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Laws of Gravity and Electrostatics Reduce Elementary Particles to Only Two – Positron and Negatron

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Abstract I demonstrate that the macrocosmic gravitational interaction between two masses and the microcosmic electrostatic interaction between two charges unify in simple concepts and mathematical laws when electric charge and ordinary mass are interpreted in reciprocal terms. No previous research has ever attempted to unify electric charge and ordinary mass. The difficulty has been the lack of an intelligible definition of charge. A three-point paradigm shift solves the problem, giving convincing evidence – for the first time – that positive electron (positron) and negative electron (negatron) are the ultimate elementary particles. That is, matter is pure positive and negative grains of electricity. Paradigm shift #1: Electron is a moving charge; a charge is a static electron – a case of one entity two identities. This implies that, contrary to popular view, ordinary matter contains equal numbers of positrons and negatron – observed in motion as electrons and at rest as charges. In motion, a positron-negatron pair obeys the laws of electrodynamics and annihilates; at rest, the pair obeys the laws of electrostatics and neutralizes. Paradigm shift #2: Electron mass and electrostatic field are either positive or negative. Thus, opposite masses and fields, rather than indefinable 'charge', give opposite electrons physical distinctiveness. Paradigm shift #3: Electric charge and ordinary mass interconvert. Positive charge (e^+) and negative charge (e^-) neutralize to neutral charge ($2e^0$), which is nature's quantum of ordinary mass. Conversely, a quantum of ordinary mass splits to opposite charges e.g., in frictional electrification. The insights systematize the search, identification and classification of the baryons, ending decades of confusion in the 'elementary particle zoo'. A third stable nucleon, in the order of proton and neutron, is identified and named the nairotron.

Keywords Electron, Electrostatics, Elementary particles, Fields, Gravity, Unification

1. Introduction

Newton discovered that masses M_1 and M_2 stationed distance r apart attract each other with a force (F) that is directly proportional to the product of the masses (M_1M_2) and inversely proportional to the square of the distance (r^{-2}). Rearranging his equation: $Fr^2/M_1M_2 = G$. About a century later Coulomb discovered that quantities of charge Q_1 and Q_2 obey a similar law: $Fr^2/Q_1Q_2 = K$. The two equations have a common mathematical configuration. In addition, the numerators describe the same entity (Fr^2). However, the products of masses (M_1M_2) and charges (Q_1Q_2) swop places. Consequently, constants G and K are different. These observations change the traditional focus on 'two types of interaction' to 'two types of matter that interact differently'.

Attempts to explain the similarities and differences between Newton's and Coulomb's laws started soon after Coulomb published his finding [1]. For over 230 years, however, unification of electric and gravitational phenomena, in general, has eluded "some of the greatest minds in science" [2] – including Faraday [3], Einstein [4] and Weyl [5]. The long and fruitless search may mean that the phenomena have no natural link; or that a paradigm shift is required to spot the link.

2. Recent Studies

Fragmented evidence hints that electrostatics and gravitation [1] are different manifestations of a common interaction. For example, Spears derives gravitation constant (G) using only electrostatic parameters and concludes that "gravity is almost certainly an electrostatic phenomenon" [6]. But his findings remain at the level of mathematical abstraction without giving physical meaning to the numerical relations. Similarly, Greulich demonstrates that "gravitation can be rewritten completely as electrostatics" as long as one assigns to matter (ordinary mass) "a very small gravitational charge density" [7]. Greulich treats ordinary

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1 The terms 'gravitation' and 'gravity' are used interchangeably throughout this article.

mass as a composite of infinitesimal quanta of electric charge and finds that 'electric charge density' and 'gravitational charge density' amount to the same thing. However, he does not explain what 'charge densities' mean in physical sense and why gravitation is only attractive. Haug, in agreement with Greulich, observes that for Planck masses Newton's formula of gravitation is mathematically exactly the same as Coulomb's formula of electrostatics. His observation suggests that at the most basic level of material structure – "at the very bottom of the rabbit hole" [8] – electric charge and ordinary mass have a common fabric. In a related study Aspden infers that gravity is the mutual electrostatic action between "material particles that are uncharged" [9]. In effect, Aspden equates gravitational mass to 'neutral electric charge'. Consistent with Aspden's proposal, Assis demonstrates that units of electrically uncharged particles – which he calls "neutral dipoles" – attracting electrostatically result in gravitation. The notion of 'neutral dipoles' suggests particles that are electrically neutral and yet exhibit internal polarity. Assis concludes that "gravitation is the statistical residual force between groups of neutral dipoles" [10]. More explicitly, he states that "heavy bodies are composed of oppositely charged particles" [11]. Beyond his statistical argument Assis does not interpret "neutral dipoles" or "oppositely charged particles" in familiar terms.

The studies cited above point at a common inference that 'unification of electrostatics and gravitation' is essentially the 'unification of electric charge and ordinary mass'. The inference agrees with the fact that charge (Q_1Q_2) and mass (M_1M_2) are the sole variables that Coulomb's and Newton's laws do not share. In other words, electric charge and ordinary mass are separate physical entities with similar and dissimilar interactive features. The similar features make Coulomb's and Newton's laws analogous. The dissimilar features result in two differences. 1) Coulomb's matter (electric charge) either attracts or repels but Newton's matter (ordinary mass) only attracts. 2) Coulomb's interaction is much stronger than Newton's interaction. The numerical value of Coulomb's constant over Newton's constant (K/G) shows that Fr^2 per interacting charges (Fr^2/Q_1Q_2) is 1.347 x 10^{20} times greater than Fr^2 per interacting masses (Fr^2/M_1M_2). Hence, correct unification of electrostatics and gravitation is only possible if the natural relation of electric charge to ordinary mass is known. No past study has ever recognized or exploited this fact. Consequently, no one has ever established a natural link between gravity and electricity [12].

3. Unification of Charge and Mass

Physics literature lacks any significant information on how nature relates electric charge to ordinary mass. The underlying difficulty has been the lack of clarity on the physical meaning of charge. Although charge has been recognized, analyzed and applied for centuries [13], its fundamental nature remains incoherent [14,15] – with no clear formulas linking it to better defined parameters [16]. This is a problem of great importance and "failure to solve it has restrained development in physics" [17]. Is charge so rudimentary that it has no further underlying meaning? Is it so unrelated to the rest of the physical realities that it cannot be interpreted in terms of anything else more comprehensible?

There are scientific findings that explicitly define electric charge. It is known that charge is the sole material entity in electrostatic (Coulomb's) interaction and ordinary mass is the sole material entity in gravitational (Newton's) interaction. Therefore, the familiar entity that compares with electric charge is ordinary mass. Moreover, physicists have established two features that distinguish charge from ordinary mass. One, charge is quantized. Millikan proved "very directly" [18] that a quantity of charge is an aggregate of individual elementary charges. Similar quantization is not observed in ordinary mass. Two, charge is polarized[2]. This fact was first established by Dufay in 1733 [19]. In contrast, positive-negative symmetry is not observed in ordinary mass. Therefore, it can be inferred, without any scientific ambiguity, that charge is the 'polarized type of matter' and ordinary mass is the 'unpolarized type of matter'. Polarized matter exhibits electric properties that include electrostatic interaction; unpolarized matter exhibits mechanical properties that include gravitational interaction. Hence, Coulomb's law describes the interaction between quantities of polarized matter and Newton's law gives a parallel account for unpolarized matter. The inference raises an imperative question: does nature polarize the unpolarized matter and vice versa? If this is shown to be the case, then electric charge and ordinary mass interconvert.

Established scientific laws specify the aspects of a particle that are either polarized or unpolarized. For example, the law of gravitation resolves an unpolarized (gravitational) mass in two components: unpolarized inertial mass and unpolarized gravitational field (Fig. 1). Newton discovered that altering either the size or the position of a massive body produces instant mechanical effect in another massive body stationed across space. This entails instant transmission of mechanical energy between physical objects that have no obvious mechanical contact. The direct interpretation of this reality is that a gravitational mass is a single mechanical system comprising a tangible (inertial) mass and an intangible (gravitational) field. In Newton's equation, the term M_1M_2 describes the contribution of inertial mass to gravitational force; and the term r^{-2} describes the contribution of gravitational field to the force. This interpretation, as demonstrated below, succeeds to explain a number of other observations. It means that gravitational field is no less a mechanical reality than inertial mass. The field is an invisible extension of gravitational mass beyond the edge of its tangible (inertial) mass. Whereas distance separates inertial

2 The term 'polarised' is used in this article to describe the type of matter that exists either in positive or negative type.

masses, there is no distance between gravitational masses. In other words, two gravitational masses are mechanically connected all the time, such that even the slightest alteration in one is instantly reflected in the other. Hence, Newton's Law of Universal Gravitation means that gravitational field mechanically connects every inertial mass to every other inertial mass. In this light, what seems like instant action at a distance [20] is instant action at no distance. Moreover, a mechanical field that originates in the center of mass and increases in direct proportion to the quantity of mass, and which extends and thins out equally in a three-dimension space, has the geometric properties that Einstein interpreted as curved space.

For the first time, Maxwell's vision of unified "field and substance" [21] is realized. In the case of gravitation, the "field" is the gravitational field and the "substance" is the inertial mass (Fig. 1). Firm theoretical and experimental evidence (presented shortly) shows that in the case of a polarized particle (a charge) the "field" is the electrostatic field and the "substance" is the electron mass (Fig. 2(a)). Put differently, the physical components of a charge are electron mass and electrostatic field. Unlike the components of a gravitational particle, the components of a charge are polarized – resulting in positive and negative charges (Fig. 2(b)). Hence, Coulomb's and Newton's laws relate the same variables – force, mass and field (distance). Differences arise because Coulomb deals with polarized mass and field and Newton deals with unpolarized mass and field.

Test charge experiments reveal that an electrostatic field is either positive or negative. Placed alternately in the fields around opposite charges a test charge deflects in opposite directions [22]. The traditional inference is that field lines face radially outward in positive charge and radially inward in negative charge (Fig. 3). Explicitly, the experiments reveal that electrostatic field – unlike gravitational field – has a positive-negative symmetry.

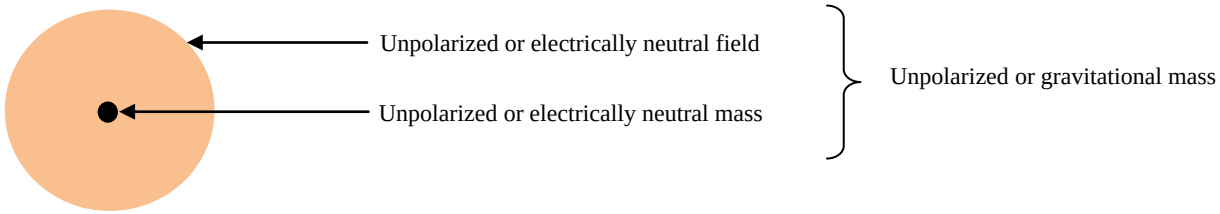

Figure 1. Newton's gravitational mass comprises unpolarized inertial mass and gravitational field. The field potential at any point is directly proportional to the magnitude of the mass. This shows that inertial mass and gravitational field are inseparable mechanical components of a gravitational mass

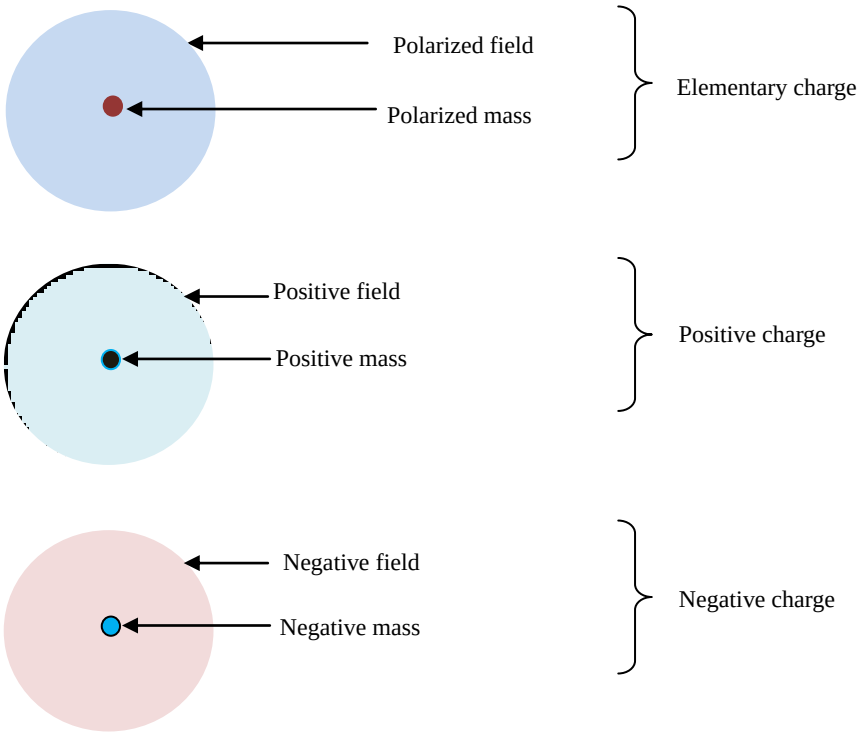

Figure 2(a) and 2(b). The physical components of a charge (polarized particle) are a blob of electron mass and an electrostatic field around the mass (Fig. 2(a)). Opposite electron masses and electrostatic fields give opposite charges their physical distinctiveness (Fig. 2(b))

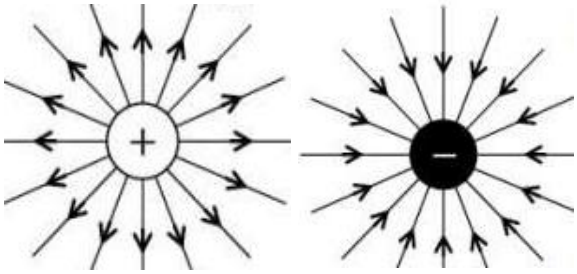

Figure 3. Test charge experiments detect two types of electrostatic field with opposite behaviors. The traditional interpretation is that field lines in a negative charge face radially inward and those in a positive charge face radially outward

Dirac, in eq. (1), proves that electron mass (m_e) is either positive (m_e^+) or negative (m_e^-). Schrodinger was the first physicist to observe this fact [23]. However, his observation was downplayed. It was eventually concluded that Dirac's negative mass solution makes only mathematical sense but lacks physical meaning [24,25]. Theorists like Luttinger [26], Bondi [27] and Price [28] give ordinary mass a positive sign. They start with 'known positive *ordinary mass*' and search for 'unknown negative *ordinary mass*'. Based on this definition, it is assumed that electron mass is ordinary and therefore positive. But Dirac's equation does not describe ordinary particles. It describes the electron [29], revealing that electron mass is fundamentally different from ordinary (unpolarized) mass. Dirac and subsequent researchers focused on 'negative energy' and paid no attention to the obvious positive-negative electron mass symmetry. This paper rediscovers the fundamental mass symmetry, as expressed in eq. (1), and demonstrates its natural significance.

$$m_e = \pm\sqrt{\frac{E^2 - p^2c^2}{c^4}}. \quad (1)$$

Dirac's theoretical finding has observational backing. In the cloud chamber photographs Anderson observed a particle (the positron) with properties that counteract those of an ordinary electron (the negatron) [30]. Subjected to uniform force (F) a positron and a negatron, each with mass m_e, experience acceleration (a) in opposite directions. Newton's second law of motion links these parameters such that $F/m_e = a$. When force (F) is fixed – has same magnitude and direction – acceleration (a) can assume opposite signs (occur in opposite directions) only if electron mass (m_e) assumes positive sign (m_e^+) or negative sign (m_e^-). In essence, a force that accelerates positron mass to the left will accelerate negatron mass to the right. Anderson's finding, therefore, is an empirical proof that positron and negatron have opposite inertial masses.

Combed, Dirac's equation and test charge experiments simplify electron to a system of polarized electron mass and an electrostatic field around the mass (Fig. 1(a)). In terms of its physical components, therefore, electron (E) can be equated to only electron mass (m_e) and electrostatic field (e_f):

$$E = m_e + e_f \quad (2)$$

Since electron (E) is either positive (E^+) or negative (E^-):

$$E^+ = m_e^+ + e_f^+ \quad (3)$$

$$E^- = m_e^- + e_f^- \quad (4)$$

Eqs. (3) and (4) identify electron mass (m_e) and electrostatic field (e_f) as the physical explanation for the oppositeness observed in electrons. The prevailing view is that positron and negatron are opposite because they 'carry' an independent entity ('charge') that exhibits positive-negative properties [31]. However, pure charge – detached from electron mass – has never been isolated [32]. Eqs. (3) and (4) remove the need for introducing an arbitrary entity called 'charge'. Contrary to the prevailing view, the equations imply that the electron does not carry any independent entity describable as charge. Instead, the intrinsic stuffs of which the electron is made constitute charge. This is consistent with the fact that the electron does not lose or gain a charge. If electron lost a charge, two entities would result – pure elementary charge and an electrically neutral electron mass. No such entities have ever been observed.

Unlike the electron, however, particles that actually carry charge are known to both lose and gain an independent physical entity that fits the description of a charge. For example, the primary carrier of the positive charge (proton) loses positive charge when it emits a positive electron (positron) in ß+ decay. A vital clue that has always been overlooked is that a lost elementary charge, whether positive or negative, is always observed as an electron. This fact suggests that electron (E) and elementary charge (e) are different manifestations of the same particle. Electron and elementary charge, however, manifest different empirical behaviors. While opposite electrons annihilate to radiant energy [33], opposite charges neutralize to electrically inert matter. The discrepancy is logically explained once electron is recognized as a charge in motion and a charge as an electron at rest. In other words, electron and elementary charge are different manifestations of a grain of electricity – one entity two identities. The behavioral difference between a static and a moving grain of electricity is drastic. For example, in motion a positron-negatron pair obeys the *laws of electrodynamics* and annihilates; but at rest the pair obeys the *laws of electrostatics* and neutralizes. Put differently, outside the atom (in motion) a positron-negatron pair annihilates; but inside the atom, the pair (at rest) coexists as electrically neutral (unpolarized) matter.

Since electron and elementary charge are intrinsically the same, charge (e), like the electron, is the sum of electron mass (m_e) and electrostatic field (e_f) – eq. (5). Hence, positive charge (e^+) is the sum of positive electron mass (m_e^+) and electrostatic field (e_f^+) – eq. (6); and negative charge (e^-) is the sum of negative electron mass (m_e^-) and electrostatic field (e_f^-) as displayed in eq. (7).

$$e = m_e + e_f \quad (5)$$

$$e^+ = m_e^+ + e_f^+ \quad (6)$$

$$e^- = m_e^- + e_f^- \quad (7)$$

Interpretation of elementary charge as a static electron sheds new light on the composition of the atom. It is known that an atom is electrically neutral because it contains equal numbers of positive and negative charges. The positive-negative charge symmetry is associated with the equal numbers of protons and negatron [34]. If the proton's positive charge is recognized as a static positron, however, it becomes evident that the atom's overall electric neutrality is due to equal numbers of static positive and negative electrons (charges). Hence, the simplest (hydrogen) atom comprises three subatomic particles: orbital static negatron (observed as negative charge), nucleus static positron (observed as positive charge) and the electrically neutral part of the proton (Fig. 4).

Positive beta (ß+) decay directly proves that positive charge is always a static positron. If proton's positive charge is an independent entity, then that entity, rather than a positron, would be emitted in ß+ decay. The fact that positron is emitted without an accompanying negatron precludes the possibility that it arises from electron pair generation. These facts force the inference that a positron pre-exists in the nucleus in static state. ß+ decay converts the static positron (positive charge) to moving positron – which is emitted. The initial discovery of the positron in cosmic radiations left a wrong but persisting impression that it is an alien, antimatter particle. But a cumulative body of evidence proves that positron is a universal component of ordinary atoms. For example, in less than two years after Anderson's discovery of the positron from the outer space, Curie and her co-workers discovered the same positron in the isotopes of ordinary matter [35]. Since then, generation of positrons from ordinary atoms has become a common practice [36]. This demonstrates that static positrons (positive charges) are no less part of ordinary atoms than the static negatrons (negative charges). The prevailing view is that negative electrons dominate our immediate universe [37]. Based on the new evidence presented here, negative electrons dominant only when the observations are limited to the environmental (moving) electrons. Universally, however, ordinary matter contains perfectly equal numbers of positive and negative electrons – observable in motion as the traditional electrons and at rest as the traditional charges.

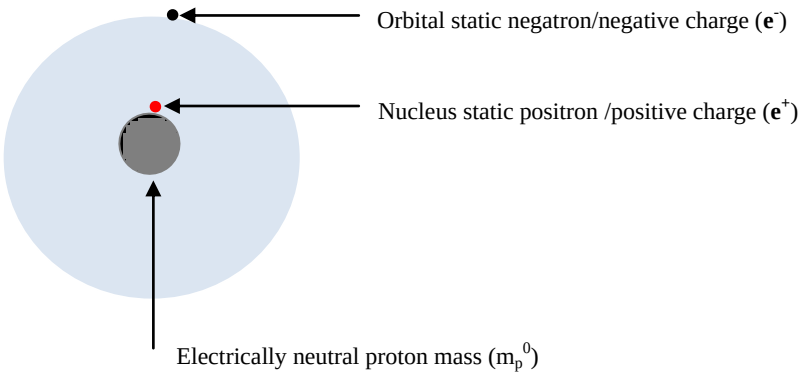

Figure 4. Recognition of electron as static charge reveals that hydrogen atom comprises three subatomic particles: static negative electron (negative charge), static positive electron (positive charge) and the electrically neutral proton mass. Other atoms are integral multiples of the three basic subatomic particles

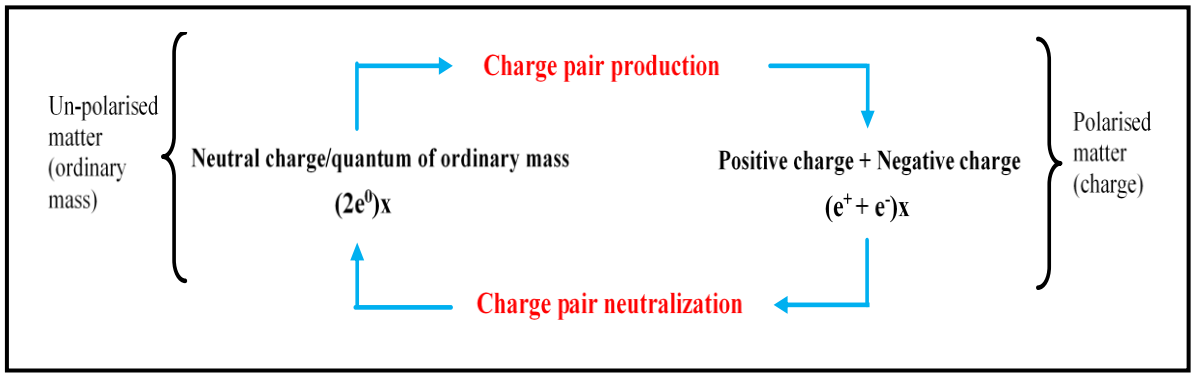

Figure 5. Processes of 'charge pair production' and 'charge pair neutralization' explain how nature interconverts unpolarized (ordinary mass) and polarized (electric charge) matter. Ordinary mass, or neutral charge, is internally polarized and quantized

The laws of electrodynamics and electrostatics are drastically different. For example, in motion a pair of opposite electrons obeys the laws of electrodynamics and can simultaneously either appear in 'electron pair production' or disappear in electron pair annihilation [38,39]. Parallel electrostatic processes are identified here and named 'charge

pair production' and 'charge pair neutralization'. While opposite electrons and radiant energy interconvert in electrodynamics; opposite charges and ordinary mass interconvert in electrostatics (Fig. 5). In charge pair production a pair of opposite charges appears simultaneously from ordinary mass. Charge pair production is familiar and easy to observe but it has never been recognized for what it is. Charge pair production is observable in simple frictional electrification, for example when glass rod is rubbed with silk. The process splits a quantum of ordinary mass to a pair of opposite charges. In reverse, charge pair neutralization converts a positive charge (e^+) and a negative charge (e^-) to a neutral charge ($2e^0$) – which is the smallest natural unit ordinary (gravitational) mass.

In essence, charge pair neutralization transforms the electric features of opposite charges displayed in eq. (6) and eq. (7) to the mechanical features of an ordinary mass as shown in eq. (8). In this process, opposite electron masses convert to a quantum of electrically neutral inertial mass while opposite electrostatic fields convert to an electrically neutral (gravitational) field. Thus, independent charges exhibit electric properties but opposite charges, coexisting at subatomic distances and in perfectly equal numbers – either as $2e^0$ or its integral multiple – exhibit mechanical properties and are observed as ordinary mass.

$$\begin{aligned} e^+ &= m_e^+ + e_f^+ \\ \underline{+\ e^- &= m_e^- + e_f^-} \\ 2e^0 &= 2m_e^0 + 2e_f^0 \end{aligned} \tag{8}$$

The full import of charge pair polarization and neutralization becomes evident when the elements of eq. (8) are tabulated (Table 1). The Table reveals that positive and negative grains of electricity – occurring in perfectly equal numbers – constitute the foundation of material existence. This simplifies matter to pure electricity, occurring in positive, negative and neutral types.

Table 1. Natural unification of elementary charge (e), elementary mass (m_e), electrostatic field and gravitational field. The most rudimentary stuff of which the material universe is made are the elementary (electron) mass and the electrostatic field

Positive charge (e^+)	=	Positive electron mass (m_e^+)	+	Positive electrostatic field (e_f^+)
+		+		+
Negative charge (e^-)	=	Negative electron mass (m_e^-)	+	Negative electrostatic field (e_f^-)
II		II		II
Neutral charge ($2e^0$) or quantum of gravitational mass	=	Neutral electron mass ($2m_e^0$) or quantum of inertial mass	+	Neutral electrostatic field ($2e_f^0$) or quantum of gravitational field

4. Predictions

Eq. (5) resolves charge (e) to electron mass (m_e) and electrostatics field (e_f). Thus, conservation of electric charge is the conservation electron mass and electrostatic field. But an electrically neutral particle must have an even number of elementary charges – half positive (e^+) and half negative (e^-). Equally, an electrically charged particle must have excess of either of the elementary charges. By associating elementary charge and electron mass, eq. (5) predicts that an electrically neutral particle must have an even number of electron mass units (EMUs) – half positive (m_e^+) and half negative (m_e^-). Conversely, a particle that carries an elementary charge must have an odd number of EMUs – with unpaired m_e^+ or m_e^-. Whether the equation is valid or not is testable against existing experimental data. Rounding off the experimental masses of the common baryons [40] to the nearest whole EMU shows that, in agreement with the equation's requirement, particles with even number of EMUs are electrically neutral and the old-numbered ones are electrically charged (Table 2). In other words, nature uses 'whole positive and negative electron mass units' as the basic building blocks of mass in in both natural and artificially generated baryons. This observation forces the conclusion that electron mass (m_e) is nature's elementary mass. In this light, decimals in the experimental EMUs may be attributed to one or more factors, such human, environmental and experimental errors.

Table 2. Rounding off the experimental baryonic masses to the nearest whole EMU links conservation of electric charge with conservation of electron mass, showing that electron is nature's elementary unit of both electric charge and mass

Multiplet	EMUs and charge states	Even-odd status	Electric charge status
Nucleon	1837^+	Odd	Charged
	1840^0	Even	Neutral
Pion	264^0	Even	Neutral
	273^+	Odd	Charged
Kaon	965^+	Odd	Charged
	968^0	Even	Neutral
	974^0	Even	Neutral
Eta	1074^0	Even	Neutral
	1077^+	Odd	Charged
Lambda	2153^+	Odd	Charged
	2183^-	Odd	Charged
Sigma	2328^0	Even	Neutral
	2343^-	Odd	Charged
Xi	2573^-	Odd	Charged
	2579^+	Odd	Charged

Consistent with eq. (5), eq. (8) and Table 1, Table 2 shows that coexisting m_e^+ and m_e^- form $2m_e^0$ – which is nature's quantum of inertial mass. Any electrically neutral mass is an integral multiple of $2m_e^0$ units. Hydrogen atom, for instance, can be reduced to only $2m_e^0$ units, provided it is recognized that nature organizes the units in 'low density outer' and 'high density inner' zones (Fig. 6). In the outer zone, m_e^+ and m_e^- are relatively far apart, resulting in a low density $2m_e^0$ unit. But the units are tightly packed in the neutral proton mass (m_p^0). Hence, the net proton mass – usual proton mass less positive elementary mass (m_e^+) – form a discrete quantum of ordinary mass. Hence, m_p^0 comprises $918m_e^+ + 918m_e^-$ units packed so compactly that they form an independent quantum of ordinary mass equal to $1836m_e^0$ units. In terms of electrically neutral mass quanta, a gravitational mass comprises equal numbers of $2m_e^0$ and m_p^0 units.

With the exception of nucleons, the subatomic particles listed in Table 2 are not locatable in the atom. It can be shown, however, that laws that govern proton-neutron inter-conversions apply to all multiplets. First, the mass difference between neutron (1840 EMUs) and proton (1837 EMUs) is 3 EMUs. It is observed here, for the first time, that the 3 EMUs constitute a universal mass phenomenon that differentiates the mass of any subatomic particle and that of its immediate neighbor in a multiplet. As shown in Table 3, it is possible to link all known particles (bolded) and to predict new ones (un-bolded) using a series of 3 EMUs. Second, proton's charge state has been linked with its odd number of EMUs and neutron's electric neutrality with its even number of EMUs (Table 2). Table 3 extends the nucleonic mass and charge rules to other multiplets. From the table, positive and negative charge states alternate with neutral (zero) states in the interludes. The observation reveals a predictable periodicity of EMUs and charge states in each multiplet.

The just observed patterns provide a fresh way to interpret nuclear reactions. For example, transmutation of neutron (N^o) to proton (P^+) can be explained in terms of the 3 EMUs. The transmutation is currently expressed as $N^0 \rightarrow P^+ + e^- + \nu_e$, where e^- is the negatron and ν_e is the electron antineutrino. But section 3 of this article has demonstrated that the proton's positive charge is a static positive electron. Therefore, the traditional proton (P^+) comprises a neutral proton part (P^0) and a positron (e^+). That is, $P^+ = (P^0 + e^+)$. Since the neutron (N^0) looses 3 EMUs to become a proton (P^+), the ($e^- + \nu_e$) account for the 3 EMUs: negatron (e^-) accounts for 1 EMU and antineutrino (ν_e) for 2 EMUs. But eq. (8) identifies a natural unit of matter with 2 EMUs as the neutral electric charge ($2e^0$). This means that the Pauli-Fermi neutrino is the neutral electric charge ($2e^0$), which is also the smallest natural unit of ordinary (gravitational mass). Hence, transmutation of neutron to proton can be rewritten as: $N^0 \rightarrow (P^0 + e^+) + e^- + 2e^0$. Or, in terms of EMUs as: $1840m_e^0 \rightarrow (1836m_e^0 + 1m_e^+) + 1m_e^- + 2m_e^0$.

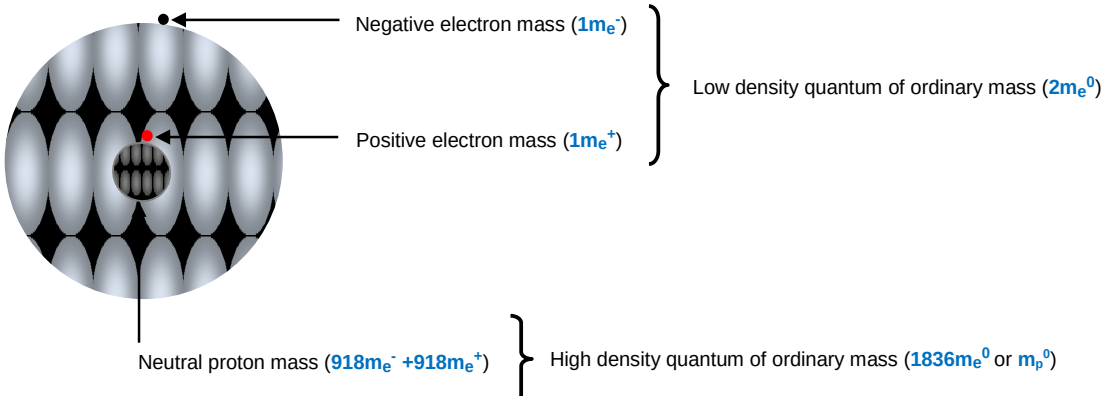

Figure 6. Hydrogen atom comprises low- and high-density quanta of ordinary mass. The masses of static nuclear positron and orbital negatron constitute the outer quantum. The densely packed m_e^+ and m_e^- pairs form the high-density quantum (m_p^0)

Table 3. Extrapolation of electron mass units (EMUs) and electric charge states in known multiplets predicts new elementary particles. A particle differs from its next neighbor by 3 EMUs. Further, particles with even number EMUs are neutral and those with odd number are charged. The highlighted particles have been experimentally detected and an infinite array of other (un-highlighted) particles is predicted

Multiplet name	Extended EMUs and charge states (superscripts) in classical multiplets
Nucleon	...1831$^-$…**1834^0**...**1837$^+$**…1840^0...1843$^-$…
Pion	... **264^0** … 267$^-$ … 270^0 … **273$^+$**...
Kaon	... **965$^+$** … **968^0** … 971$^-$ … **974^0**...
Eta	…1071$^-$... **1074^0** … **1077$^+$**...1080^0…
Lambda	... **2153$^+$**… 2156^0… 2159$^-$… 2162^0 … 2165$^+$ … 2168^0… 2171$^-$ … 2174^0 … 2177$^+$… 2180^0 … **2183$^-$**...
Sigma	... 2328^0 … **2331$^-$** … 2334^0… 2337$^+$… 2340^0… **2343$^-$**...
Xi	... **2573$^-$** … 2576^0… **2579$^+$**...

Table 4. The nucleons – reduced to positive, negative and neutral grains of electricity – reveal predictable patterns in nuclear reactions. Whereas electrochemical reactions involve only positive (e^+) and negative (e^-) grains of electricity, nuclear reactions involve positive (e^+), negative (e^-) and neutral ($2e^0$) grains of electricity. Thus, every nuclear reaction liberates a neutral charge ($2e^0$) – or neutrino – along with one of the following: e^+, e^- or both e^+ and e^-. The $2e^0$ (neutral charge) is invariably emitted as a neutrino. As a rule, nature prohibits existence of unpaired e^- in the nuclei and e^+ in the orbits. Consequently, unpaired e^- arising in the nucleus is emitted as a negative beta electron (cycle 2); and an e^+ destined for the orbits is emitted as a positive beta electron (cycle 4). When an e^- and e^+ concurrently violate the rule, the pair is ejected as gamma radiation (cycle 1). But when e^+ and e^- are concurrently liberated without breaking the rule, there no emission. Instead, internal adjustment takes place and results in a new atom (cycle 3). The cycles leave no doubt that the proton decays to a new nucleon, named the nairotron in the Table, which has previously been mistaken for neutron. The ß$^-$ decay routes are highlighted in pink; the ß$^+$ decay routes in grey; and the γ decay routes in blue. The patterns systematize the search, identification and classification of the baryons in any multiplet

Particle's EMUs & charge	Decay route	Liberated charge	Non-neutrino emission	Repeating cycles
↑ …	…	…	…	… ↑
Predicted $1846e^0$	$1846e^0 \rightarrow 1843e^- + 1e^+ + 2e^0$	Positive & negative	ß$^+$ + ß$^-$ (γ-rays)	1
Predicted $1843e^-$	$1843e^- \rightarrow 1840e^0 + 1e^- + 2e^0$	Negative	ß$^-$	2
Neutron $1840e^0$	$1840e^0 \rightarrow 1837e^+ + 1e^- + 2e^0$	Negative	None	3
Proton $1837e^+$	$1837e^+ \rightarrow 1834e^0 + 1e^+ + 2e^0$	Positive	ß$^+$	4
Nairotron $1834e^0$	$1834e^0 \rightarrow 1831e^- + 1e^+ + 2e^0$	Positive & negative	ß$^+$ + ß$^-$ (γ- rays)	1
Predicted $1831e^-$	$1831e^- \rightarrow 1828e^0 + 1e^- + 2e^0$	Negative	ß$^-$	2
Predicted $1828e^0$	$1828e^0 \rightarrow 1825e^+ + 1e^- + 2e^0$	Negative	None	3
Predicted $1825e^+$	$1825e^+ \rightarrow 1822e^0 + 1e^+ + 2e^0$	Positive	ß$^+$	4
Predicted $1822e^0$	$1822e^0 \rightarrow 1819e^- + 1e^+ + 2e^0$	Positive & negative	ß$^+$ + ß$^-$ (γ-rays)	1
Predicted $1819e^-$	$1819e^- \rightarrow 1816e^0 + 1e^- + 2e^0$	Negative	ß$^-$	2
Predicted $1816e^0$	$1816e^0 \rightarrow 1813e^+ + 1e^- + 2e^0$	Negative	None	3
Predicted $1813e^+$	$1813e^+ \rightarrow 1810e^0 + 1e^+ + 2e^0$	Positive	ß$^+$	4
↓ …	…	…	…	…↓

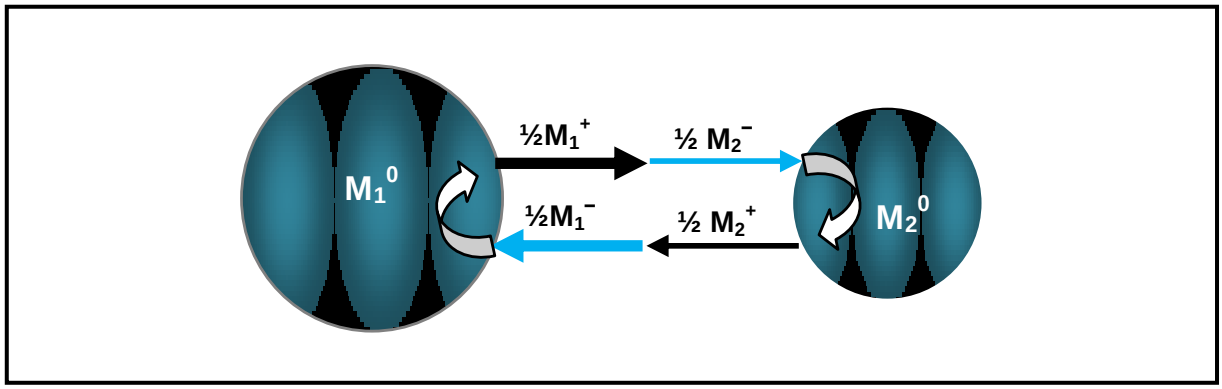

Figure 7. Gravitational attraction is the electrostatic attraction between unlike halves of like masses. Resolving Newton's mass (M^0) into ½ M^+ and ½ M^- explains why unequal gravitational masses $M_1{}^0$ and $M_2{}^0$ attract with equal but opposite forces. Each mass contributes to force in either direction

It has always been thought that ß+ decay converts proton to neutron [41] – emitting positron (e^+) and electron neutrino (ν_e) in the process. The inference is based on the fact that the atomic number of the original atom decreases by one. The reaction is expressed as: $P+ \rightarrow N^0 + e^+ + \nu_e$. But conversion of proton to three new particles with combined mass greater than its own mass would violate the law of mass-energy conservation. How can a heavier neutron arise from a lighter proton? To answer this question, it was once thought that the neutrino has zero rest mass. The explanation failed when experiments showed that the neutrino has rest mass [42]. But even if the neutrino mass were zero, the mass of the new neutron would still be greater than the mass of the original proton. The plainest interpretation is that the particle named 'neutron' in ß+ decay is different from the neutron that Chadwick discovered. This new particle is here named the nairotron. As detailed in Table 4, the nairotron is a stable, electrical neutral nucleon with a mass of 1834 EMUs, meaning it is lighter than either the neutron or the proton. Whereas the neutron can undergo negative beta decay, the nairotron can decay – if it decays at all – via the gamma route (see Table 4). If the nairotron is denoted n^0, then it can be shown that it is produced when the proton emits a neutrino (neutral charge) and a positron as follows: $(P^0 + e^+) \rightarrow n^0 + e^+ + 2e^0$. In terms of EMUs, conversion of proton to nairotron proceeds as follows: $1837m_e{}^+ \rightarrow 1834m_e{}^0 + 1m_e{}^+ + 2m_e{}^0$.

5. Unification of Electrostatics and Gravity

It has been demonstrated above, for example in Table 1, that ordinary mass is the neutral electric charge – a composite of equal numbers of positive and negative charges.

Therefore, both Coulomb's and Newton's laws can be expressed in terms of electric charges. Coulomb describes how positive and negative charges interact; Newton describes how neutral charges interact. Thus, gravitation can be expressed as the electrostatic attraction between unlike halves of like masses M_1 and M_2:

$$\tfrac{1}{2}M_1^- \times \tfrac{1}{2}M_2^+ = \tfrac{1}{4}M_1M_2^- \quad (9)$$

Unlike charges – as well as unlike magnetic poles – attract. Eq. (9) extends this rule to ordinary mass, such that 'unlike halves' of 'like masses' attract (Fig. 7). It known that in Newton's law unequal gravitational masses, such as the earth and the moon, attract with equal but opposite forces. This hints that ordinary mass has an internal symmetry. The symmetry is currently explained in terms of 'active' and 'passive' gravitational masses [43]. Active and passive gravitational masses are respectively defined as the source and the sink of gravitational field lines [44]. Thus, a gravitational mass is both the source and the sink of gravitational field lines. Eq. (9) and Fig. 7 show that the active-passive mass symmetry as the positive-negative elementary mass symmetry within an electrically neutral mass.

The product of opposite masses (¼ $M_1M_2^-$) and the product of opposite charges $Q_1Q_2^-$ represent the same physical reality – interacting quantities of opposite (polarized) matter or charges. However, polarization alone does not reveal the ultimate equivalence of the respective interactions. This is because Coulomb's and Newton's equations measure the quantities of charge in artificial units. For instance, nature recognizes quantity Q of charge as an aggregate of individual e units but Coulomb's equation recognizes it as an aggregate of individual artificial units – the coulombs (C). In nature, e is one (1) – a natural unit – but in Coulomb's equation it is assigned an artificial value of 1.604×10^{-19}C. Equally, nature recognizes quantity M of gravitational mass as an aggregate of equal numbers of $2m_e^0$ and m_p^0 units (Fig. 6). But Newton's equation recognizes a quantity of mass as an aggregate of individual artificial units – the kilograms. To prove that $Q_1Q_2^-$ and ¼ $M_1M_2^-$ represent the same physical entity, and to express the respective equations in reciprocal terms, both electric charge and gravitational mass must be expressed in natural units. This entails quantization of charge and ordinary mass; or counting matter in terms of elementary charges.

Millikan showed that quantity Q of charge is an integral multiple of the elementary charge (e). Therefore, any Q_1Q_2 is an aggregate of e^2 units. Hence, quantized Q_1Q_2 is $Q_1Q_2e^2$. In the same way, the product of opposite half masses (¼ M_1M_2) can be quantized. As illustrated in Fig. 6 and demonstrated in part III of this paper, gravitational mass is organized into high density (m_p^0) and the low density ($2m_e^0$) quanta within the atom. Polarizing these mass quanta:

$$m_p^0 = \tfrac{1}{2}m_p^+ + \tfrac{1}{2}m_p^- \text{ and } 2m_e^0 = m_e^+ + m_e^-.$$

Hence, the natural (smallest) unit of ¼ M_1M_2- is:

$$\tfrac{1}{2}m_p^+ \times \tfrac{1}{2}(2m_e)^- = \tfrac{1}{2}m_pm_e.$$

The total number of ½ m_pm_e units in ¼ M_1M_2 is:

$$\tfrac{1}{2}m_pm_e \times \tfrac{1}{4}M_1M_2 = \tfrac{1}{8}M_1M_2m_pm_e.$$

Expressed in natural units, Q_1Q_2 becomes $Q_1Q_2e^2$ and ¼ M_1M_2 becomes $^1/_8M_1M_2m_pm_e$. In these forms, the two types of matter that make electrostatics and gravitation different are standardized – polarized and quantized. This opens a way to standardize (unify) Coulomb's and Newton's equations. Coulomb shows that Fr^2/Q_IQ_2 is constant (K) and Newton shows that Fr^2/M_IM_2 is a different constant (G). Matter in Coulomb's equation (Q_1Q_2) is polarized but not quantized. On the other hand, matter in Newton's equation (M_1M_2) is neither polarized nor quantized. When Coulomb's matter is polarized and quantized, his equation becomes $Fr^2/Q_1Q_2e^2 = T_c$ where T_c is a new electrostatic constant. Equally, when Newton's matter is polarized and quantized, his equation becomes $8Fr^2/M_1M_2m_pm_e = T_n$, where T_n is a new gravitation constant. Calculations based on CODATA values of physical constants [45] show that T_c equals 3.506×10^{47} NM^2/C^4 and T_n equals $3.506 \times 10^{47} NM^2/kg^4$, meaning that electric charge (C^4) and gravitational mass (kg^4) are equivalent. The fact that constants T_c and T_n are perfectly equal proves that eq. (8) correctly unifies electric charge and ordinary mass. Equating T_c to T_n:

$$\frac{8Fr^2}{M_1M_2m_pm_e} = \frac{Fr^2}{Q_1Q_2e^2} \quad (10)$$

Inserting Newton's and Coulomb's constants in eq. (10):

$$\frac{8G}{m_pm_e} = \frac{K}{e^2} \quad (11)$$

Eq. (11) shows how nature relates the fundamental gravitation-mass constants to the fundamental electrostatic-charge constants. The equation is not only numerical balanced but also conceptually symmetrical. It shows that Coulomb's and Newton's equations can be written under a common constant (T), such that $Te^2 = K$, and $Tm_pm_e/8 = G$. Hence, Newton's equation can be rewritten as:

$$F = \frac{TM_1M_2m_pm_e}{8r^2} \quad (12)$$

Equally, Coulomb's equation can be written as:

$$F = \frac{TQ_1Q_2e^2}{r^2} \quad (13)$$

Eq. (11) has unified Newton's law of gravitation and Coulomb's law of electrostatics into a more general law, which can be stated as follows: Two quantities of electric charge separated by distance r experience a force (F) that is directly proportional to their product and inversely proportional to the square of the distance (r^{-2}). In the traditional laws, the quantities of charge in Newton's law are neither polarized nor quantized. On the other hand, the quantities of charge in Coulomb's law are polarized but not quantized. Only when the quantities of charge in both laws are standardized – polarized and quantized – is the underlying harmony observed as in eq. (11).

6. Conclusions

It has been demonstrated that the macrocosmic gravitational interaction between two masses and the microcosmic electrostatic interaction between two charges unify in simple concepts and mathematical laws when electric charge and ordinary mass are interpreted in reciprocal terms. The paper has presented firm evidence that positron and negatron are the ultimate elementary blocks of matter and identified a new, stable subatomic particle. These discoveries could not have been made earlier due to lack of clarity on the fundamental nature of electric charge. A three-point paradigm shift has solved the problem, opening new vistas in physics.

One, it has been demonstrated that an electron is a moving charge and a charge is a static electron. Electron and elementary charge have previously been regarded as two different entities, with the electron 'carrying' the charge. The confusion led to the inference that negative electrons dominate our immediate universe and that positive electrons are fringe particles. While theories – and particularly Dirac's – demand positive-negative electron symmetry in nature, lack of such symmetry has always been enigmatic. The new insights have shown that our immediate universe has equal numbers of positive and negative electrons – moving and static – meaning that the atom's overall electric neutrality is due to equal numbers of static positive and negative electrons.

Two, the paper has proved that a grain of electricity is not an ordinary particle. Its contents, the electron mass and the electrostatic field, are either positive or negative. The current view is that positron and negatron have the same type of mass but opposite types of electric charge – though 'electric charge' in existing theories is ambiguous. The new insight shows that polarized stuffs, rather than the incoherent 'charge', give opposite electrons physical distinction. Firm theoretical and experimental proof has been presented to show that electron mass and electrostatic fields are either positive or negative.

Three, it has been proved that electric charge and ordinary mass interconvert. Whereas opposite charges in motion (electrons) annihilate to energy, opposite electrons at rest (charges) neutralize to a quantum of ordinary mass. Conversely, a quantum of ordinary mass splits into a pair of opposite charges. The two processes have been named charge pair production and charge pair neutralization. It has been shown that charge pair production – the electrostatic equivalence of 'electron pair production' in electrodynamics – splits a quantum of ordinary mass to a pair of opposite charges. In reverse, charge pair neutralization – the electrostatic equivalence of electron pair annihilation in electrodynamics – converts a pair of opposite charges to a quantum of ordinary mass. That is, positive charge (e+) and negative charge (e-) convert to neutral charge ($2e^0$) – which is nature's elementary block of ordinary mass.

Two vital equations have been derived from the paradigm shift: Eq. (8) and Eq. (11). Eq. (8) unifies ordinary mass and electric charge. Among other things, it reveals that electron mass is the natural elementary mass. The Equation has made it possible to establish previously unknown patterns in nuclear reactions, leading to identification of a new subatomic particle – a third, stable nucleon – which has been named the Nairotron. In addition, the Equation has predicted an infinite array of baryons in terms of their mass and electric charge. On the other hand, Eq. (12) has established the long-sought link between gravity and electricity. Broadly, two quantities of electric charge separated by distance r experience a force (F) that is directly proportional to their product and inversely proportional to the square of the distance (r^{-2}). However, quantities of charge in Newton's equation are neither polarized nor quantized. In contrast, quantities of charge in Coulomb's equation are polarized but not quantized. Standardizing – polarizing and quantizing – quantities of charge in both equations reveals underlying harmony. Unification of gravity and electricity provides a theoretical blueprint for possible manipulation of gravity. Equally, the observed new patterns in nuclear reactions pave way to systematic search, identification and classification of baryons, ending decades of confusion in what is colloquially described as 'elementary particle zoo'.

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