Gravity’s Hidden Inverse Relationship With Electromagnetism:
A Possible Path to Solving the Hierarchy Problem

About the Author: Lamont Williams is a science writer in the Washington, DC, area. He is author of [The Greatest Source of Energy: A New Theory of Time] which presents a conceptual model for combining General Relativity and Quantum Mechanics.

Email: lamontwilliams003@gmail.com.

Abstract
The hierarchy problem — the problem of why gravity is far weaker than electromagnetism — is one of the greatest problems in physics. In this study, it is hypothesized that the disparity between the forces stems from their having an inverse, or seesaw-like, relationship — with one strength value naturally being high when the other value is low. In accordance with this seesaw-like relationship, it is further hypothesized that, as energy is increased, the strength of electromagnetism falls while the strength of gravity rises. The author suggests that theory and observation indicating a rise in electromagnetic strength with increasing energy are not accounting for gravity’s contribution to the calculated and measured coupling. It is shown that removing this contribution exposes the inverse relationship between the forces and, importantly, the lowering of electromagnetism’s strength over the increasing energy levels. Taken together, the concepts presented here may help in solving the hierarchy problem. This, in turn, may point the way to combining gravity and electromagnetism into a single framework and ultimately unifying general relativity and quantum mechanics.

Introduction
Gravity is the weakest of the fundamental forces. The electromagnetic force of repulsion between two electrons, for example, is 42 orders of magnitude stronger than the gravitational attraction between those same two particles. This discrepancy is known as the “hierarchy problem” and is considered to be one of the greatest outstanding problems in theoretical physics.

Currently, the leading idea for solving this problem is the concept that the weakness of gravity is a result of the force’s energy “leaking” from our four-dimensional spacetime into higher dimensions of space, of which we have no access. The leaking of gravity from our spacetime would cause it to be weak in our experience.¹

This concept is impressive in its scope and detail and provides an interesting and indeed plausible explanation for gravity’s weakness. However, mathematical evidence concerning the gravitational and electromagnetic coupling constants — the dimensionless numerical values that correspond to the strengths of the forces — suggests that gravity and electromagnetism exist in an inverse relationship, similar to their being on opposite
sides of a seesaw. Under this condition, one (in this case electromagnetism) is naturally high, or strong, while the other (gravitation) is low, or weak.

As such, there may in actuality be no “hierarchy problem.” It may be natural and indeed necessary for gravity to be weak when electromagnetism is strong.

**Methods**

The suggested mathematical relationship between the gravitational and electromagnetic coupling values is as follows:

\[
\alpha^2 \approx \alpha_G \left( \frac{\text{Electron Radius}}{\text{Planck Length}} \right)^2 
\]

(1)

\[
\alpha_G \approx \alpha^2 \left( \frac{\text{Planck Length}}{\text{Electron Radius}} \right)^2 
\]

(2)

Alpha is the fine-structure constant, the electromagnetic coupling constant (between two electrons in this case). The full number is about 0.007297, often abbreviated as 1/137 or 0.0073. Alpha-G is the gravitational coupling constant between two electrons, at approximately 1.752 x 10^{-45}. The classical electron radius is about 2.818 x 10^{-15} m, and the Planck length is about 1.616 x 10^{-35} m.

\[
(0.007297)^2 \approx 1.752 \times 10^{-45} \left( \frac{2.818 \times 10^{-15} \text{m}}{1.616 \times 10^{-35} \text{m}} \right)^2 
\]

(3)

\[
1.752 \times 10^{-45} \approx (0.007297)^2 \left( \frac{1.616 \times 10^{-35} \text{m}}{2.818 \times 10^{-15} \text{m}} \right)^2 
\]

(4)

Eqs. (1) and (2) can be reduced by taking the square root of each side of each equation, resulting in Eqs. (5) and (6).
\[ \alpha \approx \sqrt{\alpha_G} \left( \frac{\text{Electron Radius}}{\text{Planck Length}} \right) \]  

\[ \sqrt{\alpha_G} \approx \alpha \left( \frac{\text{Planck Length}}{\text{Electron Radius}} \right) \]

In this paper, alpha-G-prime will refer to the square root of alpha-G.

\[ \alpha \approx \alpha_G' \left( \frac{\text{Electron Radius}}{\text{Planck Length}} \right) \]

\[ \alpha_G' \approx \alpha \left( \frac{\text{Planck Length}}{\text{Electron Radius}} \right) \]

\[ 0.007297 \approx 4.185 \times 10^{-23} \left( \frac{2.818 \times 10^{-15} \text{ m}}{1.616 \times 10^{-35} \text{ m}} \right) \]

\[ 4.185 \times 10^{-23} \approx 0.007297 \left( \frac{1.616 \times 10^{-35} \text{ m}}{2.818 \times 10^{-15} \text{ m}} \right) \]

It is suggested that the Planck length value in the denominator of Eqs. (1), (3), (5), (7), and (9) and the Planck length value in the numerator of Eqs. (2), (4), (6), (8), and (10) are constants. The electron radius is considered to undergo Lorentz contraction with
increasing energy up to the limit of the Planck length. Like the electron radius, the
coupling values are also considered variables, with electromagnetic coupling falling and
gravitational coupling rising with increasing energy, with the coupling values equaling
one another when the electron radius reaches the Planck length (Figure 1).

Using the point-slope equation for a straight line, Eq. (11), and the logarithmic values for
distance and coupling strength, the slope of the electromagnetic line, referred to as the
“running electromagnetic coupling constant” (for the change in the constant’s value over
changing energy levels) is found to be 0.500 and the slope of the gravitational line, the
“running gravitational coupling constant,” is found to be –0.500 (Eqs. 12 and 13).
Where the logarithmic values are as follows:

Electromagnetic coupling, 0.007297, –2.137;
Gravitational coupling, 4.185 x 10^{-23}, –22.38;
Classical electron radius, 2.818 x 10^{-15} m, –14.55;
Planck length, 1.616 x 10^{-35} m, –34.79;
Common strength of both forces, when electron radius equals the Planck length, 5.495 x 10^{-13}, –12.26.

When evaluating changes in the strength of electromagnetism, measurements are typically taken at 91.19 GeV (the mass of the Z boson) at about 2.344 x 10^{-17} m [logarithmic value –16.63].

Rearranging the point-slope equation (Eq. 14) and using the slope values from Eqs. (12 and 13), the coupling value for electromagnetism at 91.19 GeV is calculated to be 6.61 x 10^{-4} (~3.18), while the coupling value for gravity at the same point is calculated to be 4.571 x 10^{-22} (~21.34) (Eqs. 15 and 16) (Figure 2).

\[ m = \frac{y_2 - y_1}{x_2 - x_1} \]  
\[ m = \frac{-2.137 - (-12.26)}{-14.55 - (-34.79)} = 0.500 \]  
\[ m = \frac{-22.38 - (-12.26)}{-14.55 - (-34.79)} = -0.500 \]  
\[ y_2 = (m)(x_2 - x_1) + y_1 \]  
\[ y_2 = (0.5)[-16.63 - (-34.79)] + (-12.26) = -3.18 \]  
\[ y_2 = -(0.5)[-16.63 - (-34.79)] + (-12.26) = -21.34 \]
Figure 2. The same graph as in Figure 1 is presented, but showing the logarithmic values for distance and coupling strength. As energy is increased to 91.19 GeV (approximately $2.344 \times 10^{-17}$ m, logarithmic value $-16.63$), the strength of electromagnetism falls 1.04 units, from $-2.137$ to $-3.18$, while gravitational coupling rises 1.04 units, from $-22.38$ to $-21.34$.

Thus, the above mathematics suggests that as energy is increased to 91.19 GeV, electromagnetic coupling falls 1.04 logarithmic units, from $-2.137$ ($0.007297$) to $-3.18$ ($6.61 \times 10^{-4}$), while gravitational coupling rises 1.04 units, from $-22.38$ ($4.185 \times 10^{-23}$) to $-21.34$ ($4.571 \times 10^{-22}$).

In contrast to the above, experimentation (as well as theory) suggests that over this same energy range, electromagnetic strength rises from $-2.137$ (approximately $0.007297$ or $1/137$) to $-2.109$ (approximately $0.007780$, or $1/128$).2,3,4

In the present study, however, it is hypothesized that the observed increase in coupling is actually due to an increase in gravitational coupling, not electromagnetic coupling. It is
suggested that removing the gravitational contribution will reveal a decrease in electromagnetic strength over increasing energy levels.

The questions to be answered then are, (1) If the calculated gravitational increase, as determined in this study (1.04 logarithmic units), were subtracted from the observed electromagnetic coupling strength at 91.19 GeV (–2.109), would the new value for electromagnetism’s strength match the value predicted by this study, and (2) would the slope of the new line for electromagnetism match the slope predicted in this study?

It was found that subtracting gravity’s 1.04-unit increase from the observed value for electromagnetism at 91.19 GeV leads to a new, and lower, electromagnetic coupling value of –3.15 (–2.109 – 1.04). This comes close to the predicted value of –3.18 from this study.

Using –3.15 as the new y-value, at x equals –16.63, leads to a new line for electromagnetism with a slope of 0.487, coming close to the predicted slope of 0.500 (Eq. 17 and Figure 3).

\[
m = \frac{-3.15 - (-2.137)}{-16.63 - (-14.55)} = +0.487
\]  
(17)
Figure 3. Subtracting gravity’s 1.04-unit increase from the observed value for electromagnetism at 91.19 GeV leads to a new, and lower, line for electromagnetism, with a slope nearly matching the predicted slope. (Predicted electromagnetic coupling value at 91.19 GeV, –3.18; slope for running constant, 0.50. Observed electromagnetic value minus suggested gravitational contribution, –2.109 – [–1.04] = –3.15; slope, 0.49. In the figure –3.18 occurs where the solid line for alpha from this study crosses the vertical line at 91.19 GeV. The value –3.15 occurs where the dashed line crosses the vertical line. exp., experimentation.)

Results

In this study, gravitational strength is calculated to increase by 1.04 logarithmic units from zero energy/momentum transfer to 91.19 GeV, while the electromagnetic value is calculated to fall by the same amount, from –2.137 to –3.18.

It was found that subtracting gravity’s 1.04-unit increase from the experimentally determined electromagnetic coupling strength at 91.19 GeV (–2.109) resulted in a new coupling strength for electromagnetism of –3.15, similar to this study’s calculated strength of –3.18 at that energy level.
Transforming the logarithmic values to their exponential forms results in a calculated electromagnetic coupling of $6.61 \times 10^{-4}$ from this study and a new value (i.e., experimentally determined value minus suggested gravitational contribution) of $7.08 \times 10^{-4}$.

Using the ratio of “observed over expected” — $7.08 \times 10^{-4}$ over $6.61 \times 10^{-4}$ — results in a match slightly higher than 100%, at 107%. (See Discussion for possible explanation.)

Subtracting the suggested gravitational contribution from the experimentally determined value for electromagnetism led to a new slope of 0.487, or 0.49, for the running electromagnetic coupling constant, similar to the 0.50 slope predicted in this study.

The present study also indicates that at the Planck length (at approximately $1.221 \times 10^{19}$ GeV), the strengths of gravity and electromagnetism have the same value (at about $-12.26$ logarithmic units, or $5.495 \times 10^{-13}$).

**Discussion**

The results of this investigation suggest that there is a gravitational component to the observed (as well as theorized) increase in electromagnetic strength over increasing energy levels, and that once this is accounted for, electromagnetic strength is found to actually decrease with increasing energy.

When the suggested gravitational component was removed from the observed increase in the strength of electromagnetism, the value for electromagnetism’s strength dropped from 0.007780 to $7.08 \times 10^{-4}$ ($-2.109$ to $-3.15$, logarithmically), close to this study’s calculated value of $6.61 \times 10^{-4}$ ($-3.18$). Similarly, the slope of the new running electromagnetic coupling constant, at approximately 0.49, closely matched the predicted slope from the equations in this study, at 0.50.

While the coupling values of $7.08 \times 10^{-4}$ and $6.61 \times 10^{-4}$ are close (each rounding to about $7 \times 10^{-4}$), the match exceeds unity, at 1.07, meaning that, even with the suggested gravitational contribution removed, the electromagnetic coupling value was slightly higher than what would be expected from this study. This is also reflected in the running constant, as the slope of the “gravitationally adjusted” observed running constant for electromagnetism is slightly elevated above the running constant for the force as predicted by this study (Figure 3).

This 7% increase could be attributable to the virtual-fermion cloud surrounding an electron blocking less of the bare electric charge as energy levels are raised, as suggested in Ref. [2]. That is, as probes are given an increasing amount of energy to move beyond the virtual-fermion cloud surrounding an electron, an increasing amount of the true charge of the electron would be revealed (and encountered by the probe), leading to an increase in the strength of electromagnetism over those increasing energy levels.
However, this effect is likely not associated with the fundamental relationship between electromagnetic strength and increasing energy. As an analogy, consider slowing opening the drapes in a dark room to allow sunlight to come in. Even as the room becomes progressively brighter by the opening of the drapes, the sun could be setting. Likewise, as the virtual-fermion cloud is penetrated, there could be a slight increase in the apparent strength of electromagnetism, even while the true strength of the force is actually declining. (The decline would likely be through a separate mechanism — there is nothing to dictate that the virtual-fermion cloud alone affects measurements of the force's strength.)

Eventually, however, there would be a point of diminishing returns, such that the decline would be unavoidable even with further penetration of the cloud (opening of the drapes).

Note, however, that the decrease of electromagnetism's strength would only be apparent if gravity's contribution to the calculated or measured coupling is removed. Otherwise, electromagnetism's strength will appear to only increase with increasing energy.

The idea that electromagnetism’s strength actually decreases with increasing energy aligns with — and helps connect the dots between — a number of scientific concepts, from string theory to the quantization of general relativity. Intriguingly, a consistent, but previously non-existent, theme flowing from classical physics to quantum physics to relativity is established with the addition of information from this study.

String Theory Relationship

As described in Ref. [5], a relationship between electromagnetism and gravity of the following type is suggested by string theory:

\[ \alpha \propto \sqrt{G} \]  

(18)

Where G is the gravitational constant \(6.67 \times 10^{-11} \text{ N-m}^2/\text{kg}^2\).

This is consistent in form with the relationship between the forces as suggested in this study (see Eq. 5):  

\[ \alpha \approx \sqrt{\alpha_G \left( \frac{\text{Electron Radius}}{\text{Planck Length}} \right)} \]
The gravitational coupling constant is related to the gravitational constant by the following equation:

$$\alpha_G \approx G \frac{(M_e)^2}{\hbar c}$$  \hspace{1cm} (19)

Where $(M_e)^2$ is the electron mass squared, at $8.30 \times 10^{-61}$ kg$^2$; h-bar is the reduced Planck constant, at $1.054 \times 10^{-34}$ J-s; and c is the speed of light at $3 \times 10^8$ m/s.

Taking the square root of each side of Eq. (19) gives the following:

$$\sqrt{\alpha_G} \approx \sqrt{G} \cdot \left[ \sqrt{\frac{(M_e)^2}{\hbar c}} \right]$$  \hspace{1cm} (20)

Plugging the right side of Eq. (20) into Eq. (5) yields the following:

$$\alpha \approx \sqrt{G} \cdot \left[ \sqrt{\frac{(M_e)^2}{\hbar c}} \cdot \frac{\text{Electron Radius}}{\text{Planck Length}} \right]$$  \hspace{1cm} (21)

The expression in brackets in Eq. (21) provides a proportionality factor for the string theory-inspired relation of Eq. (18), showing consistency between string theory and the present study.

**Planck Length and Big Bang**

Despite the difference in magnitude between the strengths of the gravitational and electromagnetic forces, it is generally believe that their strengths should merge at the Planck length.

This occurs naturally in the equations introduced in this study (Eqs. 1-10). As the electron radius undergoes Lorentz contraction to the size of the Planck length under increasing energy, electromagnetic strength decreases and gravitational strength increases, with the
Figure 4. As the universe expanded and cooled from the Big Bang, electrons became less massive, and the electron radius expanded from the Planck length, causing the strengths of gravity and electromagnetism to diverge from a common value of approximately $5.5 \times 10^{-13}$ to their present-day values.

strengths of the forces equaling one another at the Planck length, with a value of approximately $5.5 \times 10^{-13}$.

To see the splitting of the forces following the Big Bang, one would only need to run the scenario backwards. As the universe expanded and cooled, electrons would have lost energy, and the electron radius would have expanded. As that happened, gravitational strength would have fallen and electromagnetic strength would have risen to today’s values (Figure 4).

The lowering of the gravitational value aligns with intuition in that gravity couples to mass/energy. As the universe expanded, electron mass/energy would have decreased; thus, is it understandable that gravitational coupling would also have then decreased — that is, there would be less electron mass/energy with which gravity could couple.
Conversely, whenever energy is added above the invariant/rest mass, gravity is increased. As there is more mass/energy with which the force could couple. This is the case even in theoretical analyses involving perturbation.

As the energy of electrons is increased through perturbation, any increase in coupling would be caused by an increase in gravitational strength, not electromagnetic strength. Again, one would need to subtract gravity’s contribution to observe electromagnetism’s strength changes.

Electromagnetism appears to have an opposite reaction to energy than gravity, in that it appears to strengthen with decreasing energy, providing a possible reason why the forces split apart following the Big Bang.

*Electromagnetism in Classical Physics, Quantum Theory, and Relativity*

The currently held view that the strength of electromagnetism increases with increasing energy is a quantum theory-based view of the force’s strength. This view is not consistent with the effects increasing energy has on electromagnetism in classical physics and relativity.

Classical physics shows us that energy, in the form of heat for example, weakens electromagnetism (e.g., the electromagnetic bonds between particles). This could be demonstrated by simply placing an ice cube at room temperature. With the added energy from the room, the hydrogen bonds weaken and break, but really any structure held together by electromagnetic bonds will break down with enough energy added to it, ultimately becoming a liquid or gas.

Adding energy to particles engaged in electromagnetic bonds does not strengthen the force between them. The energy weakens the force.

In relativity, electromagnetism-related activities, such as metabolism and aging, slow down (weaken) under high-energy conditions (such as travel near the speed of light).

Thus, the notion of electromagnetic strength decreasing with increasing energy, as this study suggests, creates a consistent theme from classical physics to quantum physics to relativity (Figure 5).
Figure 5. If electromagnetic strength does decrease with increasing energy, as suggested in this study, it would be part of a consistent theme — from classical physics to quantum physics to relativity — of high energy weakening electromagnetism and electromagnetism-related activities.

Quantization of General Relativity and the Wheeler-DeWitt Equation

In attempting to unite general relativity and quantum mechanics into a single framework, an equation arises, called the Wheeler-DeWitt equation (Eq. 22), that basically says the universe experiences no changes in energy or time, with the latter being called “the problem of time.”

\[ H \Psi = 0 \]  \hspace{1cm} (22)

Interestingly, if one were to combine the increasing strength of gravity with the decreasing strength of electromagnetism over increasing energy levels, one would also find zero changes. This is because the rise in gravitational strength would mask the fall in electromagnetic strength. A distinct rise in one and a distinct fall in the other would only be apparent upon separating the phenomena (Figure 6).
In this case, there are two equal, yet opposite phenomena being united. Gravity describes one (an increase in strength); electromagnetism describes the other (a decrease in strength). Put them together and they cancel each other out mathematically, making it appear that there is no change in strength over increasing energy.

In similar fashion, the Wheeler-DeWitt equation may simply be indicating that there are two equal, yet opposite energy and time processes occurring in the universe. The equation, however, is viewing them together, which obscures the individual activities. To separate the two energy processes and the two time process, one would have to look at the local level in each theory.

Energy is not conserved at the local level in general relativity or quantum theory. When energy is coupled to a gravitational field, the energy vanishes. In a sense, the gravitational field does work on the energy. In quantum theory, electromagnetic and similar fields gain energy over time leading to infinities. Gravity, thus, involves a loss of

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Figure 6: If the strengths of gravity and electromagnetism were combined, it would appear that there were zero changes in strength over increasing energy. For example, the combined strength of gravity and electromagnetism at each of the points (A), (B), and (C) is \(-24.52\), where (A) is \(-2.137 + (-22.38)\), (B) is \(-3.18 + (-21.34)\), and (C) is \(-12.26 + (-12.26)\).
energy and quantum theory involves a gain in energy (both at the local level). The Wheeler-Dewitt equation may be reflecting the result of the two opposing energy processes together.

Similarly, the equation may be reflecting the result of two opposing time processes as well. General relativity and quantum theory each involves clocks. In relativity, every particle of matter, and every structure built from them, is its own clock, with its own time that depends on how fast the particle/object is moving or its position within a gravitational field. In quantum theory, there is one clock that ticks away regularly over the entire universe — the time parameter.

The combination of general relativity and quantum mechanics involves relativity being placed into quantum mechanics, a procedure sometimes referred to as the “quantization of general relativity.” Typically, quantum mechanics’ time parameter, its universal clock, would be used to solve the mathematics, but the time parameter has no meaning in general relativity with its many clocks.

Therefore, changes in energy (which both theories can recognize) are used as a proxy for changes in time. With this, we look to energy changes as a sign of ticking clocks, a procedure assisted by the expansion of the universe, as a dynamic element. As noted above, however, quantum mechanics and general relativity have opposing energy processes at the local level: Gravity takes energy away, and electromagnetism adds it. Thus, in a sense, the clocks of general relativity and quantum mechanics move in opposite directions. That is, general relativity’s clocks rotate in one direction by way of the subtraction of energy (say clockwise or forward) and quantum mechanics’ clock rotates in the opposite direction by way of the addition of energy (say counterclockwise or backward).

Importantly, the time that appears to move backward in quantum mechanics does not move backward as in “time travel to the past.” Quantum mechanics’ counterclockwise-running clock can be used to tell forward-running time: For example, if it is noon now and I were asked to pick someone up in an hour, a clock whose hands moved from noon to 11, would be just as useful as one whose hands moved from noon to 1. Events do not move backwards just because the clock’s hands rotate backwards. It is the same for quantum mechanics. Indeed, the only reason it is particularly obvious you have an oppositely running clock for forward-running events in quantum mechanics is because you are attempting to combine it with something (in this case general relativity) whose clocks tick in the other direction.

With the universal nature of its time, what quantum mechanics appears to be showing is that just as matter particles are clocks, so is space itself (as one unit). Matter particles are the clocks of general relativity, and space is the (single) clock of quantum mechanics. As space is everywhere, its clock — the time parameter — is everywhere, ticking at the same rate for everyone.

The question is, If time is a relative concept, how can there be a universal clock whose time we can all agree on no matter where we are in the universe? The answer is likely
that there is a universal clock, but we simply do not have direct access to its time. Unlike matter, space can and does move faster than the speed of light. As such, its time likely takes on complex values similar to faster-than-light objects that undergo time dilation (Eq. 23).

\[
\Delta t = \frac{\Delta t_0}{\sqrt{1 - (v/c)^2}}
\]  

(23)

As Eq. (23) shows, when the velocity (v) is higher than the speed of light (c), the denominator results in the square root of a negative number, leading to complex values for time.  

In similar fashion, quantum mechanics’ universal time is likely behind a curtain we cannot peer through. Thus, how its time compares to the time of any of relativity’s clocks is unknowable; there is no universal time we can all agree on. All we can discern about quantum mechanics’ time are the energy increases at the local level associated with its ticking, which are canceled by the energy decreases at the local level in general relativity.

In all, it may be possible to combine general relativity and quantum mechanics as long as it is understood that they are likely not incompatible, but rather complementary, from the standpoint of force strength, time, and energy changes at the local level (Table 1).
Conclusion
The hierarchy problem has been a long-standing puzzle in science, and has been an obstacle to combining general relativity and quantum mechanics. From the above discussion, one can conclude that the reason gravity is weaker than electromagnetism appears to be threefold: First, in comparing the strengths of the forces, gravity’s value of $1.752 \times 10^{-45}$ is typically compared to electromagnetism’s value of 0.007297. It seems, however, that $1.752 \times 10^{-45}$ is actually a squared value while the other is not.

As such, it appears better to compare the square root of the gravitational number, at $4.185 \times 10^{-23}$, to 0.007297, a view supported by string theory as some have suggested. This takes the difference in strength from 42 orders of magnitude to about 20, however still in favor of electromagnetism.

Second, there appears to be an inverse relationship between gravity and electromagnetism, necessitating the weakness of gravity when electromagnetism is strong. As such, the two forces appear to be on opposite sides of a seesaw, with electromagnetism being naturally high (strong) when gravity is low (weak) at zero energy/momentum transfer.

The third reason for the weakness of gravity compared with electromagnetism has to do with why, shortly after the Big Bang, the strengths of the forces diverged in the first place from the state in which they were equal (the balanced seesaw). The reason for this has to do with how each force reacts to a change in energy.
As the universe expanded and cooled from the Big Bang, electrons became less energetic/massive, and their radii expanded. Based on the equations introduced in this study, this appears to be associated with electromagnetism becoming stronger. Conversely, a drop in the electron mass and expansion of the radius appears to make gravity weaker per the same equations.

Adding energy to electrons, in a sense, turns back the clock toward the Big Bang, when the radius of an electron was the Planck length and the strengths of gravity and electromagnetism were equal.

Taken together, the concepts presented here may help in solving the hierarchy problem. They also appear to align with a number of scientific concepts such as string theory. Additionally, the study establishes an important connection between classical physics, quantum physics, and relativity regarding the strength of electromagnetism over increasing energy levels, and provides a possible explanation for why electromagnetism and gravity split apart after the Big Bang.

Of particular note, the study might help to unlock the door to combining gravity and electromagnetism into a single framework and ultimately unifying general relativity and quantum mechanics.

The unification of these two theories has been considered the “Holy Grail” of physics. Achieving this goal could light the way to wide-ranging advances in science and technology.

References