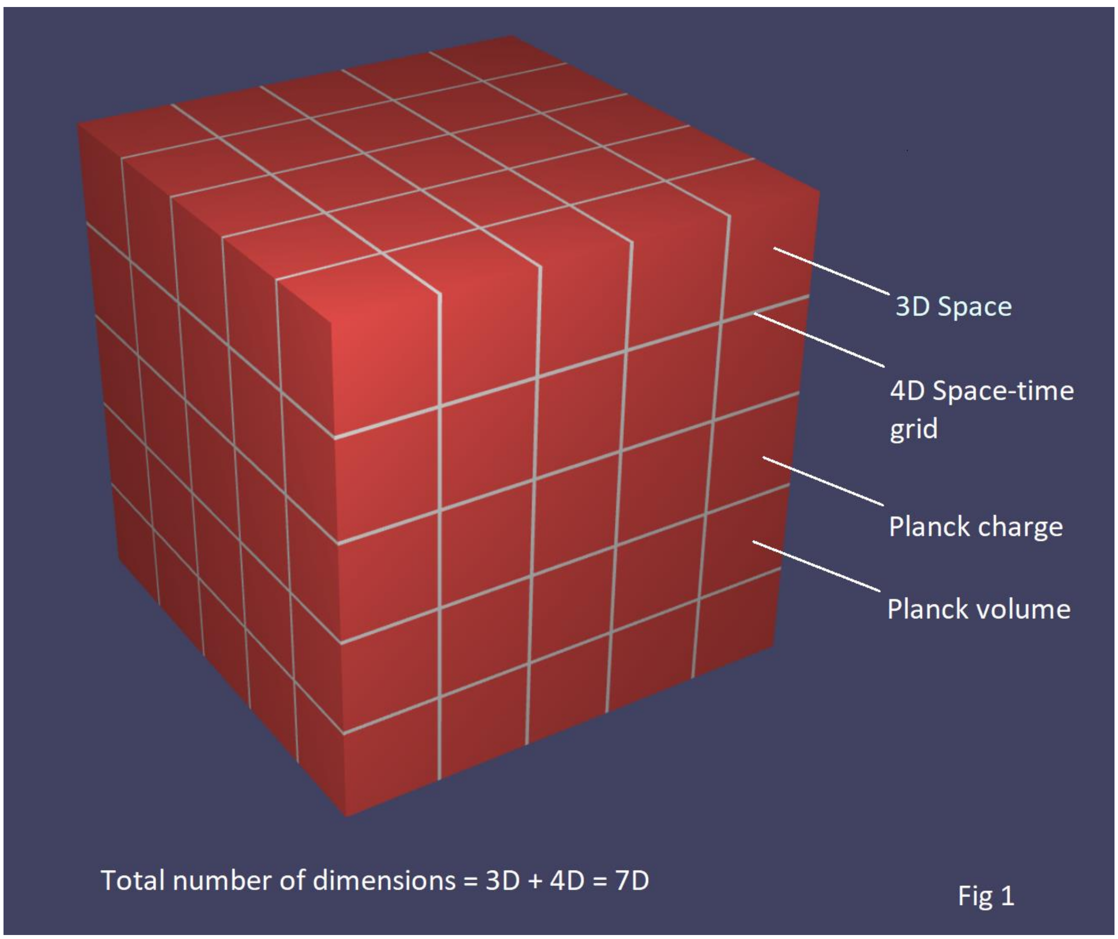
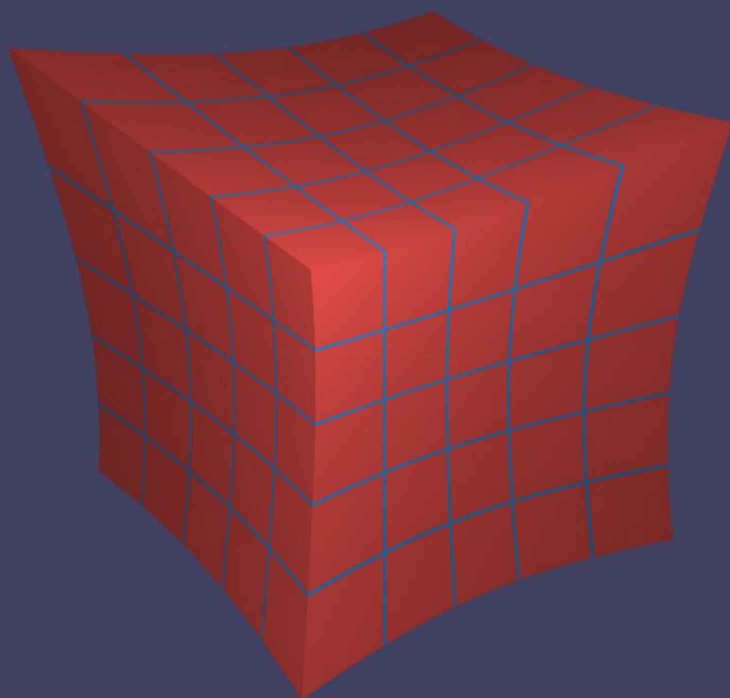
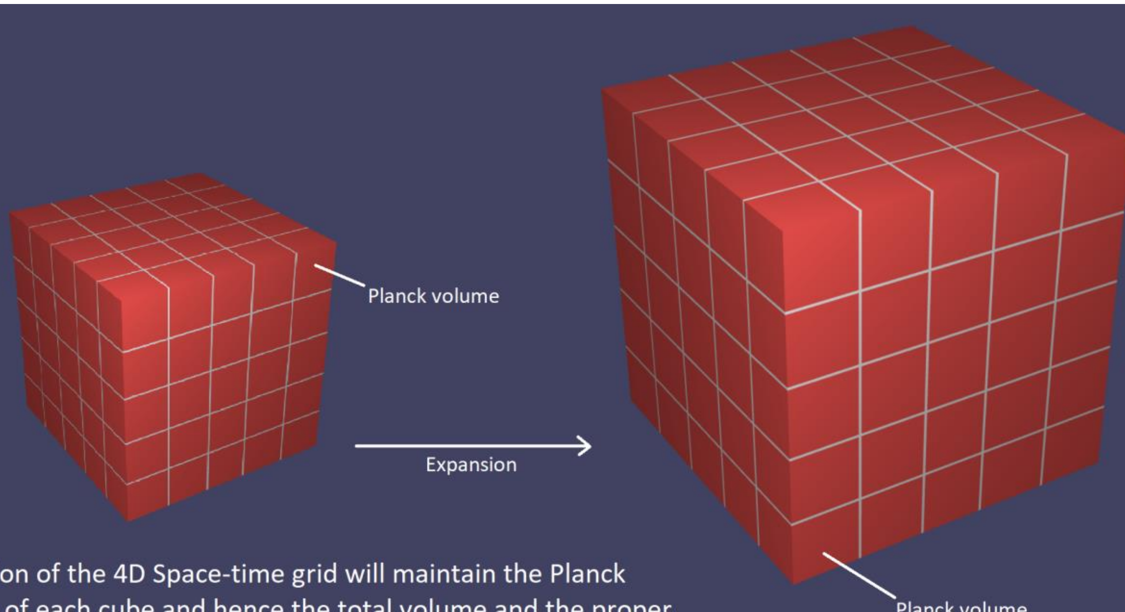


Fig 1



Matter in the 4D Space-time grid curves the space-time around it due to the electrostatic repulsion outside the matter being greater than inside as mass also increases/expands along with space-time.

Fig 2



Expansion of the 4D Space-time grid will maintain the Planck volume of each cube and hence the total volume and the proper distance remains constant. Expansion is similar to the stretching of an elastic ruler where the length remains constant.

Fig 3

Experiments and conclusion:

Experiment 1:

As the space–time fabric is more stretched out in a low gravitational field compared to a high gravitational field, the mass of an object should increase, and the gravitational constant G should decrease as the object moves away from the gravitational field. According to the electrostatic quantum dark energy theory, the Newtonian gravitational force F between two objects of masses m_1 and m_2 separated by distance D at gravitational redshift z from the earth's surface should be

$$F = \frac{G}{(1+z)} \frac{m_1(1+z) \times m_2(1+z)}{D^2} = (1+z) \times F_s$$

where F_s is the gravitational force between two masses m_1 and m_2 on the earth's surface. Therefore, the gravitational force F between two masses at a distance from the earth's surface with redshift z should be (1+z) times the gravitational force F_s on the Earth's surface. Therefore, this experiment provides another falsifiable prediction for this theory.

Experiment 2:

1) Take two identical closed boxes (Box1 and Box2) containing equal amounts of matter.
2) Convert the matter inside one of the boxes (Box1) to energy/light, and let the energy remain inside the closed box.
3) Take the two boxes to some distance into space from the earth's surface.
4) Convert the matter inside the other box (Box2) also to energy/light after it is taken to space.
5) Bring the two boxes back to the earth from space.
6) Measure the energy inside both boxes.
7) According to the electrostatic quantum dark energy theory, the energy in Box2 should be greater than the energy in Box1 and the difference in energy should be the gravitational potential energy (PE) gained by the matter inside Box2 after it is taken to space. In addition, we can observe the same difference in the energy if measured in space, and the difference should be equal to the apparent change in energy in Box1 due to the gravitational redshift after it is taken to space.

According to the electrostatic quantum dark energy theory, energy (photons) does not curve space-time, and hence predicts the energy difference between Box1 and Box2. If photons curve the space-time, then the energy in Box1 and Box2 should be equal. Let the mass of the matter inside each box be *m*. The energy difference between Box1 and Box2 should be equal to the gained gravitational PE of mass *m*, which is $[G\frac{mM}{\mathrm{R}} - \frac{G}{(1+z)}\frac{m(1+z)M}{\mathrm{R+D}}]$.

Where,
G = Gravitational constant,
M = Mass of the earth
R = Radius of the earth
c = Speed of light.
z = Gravitational redshift.

$m_D = m(1+z)$, where m_D is the increased mass of matter at distance D from the earth's surface owing to the higher stretch space-time. Therefore, the mass difference at distance D, which is $[m(1+z) - m = mz]$ will is manifested as the gravitational potential energy gained by mass *m*, which should be equal to $(mz)c^2$ based on $E = mc^2$ where z is the gravitational redshift at distance D from the earth.

Gained Newtonian $PE = G\frac{mM}{\mathrm{R}} - G\frac{mM}{\mathrm{R+D}} = (mz)c^2$. Therefore, the gravitational redshift z at distance D from the Earth's surface is given by the below.

$$z = \frac{\mathrm{GM}}{c^2}\left(\frac{1}{\mathrm{R}} - \frac{1}{\mathrm{R+D}}\right)$$

At infinite distance from the earth's surface, $z = \frac{\mathrm{GM}}{Rc^2}$

For distances near the earth's surface, $PE = mgD = (mz)c^2$ or $z = \frac{\mathrm{g}D}{c^2}$

As the above standard gravitational redshift equations have already been experimentally verified, it proves that the mass of an object increases as it moves from a lower stretch space-time to a higher stretch space-time, and the increase in mass is manifested as the gravitational potential energy of the object in a gravitational field or can be observed through the cosmological redshift due to the expansion of the universe. However, this thought experiment should prove that the energy of the light is not affected by the stretching of space-time, but only the mass of matter is affected. In other words, this experiment should prove that photons do not gravitate or curve the space-time around them. The observed cosmological redshift is due to the increase in energy of current mass compared to the energy coming from lower-stretch space-time. i.e., from the past. Therefore, this experiment provides another falsifiable prediction for this theory.

Methods:

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