Article

Matter as Pure 'Atoms' of Electricity

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Abstract: Dirac's equation depicts electron mass as either positive or negative. Taken as correct description of nature, the equation identifies electron mass as 'electrically active' – therefore fundamentally different from the ordinary, 'electrically passive' mass. Following this cue, I demonstrate that electron mass (m_e) is nature's elementary mass: positive (m_e^+) and negative (m_e^-) elementary masses neutralise to elementary unit of the electrically passive mass ($2m_e^0$). Further, I show that electron mass ($m_e^\pm$) and the electrostatic field ($e_f^\pm$) around it compose an elementary charge ($e^\pm$), thereby relating charge to mass. The underlying principles are: 1) electric charge and gravitational mass have a common root: positive (e^+) and negative (e^-) charges coexist as neutral charge ($2e^0$) or nature's quantum of gravitational mass; 2) charge is a static (nonrelativistic) 'atom of electricity'; electron is the same 'atom' at ultrahigh (relativistic) speed. The decisive proof that this paradigm shift correctly describes nature is that it unifies, verifiably, Newton's laws of gravity and Coulomb's law of electrostatics to: $8G/m_pm_e = K/e^2$; where G and K are respective constants, m_p proton mass, m_e electron mass, and e elementary charge. Ultimately, I prove that matter consists of pure 'atoms' of positive and negative electricity.

Keywords: electric charge; electricity; electron; elementary particle; gravity; matter

1. Introduction

The ancient Greek philosopher, Democritus, theorized that by repeatedly cutting a piece of matter one would end up with *atomos* or "the uncuttable".[1] In 1808 Dalton proved that each chemical element comprises uniform building blocks[2] – the modern atoms. Dalton thought he had found the uncuttable particles in Democritus's theory. However, in 1897 Thomson discovered the electron, which is 1,837 times lighter than the smallest atom, proving that nature has material particles smaller than the atom. Later, two more subatomic particles were found – the proton and the neutron. By 1932 physicists had proved that Dalton's atom has a simple structure comprising only three types of building blocks: electron, proton, and neutron. Griffiths observes: "Never before (and I'm sorry to say never since) has physics offered so simple and satisfying an answer to the question, 'What is matter made of?'"[3] Logically, the next challenge was to unify electron, proton, and neutron.

However, in the same year physicists started to observe additional subatomic particles from cosmic radiation, nuclear reactors and particle accelerators.[4] [5] The first was the positron; then a bewildering array of particles presently dubbed the "particle zoo."[6] The new particles are short-lived and lack obvious place in the atomic structure. Nevertheless, all of them – paradoxically, even those considered 'antimatter' like the positron – originate from atoms of ordinary matter.[7] In response to the new phenomena, physicists expanded the search for the ultimate building blocks of the physical universe to encompass both 'matter particles' and the 'forces' that bind them.[8] Mendeleev's Periodic Table of chemical elements influenced the search,[9] inspiring hope that nature arranges subatomic particles and Dalton's atoms in analogous patterns. The effort culminated in the Standard Model (SM) of particle physics.[10] Formally, the SM explains matter and binding forces in 17 building blocks – 12 fermions and 5 bosons.[11] It recognizes negative electron as fundamental and irreducible, but suggests that proton and neutron consist of simpler particles

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– the quarks. Each quark, according to the SM, has one-third or two-thirds of the elementary charge.[12] [13] However, a number[14] of credible experiments have not detected the proposed fractional charges.[15] [16] Hence, as yet, the fractional charge hypothesis lacks direct experimental proof.

In contrast, Faraday,[17] Stoney,[18] and Millikan,[19] among others, provide conclusive evidence that electric charge exists naturally in integral multiples of the elementary charge (e). In electrical, chemical, and nuclear process, charge occurs invariably in whole natural units. Regardless, no one has ever utilised the proven 'whole charges', as opposed to hypothetical 'fractional charges', to explain the subatomic particles – electron, proton, neutron and the 'particle zoo'. The difficulty comes from the enigmatic nature of charge. Of course, a lot is known and applied about charge; but the question of its fundamental nature is always skipped.[20] [21] [22] This is, perhaps, the most serious oversight in the history of science. It means that the essence of the atom – hence matter – remains shrouded in mystery; and that any theory that deal with the physical nature of charge – such as its divisibility or indivisibility – is founded on the unknown.

A fresh synthesis of scattered pieces of scientific evidence, collected over the centuries, leads to a definite but surprising discovery: a charge (e) is the static (nonrelativistic) electron; and an electron (E) is the moving (relativistic) charge – one entity two identities. Thus, Thomson and Anderson, respectively, observed negative and positive charges at relativistic speed but considered them new entities – negative and positive electrons respectively. The discovery paves the way to prove that 'atoms of electricity'[23] – observed at rest as charges and in motion as electrons – are all there is in the known material universe. An 'atom of electricity', however, is fundamentally different from the 'atom of element'.

2. Positive-negative mass and field symmetry

Maxwell envisaged the unification of "field and substance";[24] the intangible reality his equations describe and the tangible matter. The two realities are discernible in the electron. Thomson's m_e/e ratio defines electron in just two parameters:[25] electron mass (m_e) and electric charge (e). The directly detectable entities, however, are electron mass and electrostatic field.[26] Like electron mass, electrostatic field – or Faraday's lines of force[27] – is "very real."[28] It underlies Maxwell's equations, "contains energy, and its presence precludes a classical 'true vacuum.'"[29] Thus, electron mass and electrostatic field, respectively, match Maxwell's 'tangible' and 'intangible' realities. Besides electron mass and electrostatic field, the electron has nothing else (fig. 1). Conspicuously, it lacks a discrete 'charge'. Mathematically, electron (E) is the sum of electron mass (m_e) and electrostatic field (e_f):

$$E = m_e + e_f \qquad (1).$$

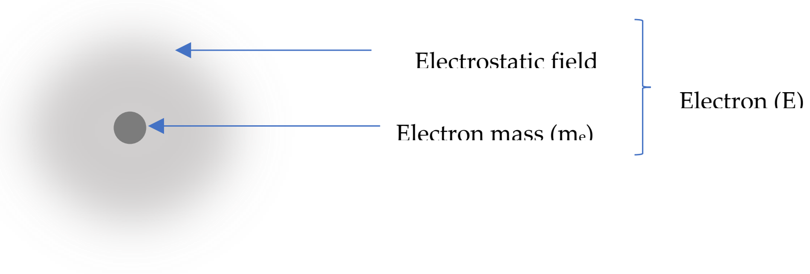

Figure 1. An electron comprises only two physical components: electron mass and electrostatic field. It lacks any independent entity identifiable as a charge.

Firm theoretical and experimental evidence, presented shortly, shows that electron mass and electrostatic field naturally exist in opposite types. That is, positive electron (E^+) is the sum of positive electron mass (m_e^+) and positive electrostatic field (e_f^+) as expressed in Eq. (2); and negative electron (E^-) is the sum of negative electron mass (m_e^-) and negative electrostatic field (e_f^-) as expressed in Eq. (3). Hence, opposite masses and fields differentiate positive and negative electrons (fig. 2). (For the sake of clarity, the terms positron and negatron are hereafter used, per the original proposal,[30] to denote positive and negative electrons respectively; and 'electron' to denote both).

$$E^+ = m_e{}^+ + e_f{}^+ \quad (2);$$

$$E^- = m_e{}^- + e_f{}^- \quad (3).$$

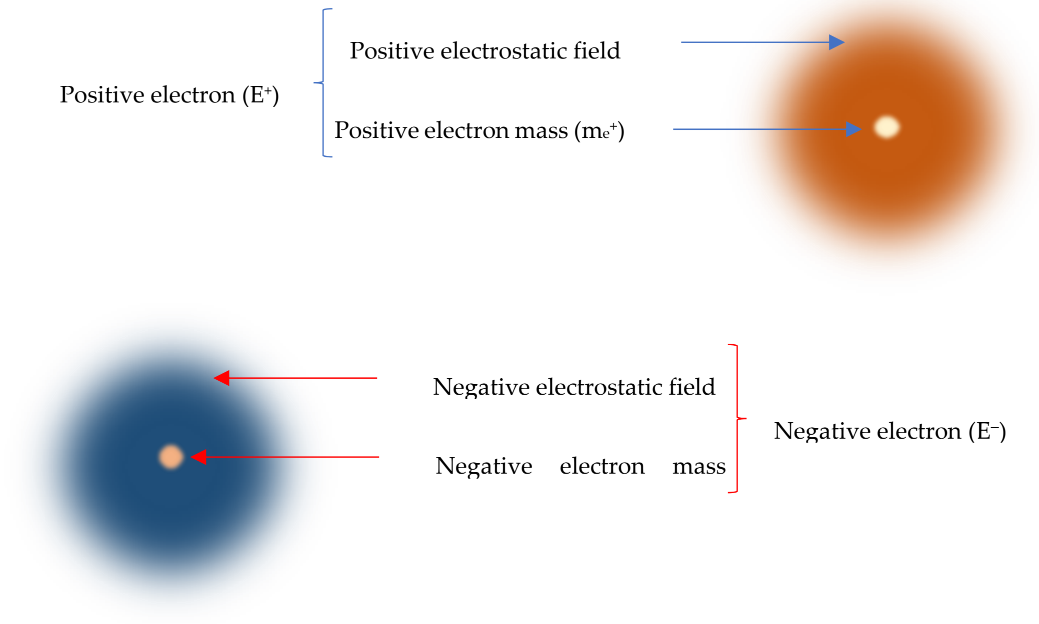

Figure 2. Opposite electron masses and electrostatic fields are the physical constituents of opposite electrons.

In agreement with Eq. (2) and Eq. (3), Dirac, in Eq. (4), shows that electron mass is either positive (m_e^+) or negative (m_e^-). Schrodinger was the first physicist to highlight this fact.[31]

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

Eq. (4) is currently interpreted to mean that positive electron mass exists in nature but its negative counterpart does not. Literature indicates that negative mass makes mathematical sense[32] but has no natural meaning.[33 34] The reasoning is based on the tacit definition of all known mass, including electron mass, as always positive.[35, 36 37] However, Dirac's equation has such predictive power that its positive-negative mass symmetry cannot just be dismissed. The equation, for example, correctly predicted the existence of the positron before Anderson observed the actual particle.[38] An overlooked fact is that Anderson also confirms that Dirac's positive-negative mass symmetry is a natural phenomenon. In his photographs, Anderson observed that subjected to uniform force (F) opposite electrons, each with inertial mass m_e, experience equal acceleration (a) but curve in the opposite directions.[39] The magnitude of the curvature varies with the particle's inertial mass. From Newton's second law of motion, $F/m_e = a$. When 'F' is unform (fixed sign), 'a' can gain plus or minus sign only if 'm_e' is ascribed a corresponding sign. In one direction, force (F) equals $m^+_e \times a^+$; in the other, it equals $m_e^- \times a^-$. Put simply, a force that accelerates positive electron mass to the left will accelerate negative electron mass to the right. Hence, in agreement with Eq. (4), Anderson's finding proves that positron and negatron have opposite inertial masses.

To complement the Dirac-Anderson finding, test charge experiments demonstrate that electrostatic field is either positive or negative. Placed alternately in the fields around opposite charges, a test charge oscillates in opposite directions.[40] The usual interpretation is that field lines face radially outwards (out-facing arrows) in positive charge and radially inwards (in-facing arrows) in negative charge.[41] Explicitly, the experiments reveal that electrostatic fields in opposite charges are inherently opposite.

Combined, Dirac's equation, Anderson's observation and the test charge experiments compel two conclusions. One, an electron is fundamentally different from an ordinary particle. Its physical components – electron mass and electrostatic field – are either positive or negative. In contrast, ordinary mass and ordinary (gravitational) field do not exhibit positive-negative symmetry. Hence, electron mass and electrostatic field are electrically active while ordinary mass and gravitational field are electrically passive.

Two, positron (E^+) and negatron (E^-) are opposite simply because they are made of intrinsically opposite masses and the fields. The prevailing theory is that positron and negatron have identical positive mass[42] but carry opposite charges.[43] The theory, however, does not define charge in familiar terms[44] or relate it to any of the fundamental quantities of the universe – mass, length and time.[45] The failure to plainly define a charge has been termed "a problem of great importance" and an hindrance to "development in physics."[46] Eq. (2) and Eq. (3) partially solve the problem: if charge is the feature that distinguishes positron and negatron, then charge is the sum of electron mass and electrostatic field. But Eq. (1) defines electron (E) in the same parameters, implying that, as physical entities, charge (e) and electron (E) are indistinguishable. For this reason, electron does not carry 'charge'. Rather, electron mass (m_e) and electrostatic field (e_f) constitute a charge (e):

$$e = m_e + e_f \qquad (5).$$

Hence, positive (e^+) and negative (e^-) charges, like positive (E^+) and negative (E^-) electrons, comprise opposite electron masses and electrostatic fields:

$$e^+ = m_e{}^+ + e_f{}^+ \qquad (6);$$

$$e^- = m_e{}^- + e_f{}^- \qquad (7).$$

Thus,

$$e = m_e + e_f \qquad \text{and} \qquad E = m_e + e_f.$$

Consequently,

$$e = E \qquad (8).$$

Empirically, however, charge (e) and electron (E) behave differently. But physicists already know that electricity at rest and in motion behaves differently. At rest, electricity is an electrostatic phenomenon; in motion, it is an electrodynamic phenomenon. Based on Eq. (8), it can be inferred that a charge (e) is the 'atom of electricity' at rest; and an electron (E) is the same 'atom' in motion. That is, the difference between a charge and an electron is behavioural; not physical. Scientific facts support this inference.

3. Charge and electron: one entity two identities

Our knowledge of electricity is based on two parallel lines of research: one focusing on 'charge' and the other on 'electron'. The natural relation of the two is blurred. In 1874 Stoney interpreted Faraday's laws of electrolysis to mean that "positive as well as negative electricity", like matter, comprises "indivisible particles."[47] He proposed the name "electron" for the "atom of electricity."[48] By then it was known that electricity exists in positive and negative types. Thus, in Stoney's original terminology, electricity comprises discrete positive and negative "electrons". With time, Stoney's "electron" was renamed 'charge' and his "atoms of electricity" are the modern charges. Later, Millikan proved "very directly"[49] that a quantity of charge consists of individual elementary charges. His oil drop experiment provides hard evidence that a charge, consistent with Stoney's description, is a particle. Charges behave like infinitesimal, perfectly uniform billiard balls occurring in electrically opposite types. For instance, charges are countable,[50] storable [51] and transferable from one object to another. Regardless, the physical nature of the Stoney-Millikan charge is enigmatic.[52, 53, 54] Confusion arises because rest mass (hence volume) defines a physical particle but no one has ever ascertained whether charge, a physical particle on other counts, has rest mass.

In 1897 Thomson discovered a definite physical particle that was finally named "electron". Accurately, he discovered the negatron and demonstrated that it has rest mass. Later, Anderson discovered the positron, proving that electrons, like charges, have positive-negative electric symmetry. Besides this symmetry, however, it appeared like the Stoney-Millikan charges and the newfound electrons have nothing in common. Physicists took the position that a charge and an electron are fundamentally different entities cojoined in such a way that the known particle – the electron – carries[55] the mysterious charge. This position arises from four considerations (table 1). 1) The atomic ratio of negative to positive charges is 1:1; but the atomic ratio of negative to positive electrons is 1:0 – positrons are deemed absent in the atom.[56] 2) Rest mass defines an electron as a physical particle; but a charge is tacitly considered massless. 3) Opposite electrons annihilate; but opposite charges neutralise. 4) The environmental ratio of negative to positive charges is 1:1, resulting in the conservation of electric charge, but by far more negative than positive electrons are observed. [57] [58]

Table 1. Four considerations make it appear like a charge and an electron are fundamentally different things (in blue colour). 1) The atomic ratio of positive to negative charges is 1:1, but the ratio of negative to positive electrons is 1:0 – positive electrons are considered absent in the atom. 2) An electron has known rest mass but a charge is tacitly considered massless. 3) A pair of opposite charges neutralises but a pair of opposite electrons annihilates. 4) The ratio of positive to negative charges in our environment is 1:1, but negative electrons considerably outnumber positive electrons.

Entity	Electric symmetry (a shared feature)	Presence in the atom	Rest mass	Positive-negative pair interaction	Numerical symmetry
Charge	Positive (known)	Present (50% of charges)	Absent?	Neutralisation	Symmetrical (same number of opposite charges observed)
	Negative (known)	Present (50% of charges)			
Electron	Positive (known)	Absent (0% of electrons)?	Present	Annihilation	Asymmetrical (more negative than positive elections observed)
	Negative (known)	Present (100% of electrons)			

According to CERN, "one of the greatest challenges in physics is to figure out … why we see an asymmetry between matter and antimatter."[59] Conspicuously, negatrons are deemed present in the atom and positrons absent[60] (table 1). Further, CERN puts the chances of observing a positron, rather than a negatron, at one to a billion – resulting in observable asymmetry in numbers (table 1). By early 1930s, however, positive beta (β^+) decay was interpreted as evidence that positrons do exist in atomic nuclei.[61] [62] The interpretation was based on the Curie-Joliot inference that the proton is a "complex structure" that breaks up into a "positron" and an electrically neutral particle they termed "neutron."[63] Unmistakably, Curie and Joliot deduced that proton (p^+) as a whole is no more an electric object than, for example, a sodium ion (Na^+). Its electric effects stem from a discrete positron that it carries, and which beta decay frees (along with a neutrino), leaving behind the "neutron". In that case, there is a positron on every proton. And since for every proton there is a negatron, the atomic ratio of negatrons to positrons is 1:1.

Elsasser, among others, immediately accepted the Curie-Joliot explanation of the source of the positrons as "superior to Dirac's hole theory"[64] because it establishes the numerical symmetry between opposite electrons. That is, the negatron's natural counterpart is the 'positron-on-proton'. The idea solved an outstanding problem. The proton was initially considered the 'positive electron' and – since the positron is deemed absent in the atom – it is still regarded as the negatron's atomic counterpart. However, proton is about 1,837 times heavier than negatron. The mass difference disqualifies it as negatron's natural counterpart. Prior to the discovery of the actual positive electron, Rutherford noticed the difficulty: "It might a priori have been anticipated that the positive electron should be the counterpart of the negative electron and have the same small mass. There is, however, not the slightest evidence of the existence of such a counterpart."[65] A few years later, "such a counterpart" (positron) with "the same small mass" was found. Still, the positron did not fit as negatron's natural opposite. Whereas negatron and proton fail to match due to mass asymmetry, negatron and the observable positron fail to match due to numerical asymmetry. Against these difficulties, the Curie-Joliot positron-on-proton emerges as the negatron's perfect match – equal in mass, in magnitude of charge, in natural abundance, and opposite in electric effects (table 2).

Table 2. The Curie-Joliot interpretation of β^+ decay reveals that a positron-on-proton is the negatron's natural match. A negatron-proton pair does not match due to mass asymmetry; and a negatron-positron pair fails to match due to numerical asymmetry.

		Negatron (negative electron)			
		Equal mass	Equal charge	Equal number	Opposite electric effect
Nature's positive counterpart	Proton?	X	√	√	√
	Environmental positron?	√	√	X	√
	Positron-on-proton?	√	√	√	√

Despite its success in identifying the positive-negative 'electron symmetry', the Curie-Joliot version of β+ decay was downplayed and finally forgotten. This is because the distinction between positron-on-proton and the environmental positron was missed. If Curie and Joliot described the environmental positron, then their inference contradicts experiment. First, it would mean that positrons and negatrons have a ratio of 1:1, whereas, empirically, negatrons outnumber positrons. Second, it would mean that opposite electrons coexist in the short intra-atomic distances whereas, empirically, at such short distance the pair should 'annihilate'.[66] But Curie and Joliot described the positron-on-proton and not the environmental positron. The difference is significant because positron-on-proton and environmental positron behave differently. Notably, positrons-on-protons and atomic negatrons are numerically equal and interact by neutralisation rather than by annihilation. Thus, positron-on-proton and orbital negatron behave, respectively, like positive and negative charges (table 3).

Table 3. Positron-on-proton and orbital negatron have characteristics of charges rather than those of electrons.

	Empirical characteristics	
Subatomic pair	**Pair interaction**	**Numerical symmetry**
Nuclear positive charge and orbital negative charge	Neutralisation (coexistence)	Symmetrical
Positron-on-proton and orbital negatron	Neutralisation (coexistence)	Symmetrical

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The empirical behaviours of positron-on-proton and orbital negatron (table 3) compel the conclusion that these entities are certainly not the usual electrons. Rather, they are positive and negative charges. Hence, considering the different behaviours of charges and electrons (table 1), the atom has no electrons; it has only charges. Within the atom, electricity is at rest; it consists of charges. Ejected from the atom at high speed, electricity is in motion; it consists of electrons. This conclusion agrees with an already known fact that electricity at rest and in motion behaves differently. At rest, it is governed by laws of electrostatics; in motion, by the laws of electrodynamics. For this reason, a charge is the static (nonrelativistic) electron; an electron is the ultrahigh speed (relativistic) charge (table 4).

Table 4. The sole difference between a charge and an electron is the speed at which they are moving. An 'atom of electricity' at near-static and ultrahigh speeds is recognised as a charge and an electron 7respectively.

				Material uniformity of charge and electron		Differences due to behaviours		
Entity	**Speed**	**Location**	**Name**	**Types**	**Rest mass**	**Presence in atom**	**Positive-negative pair interaction**	**Natural abundance**
'Atoms of electricity'	Near-static	Inside the atom or on material surface	Charges	Positive	Positive electron mass	Present	Neutralisation	Symmetrical (positive to negative ratio of 1:1)
				Negative	Negative electron mass	Present		
	Ultrahigh	Extra-atomic environment	Electrons	Positive	Positive electron mass	Absent	Annihilation	Asymmetrical (more negative than positive)
				Negative	Negative electron mass	Absent		

The just reached conclusion explains, effortlessly, why more negatrons than positrons are observed in our environment. Located in the atomic nuclei, the Curie-Joliot positrons-on-protons (positive charges) are heavily shielded by the orbital static negatrons (negative charges) and have negligible chances of escaping to the extra-atomic environment where they are detectable as the usual positrons. In other words, more energy is required to liberate a positive charge (static positron) from the nucleus than to liberate a negative charge (static negatron) from the orbit. However, whether positive or negative, an 'atom of electricity' is ejected from the 'atom of element' at tremendous speed, losing the characteristics of a charge and gaining those of an electron. Rutherford (1925) recognized Thomson's negative electron as "an actual disembodied atom of electricity", meaning that negatron is Stoney's 'atom of negative electricity' detached from the 'atom of an element'. Conversely, Anderson's positron is Stoney's 'atom of positive electricity', or the Curie-Joliot positron-on-proton, detached from the 'atom of matter'. Additional pieces of evidence leave no doubt that Rutherford correctly associated 'atomic charge' with 'environmental electron'.

First, negatrons originate from the atomic orbits where Stoney's negative charges are located. Likewise, Anderson[67] and Curie[68] concluded that positrons originate from the atomic nuclei – where Stoney's positive charges are located (figure 3). But charge and electron are inseparable[69]; nature has neither chargeless (electrically neutral) electron nor electronless (electron-independent) charge. Hence, at its atomic origin, an 'atom of electricity' is the charge; but travelling at high speed outside the atom, it is an electron. Second, the historical methods used to investigate electricity reveal that the sole difference between charges and electrons is the speed at which they are observed. Coulomb, Faraday, Millikan, and other 'electrostatic students' observed 'atoms of electricity' at near-static speeds – in jars, electrolytes, electroscopes, oil drops, glass rods, etc – and recognized them as charges. In contrast, Thomson, Anderson, Dirac[70] and other 'electrodynamic students' observed the same 'atoms of electricity' detached from atoms of elements and moving at ultrahigh speed through vacuumed cathode tubes and cosmic rays and thus recognised them as electrons. Strictly, therefore, electrons – as ultrahigh speed particles – do not exist

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in atoms; they are observable in the extra-atomic environment. Within the atoms, latent positive and negative electrons coexist as opposite charges.

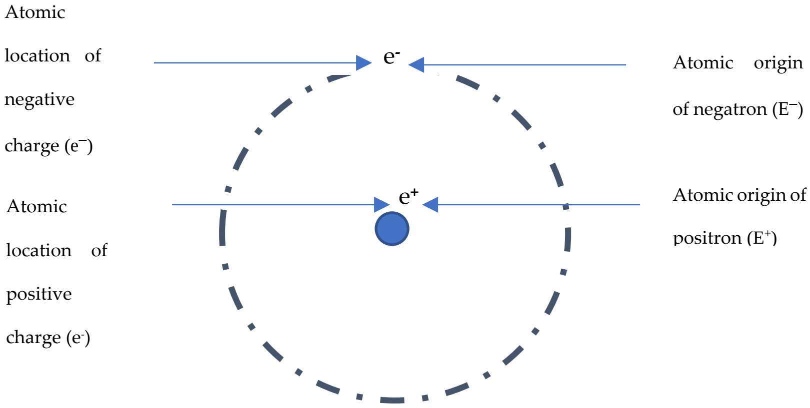

Figure 3. Atomic locations of opposite charges match the atomic origins of opposite electrons. This suggests that an electron is a charge travelling at high speed outside the atom.

4. Unification of electric charge and gravitational mass

A colliding pair of opposite electrons (highspeed charges) 'annihilates';[71] [72] but a pair of opposite charges (near-static electrons) neutralises[73] (table 4). However, evidence shows that 'annihilation' does not literally obliterate the electrons. With a lifespan of more than 6.6x10^{28} years,[74] the electron has been described as "practically immortal",[75] "indivisible and unbreakable",[76] as well as "absolutely stable."[77] Unlike any other known particle, the electron is irreducible. Put simply, the electron – positive or negative – is the veritable unit of matter that can neither be created nor destroyed. If nature prefers the most stable particle as the foundational block of the material universe, then the electron has no competitor. Plausibly, therefore, 'annihilation' mutually plunges opposite electrons into their lowest energy level, where they coexist as a relativistic neutron charge, and their opposite fields annihilate into gamma rays.

Similarly, positive and negative charges (near-static electrons) mutually 'fall' into a lower energy level and convert to an electrically neutral entity. In the process, the opposite electrostatic fields annihilate into a spectrum of lower frequency electromagnetic radiations. Thus, 'electron pair annihilation' and 'charge pair neutralisation' are essentially the same process occurring, in that order, at relativistic and nonrelativistic speeds. A key difference is that neutralised positive and negative charges remain relatively far apart compared with the 'annihilated' positive and negative electrons.

Practically, neutralised positive and negative charges mutually conceal their opposite electric properties such that they become undetectable by a third charge. This is analogous to mutual concealment of 'a peg and a hole', where nothing disappears in a literal sense. Expanding e^+ and e^- as in Eq. (6) and Eq. (7), respectively, sheds light on how charge pair neutralisation occurs – Eq. (9).

$$\begin{array}{r} e^+ = m_e^+ + e_f^+ \\ \underline{+\ e^- = m_e^- + e_f^-} \\ 2e^0 = 2m_e^0 + 2e_f^0 \end{array} \qquad (9).$$

Eq. (9) signifies that in their independent existence, e^+ and e^- are electrically active and exhibit electric behaviours. However, coexisting at subatomic distances (neutralised state) the opposite charges cease to exhibit their individual electric behaviours and, instead, mutually exhibit the mechanical behaviours that characterise ordinary (gravitational) matter. Thus, the equation reveals that charge pair neutralisation is the natural process by which positive and negative units of electrically active matter convert to a unit of electrically passive (gravitational) matter (Table 5).

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Table 5. Coexisting at subatomic distances, opposite charges neutralise into a natural unit of electrically neutral matter – which is the quantum of ordinary (gravitational) mass.

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^-})
=		=		=
Neutral charge ($2e^0$) or quantum of ordinary mass	=	Quantum of electrically neutral inertial mass ($2m_e^0$)	+	Neutral electrostatic field ($2e_f^0$) or gravitational field

Applied to the simplest (hydrogen) atom (fig. 4), Eq. (9) reveals that the observable positive and negative charges in the atomic 'outer part' constitute a single unit of neutral charge ($2e^0$) or a natural quantum of ordinary (gravitational) mass. Since any atom has the same number of positive nuclear and negative orbital charges (static electrons), it can be generalised that the material content of the atomic outer zone is pure neutral electric charges or integral multiples of $2e^0$.

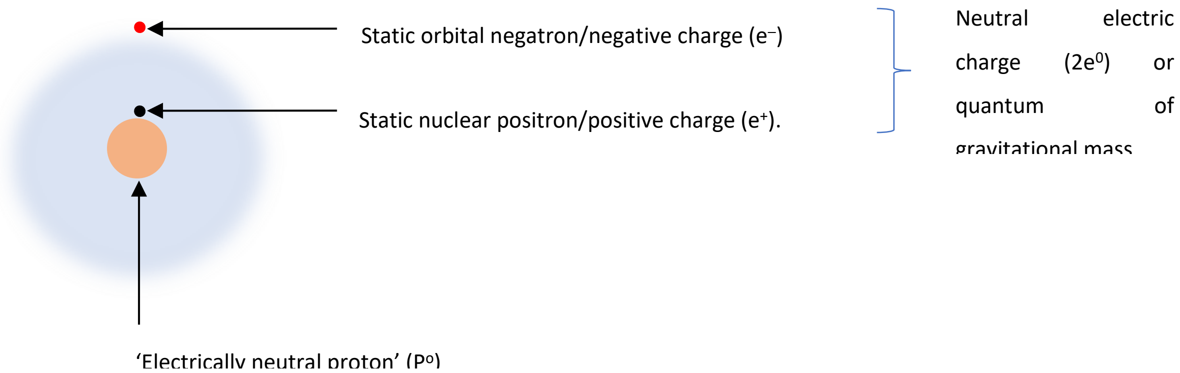

Figure 4. A pair of opposite charges constitutes a unit of ordinary mass or the electrically neutral charge ($2e^0$). An integral multiple of such units form the material content (gravitational mass) of an atom's 'outer zone'.

The process that reverses charge pair neutralisation can be termed 'charge pair production', which is the nonrelativistic equivalence of electron pair production. Charge pair production is familiar and easy to observe but has never been recognized for what it is. It is observable in frictional electrification, for example when glass rod is rubbed with silk. The rubbing literary splits a unit of electrically passive (gravitational) mass ($2e^0$) to positive (e^+) and negative (e^-) units of the electrically active matter. The processes of charge pair production and neutralisation reveal that: 1) ordinary mass and electric charge do interconvert; 2) contrary to the view that ordinary mass exists in indefinite and unpolarised continuum, mass is ultimately quantized and polarized; 3) positive and negative 'atoms of electricity' are the natural bricks of both the electrically active and electrically passive matter (figure 5).

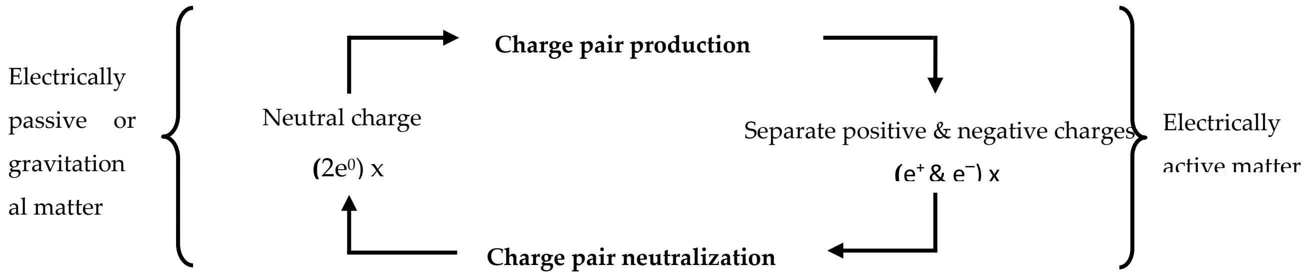

Figure 5. Interconversion of the electrically active matter (electric charge) and the electrically passive (ordinary mass) matter is an interplay of discrete positive, negative and neutral electric charges.

5. The atom as a composite of pure positive and negative charges

Eq. (9) establishes that nature combines positive (e^+) and negative (e^-) charges to construct a unit of gravitational mass ($2e^0$). Based on the equation, the whole atom, which is a gravitational mass particle, is made of pure positive and negative charges. The atom is electrically neutral for the sole reason that half of its mass is positive and half is negative. Figure 5 illustrates how this arrangement explains the material content of the atomic outer zone. In this zone, same number of positive nuclear and orbital negative charges constitute the gravitational mass. A fresh probe into existing facts reveals that nucleons, which occupy the atomic inner zone, are equally made of pure positive and negative charges.

First, the proton carries a positive charge but the neutron is electrically neutral. This fact makes physical sense and agrees with experiment as along as positive and negative charges are recognised as the sole building blocks of both nucleons. Blackett established that the proton is 1,837 times heavier than the electron,[78] implying that 1,837 electron mass units ($1{,}837m_e$) go into a proton. Similarly, Chadwick determined that the neutron is 1,840 times heavier than the electron, meaning that 1,840 electron mass units ($1{,}840m_e$) go into a neutron. But Eq. (5) associates elementary mass (m_e) with elementary charge (e), such that the number of elementary mass units in a particle equals the number of the elementary charge units. Hence, the proton comprises 1,837 charges (1,837e); and neutron comprises 1,840 charges (1,840e). Consistent with Eq. (9), the neutron's electrical neutrality is due to its even number of elementary charges ($920e^+$ and $920e^-$) or masses ($920m_e^+$ and $920m_e^-$). Conversely, proton's positive charge is due to the odd number of charges ($920e^+$ and $920e^-$) or masses ($920m_e^+$ and $920m_e^-$).

Eq. (5) and Eq. (9) reveal a universal principle: an electrically neutral particle comprises, invariably, an even number of electron mass units; and a particle that manifests one elementary charge has an odd number of electron masses. Rounded off to the nearest whole electron mass, empirical masses[79] of baryons agree with the equations, exposing natural patterns that associate each particle's electric charge status with the evenness or oddness of number of its electron mass units (Table 6). The simplicity and universality of these patterns lead to the inference that positive and negative charges (static electrons) are the elementary building blocks of all baryons.

Table 6. Rounding off the empirical masses of baryons to the nearest whole electron mass (m_e) reveals that a particle's charge status depends on whether it consists of an odd or an even number of electron masses. The charge-mass relation harmonizes with Eq. (5) and Eq. (9), implying that positive and negative electron masses are the natural bricks of which baryonic masses are made.

Multiplet	Electron or elementary mass (m_e) units in a particle	Number of charges (e) and charge states (superscript)	Electron mass even-odd status	Electric charge status
Nucleon	$1837m_e$	$1837e^+$	Odd	Charged
	$1840m_e$	$1840e^0$	Even	Neutral
Pion	$264m_e$	$264e^0$	Even	Neutral
	$273m_e$	$273e^+$	Odd	Charged
Kaon	$965m_e$	$965e^+$	Odd	Charged
	$968m_e$	$968e^0$	Even	Neutral
	$974m_e$	$974e^0$	Even	Neutral
Eta	$1074m_e$	$1074e^0$	Even	Neutral
	$1077m_e$	$1077e^+$	Odd	Charged
Lambda	$2153m_e$	$2153e^+$	Odd	Charged
	$2183m_e$	$2183e^-$	Odd	Charged
Sigma	$2328m_e$	$2328e^0$	Even	Neutral
	$2343m_e$	$2343e^-$	Odd	Charged
Xi	$2573m_e$	$2573e^-$	Odd	Charged
	$2579m_e$	$2579e^+$	Odd	Charged

Second, proton mass ($1,837m_e$) is $3m_e$ less than neutron mass ($1,840m_e$). Beta decays explain the difference. In beta negative (β^-) decay, neutron (N^0) disintegrates to proton (P^+), negatron (e^-) and neutrino (ν). Similarly, in beta positive (β^+) decay, proton (P^+) disintegrates into positron (e^+), neutrino (ν) and a particle considered a 'neutron' (n^0). In Pauli's summary "a neutrino always accompanies the beta electron."[80] Concurrently, nature chips an electron and a neutrino out of a nucleon. Since mass is strictly conserved, the $3m_e$ lost when neutron converts to proton is shared by electron and neutrino. The electron accounts for $1m_e$; therefore, the neutrino must account for the $2m_e$. In this perspective, Pauli's neutrino matches the neutral electric charge ($2e^0$) – an electrically neutral particle with two units of electron mass ($2m_e^0$). Pauli was once close to this inference when suspected that "neutrino might be a combination of a Bose-positron and an electron (negatron)."[81] But the idea that neutrino is massless prevailed.[82] Later studies, however, "have conclusively established that neutrinos"[83] have rest mass. Moreover, recognition of beta electrons as ultrahigh speed positive (e^+) and negative (e^-) charges (section 4) provides sound ground to infer that Pauli's neutrino is the ultrahigh speed (relativistic) neutral charge (table 7).

Table 7. The particles recognised as positive, negative and neutral electric charges at nonrelativistic speeds are the same ones recognised as positive (beta) electron, negative (beta) electron, and neutrino at relativistic speeds.

	Name of particle at non-relativistic (near-static) speed	*Symbol and charge status of particle at nonrelativistic speed*	*Name of particle at relativistic (ultra-high) speed*
1	Positive charge	e^+	Positron (beta positive electron)
2	Negative charge	e^-	Negatron (beta negative electron)
3	Neutral charge	$2e^0$	Neutrino (beta neutrino)

Fruitful results emerge when Pauli's summary is applied to other multiplets, providing extra evidence that the $3m_e$ and the neutron-proton charge states are universal phenomena. Invariably, a $3m_e$ unit separates a particle and its next neighbour in a multiplet; and charge states alternative as: … neutral → positive → neutral → negative → neutral → positive … (See table 8 superscripts). In harmony with Eq. (5) and Eq. (9), particles with even-numbers of charges are electrically neutral and the odd-numbered ones are electrically charged. Thus, it is possible to connect known members of each multiplet by filling the gaps between them with a series of 3m_e units, thereby predicting a range of new particles (table 8).

Table 8. A unit of 3m_e differentiates a proton and a neutron. The principle works in other particle multiplets, revealing linking known particles (bolded) by filling the gaps between them with a series of 3m_e units. The scheme predicts an array of new particles in terms of their masses and electric charge statuses. .

Multiplet	Known (bolded) and potential members of multiplets in elementary mass units and charge states
Nucleon	...1831e^-…1834e^0...**1837e^+**…**1840e^0**...1843e^-…
Pion	... **264e^0** … 267e^- … 270e^0 … **273e^+**...
Kaon	... **965e^+** … **968e^0** … 971e^- … **974e^0**...
Eta	…1071e^-... **1074e^0** … **1077e^+**...1080e^0…
Lambda	... **2153e^+**… 2156e^0… 2159e^-… 2162e^0 … 2165e^+ … 2168e^0… 2171e^- … 2174e^0 … 2177e^+… 2180e^0 … **2183e^-**...
Sigma	... 2328e^0 … **2331e^+**… 2334e^0… 2337e^-… 2340e^0… **2343e^+**..
Xi	... **2573e^-** … 2576e^0… **2579e^+**...

Pauli's summary, as expounded in table 8, hints that the nucleon multiplet has, at least in theory, more than the two recognized members (neutron and proton). Empirically, nucleon decays have four possible emission outcomes. 1) Nothing is emitted besides the neutrino; but the atomic number increases by one (internal adjustment). 2) Spontaneous emission of positive beta (β^+) electron (positron) and neutrino. 3) Spontaneous emission of negative beta (β^-) electron (negatron) and neutrino. 4) Spontaneous emission of gamma rays (γ) and neutrino. To account for these outcomes, nature imposes four rules (table 9).

Table 9. Four natural rules govern beta decays, yielding the four observable outcomes.

Cycle	Nature's rule	Emission outcome	Non-neutrino emission
1	Nuclear positive and orbital negative charges (static electrons) can appear concurrently and remain in the atom.	No emission besides neutrino. This is 'internal adjustment' and increases atomic number by one. To conserve charge and keep the atom stable, the new positive and negative charges (static electrons) are retained in the nucleus and orbit respectively.	None
2	Positive charge is not allowed in the orbits.	Beta positive electron (positron) emission.	β^+
3	Nuclear negative and orbital positive charges may emerge concurrently but both are not allowed in the atom.	Positive and negative electrons concurrently emitted but 'annihilate' into gamma rays.	γ
4	Unpaired negative charge not allowed in nucleus.	Beta negative electron emitted.	β^-

An examination of the expanded nucleon multiplet against Pauli's summary (table 8) and natural decay rules (table 9) leads to a surprising discovery: besides Chadwick's neutron, nature has two more stable, electrically neutral nucleons. In addition, an unstable (transient) nucleon with a negative charge is identifiable. In effect the four rules (table 9) describe how four different nucleons decay (table 10). The implication is that nucleons and other baryons can repeatedly decay into pure charges (positive and negative) and neutrinos. The neutrino, however, decays further into a pair of opposite electrons in electron pair production. Hence, positive and negative 'atoms of electricity' are all there is in the known material universe.

Rule 1: Chadwick's neutron (N^0) is stable. It decays to proton, static negatron (negative charge) and neutrino: $N^0 \rightarrow P^+ + e^- + \nu^0$. A critical inference is that neutron decay is not the source of the observable negatron. To conserve charge and stabilise the atom, both P^+ and e^- are retained in the atom. Hence, neutron decay emits nothing besides the neutrino. However, it increases the atomic number bay one.

Rule 2: The proton (P^+) is table. In β^+ decay it emits a positron, reducing the atomic number by one and converting to a particle presently called 'neutron'(n^0): $P^+ \rightarrow n^0 + e^+ + \nu^0$. But the law of conservation of mass prohibits the conversion of lighter proton to heavier neutron. Hence, the stable, electrically neutral particle resulting from proton decay is a new nucleon, here named the nairotron (n^0) (table 10).

Rule 3: The nairotron (n^0) is stable (table 10). It decays into an unstable nucleon that carries a negative charge, here named transitron (t): $n^0 \rightarrow t^- + e^+ + \nu^0$. Negative and positive charges emerge concurrently in the nucleus and orbit respectively. Consequently, both are concurrently ejected from nucleus as opposite electrons (highspeed charges) and they 'annihilate' into gamma rays.

Rule 4: The transitron (t^-) is unstable. It decays to a smaller but stable neutral particle, here named the afritron (A), as well as the observable negatron: $t^- \rightarrow A^0 + e^- + \nu^0$. The fact that the transitron is the source of the observable negatron implies that the electrically neutral and stable Afritron (1,828e^0) does exists a stable atomic nucleon. If the Afritron decays at all, it follows the same route of the ordinary neutron – restarting the four-step decay cycle (table 10).

Table 10. Empirical beta decay outcomes fit into a clear 'segment' of the nucleon decay spectrum (shaded grey). This identifies three new nucleons – nairotron, transitron and Afritron. The nairotron differs from Chadwick's neutron because it has smaller mass and different decay products. The Afriton, other being lighter, is exactly like Chadwick's neutron.

Particle's EMUs & charge status	Decay route	Original particle	Non-neutrino emission	Decay cycle/rule
↑ …	…	…	…	… ↑
Predicted 1843e^-	1843e^- → 1840e^0 + 1e^- + 2e^0	Unstable	ß$^-$	Rule 4
Neutron 1840e^0	1840e^0 → 1837e^+ + 1e^- + 2e^0	Stable (neutron)	None	Rule 1
Proton 1837e^+	1837e^+ → 1834e^0 + 1e^+ + 2e^0	Stable (proton)	ß$^+$	Rule 2
Nairotron 1834e^0	1834e^0 → 1831e^- + 1e^+ + 2e^0	Stable (Nairotron)	ß$^+$ + ß$^-$ (2e^0 + γ-rays)	Rule 3
Transiton 1831e^-	1831e^- → 1828e^0 + 1e^- + 2e^0	Unstable (transient)	ß$^-$	Rule 4
Afritron 1828e^0	1828e^0 → 1825e^+ + 1e^- + 2e^0	Stable	None	Rule 1
Predicted 1825e^+	1825e^+ → 1822e^0 + 1e^+ + 2e^0	Stable	ß$^+$	Rule 2
Predicted 1822e^0	1822e^0 → 1819e^- + 1e^+ + 2e^0	Stable	ß$^+$ + ß$^-$ (2e^0 + γ- rays)	Rule 3
Predicted 1819e^-	1819e^- → 1816e^0 + 1e^- + 2e^0	Unstable	ß$^-$	Rule 4
Predicted 1816e^0	1816e^0 → 1813e^+ + 1e^- + 2e^0	Etc	Etc	Etc
↓ …	…	…	…	… ↓

6. Unification of gravity and electricity

A decisive proof that Eq. (9) correctly portrays nature is that it verifiably unifies Newton's law of gravity and Coulomb's law of electrostatics to $8G/m_p m_e = K/e^2$, where G and K are the respective constants, m_p the proton mass, m_e the electron mass, and e the elementary charge. A clear-cut principle underlies this discovery: Newton deals with 'electrically passive mass and field'; Coulomb with 'electrically active mass and field'. Both interactions deal with 'mass and field'. This makes them analogous. But Newton deals with 'electrically passive mass and field' and Coulomb with 'electrically active mass and field'. This explains the difference. Essentially, therefore, Newton's mass (M) is a neutral electric charge; and gravitation is the electrostatic attraction between unlike halves of like masses M_1 and M_2:

$$\frac{1}{2}M_1^- \times \frac{1}{2}M_2^+ = \frac{1}{4}(M_1M_2)^- \qquad (10)$$

Empirically, opposite charges – and opposite magnetic poles – attract. Eq. (10) extends this rule to gravitational mass: 'opposite halves' of 'like masses' attract (Fig. 6). A familiar puzzle of gravity is that unequal masses, such as the earth and the moon, attract

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each other with a force of the same magnitude. The prevailing explanation is that a gravitational mass has an intrinsic active-passive symmetry.[84] Active gravitational mass is the source of gravitational field lines,[85] passive mass is their sink. Eq. (9) explains the puzzle as due to the positive-negative elementary mass symmetry within an ordinary mass object (fig. 6).

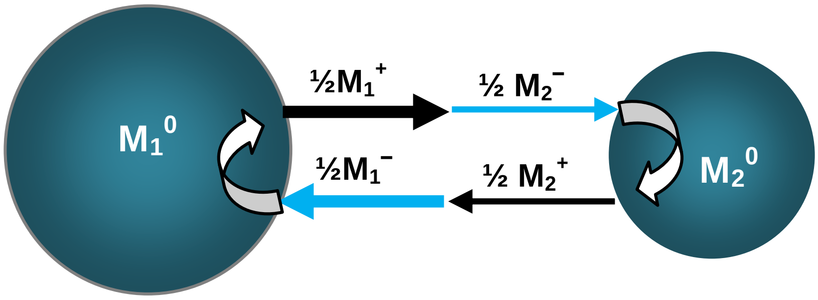

Figure 6. A gravitational mass (M) with an intrinsic positive-negative symmetry explains why unequal masses (M_1 and M_2) attract with the same magnitude of force.

In the light of Eq. (9), as illuminated in table 4, a gravitational mass has tangible (inertial mass) and intangible (gravitational field) components (fig. 7). This throws fresh light into Newton's gravitation: the strength of gravitational interaction is directly proportional to the product of the tangible (inertial) masses (M_1M_2) and inversely proportional to the product of the intangible gravitational fields, which corresponds with Newton's r^{-2}. The tangible mass and the intangible field are inseparable, mechanical components of a gravitational mass. Therefore, two gravitational masses are always in mechanical contact (no distance between them) and even the slightest alteration in one is instantly reflected in the other. Newton's Law of Universal Gravitation, therefore, means that gravitational field mechanically connects every inertial mass to every other inertial mass in the universe. Hence, what seems like 'instant action at a distance'[86] is instant action at no distance. Distance (gravitational field) exists between two inertial masses; but there is no distance (gravitational field) between two gravitational masses. Moreover, a gravitational field that stems from the centre of mass and increases in direct proportion to the quantity of mass, and which extends and thins out equally in a three-dimension space, must have the geometric properties that Einstein perceived as curved space. Hence, inertial mass does not curve space – inertial mass and the curved space (gravitational field) are different components of a gravitational mass (fig 7). Gravitational field does not fill the space between two inertial masses; it is the space.

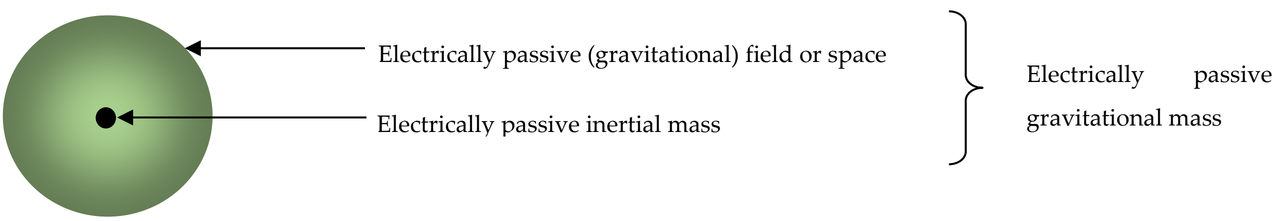

Figure 7. Newton's gravitational mass comprises electrically passive inertial mass and gravitational field. Gravitational field does not fill the space between two inertial masses; it is the space. .

The relation of electric charge to gravitational mass (table 5) indicates that Newton's equation of gravity and Coulomb's equation of electrostatics have an underlying uniformity. To expose the uniformity, two problems must be solved. One, electric charge in Coulomb's equation ($F = Q_1Q_2/r^2$) is polarised – it is either positive or negative – but it is not quantised. That is, the equation utilises artificial units (coulombs) rather than natural units. Two, mass in Newton's equation ($F = M_1M_2/r^2$) is neither polarised nor quantised.

That is, the equation does not take into account the fact that gravitational mass has an intrinsic positive-negative symmetry and, like Coulomb's equation, it utilises artificial units (kilograms). Thus, to unify the two equations, both Coulomb's product of charges (Q_1Q_2) and Newton's product of masses (M_1M_2) must be unified – polarised and quantised.

Eq. (10) polarises Newton's masses M_1 and M_2. The product of polarised masses (¼$M_1M_2^-$) is interactively equivalent to the product of polarised charges ($Q_1Q_2^-$) – these are interactions between oppositely charged matter. Quantization of ¼$M_1M_2^-$ and $Q_1Q_2^-$ entails simplifying them to natural units. Millikan simplified quantity Q of charge to an integral number of elementary charges. Hence, the number of elementary charges in Q_1 and Q_2 are Q_1/e and Q_2/e. Polarised and quantised, therefore, Coulomb's product charges become Q_1Q_2/e^2 and his equation is rewritten as:

$$\mathrm{F} = \frac{\mathrm{K}Q_1Q_2}{e^2\mathrm{r}^2} \qquad (11).$$

Rearranging Eq. (11):

$$\frac{Fr^2}{Q_1Q_2} = \frac{\mathrm{K}}{e^2} \qquad (12).$$

Like Coulomb's, Newton's equation can be polarised and quantised. Eq. (10) has already polarised the product of masses to ¼$M_1M_2^-$. But how does nature quantise gravitational mass? Aston's "whole number rule" states that "masses of the isotopes are whole number multiples of the mass of the hydrogen atom (protium)."[87] Put simply, a gravitational mass is a whole number multiple of the mass of the simplest atom. But hydrogen atom has distinct inner and outer zones (fig. 4) – the nuclear proton mass (mass = m_p) and the masses of nuclear and orbital charges (mass = $2m_e^0$). That is, the mass of hydrogen atom is organised into two quanta – m_p^0 and $2m_e^0$. Eq. (9), however, makes $2m_e^0$ the natural quantum of the electrically passive inertial mass. Hence, proton's m_p^0 and $2m_e^0$ units indicate that atomic mass is organised into low- and high-density zones. In the low-density outer zone, pairs of opposite charges are relatively far apart. In the proton, pairs of opposite charges are so tightly compacted that the proton exists as a discrete natural unit of gravitational mass. Thus, nature has two distinct quanta of gravitational mass: mass of proton (m_p^0) and mass of the neutral charge ($2m_e^0$). In this light, the smallest product of Newton's polarised masses (¼$M_1M_2^-$) is:

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

The total number of such units in ¼M_1M_2 is:

$$\frac{1}{2}\mathrm{m_p m_e} \times \frac{1}{4}\mathrm{M_1M_2} = \frac{1}{8}\mathrm{M_1M_2m_pm_e}.$$

Therefore, polarised and quantised, the product of Newton's masses is $M_1M_2m_pm_e/8$, and his equation becomes:

$$\mathrm{F} = \frac{8\mathrm{G}M_1M_2}{m_em_p\mathrm{r}^2} \qquad (13).$$

Rearranging Eq. (11):

$$\frac{Fr^2}{M_1M_1} = \frac{8G}{m_pm_2} \qquad (14).$$

A vital fact is noticed when the constants in Eq. (12) and Eq. (14) are equated – Coulomb's equation and Newton's equation become numerically and conceptually equal:

$$\frac{K}{e^2} = \frac{8G}{m_pm_e} = T \qquad (15).$$

Using the CODATA values[88] of physical constants: K/e^2 equals 3.506 x 10^{47} Nm^2/C^4 and $8G/m_pm_e$ equals 3.506 x $10^{47}Nm^2/kg^4$. The numerical and conceptual equality of the two interactions leave no doubt that Eq. (15) succeeds to correctly unify Coulomb's and Newton's equations. Effectively, the equation unifies electric charge and gravitational mass, replacing the respective constants (K and G) with a common constant T. Consequently, the unified law can be stated as: 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}). Traditionally, the quantities of passive electric charge (gravitational mass) in Newton's law are neither polarized nor quantized. On the other hand, the quantities of active electric charge in Coulomb's law are polarized but not quantized. Quantisation and polarisation of both Newton's masses and Coulomb's charges expose the underling uniformity of the two interactions.

7. Conclusion

This article has synthesised scattered bits of scientific evidence, collected over centuries, to arrive at a verifiable conclusion that positive and negative 'atoms of electricity' – collectively charges and electrons – are the ultimate building blocks of the material universe.

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