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The Fifth Fundamental Force, the Equation of the Flat Universe, and the Classical Unification of the Fundamental Forces

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Abstract

Whether the universe is a flat or a closed system remains an open question. We derive the reason for the inflationary universe. Furthermore, we discuss why a surface-tension force is required. We present a model of the universe with an equation for its radius that suggests that the universe is infinite and flat. Further, we classically unify all the fundamental forces. Since the universe may have evolved from a point and a closed system to a flat system, our paper may help resolve the cosmological crisis. We provide the theoretical basis of all our findings.

Keywords: inflationary universe; surface tension; dark energy; dark matter

1. Introduction

From Planck cosmic microwave background (CMB) data, one can conclude that the universe is closed, with odds of 50:1 (Handley 2021). Evidence for a closed universe from Planck naturally explains the anomalous lensing amplitude (Di Valentino et al. 2019). Further, it removes a well-known tension in the Planck dataset regarding the values of cosmological parameters derived at different angular scales (Di Valentino et al. 2019). In contrast, the Boomerang CMB suggests a flat universe (De Bernardis et al. 2000). Thus, whether the universe is flat or closed is an open question. Further, a cosmological crisis in which disparate observed properties of the universe appear mutually inconsistent could be masked by the suggestion of a flat universe (Di Valentino et al. 2019).

The universe contains collisionless cold dark matter (CDM), which interacts only gravitationally (De Bernardis et al. 2000)(Pontzen and Governato 2014). On the other hand, the dark energy may be the vacuum energy(Elizalde et al. 2005)(Guberina et al. 2006)(Zhang 2006)(Beck and Mackey 2007)(Fiscaletti 2016)(Kragh 2011)(Carneiro and Tavakol 2009) given by a quantum vacuum field (QVF). Further, cold dark matter and dark energy are linked(Chimento et al. 2013)(Spergel 2015)(Comelli et al. 2003)(Bento et al. 2004)(Abdalla et al. 2010)(Wang et al. 2016) and dark energy may be decaying into dark matter(Abdalla et al. 2009). The pressure due to the QVF is proportional to $1/r^4$, when the field strength is unity(Ford 1976)(Ford 1975), where r is the radius of the universe. Then, we show that the pressure due to QVF scales as 1/r and gives rise to a surface tension force **(Supplementary information 1)**. Further, the creation of a vacuum may close the universe. Thus, as a model, the universe contains matter and dark matter surrounded by a vacuum. Interestingly, the pressure of QVF is analogous to the pressure due to surface tension of a water drop given by the Young-Laplace equation $\left(\frac{2\gamma}{r}\right)$. Hence, the universe is analogous to a water drop in a vacuum. In analogy with a water drop, interior dark matter particles interact with cohesive and adhesive forces, while an additional surface force due to the pressure of the quantum vacuum field (QVF) also acts. The radius r is negative for the vacuum and positive for the positive volume containing CDM. On the other hand, since Boomerang CMB suggests a flat universe(De Bernardis et al. 2000), the flat universe may be the surface, containing matter.

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The Hubble constant, H, is given as:

$$H = \left(\frac{v}{r}\right) \tag{1}$$

where, v is the radial velocity of the surface, and r is the radius of the universe.

For a universe whose surface is moving with a constant radial velocity v (the equilibrium model), the rate of change of the Hubble constant, H, is given by

$$\frac{dH}{dt} = -\left(\frac{v}{r}\right)^2 \tag{2}$$

Further,

$$V = \frac{4\pi r^3}{3} \tag{3}$$

where, V is the volume of the universe.

From equation 3,

$$\frac{dV}{dt} = 4\pi r^2 v \tag{4}$$

where, v is the radial velocity of the surface of the universe.

From equations 1 and 4,

$$H = \frac{1}{3V}\frac{dV}{dt} \tag{5}$$

where, V is the volume of the universe.

From equation 5,

$$\frac{dH}{dt} = \frac{1}{3}\left[-\frac{1}{V^2}\left(\frac{dV}{dt}\right)^2 + \frac{1}{V}\frac{d^2V}{dt^2}\right] \tag{6}$$

which is also valid for the universe at nonequilibrium, with the surface moving with a variable radial velocity v, since the derivation of equation 6 does not assume v to be constant, unlike that of equation 2.

2. Methods

Since dark matter particles were constrained at r=0⁺, the length scale of particle interaction can be assumed to be the radius of the universe, r, at $t \to 0^+$, just after the freeze-out. A dark matter particle, in the interior of the universe, is in equilibrium because of the cohesive and adhesive forces exerted on it in all directions by the neighbouring particles. As the universe expands, this equilibrium is temporarily disturbed, and the particle accelerates to its new location, where it is again in equilibrium. This is a quasi-equilibrium model driven by nonequilibrium. During the motion of an interior dark matter particle from the old to the new location, a net force acts on it. This temporary acceleration, at $t \to 0^+$, just after the freeze-out, can be used to determine the functional form, $F_{cohesive\&adhesive} = f(r)$, of the cohesive and adhesive forces. Further, since the surface of the universe is flat(De Bernardis et al. 2000), the relativistic effect in the r direction is absent. Consistently, the CDM is non-relativistic(Armendariz-Picon and Neelakanta 2014). Thus,

$$F_{cohesive\&adhesive} = f(r) = m\frac{d^2r}{dt^2} \tag{7}$$

where, m is the particle's mass and r is the radius of the universe.

We assume that at t=0, $\frac{dr}{dt} = v$, which is the velocity of the surface in the equilibrium model. Then, from equations 6 and 7 **(Supplementary information 2),**

$$\frac{dH}{dt} = -\frac{1}{r^2}\left(\int_0^t \frac{f(r)}{m}dt + v\right)^2 + \left(\frac{1}{r}\frac{f(r)}{m}\right) \tag{8}$$

For the equilibrium model, when the velocity of the surface is a constant, $\frac{dH}{dt} = -\left(\frac{v}{r}\right)^2$, where H is the Hubble constant. Thus, from equation 8, $\frac{f(r)}{m}$ is zero, which is a trivial case since matter and dark matter will not be present without the cohesive and adhesive forces. Thus, the quantum vacuum field (QVF) will not be created, and the surface tension force will not be present. The trivial case can

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be proven by mathematical induction using equation 23 **(Supplementary information 3).** Thus, $\frac{f(r)}{m} \neq 0$, and the velocity of the surface is not constant. Therefore, a net constant radial force (k_0) acts on the surface, which is in a non-equilibrium condition. The net radial force k_0 is like the constant of integration that may arise when we solve equations 8 and 9 together. Further, since Newton's second law of motion is universally valid, we assume that the net constant radial force that acts on the surface and the deviation of $\frac{dH}{dt}$ from $-\left(\frac{v}{r}\right)^2$ is as small as possible while avoiding the trivial case. Thus(Dennis Gallagher et al. 2007),

$$\frac{dH}{dt} = -\left(\frac{v}{r}\right)^2 (1+\varepsilon) \tag{9}$$

where, $\epsilon \ll 1$

From equations 8 and 9, we conclude that $\frac{f(r)}{m}$ must include a $\frac{1}{r^\infty}$ term, but it must also include other terms to avoid the trivial case. Further,

$$r = vt + \frac{1}{2}\alpha t^2 \tag{10}$$

where, α is the acceleration of the surface, and v is its initial radial velocity at t=0.

$$\alpha = \frac{k_0}{m_e} \tag{11}$$

where, k_0 is the net constant radial force acting on the surface and m_e is the mass of the surface.

Since $t \to 0^+$, the $O(t^2)$ term in equation 10 is negligible in comparison to $O(t)$ term **(Supplementary information 4).** Then (quasi-equilibrium),

$$r = vt \tag{12}$$

Next, we used equations 8 and 9 to find the functional form of cohesive/adhesive forces $F_{cohesive\&adhesive} = f(r)$.

3. Results and Discussion

3.1. The Functional Form of the Cohesive/Adhesive Forces

First, we consider a case in which $\frac{f(r)}{m}$ includes a constant term, i.e.,

$$\frac{f(r)}{m} = k_0'' = \text{constant} \tag{13}$$

Then, from equations 8, 12, and 13 **(Supplementary information 5),**

$$\frac{dH}{dt} = -\left(\frac{v}{r}\right)^2 \left[1 + \left(\frac{k_0''\, r}{v^2}\right)^2 + \frac{k_0''\, r}{v^2}\right] \tag{14}$$

Comparing equation 14 with equation 9, since $\varepsilon \ll 1$, in equation 14, ε must not contain the positive powers of r. Therefore, $\frac{f(r)}{m}$ may not include a constant term.

Next, we consider another case in which $\frac{f(r)}{m}$ includes a term $\frac{1}{r^x}$, where x is a positive real number other than 1,

$$\frac{f(r)}{m} = \frac{k_x''}{r^x} \tag{15}$$

Then, from equations 8, 12, and 15 **(Supplementary information 6),**

$$\frac{dH}{dt} = -\frac{\left(v - \frac{k_x''\ r_f^{1-x}}{v\,(1-x)}\right)^2}{r^2} - \left(\frac{k_x''}{v\,(1-x)\,r^x}\right)^2 - \left(\frac{2}{1-x} - \frac{2k_x''\ r_f^{1-x}}{v^2\,(1-x)^2} - 1\right)\frac{k_x''}{r^{1+x}} \tag{16}$$

or

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$$\frac{dH}{dt} = -\left(\frac{v - \frac{k''_x \quad r_f^{1-x}}{v \ (1-x)}}{r}\right)^2 \left[1 + \left\{\left(\frac{k''_x}{v \ (1-x)}\right) \Big/ \left(v - \frac{k''_x \quad r_f^{1-x}}{v \ (1-x)}\right)\right\}^2 \left(\frac{1}{r^{2x-2}}\right) + \left\{\left(\frac{2}{1-x} - \frac{2k''_x \quad r_f^{1-x}}{v^2 \ (1-x)^2} - 1\right) k''_x \Big/ \left(v - \frac{k''_x \quad r_f^{1-x}}{v \ (1-x)}\right)^2\right\} \left(\frac{1}{r^{x-1}}\right)\right] \tag{17}$$

where, r_f is the radius of the universe at $t \to 0^+$, the start of the freeze-out.

In equation 17, for $\varepsilon \ll 1$, x must be greater than 1. Further, due to the existence of a vacuum, i.e., a negative radius, from equation 17, x can be either natural numbers greater than 1 or x=3/2, 5/2, 7/2, … so that $\left\{\left(\frac{k''_x}{v \ (1-x)}\right) \Big/ \left(v - \frac{k''_x \quad r_f^{1-x}}{v \ (1-x)}\right)\right\}^2 \left(\frac{1}{r^{2x-2}}\right)$ term in equation 17 does not become imaginary. Furthermore, $\left(\frac{2}{1-x} - \frac{2k''_x \ r_f^{1-x}}{v^2 \ (1-x)^2} - 1\right) k''_x$ will change the sign depending on the sign of k''_x **(Supplementary information 7)**. Therefore, if x=3/2, 5/2, 7/2,…., the forces must be attractive-repulsive perfect conjugate pair for each x so that $\left(\frac{1}{r^{x-1}}\right)$ terms in ε cancel and equation 17 does not become an imaginary number due to a negative value of r.

Next, we consider another case in which $\frac{f(r)}{m}$ includes a $\left(\frac{1}{r}\right)$ term,

$$\frac{f(r)}{m} = \frac{k''_1}{r} \tag{18}$$

Then, from equations 8, 12, and 18 **(Supplementary information 8),**

$$\frac{dH}{dt} = -\left(\frac{v}{r}\right)^2 \left[1 + \left(\frac{k''_1 \ln \frac{r}{v}}{v^2}\right)^2 - 2\left(\frac{k''_1}{v^2}\right)^2 \left(\ln \frac{r_f}{v}\right) \ln \frac{r}{v} + 2\frac{k''_1}{v^2} \ln \frac{r}{v} - \frac{k''_1}{v^2} + \left(\frac{k''_1 \ln \frac{r_f}{v}}{v^2}\right)^2 - 2\frac{k''_1}{v^2} \ln \frac{r_f}{v}\right] \tag{19}$$

Since in equation 19, ε contains the logarithmic term in r, ε will diverge. Therefore, $\frac{f(r)}{m}$ may not include a $\left(\frac{1}{r}\right)$ term. For a similar reason, $\frac{f(r)}{m}$ may also not include terms with positive powers of r. Therefore,

$$\frac{f(r)}{m} = \frac{k''_x}{r^x} + \cdots \pm \frac{k''_{x-1/2}}{r^{(x-1/2)}} \ldots\ldots\ldots + \frac{k''_\infty}{r^\infty} \tag{20}$$

where, x is a natural number greater than 1, $k''_x \ldots k''_{x-1/2} \ldots k''_\infty$ are real number constants, and m is the particle's mass experiencing the cohesive and adhesive forces. The constant $k''_{x-1/2}$ can also take imaginary values.

Thus, from equation 20, the cohesive and adhesive forces between two matter/dark matter particles of mass m_1 and m_2 can be given as:

$$f(r) = m_1 m_2 \left(\frac{k'_x}{r^x} + \cdots \pm \frac{k'_{x-1/2}}{r^{(x-1/2)}} \ldots\ldots\ldots + \frac{k'_\infty}{r^\infty}\right); \text{ where, x is a natural number>1} \tag{21}$$

Further, from the comparison of the front term, $\left(\frac{v - \frac{k''_x \ r_f^{1-x}}{v \ (1-x)}}{r}\right)^2$, in equation 17, with the front term in equation 9, the change in the velocity of the surface, Δv, after the addition of each force during the freeze-out is:

$$\Delta v = -\frac{k''_x \quad r_f^{1-x}}{v \ (1-x)} \tag{22}$$

where, r_f is the radius and v is the velocity of the surface at the start of the addition of cohesive/adhesive forces. The change in velocity is very small since $r_f \gg 1$ and $x > 1$.

Since $x > 1$, from equation 22, the velocity increases when a repulsive force is added and decreases when an attractive force is added. Further, when a force with a large value of x is added, the change in the velocity is small. Furthermore, if an attractive-repulsive perfect conjugate corresponding to x=3/2 or 5/2 or 7/2….is added, the velocity does not change.

3.2. Force Balance on the Surface of the Universe

On the surface, the surface tension force and the cohesive/adhesive forces act, resulting in a net radial surface force k_0.

The surface tension force is due to pressure $\frac{2\gamma}{r}$, resulting in a force of $8\pi\gamma r$.

Thus, applying the force balance on the surface of the mass m_e caused by the internal mass of the universe, m_i, with the help of cohesive/adhesive forces given by equation 21, we obtain the following equation:

$$m_i m_e\left(\frac{k'_2}{r^2}+\frac{k'_3}{r^3}+\frac{k'_4}{r^4}+\frac{k'_5}{r^5}\dots\dots\pm\frac{k'_{x-1/2}}{r^{(x-1/2)}}\dots\dots+\frac{k'_\infty}{r^\infty}\right)+8\pi\gamma r=k_0 \tag{23}$$

where, k_0 is the net radial force acting on the surface. Further, k_0 is a constant; otherwise, the net force acting on the surface will diverge for $0 \le t < \infty$.

Since the cold dark matter particles are at equilibrium(Armendariz-Picon and Neelakanta 2014) after the freeze-out, their spatial free-energy change is zero, and the chemical potential is constant. Therefore, their density in the interior of the universe must be a constant. On the other hand, the density may vary when the universe expands (the quasi-equilibrium)

Thus,

$$m_i = \rho_0\left(\frac{4\pi r^3}{3}\right) \tag{24}$$

where, ρ_0 is the density of the cold dark matter particles.

On the other hand, the mass of the surface, m_e, is independent of r. Hence, m_e is a constant.

3.3. The Electrostatic Force

Since the cold dark matter particles interact only by gravitational interaction, they must be uncharged. On the other hand, the positive volume may also contain charged massive dark matter particles that survived annihilation in the early universe (De Rújula et al. 1990). Thus, although the mass of the CDM increases as the radius of the internal positive volume increases (equation 24), the charge of the positive volume, q_i, remains constant. Thus,

$$q_i = c_1 \tag{25}$$

where, c_1 is a constant.

From equations 24 and 25,

$$q_i = c_1\left(\frac{m_i}{\frac{4}{3}\pi r^3\,\rho_0}\right) \tag{26}$$

Let's take a quasi-equilibrium model of the universe. In this model, a positive volume containing CDM is surrounded by a negative volume or vacuum. The sphere containing the CDM has a constant radius, c. The sphere has a constant internal charge, q_i and a constant surface charge q_{ec}. As the universe expands, the charge of the vacuum or the negative volume surrounding the surface is a variable, q_{ev} and the negative volume has a variable radius r.

From Gauss's law,

$$\nabla.E = \frac{\rho}{\varepsilon_0} \tag{27}$$

where, ρ is the volume charge density.

q_e is the total charge of the surface and the negative volume. Thus,

$$q_e = q_{ec} + q_{ev} \tag{28}$$

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From equation 27,

$$\frac{d}{dr}\left\{\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{(q_i+\ q_{ev})}{r^2}\right\}=\frac{3(q_i+\ q_e)}{4\pi\varepsilon_0 r^3} \tag{29}$$

or,

$$\frac{d(q_i+\ q_{ev})}{dr}-\frac{2}{r}(q_i+\ q_{ev})=\frac{3(q_i+\ q_{ec+}q_{ev})}{r} \tag{30}$$

From the quasi-equilibrium assumption, the derivative term on the left-hand side (LHS) of equation 30 vanishes, and equation 30 converts into:

$$-2\left(\frac{q_i}{r}+\ \frac{q_{ev}}{r}\right)=\frac{3(q_i+\ q_{ec})}{c}+\frac{3q_{ev}}{r} \tag{31}$$

The first term on the right-hand side (RHS) of the above equation is in the constant volume, whereas the second term of the RHS is in the variable volume.

From equation 31,

$$q_{ev}=-\frac{1}{5}\left[3(q_i+\ q_{ec})\frac{r}{c}+2q_i\right] \tag{32}$$

In equation 32, $r\geq 0$. However, the variable radius has a negative volume and is negative in our system. Therefore, we change equation 32 as:

$$q_{ev}=-\frac{1}{5}\left[3(q_i+\ q_{ec})\frac{(-r)}{c}+2q_i\right] \tag{33}$$

In equation 33, r is negative.

From charge conservation,

$$q_i+\ q_{ec}+\ q_{ev}=0 \tag{34}$$

From equations (33) and (34),

$$q_{ec}=\frac{3q_i\left(-\frac{r}{c}-1\right)}{5-\frac{r}{c}} \tag{35}$$

At $r=-c,\ q_{ec}=0$ i.e., when the negative volume (the vacuum) and the positive volume have the same radius c, the charge of the surface is zero, which is consistent with the fact that the surface shared between the positive and negative volumes is uncharged.

Thus, from equation 34,

$$q_{ev}=-\frac{1}{5}\left[\frac{-3r}{c}+2\right]q_i \tag{36}$$

Equation 36 is the charge of the negative volume (i.e., $r<0$). Thus, from equation 36, q_{ev} and q_i have opposite signs to the charges.

The electrostatic force between the positive and negative volumes, $F_{Coulomb}$, is

$$F_{Coulomb}=\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{(q_i.q_{ev})}{r^2} \tag{37}$$

The force $F_{Coulomb}$ is negative because the charges q_i and q_{ev} have the opposite signs.

Substituting equation 36 in equation 37,

$$F_{Coulomb}=-\left(\frac{1}{4\pi\varepsilon_0}\right).\frac{1}{5}\left[\frac{-3r}{c}+2\right]\frac{(q_i.q_i)}{r^2} \tag{38}$$

In equation 38, $r<0$ and $F_{Coulomb}<0$

From equations 26 and 38,

$$F_{Coulomb}=-k_4\frac{(m_i.m_e)q_i}{\rho_0\, r^4}-k_5\frac{(m_i.m_e)q_i}{\rho_0\, r^5} \tag{39}$$

Further, k_4 and k_5 are positive constants. Furthermore, m_e is a constant. In equation 39, since the first term on the RHS is much bigger than the second term as r is large, and since $F_{Coulomb}$ is negative and m_i is positive, the constant q_i must be positive. Furthermore, both addition terms in the RHS of equation 39 are individually negative.

3.4. The Strong Force

The two-pion exchange potential, $V^{\pi:\pi}$, caused by the mass of pions, m_π, present in the internal universe, in the chiral limit, is given as(Beane and Savage 2003),

$$V^{\pi:\pi} = -\frac{k_3''' m_\pi^2}{r^5} \tag{40}$$

The two-pion exchange field, $E^{\pi:\pi}$, experienced by the nucleons of the surface and caused by the nucleons of the internal universe is,

$$E^{\pi:\pi} = -\frac{k_3'''' m_\pi^2}{r^6} \tag{41}$$

Further,

$$m_\pi = c_3 m_i \tag{42}$$

where, c_3 is a constant.

Thus, the two-pion exchange force caused by the nucleons present in the internal universe on the nucleons present at the surface is

$$F_{\pi:\pi} = -\frac{k_3''''' \; {m_i}^2 \, {m_e}^2}{r^6} \tag{43}$$

From equations 24 and 35,

$$F_{\pi:\pi} = -\frac{k_3 \;\, \rho_0 m_i m_e}{r^3} \tag{44}$$

where, k_3 is a positive constant and m_e is the mass of the surface, which is a constant.

3.5. The Unification Equation

Thus, from equation 23, the unified equation involving the gravitational force, the strong force, the electrostatic force, the surface tension force, and the force k_0 is given as:

$$m_i m_e \left[\frac{-G}{r^2} + \left(-\frac{\rho_0 k_3}{r^3}\right) + \left(-k_4 \frac{(q_i)}{\rho_0 \, r^4} - k_5 \frac{(q_i)}{\rho_0 \, r^5}\right) \pm \frac{k'_{x-1/2}}{r^{(x-1/2)}} + \frac{k'_\infty}{r^\infty}\right] + (8\pi\gamma r) = k_0 \tag{45}$$

where, k_3 , k_4 and k_5 are positive constants, and x is a natural number greater than 1.

From equations 24 and 45,

$$-k_0 = \left(\frac{4\pi}{3}\right)\left[(Gm_e\rho_0)r + (\rho_0^2 k_3 m_e) + \left(\frac{k_4 m_{e\cdot}.q_i}{r}\right) + \left(\frac{k_5 m_e.q_i}{r^2}\right)\right] - (8\pi\gamma r) \tag{46}$$

The unified equation must be valid at r = 0. From equation 46, taking the limit at r=0, we find that,

$$-k_0 = \left(\frac{4\pi}{3}\right)(\rho_0^2 k_3 m_e) \tag{47}$$

From equations 46 and 47,

$$\left(\frac{4\pi}{3}\right)\left[-(6\gamma - Gm_e\rho_0)r + \left(\frac{k_4 m_{e\cdot}.q_i}{r}\right) + \left(\frac{k_5 m_e.q_i}{r^2}\right)\right] = 0 \tag{48}$$

or,

$$-(6\gamma - Gm_e\rho_0)r^3 + k_4 m_{e\cdot}.q_i.r + k_5 m_e.q_i = 0 \tag{49}$$

Equation 49 must also be valid at r=0+. Taking the limit at r=0+, from equation 49, we find,

$$k_5 m_e.q_i = 0 \tag{50}$$

Hence, from equation 49,

either r=0 or

$$-(6\gamma - Gm_e\rho_0)r^2 + k_4 m_{e\cdot}.q_i = 0 \tag{51}$$

or,

$$r = \pm\sqrt{\frac{k_4 m_{e\cdot}.q_i}{6\gamma - Gm_e\rho_0}} \tag{52}$$

When $\gamma \to \infty$, r→ 0 and when $\gamma = \frac{Gm_e\rho_0}{6}$, $r \to \pm\infty$. Hence, the surface tension must have decreased as the universe evolved from a closed system to a flat universe.

3.6. Comparison of the Strong and the Weak Forces at r=0

We hypothesize that $-k_0$, given by equations 45 or 46, is the weak force. On the other hand, the strong force is given by the Yukawa potential.

The Yukawa potential is given by,

$$V(r) = -\frac{k_6}{r}\, e^{-mr} \tag{53}$$

where, k_6 is a constant, and m is the mass of the particle mediating the force.

Thus, the Yukawa force F_{Yukawa} is given as,

$$F_{Yukawa} = -\frac{k_6}{r}\left(me^{-mr} + \frac{1}{r}e^{-mr}\right) \tag{54}$$

or

$$F_{Yukawa} = -\frac{k_6}{r}\left[\left(m - m^2r + \frac{m^3r^2}{2} - \frac{m^4r^3}{6} \ldots\ldots\right) + \left(\frac{1}{r} - m + \frac{m^2r}{2} - \frac{m^3r^2}{6} + \frac{m^4r^3}{24} \ldots\ldots\right)\right] \tag{55}$$

$$F_{Yukawa} = k_6\left[\left(-\frac{1}{r^2} + \frac{m^2}{2} - \frac{m^3r}{3} + \frac{m^4r^2}{8} - \frac{m^5r^3}{30} + \frac{m^6r^4}{144} \ldots\ldots\right)\right] \tag{56}$$

From equation 56, at r=0,

$$F_{Yukawa} = k_6\left[\left(-\frac{1}{r^2} + \frac{m^2}{2}\right)\right] \tag{57}$$

Further, taking the limit $r \to 0$ in equation 57,

$$F_{Yukawa} = k_6\left[\left(\frac{m^2}{2}\right)\right] = \text{constant} \tag{58}$$

Since in equation 46, $\left(\frac{4\pi}{3}\right)(\rho_0^2 k_3 m_e)$ is the strong force, the equality of the weak $(-k_0)$ and the strong force at r=0, as shown by equation 47, is consistent with the Yukawa force at r=0 becoming a constant, as shown by equation 58.

4. Conclusions

In summary, we suggest that a surface tension force exists. Further, we suggest that there are two spheres in the universe with equal radii but opposite signs, given by equation 52. However, since the universe is flat, the possibility is that $\gamma = \frac{Gm_e\rho_0}{6}$ and $r \to \pm\infty$. Furthermore, we suggest that there is a classical solution to the unification problem and provide an equation that unifies all the forces of nature within classical physics. We hypothesize that $-k_0$ is the weak force. Equation 45 unifies all the forces of nature. Equation 47 unifies the weak and the strong force. Equation 48 unifies the gravitational, surface-tension, and electrostatic forces.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

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Code Availability: No computer code has been used in this study.

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