

THE GRAVITATIONAL SUPERFORCE HYPOTHESIS*

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The gravitational superforce hypothesis states: *The gravitational force is always equal to a constant superforce for the same mass and distance that exists at the mass energy equivalence of the gravitation potential energy.* A specific superforce that impacts a broad range of theoretical physics and cosmology is defined by this hypothesis. This superforce is suggested as a baseline for comparison with any future superforce.

Introduction

Paul Davies [1] published a book in 1984 with the title, *Superforce: The Search for a Grand Unified Theory of Matter*. He predicted a number of characteristics that a superforce should possess, such as: represents a path to an integrated and harmonious framework of the universe; exists at the convergence of the four fundamental forces at the Planck energy; and, consists of a single, simple superforce. No superforce has been identified to date with any of these characteristics. Nevertheless, no reason has surfaced to withdraw these predictions. This paper proposes a superforce that fulfills most of these predictions.

The Gravitational Superforce Hypothesis

A conceptual framework is proposed based upon working with forces as force laws and assuming that the four fundamental constants are always constant. The gravitational superforce hypothesis summarizes the conditions for the existence of a superforce.

The Newton gravitational force is always equal to a constant superforce for the same mass and distance that exists at the mass-energy equivalence of the gravitation potential energy.

Starting at the end of the hypothesis and working backwards, the mass-energy equivalence of the gravitation potential energy defines the gravitational collapse limit as the length r_s .

$$mc^2 = m^2G/r_s \quad (1)$$

$$r_s = mG/c^2 \quad (2)$$

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The gravitational collapse limit occurs when all matter becomes energy. This limit is already used [2] as a “characteristic measure of relativistic effects in bodies” as r approaches r_s . This characteristic measure is expressed as n , as noted in the frame. It is suggested that at the Schwarzschild radius, $r = 2mG/c^2$, that $n \geq 0.5$. A black hole is still accreting. Conditions at the big bang, or wherever mass-energy equivalence exists, are expected to be at $n = 1$.

Relativistic Effects	
$n = mG/c^2 r$	
Sun	$n = 10^{-5}$
White Dwarf	$n = 10^{-3}$
Neutron Star	$n = 0.3$

When the gravitational collapse length from equation (2) is substituted into the Newton gravitational force, the result is the gravitational superforce.

$$m^2 G / r_s^2 = m^2 G (c^2 / mG)^2 = c^4 / G \quad (3)$$

The gravitational superforce is equal to the speed of light to the fourth power divided by Newton’s universal gravitational constant, c^4/G . It is called the gravitational superforce because the superforce was derived based upon the gravitational collapse of matter to energy. Mass cancels out of equation (3). Consequently, the result is independent of whether the masses interacting are electrons, protons, bowling balls, moons, star, galaxies, or a mixture of these.

Note that equation (2) may be rearranged to express the so-called gravitation potential as being equal to c^2 .

$$mG / r_s = c^2 \quad (4)$$

When both sides of equation (4) are multiplied by mass m , the result is the same as equation (1), which means that equation (4) defines the gravitation potential of any mass at the superforce.

The superforce does have the units of a force and is justified in being called a superforce because of its enormous scalar magnitude.

$$c^4 / G \sim (m/sec)^4 (kg \text{ sec}^2 / m^3) \sim kg \text{ m} / \text{sec}^2 \sim N \quad (5)$$

$$c^4 / G = 1.21 \times 10^{44} \text{ N} \quad (6)$$

One gauge of the enormity of the superforce is that the magnitude of c^4/G is 1.70×10^{38} times greater than the measured color force between quarks at the Compton wavelength of a proton [3]. Another comparison is that c^4/G is 2.90×10^{76} times greater than the gravitational force between two protons at the Compton wavelength of a proton. This comparison defines the Eddington number [4] physically as the relative magnitude of the strongest force (the superforce) to the weakest force (gravitational force).

Speculations may be made about other characteristics of the superforce c^4/G . If the superforce is always associated with a condition of mass-energy equivalence, then it would be

expected that the unleashing of the superforce is probably the cause of the dynamics of nuclear explosions. Since the superforce is also associated with gravitational collapse, the superforce could be an action-reaction force to counter gravitational collapse to infinity and is probably repulsive. Over and above these speculations, two primary conclusions result from this section. The gravitational superforce hypothesis does define a superforce. This superforce is c^4/G . The superforce is *simple*, as Davies predicted [5].

The Superforce Hypothesis and the Electromagnetic Force

The Coulomb (electromagnetic) force complies with the gravitational superforce hypothesis. Both the Newton gravitational force and the Coulomb electromagnetic force are inverse square relationships. Consequently, the two forces overlies each other at a constant mass.

$$m_K^2 G / r_K^2 = e^2 / 4\pi\epsilon_0 r_K^2 \quad (7)$$

$$m_K = (e^2 / 4\pi\epsilon_0 G)^{1/2} \quad (8)$$

If the Newton force terminates at the superforce at any mass, and the Coulomb force is now equal to the Newton force, then the Coulomb force probably terminates at this same superforce. It is proposed that the termination point for the Coulomb force is defined by the mass-energy equivalence of the Coulomb potential energy.

$$m_K c^2 = e^2 / 4\pi\epsilon_0 r_K \quad (9)$$

$$r_K = e^2 / 4\pi\epsilon_0 m_K c^2 = (e^2 G / 4\pi\epsilon_0 c^4)^{1/2} \quad (10)$$

The resulting length r_K is the classical radius, not of the electron, but of some mass m_K . Substitution of the mass m_K from equation (8) into equation (10) gives a constant magnitude for r_K . Notice the presence of the superforce in inverse form in equation (10). When this value of r_K is inserted into the Coulomb force and r_K and m_K are both inserted into the Newton force, both forces are equal to the superforce.

$$e^2 / 4\pi\epsilon_0 r_K^2 = c^4 / G = m_K^2 G / r_K^2 \quad (11)$$

The result in equation (11) should have some significance relative to any future resolution of Einstein's unified field theory. If the gravitational field is ever unified with the electromagnetic field, it is predicted that this unified field should have a point solution at m_K , r_K , and c^4/G .

Another consequence of the relationship of the Coulomb force with the superforce is that a Coulomb scale (see frame) apparently exists at the superforce independent of the Planck scale. Coulomb did not derive the Coulomb scale. The Coulomb scale also does not obey the uncertainty principle. The quantities in the frame were probably first derived by G. Johnstone Stoney in 1874 [6]. He called them "natural units" and did not identify them

Coulomb Scale	
Length	$r_K = (e^2 G / 4\pi\epsilon_0 c^4)^{1/2}$
Time	$t_K = (e^2 G / 4\pi\epsilon_0 c^6)^{1/2}$
Mass	$m_K = (e^2 / 4\pi\epsilon_0 G)^{1/2}$

with a superforce or a Coulomb scale as such. I derived the Coulomb scale with no knowledge of Stoney's work and named it the Coulomb scale because it is the terminus of the Coulomb force at the superforce. Davies' prediction [7] that the four fundamental forces converge on a superforce is partially fulfilled by the convergence of the Coulomb and the Newton forces on the superforce c^4/G .

The Superforce Hypothesis and the Planck Scale

The Planck scale is given in the frame. The Coulomb scale, discussed in the last section, is related to the Planck scale by the square root of the fine structure constant. Even though related, the two scales function independently. Electric charge is not present in the Planck scale and the Planck constant does not appear in the Coulomb scale.

The superforce and the Planck scale are related in a very simple way. Just substitute the Planck mass and the Planck length into the Newton gravitational force.

$$m_p^2 G / r_p^2 = [(hc/2\pi G)^{1/2}]^2 G / [(hG/2\pi c^3)^{1/2}]^2 = c^4/G \quad (12)$$

As Davies predicted [8], the superforce co-exists with the Planck scale.

If the Coulomb scale is the terminus of the Coulomb force at the gravitational superforce c^4/G , what is the Planck scale? Some background [9] about the Planck scale is necessary to answer this question. After Planck discovered the quantum unit, $h/2\pi$, he manipulated his constant dimensionally with the constants c and G to obtain "natural units" of length, time, and mass. The Planck scale is an arbitrary construction. The Planck scale is like an oasis where no marked paths or roads lead to the oasis. Anyone who reaches the Planck scale has gotten there by chance or lucky guesses. There is no Planck scale theory.

Planck Scale	
Length	$r_p = (hG/2\pi c^3)^{1/2}$
Time	$t_p = (hG/2\pi c^5)^{1/2}$
Mass	$m_p = (hc/2\pi G)^{1/2}$

Derivation of a pathway to the Planck scale requires a more general interpretation of the gravitational superforce hypothesis. This general superforce hypothesis is: *Every force is equal to the superforce at the mass-energy equivalence of its potential energy.* Assume that the Planck energy equation is the potential energy of some hypothetical Planck force. Apply the superforce hypothesis:

$$h\omega/2\pi = hc/2\pi r_p = m_p c^2 \quad (13)$$

$$r_p = h/2\pi m_p c \quad (14)$$

The Compton wavelength of the Planck mass is equal to the Planck length in equation (14). It is suggested that a hypothetical inverse square force is equal to c^4/G at the Planck length. If a/r^2 is this so-called Planck force, then

$$m_p^2 G / r_p^2 = a / r_p^2 \quad (15)$$

$$a = hc/2\pi \quad (16)$$

The familiar $E = h\omega/2\pi$ is actually the potential energy of a hypothetical Planck force $hc/2\pi r^2$ that has its terminus at the Planck scale. This force is equal to the superforce at the mass-energy equivalence of its potential energy.

$$hc/2\pi r_p^2 = c^4/G = m_p^2 G/r_p^2 \quad (17)$$

The Planck force is a legitimate force, which is probably the force law for the Casimir effect and the zero-point force [10]. The Planck force is not only the path to the Planck scale, but also introduces the quantum into the interactions of forces. In addition, The Planck force times the speed of light [$L = h\omega^2/2\pi$] gives a radiance, or luminosity flux, that may be of experimental interest. Every frequency has a peak flux rate, the higher the frequency, the higher the flux rate. The highest possible flux rate should be at the Planck frequency [$L_p = hc^2/2\pi r_p^2$].

The relationships described in this paper so far may be illustrated in a plot of Log Force versus Log Distance, as shown by Fig. 1.

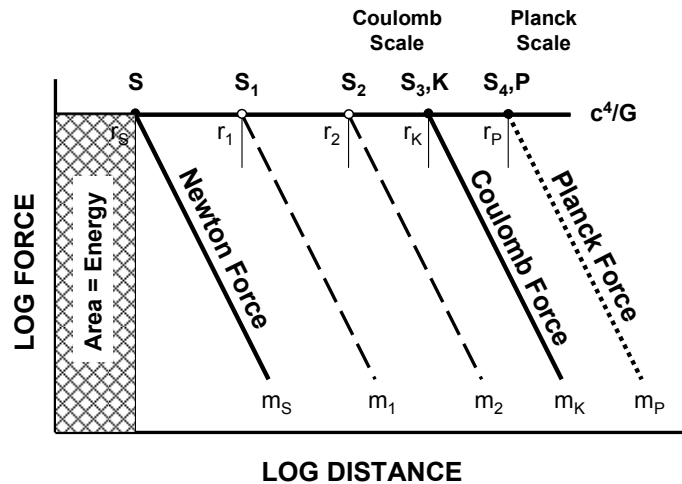


Figure 1. Plot of the Newton gravitational force for various masses with the Coulomb electromagnetic force and the hypothetical Planck force.

The Newton gravitational force is free to change locations with changing mass, but the Coulomb and the Planck forces are fixed. The area under the curve at each point equates to the mass-energy equivalence of the potential energy of the particular force or mass.

$$m_S^2 G/r_S^2 \times r_S = m_S c^2 \quad (18)$$

$$e^2/4\pi\epsilon_0 r_K^2 \times r_K = m_K c^2 \quad (19)$$

$$hc/2\pi r_p^2 \times r_p = m_P c^2 \quad (20)$$

Equations (18), (19), and (20) support the superforce hypothesis. It may also be concluded from these equations and Figure 1 that different forces are equal to c^4/G at different energy levels. This result is in possible opposition to the *Standard Model*, which proposes [11] that all four fundamental forces converge on a common energy representing the superforce at the Planck scale. However, the gravitational superforce hypothesis predicts that different forces may converge on the superforce c^4/G at different energy levels. The gravitational force may converge on the superforce at any energy level, including the Coulomb energy and the Planck energy. The Planck force does converge on the Planck scale at the Planck energy, but the Standard Model does not recognize the Planck force. It is suggested that this issue be examined. On the other hand, the Standard Model includes the strong and the weak forces, which may converge at the Coulomb scale. This issue must also be resolved.

The Superforce Hypothesis and the Einstein Field Equations

The objective here is to show that the gravitational superforce plays a major role in the Einstein field equations of general relativity. One of the most frequent forms of the Einstein field equations is the following [12], without the cosmological constant. The presence of this constant would not change the results.

$$R_{ab} - \frac{1}{2}g_{ab}R = 8\pi T_{ab} \quad (21)$$

The simplest way to analyze this equation is dimensionally. The left side, which is concerned with the curvature of space and the gravitational metric is in units of length per unit volume. The right side, which Einstein called “ugly,” contains the energy tensor, T_{ab} , which has units of energy per unit volume, or energy density. A virtual force is present to make both sides have the same units. This form of the Einstein field equation is in so-called geometrized units.

The basic field equation does contain the superforce in inverted form. Einstein often rolled this force into a “kappa” constant [13].

$$R_{ab} - \frac{1}{2}g_{ab}R = 8\pi GT_{ab}/c^4 \quad (22)$$

Units are visibly balanced in the basic equation. More can be learned by rearranging the basic equation so that the superforce is more apparent.

$$c^4/G = 8\pi T_{ab}/[R_{ab} - \frac{1}{2}g_{ab}R] \sim Mc^2/(MG/c^2) \quad (23)$$

On the far right, the limits of the Einstein field equation are expressed in gravitational superforce hypothesis terms. The maximum level of the energy tensor is Mc^2 , where M is the mass of the universe. The gravitational collapse limit, or mass-energy equivalence length, is MG/c^2 . This combination of mass-energy and gravitational collapse limit is equal to the superforce, c^4/G . Mass cancels out as in the gravitational force calculations. It is as if the superforce is the child of the marriage of the special theory of relativity to the general theory of relativity.

The arrangement of equation (23) offers a means of briefly examining different variations in the Einstein field equation of general relativity because of the presence of c^4/G .

- Divide by c : Momentum density with c^3/G . Dividing by c leaves c^3/G on the left. Dividing Mc^2 or the energy tensor by c creates a momentum density function, Mc . Corresponding changes occur in the following.
- Divide by c^2 : Mass density with c^2/G . Einstein frequently used this form.
- Divide by c^4/G : Energy density, basic equation (22).
- Multiply by c : Radiance density with c^5/G [14].
- Apply units of $c = G = 1$ in those units: Geometrized virtual force equation (21).

Many details could be given for each of the above operations. Other aspects of the role of c^4/G in the Einstein field equations have been discussed elsewhere [15, 16]. The main point here, though, is that the flexibility that exists in the Einstein field equations is linked to the superforce, that is, c^4/G is vital in the field equations. The derivations made in the previous sections may all be associated with the Einstein field equations through the superforce.

$$m_S^2 G / r_S^2 = e^2 / 4\pi\epsilon_0 r_K^2 = hc / 2\pi r_P^2 = c^4 / G = 8\pi T_{ab} / [R_{ab} - \frac{1}{2}g_{ab}R] \quad (24)$$

The Newton gravitational force, Coulomb electromagnetic force, Planck force, the Planck scale, and the superforce are all coupled with the Einstein field equations. Each of the functions to the left of the superforce may be substituted for c^4/G in the Einstein field equations. This is all very tidy, but the question remains whether or not any part or all of 8π with the energy tensor belongs with the superforce. In any case, the versatility of the applications of c^4/G in the field equations as well as elsewhere in this paper fulfills another prediction by Davies [17] about the superforce bestowing an “integrated and harmonious framework” upon the universe.

Conclusions

This paper uses relatively simple scalar mathematics to manipulate functions of physics that have been known for over 50 years to reveal the existence of two new forces: the superforce and the Planck force. The superforce c^4/G may be linked to the Newton gravitational force, Coulomb electromagnetic force, the Coulomb scale, the Planck scale, a hypothetical Planck force, the special theory of relativity, the general theory of relativity, gravitational collapse limit, and gravitational luminosity. Any theory which converges on the Planck scale, such as string theory as a limit, or inflation theory (when changing from inflation to expansion) has probably encountered the superforce in some hidden manner. Theories about the vacuum may also be influenced by the superforce, since c^4/G is contained in the equation for the limit of the vacuum energy density and the pressure of the vacuum [18].

The ubiquitous presence of c^4/G in so many relationships indicates that c^4/G is more than a fortuitous combination of fundamental constants. It is concluded that c^4/G acts as an asymptote and should be given more prominence in the solutions of the Einstein field equations. Moreover,

the superforce c^4/G merits consideration as a baseline for comparison with the magnitude of any future superforce.

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