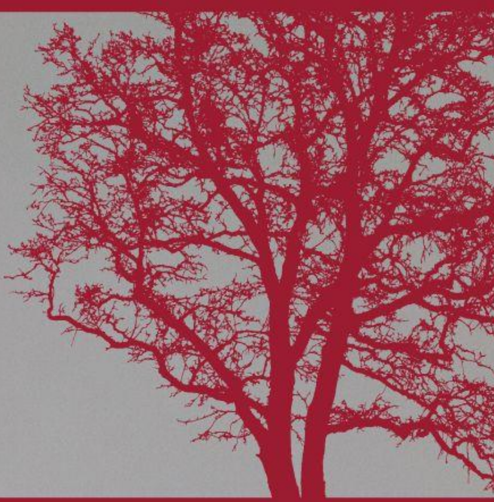
INTRODUCTION TO THE QUANTUM

THEORY OF ELECTROGRAVITATION

- MATRIX AND SIMULATION -



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ARCANGELO RECCHIA

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WORKING PAPER VERSION 16°

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Fortis imaginatio generat casum.

Michel de Montaigne (?)

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Abstract

In the first part of **Chapter 1**, the "conversion factors" are derived, which are dimensionless coefficients used to evaluate the effect of the accelerated expansion of spacetime on measurements. These factors can be expressed using a common parameter, denoted by the letter α, which is subsequently shown to be the fine-structure constant. The latter can be expressed as the ratio, raised to the fourth power, between the theoretical R_{uT} and the measured radius of the observable universe R_{uI}.

$$\alpha = \left(\frac{R_{uT}}{R_{uI}}\right)^4 \approx \left(\frac{13.6\ Gly}{46.5\ Gly}\right)^4 \approx \frac{1}{137} \qquad (1.21)$$

The hypothesis of matter contraction is then discussed: the Hubble's law alone does not allow us to distinguish whether it is the universe that is expanding or the matter within it that is contracting. In this perspective, the redshift observed by Hubble reflects not the expansion of the universe, but the contraction of matter, and therefore of the "ruler" with which measurements are made. The limits of observability of the universe are then explored, and in the final part, the application of the conversion factors in the hypothesis of contracting matter is addressed, extending their validity to each singularity. In **Chapter 2**, it is demonstrated that dark matter and dark energy do not exist. Considering the abundance of dark energy in the universe ($\approx 68\%$), if we divide this value by the conversion factor ($1/2\alpha \approx 68.5$), we realize that it is nothing but ordinary energy ($\approx 1\%$), whose value is erroneously detected due to the distance between the observer and the events. A similar reasoning applies to dark matter. We are told that it contributes to 27% of the observed gravitational effects in the entire universe and that it constitutes about 85% of the mass of a galaxy. By dividing these values by the conversion factor ($1/2\sqrt{\alpha} \approx 5.85$), we obtain exactly the percentage of ordinary matter that constitutes the universe ($\approx 4.6\%$) and the galaxies ($\approx 15.5\%$), respectively. This implies that, for both the universe as a whole and in the context of a single galaxy, about 85% of the mass does not exist, and the gravitational effects attributed to it are actually caused solely by ordinary matter. Lastly, by summing the percentage values of ordinary mass and energy, derived from observations of dark matter and dark energy, we obtain a total of 5.6%, which does not differ much from the 5% of the Λ-CDM model. The other 95% does not exist as matter, but only as "effects" due to the spacetime distance separating the observer and the measured events. In **Chapter 3**, Newtonian gravitation theory is reformulated as Newtonian electrogravitational theory. It begins with the Stoney units, natural units definable using only principles of classical physics. These include the units of length (l_S), energy (E_S), and Stoney mass (m_S). The latter connects mass and energy to the elementary electric charge (charge-energy-mass equivalence law).

$$m_z = -\sum_{j=1}^{n} \frac{K}{c^2}\frac{q_e^+ q_e^-}{a_k l_S} = m_S \sum_{j=1}^{n} \frac{1}{a_k} \qquad (a_k \in \mathbb{N})^* \qquad (3.4)$$

In this way, a generic mass m_z can be expressed in terms of the Stoney mass unit. This relation tells us that the mass of a system composed of non-interacting elementary dipoles ($a_k = 1$), must necessarily be a multiple n_i: ($n_i \epsilon \mathbb{N}$) of the Stoney mass. This concept is integrated into the gravitational attraction law to obtain

$$\boldsymbol{F} = -\,G\left[n_1\left(-\frac{K}{c^2}\frac{q_e^+ q_e^-}{l_S}\right)\right]\left[n_2\left(-\frac{K}{c^2}\frac{q_e^+ q_e^-}{l_S}\right)\right]\frac{\boldsymbol{r}}{r^3} \qquad (3.8)$$

the Newtonian electrogravitational attraction law. In **Chapter 4**, Newton's theory is extended into the generalized gravitational theory (of which Newtonian theory represents a limiting case). In the generalized gravitational theory, it is assumed that gravitational interactions are mediated by two force fields, the gravitational field **g** and the cogravitational field **K**. As in the Newtonian case, it is possible to formulate the generalized theory in terms of fields, in this case **g** and **K**. This leads to four differential equations, called GEM or Jefimenko's equations, which constitute the gravitational analog of Maxwell's equations. The generalized gravitational theory, formulated in this way, predicts a wide range of phenomena, including the existence of gravitational waves. By integrating the Stoney mass unit into the generalized gravitational theory, the latter transforms into the generalized electrogravitational theory. Jefimenko's equations are then converted into electrogravitational equations (shown below, 4.8-4.11), among which solutions include electrogravitational waves.

$$\nabla \cdot \mathbf{g} = -\frac{4\pi G K}{c^2}\frac{q_e^2}{l_S}\rho_n \qquad (4.8)$$

$$\nabla \cdot \mathbf{K} = 0 \qquad (4.9)$$

$$\nabla \times \mathbf{g} = -\frac{\partial \mathbf{K}}{\partial t} \qquad (4.10)$$

$$\nabla \times \mathbf{K} = -\frac{4\pi G K}{c^4}\frac{q_e^2}{l_S}\boldsymbol{J}_n + \frac{1}{c^2}\frac{\partial \mathbf{g}}{\partial t} \qquad (4.11)$$

Electrogravitational waves indicate that the photon γ^0 and the graviton g^0 describe two aspects of the same particle, the graviphoton $g\gamma^0$. In **Chapter 5**, Planck's relation is derived from first principles. The energy of the electrogravitational wave depend on its position in spacetime. When the wave propagates on the horizon of a singularity (quantum or black hole), its energy, as measured by an external observer (positioned outside the singularity's cone of influence), is given by the relation:

$$E_S = \frac{\mu_e G K}{2c^3}\left(\frac{q_e^2}{l_S}\right)^2 v = \mu_e c\frac{q_e^2}{2}v = \frac{Z_0 q_e^2}{2}v = h_S v \qquad (5.5)$$

Here, E_S is the Stoney energy, $h_S \approx 4.84 \cdot 10^{-36}\, J \cdot \mathrm{s}$ is the Stoney constant, v is the wave frequency, and Z_0 is the impedance of free space. When the wave propagates in locally flat spacetime, its energy is approximately $(1/\alpha \approx 137)$ times greater:

$$E_P = \frac{1}{\alpha}\frac{\mu_e G K}{2c^3}\left(\frac{q_e^2}{l_S}\right)^2 v = \mu_e c \frac{q_e^2}{2\alpha} v = \frac{Z_0 q_e^2}{2\alpha} v = \frac{h_S}{\alpha} v = h_P v \tag{5.6}$$

Here, E_P represents the Planck energy and $h_P \approx 6.626 \cdot 10^{-34}\, J \cdot \mathrm{s}$ is the Planck constant. When a graviphoton is absorbed by an elementary particle, such as an electron, the energy it contributes to the system is (for an external observer) approximately $(1/\alpha \approx 137)$ times less than the energy possessed by the graviphoton in locally flat spacetime. If we use the Stoney constant instead of the Planck constant in the calculation of the energy levels of the orbitals in atoms, there is no need to introduce α. In **Chapter 6**, the electrogravitodynamic equations (which describe the propagation of the scalar and vector potentials) and the stress-energy tensor are developed. Finally, in **Chapter 7**, the electrogravitational field equation is presented.

$$R_{\mu\nu(f)} - \frac{1}{2} g_{\mu\nu(f)} R_{(f)} = \frac{32\pi^2 G_{(f)} K_{(f)}}{\mu_{e(f)} c_{(f)}^6} T_{\mu\nu(f)} \tag{7.2}$$

Here, the subscript (f) indicates the dependence of the different terms on their respective conversion factors, implicitly highlighting their relationship with the fine-structure constant α. The left-hand side of the equation remains unchanged (even in derivation) compared to that developed by Einstein: all terms present are continuous quantities. The right-hand side, however, is quantized. Quantization of the left-hand side is achieved by taking the length unit l_u from the tensor $T_{\mu\nu}$ (which can only assume values between l_S and l_P), and placing it (its square) in the numerator on the left-hand side, thereby discretizing the elements $R_{\mu\nu}$, $g_{\mu\nu}$ and R. In this way, a fully quantized (and dimensionless) version of the electrogravitational field eq. is obtained.

$$l_{u(f)}^2 R_{\mu\nu(f)} - \frac{l_{u(f)}^2}{2} g_{\mu\nu(f)} R_{(f)} = \frac{32\pi^2 G_{(f)} K_{(f)}}{\mu_{e(f)} c_{(f)}^6} l_{u(f)}^2 T_{\mu\nu(f)} \tag{7.3}$$

In this equation, $1/l_{u(f)}^2$ represents the "curvature quantum", expressed in terms of the minimum measurable length (l_u represents both the radius of the elementary electric charge, and the binding distance between the charges of the graviphoton). This can be compactly expressed as (7.4). The solutions to Einstein's field equation are represented by the spacetime metrics. In the electrogravitational case, since the field equation is quantized, the solutions are also found to be quantized. These solutions allow us to address phenomena from both a relativistic and quantum-mechanical perspective. In **Chapter 8**, the steps leading to our current understanding of matter are retraced, from the establishment of the concept of atoms to elementary particles. Subsequently, the possibility that elementary particles themselves are composed is examined and discussed: the electrogravitational theory suggests that the graviphoton is formed by two oppositely charged electric charges. Similar to how various elements in the periodic table trace back to the hydrogen atom, elementary particles can be traced back to the elementary electric charge $q_e^{-/+}$. Within atoms, electrons occupy orbitals that necessarily have opposite spins (Pauli exclusion principle). A similar scenario applies to elementary particles: they lack a nucleus (the role of which is taken by the charge center), and instead of electrons, their orbitals are occupied by elementary electric charges. In the case of elementary particles, a principle akin to exclusion applies directly to the sign of charges: within the same orbital only charges (bosons) of opposite signs (-/+) can coexist. A fully filled orbital results in a neutral elementary particle, while a single unpaired charge results in either a (-) particle or a (+) antiparticle. With only 10 available slots (?), there are 10 possible elementary particles, 4 bosons, and 6 leptons. The filling of orbitals among elementary particles results in each particle differing from the next by exactly one elementary electric charge. Therefore, we can assign to particles (including non-elementary ones) a parameter analogous to atomic number, the charge number (n_c). The proton and neutron each consist of 3 leptons with $n_c = 3$, held together by a free delocalized elementary electric charge. This molecular model will be used in **Chapter 9** to calculate the ratio of the proton mass (m_P) to the electron mass (m_e). The mass difference between these subatomic particles arises because the 3 leptons (in the form of up/down quarks) that constitute the proton, during rotation, each fall within the influence cone of the adjacent lepton (quark), which does not occur* in the case of the 3 charges of the electron as they rotate around their charge center. The ratio (m_P/m_e) is calculated using the formula (other approaches can be used):

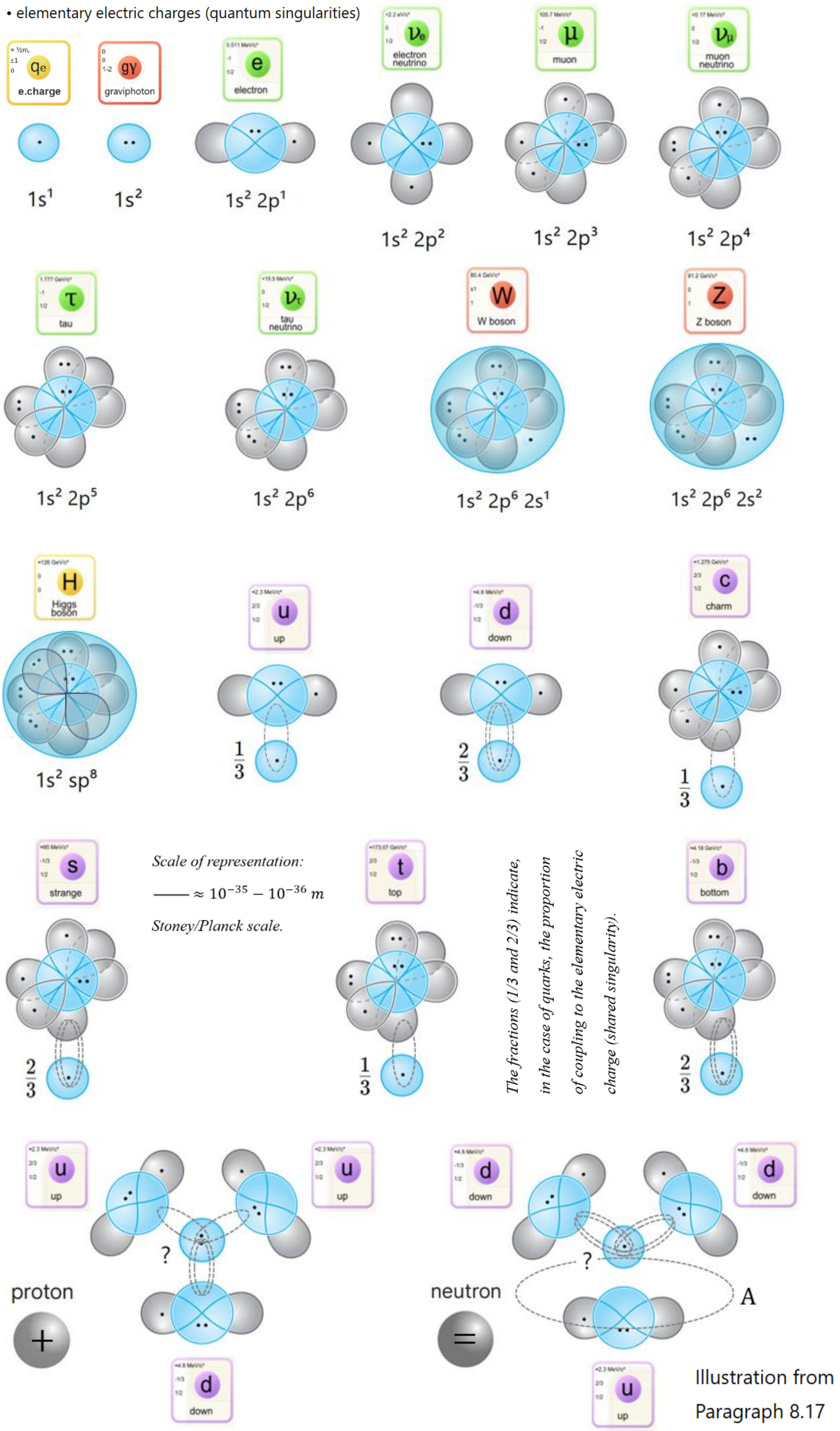
$$\frac{m_P}{m_e} = R \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = R \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^N \approx 1.1466 \cdot (11.7)^3 \approx 1836 \qquad (9.4)$$

Here, $\sqrt{\alpha}$ corresponds to (for an observer "external" to the singularity's influence cone) the conversion factor for force. R is the ratio between the average charge number of one of the particles composing the proton ($\bar{n}_c = 10.3\overline{3}/3 \approx 3.44$) and the charge number of the electron ($n_c = 3$), and N is the ratio between the number of quasi-particles composing the proton (3) and the number of particles composing the electron (1). In **Chapter 10**, the concept of force is revisited: from a quantum perspective, force is nothing but the effect that occurs due to the exchange of particles, thus called mediators. Since all particles can be exchanged, all are carriers of force. In **Chapter 11**, the theory of the multiverse with repeated gravitational collapses (like Matrioshka) is presented. Our universe would be part of a black hole that formed approximately 13.6 billion years ago in a higher (parent) universe, through the gravitational collapse of a sufficiently high concentration of mass present there. Our universe resides within a larger universe and contains, in turn, other universes. In this perspective, our universe represents just one of the many levels (realms) that make up the multiverse, all separated by horizons (boundaries), which are simultaneously event horizons (for an external observer) and cosmological horizons (for an internal observer). For an observer approaching a horizon, crossing this boundary never occur because the horizon continues to move until it disappears from the observer's view, and new spacetime appears. Viewing the multiverse as a series of repeated gravitational collapses connects to the concept of "eternal return". This concept states that all events repeat over time after a certain period (return period), similarly, in an infinite cycle, like seasons (Ouroboros). In **Chapter 12**, the steps leading to the birth of information theory are retraced. Everything, whether sounds, images, or texts, can be digitized and transmitted as bits, using a system capable of assuming at least two states. To force a system into a specific state, energy must be supplied, hence energy and information are interconnected concepts. Indeed it has always been clear that creating physical order, such as building architectural or digital structures, incurs an energy cost. Moreover, despite the abstract nature of information, it must be embodied in a physical system. Information must be "contained" by something, whether it's a stone slab, a book, a CD, or any other medium. This raises the question of whether there exists a fundamental level at which information can be encoded, the level of fundamental "0" and "1." This can only be spacetime itself (electrogravitational field). We have seen how the smallest fluctuation of spacetime corresponds to the elementary electric charge, which therefore represents the "curvature quantum" (with the sign, positive or negative, corresponding to that of the fluctuation). The field assumes the value "0" where undisturbed and "1" where an elementary electric charge is present. The entire reality is thus a vast dynamic matrix (binary or ternary, depending on whether the signs of charges are considered). The total curvature of the field (mass) is given by the sum of all charges, regardless of their sign, and thus by all those non-zero points of the field. Furthermore, since charge is conserved, information must also be conserved:

$$n(1) + n(-1) = 0 \tag{12.1}$$

For $(n \in \mathbb{N}) = 1$, this reduces to the constitutive relation of the graviphoton, represented by the string (-1;1). Summarizing, everything that exists can be reduced to atoms, atoms to subatomic particles, subatomic particles to elementary particles, elementary particles to elementary electric charges, and finally these to the bits of the program (field) we call "reality". The universe, matter, energy, spacetime, are essentially computational: everything is made of rules, laws, strings (each particle can be equated to a numeric string). This demonstrates that the universe is nothing more than a vast program, an illusion interpreted as real by our brains. According to digital physics, this inevitably implies the existence of an external "programmer" who has devised the simulation in which we live. In this sense, human consciousness is not part of spacetime, it interacts with the world through a system of input and output, similar to what happens with computer programs, interfacing with the physical world through the senses. Consciousness is thus "causality" originating outside spacetime. Furthermore, considering that a bit represents a choice between two states, this implies that the universe is fundamentally dual at its elementary level. Duality underpins the dynamics of physical systems. Without opposites, there would be no differentiation, no forces, and everything would be inert. Duality is a symmetry law that applies to every entity and every level of existence. Everything that exists has formed and forms through consecutive ramifications (divisions or symmetries), like the branches of a tree. Hence arises the parallel with the tree of life. All existence can be traced back to a single root, the electrogravitational field. In this sense, elementary electric charge (q_e) represents the cell (fundamental unit) of our reality.

STRUCTURE OF ELEMENTARY PARTICLES



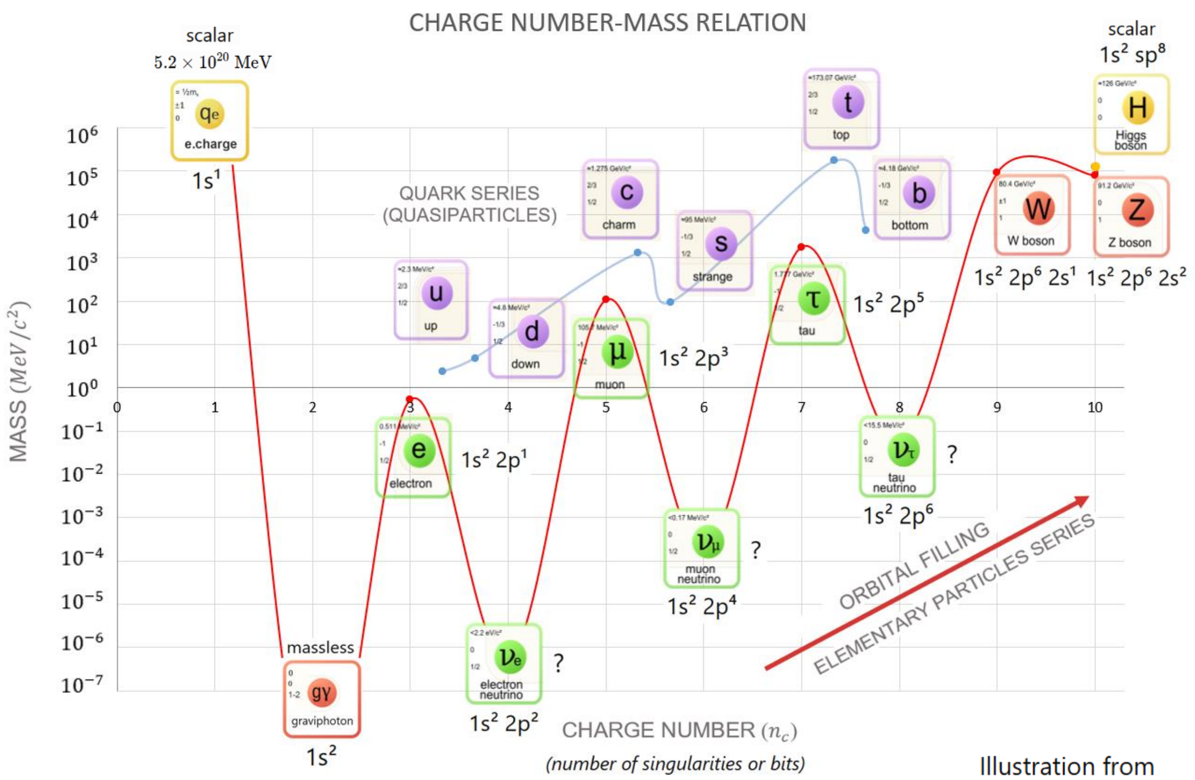
This representation also applies to antiparticles. In this way, neutral particles are their own antiparticles, making neutrinos Majorana particles. Particles with an even integer charge number are neutral, whereas those with an odd or fractional charge number are charged.

Illustrations based on *Organic Chemistry*, 5th Edition, Chapter 1.2 – Atoms and Atomic Orbitals, W. W. Norton & Company; Fig. 1.12

Introduction

Since ancient times, the nature of space and time has been a central theme in natural philosophy. Galileo [1] and Newton [2] conceived space as a static, immutable, and continuous container in which natural events unfold, within which absolute time flows uniformly and continuously at all points. In Newton's theory, the structure of space was described by Euclidean geometry (itself based on the assumption of continuity). Newton's hypothesis of the continuity of space and physical quantities (continuity of observables) led to the development of infinitesimal calculus, which in turn contributed to the construction of the imposing edifice of classical physics, from its origins to the theory of relativity. The subsequent interpretation of electromagnetic phenomena through Maxwell's laws [3] led to the definition of a new physical entity, the electromagnetic field. Maxwell's theory, too, was based on the idea of the continuity of space and time. An interesting aspect is that classical physics, through its equations, reveals [4] a perfectly predictable and deterministic universe in its evolution. A true revolution in the understanding of the nature of space and time occurred with Einstein's theory of special relativity [5] (published in 1905). Einstein's theory replaced Newton's absolute space and time with a spacetime continuum. Special relativity also led to the equivalence between mass and energy. Subsequently, Einstein further extended the principle of relativity to all reference systems, including accelerated ones. This led him to formulate the theory of general relativity [6] (published in 1916), in which the gravitational field is interpreted as the curvature of spacetime. Despite the revolutionary conception of the nature of space and time presented in this theory, it remains firmly tied to the principle of determinism that characterizes classical physics. Regarding the nature of matter, Democritus was the first to propose the concept that matter is composed of atoms. Experimental confirmation of the existence of atoms came in the early 1900s [7]. There was, however, a problem. While matter appeared discontinuous, Maxwell's theory described light and electromagnetic phenomena as continuous. This problem was resolved in 1900 by Max Planck [8], who hypothesized a granular nature for energy as well. Einstein later used this hypothesis to explain the photoelectric effect [9]. This marked the beginning of quantum mechanics. Within quantum theory emerges a fundamental symmetry of reality, the granularity of matter and energy. The introduction of the concept of the photon by Einstein in the context of the photoelectric effect highlighted the simultaneous nature of light, both as a wave in the theory of special relativity and as a particle in quantum theory. The extension of this duality to all particles, proposed by Louis de Broglie [10], highlighted the inadequacy of the then-existing mathematical framework (developed within the realm of classical physics), to describe this new entity consisting of the wave-particle duality. The main problem lay in the concept of action itself. In quantum mechanics, the relationship between spatial coordinate and momentum is governed by

Heisenberg's uncertainty principle [11]. This principle tells us that the phase space area is bounded from below by the action quantum. In other words, phase space is pixelated [12]. This led to the need for a new mathematics, primarily developed by Schrödinger [13] and Heisenberg [14]. Bohr [15] understood that the representation of the atomic world based on his hypothesis of electron stationary states did not allow the creation of a spacetime model centered on Newtonian principles (determinism). In fact, any attempt to fix the coordinates of particles constituting an atom would ultimately lead to an uncontrollable exchange of energy and momentum. The existence of stationary states in the atom, and the possibility for an electron to "jump" between states with the emission of a photon, in Bohr's representation, is justified by the hypothesis that not only the energy of the photon is quantized, but also its orbital angular momentum. This highlights that, at the elementary level, various mechanical quantities are inherently discontinuous. At the time of Planck, the following constants of nature were known*, the universal gravitational constant G, introduced by Newton, the Coulomb constant K, the speed of light in vacuum c (measured and deducible from Maxwell's equations), and the quantum of action h. It was Planck himself [16], inspired by George Stoney's earlier work [17], who realized that these could be combined to derive natural units of mass, length, and time. *There was also the electric charge q_e, but this was not used by Planck in formulating his system of natural units. The three quantities immediately proved suitable for constituting a system of absolute units. The physical significance of Planck units began to become clear (?) only with the developments of relativity theory in relation to quantum mechanics. If we have managed to reconcile special relativity with quantum mechanics, it is also thanks to the conceptual framework provided by the natural units introduced by Planck. Conversely, in attempting to combine quantum mechanics with general relativity, we immediately encounter limitations imposed by the uncertainty principle, which leads to defining lower limits for observations. From the 1980s onward, many theoretical physicists focused on formulating a theory that could reconcile quantum mechanics and general relativity. General relativity describes the gravitational field in geometric terms, using the notion of spacetime curvature and, as such, it is not a quantized theory. The quantization of the gravitational field implies identifying the particle associated with the field, the graviton [18]. This process is not as straightforward as it might seem. Many difficulties in constructing a quantum theory based on general relativity arise from disparities in the reality view of each theory. Quantum field theory describes particles in terms of fields propagating in the flat spacetime of special relativity, that is Minkowski spacetime. For general relativity, however, the graviton represents the elementary fluctuation (quantum) of spacetime itself, and not of another field. Moreover, since the conditions under which quantum effects on gravity become evident are beyond the reach of experiments, there is no data that can shed light on how spacetime behaves at the Planck scale. A first step toward reconciliation between general relativity and quantum mechanics was achieved by Jacob Bekenstein [19] and Stephen Hawking [20], who intuitively grasped that black holes could be described thermodynamically. However, it is now established that the two theories must somehow coexist at the Planck scale, where they must give rise to quantum gravity. According to some, the definition of absolute units of length and time highlights that spacetime exhibits a certain discontinuity in its elementary structure. This hypothesis has given rise to various versions of quantum gravity, including that proposed by string theory [21]. In this theory, particles are nothing more than different vibrational modes of these strings. It also predicts the existence of the graviton, the quantum of the gravitational field, with zero mass and Spin 2, which represents the analogue of what the photon is for the electromagnetic field. Just as photons are the "building blocks" of electromagnetic waves, gravitons would represent the constituents of gravitational waves (predicted by general relativity as perturbations of spacetime propagating at the speed of light). In this text is presented a unified theory that integrates quantum mechanics and general relativity. We will see how the smallest fluctuation of spacetime, the "quantum of curvature", is identified with the elementary electric charge, with its sign corresponding to that of the perturbation of the spacetime. Moreover, the graviton and photon turn out to be the same particle, the graviphoton, which consists of two elementary electric charges of opposite sign separated by a distance equal to the Stoney/Planck length. The graviphoton acts as a mediator for both the electromagnetic and gravitational field. In this way, these two fields are merged into a single entity, the electrogravitational field. Furthermore, since all matter can be converted into graviphotons, in the universe there exists nothing but elementary electric charges (quantum singularities), which, combined in various ways, form all the particles and thus the entire reality.[*]



This representation also applies to antiparticles. In this way, neutral particles are their own antiparticles, making neutrinos Majorana particles. Particles with an even integer charge number are neutral, whereas those with an odd or fractional charge number are charged.

Illustration from Paragraph 8.17

1. Conversion factors

1.1 THE ORIGIN OF THE UNIVERSE

There are numerous stories that attempt to narrate the origin of the universe in a mythological sense [22]. In some of these, its birth is attributed to the creative intervention of a supreme God who created everything from nothing, while in others, it is believed that something has always existed. Mythological-like images of the universe's origin have been described by astrophysicists since the 1930s. During those years, the idea of a preexisting singularity emerged, from which the entire universe would have developed following the Big Bang, becoming manifest when it began to emit light. This idea stems from the attempt to integrate into the cosmological theories of the time the observations regarding the recession velocities of galaxies [23].

1.2 THE OBSERVABLE UNIVERSE

In cosmology, the term "observable universe" refers to that portion of the universe that can be examined by a specific observer. Every point in space has its own observable region. If the universe (light sphere) had expanded linearly (at a constant speed c), its radius would equal the distance traveled by light during its entire existence. In other words, the horizon of the observable universe would be approximately [24] 13.6-13.8 Gly from the point of observation. However, due to accelerated expansion, the actual size of this horizon is larger. Some [25] estimates suggest that space could have expanded to about 46.5 Gly. Since the expansion is still ongoing, this means that the limit of the observable universe continues to shift. Beyond this boundary, every object is receding from the observer at speeds greater than that of light (a situation similar, but opposite, to that of a black hole [26]). This limit represents the maximum distance with which causal contact is possible.

1.3 CONVERSION FACTORS

We ask whether the effect of the accelerated expansion of the universe acts only on the position and recession velocity of cosmic objects [23] (and thus on the value of the radius of the observable universe), or also on other types of observations (conducted on a cosmic scale). To assess the influence of the accelerated expansion of the universe (interpreted as the expansion of spacetime) on measurements, we can compare what we observe at the limits of our observable universe (at distances $R_{uI} \approx 46.5\ Gly$), with what we would have expected to observe if the expansion had occurred and were still occurring linearly (at a constant speed equal to the speed of light c). By taking the ratio of these two measurements, we obtain dimensionless coefficients, the conversion factors. We denote by uI the values actually observed (which include a component due to the accelerated expansion of spacetime), and by uT the (theoretical) values that would have been expected to be measured at the boundaries of our observable universe. In this way, we obtain two sets of measurements, whose only common element is time, 13.6 Gy (we will use the value obtained from WMAP data [27]). Some of the conversion factors are calculated below. Their numerical value is accompanied by the corresponding value in units $\alpha \approx 1/137$. Subsequently, the equivalence of the parameter α with the fine-structure constant will be demonstrated. Other conversion factors can be deduced through the combination of those listed. It is also possible to obtain dimensionless parameters that are spatially invariant but depend on the spacetime expansion (1.21).

1) Conversion Factor for Time. The conversion factor for time is defined as the ratio between the measured and theoretical age of the universe; by definition, it equals 1.

$$f[t] = \frac{T_{uI}}{T_{uT}} = \frac{13.6\ \mathrm{Gy}}{13.6\ \mathrm{Gy}} = 1 \tag{1.1}$$

2) Conversion Factor for Lengths. The conversion factor for lengths is determined by taking the ratio between the measured and theoretical radius of the universe.

$$f[l] = \frac{R_{uI}}{R_{uT}} = \frac{46.5\ \mathrm{Gly}}{13.6\ \mathrm{Gly}} = \frac{1}{\sqrt[4]{\alpha}} \approx 3.42 \tag{1.2}$$

3) Conversion Factor for Velocities. The conversion factor for velocities is defined as the ratio between the expansion velocities of the two universe models.

$$f[\boldsymbol{v}] = \frac{\boldsymbol{v}_{uI}}{\boldsymbol{v}_{uT}} = \frac{f[l]}{f[t]} = \frac{1}{\sqrt[4]{\alpha}} \approx 3.42 \tag{1.3}$$

4) Conversion Factor for Accelerations. The conversion factor for accelerations has the same value as that for lengths, since the conversion factor for time is $f[t] = 1$.

$$f[\boldsymbol{a}] = \frac{\boldsymbol{a}_{uI}}{\boldsymbol{a}_{uT}} = \frac{f[l]}{f^2[t]} = \frac{1}{\sqrt[4]{\alpha}} \approx 3.42 \tag{1.4}$$

5) Conversion Factor for Curvature. This conversion factor is determined by the ratio between the squares of the theoretical and measured radii of the universe.

$$f[S] = \frac{S_{uI}}{S_{uT}} = \frac{R_{uT}^2}{R_{uI}^2} = \frac{1}{f^2[l]} = \sqrt{\alpha} \approx \frac{1}{11.7} \tag{1.5}$$

6) Conversion Factor for Gravitational Attraction Force. The conversion factor for gravitational attraction force is equal to the inverse square of the conversion factor for lengths. This is because, according to general relativity, Gmm is an invariant [28].

$$f[\boldsymbol{F}_g] = \frac{\boldsymbol{F}_{g\,uI}}{\boldsymbol{F}_{g\,uT}} = \frac{1}{f^2[l]} = \sqrt{\alpha} \approx \frac{1}{11.7} \tag{1.6}$$

7) Conversion Factor for Energy. The conversion factor for energy can be derived from the conversion factors for force and length.

$$f[E] = \frac{E_{uI}}{E_{uT}} = f[\boldsymbol{F}_g] \cdot f[l] = \sqrt[4]{\alpha} \approx \frac{1}{3.42} \tag{1.7}$$

8) Conversion Factor for Mass. The conversion factor for mass can be calculated from the conversion factors for energy and velocity.

$$f[m] = \frac{m_{uI}}{m_{uT}} = \frac{f[E]}{f^2[\boldsymbol{v}]} = \sqrt[4]{\alpha^3} \approx \frac{1}{40} \tag{1.8}$$

9) Conversion Factors for the Gravitational Constant 'G', Permittivity, and Gravitational Permeability. The conversion factor for the gravitational constant 'G' is obtained by combining the conversion factors for force, length, and mass. The conversion factor for gravitational permittivity is simply its inverse.

$$f[G] = \frac{G_{uI}}{G_{uT}} = \frac{f[\boldsymbol{F}_g] \cdot f^2[l]}{f^2[m]} = \frac{1}{\alpha\sqrt{\alpha}} \approx 1600 \tag{1.9}$$

$$f[\varepsilon_g] = \frac{\varepsilon_{g\,uI}}{\varepsilon_{g\,uT}} = \frac{1}{f[G]} = \alpha\sqrt{\alpha} \approx \frac{1}{1600} \tag{1.10}$$

The conversion factor for gravitational permeability is deduced by combining the conversion factors for velocities and for gravitational permittivity ε_g.

$$f[\mu_g] = \frac{\mu_{g\,uI}}{\mu_{g\,uT}} = \frac{f[\varepsilon_g]}{f^2[\boldsymbol{v}]} = \frac{1}{\alpha} \approx 137 \tag{1.11}$$

10) Conversion Factor for Coulomb Force. The conversion factor for Coulomb force must be identical to that for gravitational attraction force. This principle applies, in general, to every quantity that has the same units.

$$f[\boldsymbol{F}_e] = \frac{\boldsymbol{F}_{e\,uI}}{\boldsymbol{F}_{e\,uT}} = \frac{1}{f^2[l]} = \sqrt{\alpha} \approx \frac{1}{11.7} \tag{1.12}$$

11) Conversion Factor for Electric Charge. The conversion factor for electric charge can be determined by considering that the conversion factor for the electric field $\boldsymbol{E}$ must necessarily be unity. This is because electric fields, unlike gravitational fields whose variations have led to postulating the existence of dark energy and dark matter, do not show anomalies (?). This is evidenced by measurements of the CMB, which is homogeneous and isotropic on a large scale [29].

$$f[q] = \frac{f[\boldsymbol{F}_e]}{f[\boldsymbol{E}]} = f[\boldsymbol{F}_e] = \frac{q_{uI}}{q_{uT}} = \sqrt{\alpha} \approx \frac{1}{11.7} \tag{1.13}$$

12) Conversion Factors for Coulomb's "Constant", Electric Permittivity, and Magnetic Permeability. The conversion factor for Coulomb's "constant" K is derived from the conversion factors for force, length, and electric charge. The conversion factor for electric permittivity is its inverse.

$$f[K] = \frac{K_{uI}}{K_{uT}} = \frac{f[\boldsymbol{F}_e] \cdot f^2[l]}{f^2[q]} = \frac{1}{\alpha} \approx 137 \tag{1.14}$$

$$f[\varepsilon_e] = \frac{\varepsilon_{e\,uI}}{\varepsilon_{e\,uT}} = \frac{1}{f[K]} = \alpha \approx \frac{1}{137} \tag{1.15}$$

The conversion factor for magnetic permeability is deduced by combining the conversion factors for velocity and electric permittivity ε_e.

$$f[\mu_e] = \frac{\mu_{e\,uI}}{\mu_{e\,uT}} = \frac{f[\varepsilon_e]}{f^2[\boldsymbol{v}]} = \frac{1}{\sqrt{\alpha}} \approx 11.7 \tag{1.16}$$

1.4 Unitary conversion factors

It is important to note that since Hubble's law [23] is a linear relationship, it is possible to divide the conversion factors for the radius of the observable universe $R_{uI} \approx 46.5\,Gly$, in order to obtain unitary conversion factors (expressed in m^{-1}). These indicate how much measurements must be corrected for every meter between the observer (0) and the event location (d). This effect is so small that a photon emitted with $\lambda = 1m$ and detected $1m$ away from the emission point undergoes a wavelength increase of only $7.8 \cdot 10^{-27}m$. A photon emitted with a wavelength of $1m$ at the edge of our observable universe is detected here on Earth with a wavelength of 3.42 meters. These effects are so small that they are detectable only on a cosmic scale or in systems characterized by significant spacetime curvature, such as near black holes.

However, we will see later how it is precisely the combination of these effects that determines all those phenomena that are falsely attributed to dark matter and energy and that influence the value of the quantum of action. They are listed in the appendix.

1.5 Equivalence between α and the fine-structure costant

The fine-structure constant, denoted by the Greek letter α', represents the coupling constant of electromagnetic interaction. It is a dimensionless quantity with a value of approximately $1/137$. It was introduced by Arnold Sommerfeld [30] as a measure of the relativistic deviation of spectral lines of the Bohr atom. To demonstrate that the parameter α, introduced earlier, is equivalent to the fine-structure constant α', let's consider a generic electromagnetic field. This field is associated with a total energy density equal to $|\boldsymbol{S}|/c$. Our aim is to understand how its presence relativistically modifies spacetime. To do this, we use Einstein's field equation. When propagating through vacuum, the electromagnetic field does not perceive effects related to the accelerated expansion of spacetime, as light maintains its constant speed while crossing expanding space. Therefore, the quantities used to describe the field are of type uT (concepts introduced in Paragraph 1.8 are used).

$$G_{\mu\nu(uT)} = \frac{8\pi G_{uT}}{c_{uT}^4} T_{\mu\nu(uT)} \tag{1.17}$$

Let's now suppose that the field is absorbed (in the form of photons) by matter. Even though the field no longer exists as such, it still contributes to the energy of the system of which it is now a part, and therefore to the curvature of that region of spacetime. Consequently, the units must be converted from uT to uI, since matter perceives the passage of time and the accelerated expansion of the universe. Now, using the conversion factors (appendix), let's calculate the ratio between the energies.

$$\frac{\int \rho_{E_{uI}}\, dV}{\int \rho_{E_{uT}}\, dV} = f[E] \cdot f^{-3}[l] = \alpha \tag{1.18}$$

This ratio turns out to be equal to α. Here, V represents the integration volume measured in an external reference frame, so its value is the same before and after the interaction (it does not depend on conversion factors). When it is stated that the fine-structure constant represents the interaction constant between light and matter, there is an implicit reference to the ratio between the electrostatic energy accumulated by a system of two charges and the quantum energy possessed by the incident photon [31]. Put simply, the system accumulates (apparently) less energy than that possessed by a photon in vacuum. This means that the contribution of the field to the relativistic curvature of that particular region of spacetime is also less. If ρ_{E_0} and ρ_E are the energy densities of the field before and after the interaction, we can write [32]:

$$\frac{\int \rho_E \, dV}{\int \rho_{E_0} \, dV} = \alpha' \tag{1.19}$$

Therefore, the variation predicted by the conversion factors is effectively the same as that observed in the interaction between light and matter. Thus we can write:

$$\alpha = \alpha' \tag{1.20}$$

Since this reasoning holds generally, it must also apply to an electromagnetic field such that its curvature radius (assuming spherical symmetry) is, before and after the interaction, equal to the theoretical radius R_{uT} and the measured radius R_{uI} of the universe. From this, it follows that the fine-structure constant can be expressed as:

$$\alpha = \left(\frac{R_{uT}}{R_{uI}}\right)^4 \approx \left(\frac{13.6 \text{ Gly}}{46.5 \text{ Gly}}\right)^4 \approx \frac{1}{137} \tag{1.21}$$

1.6 Is the universe really expanding?

As we have seen, the accelerated expansion of the universe is a fundamental concept in cosmology. It is based on the observation that galaxies are moving away from each other in a manner proportional to their distance. However, in the absence of an absolute reference frame in the universe, Hubble's law alone does not allow us to distinguish whether the universe itself is expanding or the matter within it is contracting [33]). In other words, while we see galaxies moving away from each other, we cannot say with certainty whether each galaxy is moving away or if the matter that composes them is falling towards the "infinitely" small (spacetime and matter are the same thing: matter is merely a fluctuation/ripple in the fabric of spacetime). To consider the universe as expanding, we must postulate the existence of an invisible source of energy [34] (dark energy). On the other hand, considering the matter falling [35] towards the "infinitely" small, allows us to extend the concept of gravitational fall and, secondly, as we will see, provides a theoretical basis for deriving the exact value of the quantum of action from first principles. From this perspective, the redshift observed by Hubble reflects not the expansion of the universe, but the contraction of matter and, consequently, of the "ruler" with which measurements are made. Every point in spacetime contracts by the same amount, and it is the presence of mass (energy) that locally accelerates this contraction. The contraction of the "ruler" can only be accelerated, but not slowed down (negative masses and energies don't exist, except as energy and mass associated with electric potential energy). This effect has a substantial impact on all those regions where there are high concentrations of mass and energy, such as in galaxies (where the differential contraction of spacetime between the periphery and the center leads to the postulation of additional matter, dark matter) and near quantum singularities.

1.7 The observability limits of the universe

The idea that matter contracts, rather than the universe expanding, leads to the conclusion that it is not photons traveling away from their point of emission, but the emitter itself moving away, due to its contraction, at the speed of light. In this scenario, a photon represents a stationary excitation of spacetime; in fact, for a photon, time does not pass. The contraction of spacetime also implies the existence of regions that contract at speeds greater than c (relative to an external observer). These regions are the quantum singularities, which correspond to the elementary electric charges; they are separated from the observable universe by the quantum limit, beyond which even light cannot penetrate. The cosmic horizon and the quantum horizon constitute, respectively, the upper and lower limits of observability of our universe. Beyond these, there are two other limits: the limit represented by the "event horizons" of black holes and the limit of the light spheres of past events. In the latter case, the primordial light sphere coincides with the cosmic horizon. Due to the speed of light, these limits are physically identical. Their union forms the "limit (or horizon) of observability" of the universe. Every observer has their own horizon of observability, which also depends on their state of motion and that of other bodies.

1.8 Extension of conversion factors

In the case of a contracting universe (matter), the conversion factors can be reinterpreted as coefficients that allow us to convert observational results to account for the effects related to the contraction of spacetime. We have seen that there are four insurmountable horizons in the universe, imposed by the speed of light. Therefore, we can extend the concept of conversion factors to each of these singularities (this concept was already used in Paragraph 1.5, where it was introduced for the calculation of the fine-structure constant α). These coefficients, as defined, allow us to translate a measurement taken by an observer located at the center of a singularity of an event placed on the outer horizon of the same (where the component due to the contraction of spacetime on the measurement is maximal), into a local measurement (in which this component is negligible or absent). The unit conversion factors allow us to correct these effects for observations made at intermediate distances (between the observable horizon of the singularity and its center). For an observer at the center of a singularity (thus at the center of the celestial sphere, a black hole, a quantum singularity, or a light sphere*), the conversion factors (or the unitary ones*), for observations towards the respective horizons should be applied as previously defined: as the observation distance increases, the observer will see the recession velocity of bodies grow linearly, as happens with galaxies. Conversely, for an observer located on the horizon or completely outside the cone of influence of a singularity, the conversion factors should be applied in reverse (looking towards the center of the singularity, the observer will see the velocity of bodies decrease, as happens with the rotation curves of galaxies). These coefficients are in the appendix.

1.9 DERIVATION OF THE FINE-STRUCTURE CONSTANT

Here, we attempt to provide a more rigorous demonstration of what was stated in Section 1.6. In quantum electrodynamics (QED), the fine-structure constant α arises from the square of the electron–photon coupling coefficient at the vertices of Feynman diagrams. In QED, spacetime is flat and static; however, in the physical reality, field propagation occurs in a dynamic spacetime described by the Friedmann–Lemaître–Robertson–Walker (FLRW) metric. While comoving, matter has its own proper time and therefore directly experiences the accelerated expansion of the universe through the scale factor $a(t)$. On the other hand light sees a static spacetime (photons travel along null trajectories), since Maxwell's dynamics is conformally invariant. From this observation arises the key idea that light and matter perceive two metrically distinct universes. This suggests a bimetric approach. By introducing two distinct conformal metrics, one for light and one for matter, we obtain two scale factors, $a_\gamma(\eta)$ and $a_\psi(\eta)$, which reflect the different perceptions of spacetime by the two systems. The ratio between these two scale factors, a_γ/a_ψ, thus becomes a fundamental parameter that enters into the normalization of the fields and therefore into the light–matter coupling, determining the value of the fine-structure constant. To formally describe this, we assume two conformal metrics:

$$g_{\mu\nu}^{(\gamma)} = a_\gamma^2(\eta)\,\eta_{\mu\nu} \qquad g_{\mu\nu}^{(\psi)} = a_\psi^2(\eta)\,\eta_{\mu\nu} \tag{1.22}$$

Here, $g_{\mu\nu}^{(\psi)}$ corresponds to the standard FLRW metric as seen by matter, while $g_{\mu\nu}^{(\gamma)}$ describes an effective metric for light, in which spacetime appears static. The scale factor $a_\psi(\eta) = a(t)$ is the standard one for matter, while $a_\gamma(\eta)$ corresponds to that for light. In conclusion, light and matter "experience" different metrics. Naturally, the transition from one metric to the other can be made through conversion factors, which are analogous to Lorentz transformations. Now defining the tetrads:

$$e_\mu^{(\gamma)a} = a_\gamma \delta_\mu^a \qquad e_\mu^{(\psi)a} = a_\psi \delta_\mu^a \tag{1.23}$$

The reference actions are, for the Photon (Maxwell on $g^{(\gamma)}$):

$$S_{\text{EM}} = -\frac{1}{4}\int d^4x\sqrt{-g^{(\gamma)}}\,g^{(\gamma)\mu\alpha}g^{(\gamma)\nu\beta}F_{\mu\nu}F_{\alpha\beta} \tag{1.24}$$

For the Fermion (Dirac on $g^{(\psi)}$):

$$S_{Dirac} = \int d^4x\sqrt{-g^{(\psi)}}\,\left(i\bar{\Psi}\gamma_{(\psi)}^{\mu}\nabla_\mu^{(\psi)}\Psi - m\bar{\Psi}\Psi\right) \tag{1.25}$$

where:

$$\gamma^{\mu}_{(\psi)} = a_{\psi}^{-1}\gamma^{a}\delta^{\mu}_{a} \tag{1.26}$$

For the interaction action:

$$S_{\text{int}} = e_0 \int d^4 x \sqrt{-g^{(\psi)}}\, \bar{\Psi}\gamma^{\mu}_{(\psi)} A^{(\psi)}_{\mu} \Psi \tag{1.27}$$

The canonical rescaling of the fermionic field:

$$\Psi = a_{\psi}^{-3/2}\chi \tag{1.28}$$

leads to the cancellation of the a_{ψ} factors. The crucial part concerns the relation between the vector potential in the two frames. The EM energy density scales as $\rho_{\text{EM}} \sim a_{\gamma}^{-4}$, so the amplitude of the potential as $A^{(\gamma)} \sim a_{\gamma}^{-2}$. In the matter frame:

$$A^{(\psi)} \sim \left(\frac{a_{\gamma}}{a_{\psi}}\right)^{2} A^{(\gamma)} \tag{1.29}$$

This follows from the fact that the photon energy scales as $1/a_{\gamma}$ (redshift) and the volume as a_{γ}^{3}, so that $\rho_{EM} \sim |A|^2$, from which the dependence $A \sim a_{\gamma}^{-2}$ in a 3+1 dimensional spacetime immediately follows. Substituting the rescalings into S_{int}:

$$S_{\text{int}} \sim e_0 \left(\frac{a_{\gamma}}{a_{\psi}}\right)^{2} \int d^4 x\, \bar{\chi}\, \gamma^{a} \chi\, A^{(\gamma)}_{a} \tag{1.30}$$

It follows that the effective coupling costant is given by the ratio of the two scale factors. Since the fine-structure constant is proportional to the square of the coupling:

$$e_{\text{eff}} \sim e_0 \left(\frac{a_{\gamma}}{a_{\psi}}\right)^{2} \quad \rightarrow \quad \alpha \sim e_{\text{eff}}^{2} \sim e_0^{2} \left(\frac{a_{\gamma}}{a_{\psi}}\right)^{4} \tag{1.31}$$

By identifying the scale factors with theoretical $R_{uT} = a_{\gamma} = cT \approx 13.6\text{–}13.8$ Gly and observed radius $R_{uI} = a_{\psi} \approx 46.5$ Gly of the observable universe, we obtain:

$$\alpha = \left(\frac{R_{uT}}{R_{uI}}\right)^{4} \approx \left(\frac{13.6\ \text{Gly}}{46.5\ \text{Gly}}\right)^{4} \approx \frac{1}{137} \tag{1.21}$$

2. Dark energy and dark matter

2.1 THE RECESSION VELOCITY OF GALAXIES

To explain the observed recession velocity of galaxies, which increases linearly with increasing observational distance, the existence of dark energy is postulated [34]. However, it is the effects due to the contraction of spacetime (and matter), occurring between the point where the event is located (the galaxy whose velocity is being measured and the source of the observed light, most likely near the cosmic horizon) and the point of observation, that create the illusion that the galaxies are moving away (at speeds up to approximately $v \approx 3.42\ c$). In fact, it is the observer (matter), positioned at the center of his celestial sphere (universe), who is accelerating (relative to the cosmic horizon) his own fall [35] towards the "infinitely" small (see Fig.1).

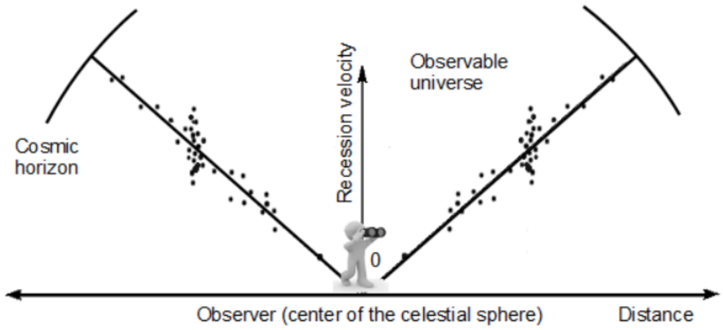


Fig.1

Let's imagine we have two spheres of equal mass, separated by a certain distance, here on Earth. Now, suppose we instantaneously move one of the two spheres near the cosmic horizon. Then we observe (from Earth) the force with which these spheres attract each other in the new configuration. After correcting the measurements for all other effects, we will still observe a discrepancy between the measured and expected values. The attractive force between the two spheres will be less intense by a factor of $1/\sqrt{\alpha} \approx 11.7$. There will be no variations observed in the physics of the system, as the Coulomb attraction force also varies in the same manner. Specifically, we will see the distance separating the two spheres expanded by a factor of $1/\sqrt[4]{\alpha} \approx 3.42$ (indeed, we will measure a value of $46.5\ Gly$ for the radius of the universe instead of $13.6\ Gly$). The mass of the sphere placed on the horizon will appear smaller by a factor of $1/\sqrt[4]{\alpha^3} \approx 40$, while the constant "$G$" will appear increased by a factor of $\alpha\sqrt{\alpha} \approx 1600$. Furthermore, since looking towards the cosmic horizon is *equivalent to looking into the past [36], this means that in ancient times the various units and physical constants had, from the perspective of a present-day observer, different values. Obviously, since the impact of spacetime contraction on the measurements increases *linearly with the distance of the observation, its effects will also increase linearly. In this way, a linear increase in the recession velocity of galaxies is observed.

2.2 DARK ENERGY DOES NOT EXIST

Physical laws tell us that an increase in the recession velocity of an object implies that the object must also have greater kinetic energy, $E = 1/2\, mv^2$. The kinetic energy of galaxies is estimated [37] based on their recession velocity (obtained through redshift measurements) and their mass (evaluated based on their rotational velocity or luminosity). The constant increase in the recession velocity of galaxies does not seem to have a detectable causal source, and is therefore attributed to an invisible (dark) energy that permeates the entire universe. Observations tell us that the universe is composed of 68% dark energy and only about 1% ordinary energy. However, we know that for events far from the observer's location, just as velocities appear dilated, masses and energies will appear reduced. The measured energy (from Earth) of galaxies positioned on the cosmic horizon is reduced by a factor of $1/\sqrt[4]{\alpha} \approx 3.42$ for each of the four components of the velocity vector (since galaxies are not only receding longitudinally from the observer but also, on a large scale, from each other and over time). Therefore, the conversion factor for energy (its inverse) must be raised to the fourth power and divided by 2 (since the average value for a linearly growing function is its maximum value divided by 2), as the measurements extend from the center of the celestial sphere to the edges of the observable universe.

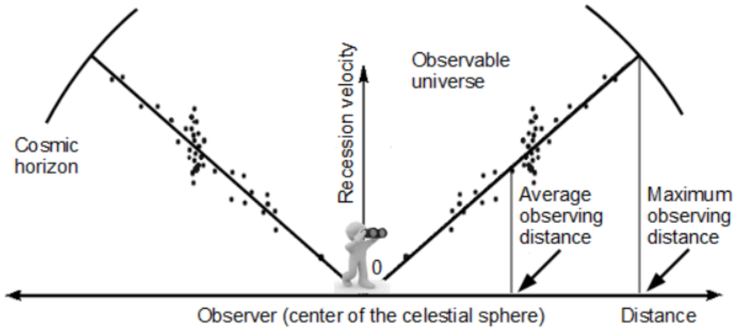


Fig.2

$$\bar{f}^{-1}[E(m,\boldsymbol{v})] = \frac{1}{2} \cdot \left(\frac{1}{\sqrt[4]{\alpha}}\right)^4 = \frac{1}{2\alpha} \approx \frac{137}{2} \approx 68.5 \tag{2.1}$$

Knowing the abundance of dark energy in the universe (68%), if we divide this value by the coefficient we just derived (68.5), we see that it is nothing more than ordinary "non-massive" energy (1%), whose value is erroneously detected due to the spacetime distance interposed between the observer and the observed events. In this way:

$$\mathit{Ordinary\ energy\ in\ the\ universe} \approx 68\% \cdot 2\alpha \approx 68\% \cdot \frac{2}{137} \approx 1\% \tag{2.2}$$

2.3 THE ROTATION CURVES OF GALAXIES

In the case of galaxy rotation curves, to explain the discrepancy (which increases moving from the center towards the outer regions) between the observed and the expected velocities (of celestial bodies) based on visible matter (stars and gas), the existence of dark matter is postulated [39]. However, it's not the periphery that contains additional matter (dark matter), but rather the center that appears more massive, approximately 40 times more for an observer located in the galactic periphery or completely outside the influence cone of the black hole (singularity). To illustrate this concept, we can again use the two-sphere thought experiment.

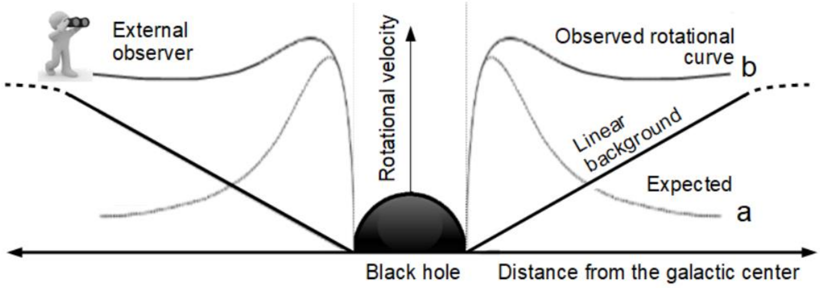


Fig.3

On Earth (galactic periphery), the two spheres interact reciprocally with a force determined by the universal law of gravitation. Now, imagine moving one sphere near the event horizon of the black hole (located at the center of our Milky Way) and observing, from Earth, the force with which these spheres attract each other. Once again, after correcting the measurements for all other effects, we will observe a stronger force by a factor of $1/\sqrt{\alpha} \approx 11.7$. In detail, the measured distance between the two spheres will appear shorter by a factor of $1/\sqrt[4]{\alpha} \approx 3.42$. The mass of the sphere placed on the event horizon will appear greater by a factor of $1/\sqrt[4]{\alpha^3} \approx 40$, while the gravitational attraction constant "G" will appear smaller by a factor of $1/\alpha\sqrt{\alpha} \approx 1600$. Therefore, between our observation point (flat spacetime) and the cosmic horizon (origin of times), the same effects exist on measurements, but in reverse, compared to those between our observation point and the center of the Milky Way (event horizon), or between any galactic periphery and its center (event horizon). These effects manifest on everything within the influence cone. Celestial bodies present in galaxies, such as stars, planets, and other cosmic objects, will experience the effects of differential spacetime contraction due to the black hole, relative to the distance that separates them from it. As a consequence, all parameters associated with them measured by an external observer will appear distorted. For an observer in the galactic periphery, the velocity of celestial objects near the event horizon will appear approximately $1/\sqrt[4]{\alpha} \approx 3.42$ times lower (per component) compared to the value measured by an observer located on the horizon itself. This creates the illusion that objects in the periphery have additional velocity (attributed to the presence of invisible matter, the dark matter). This occurs because the rotation curve of galaxies is estimated [40] based on the "apparent" gravitational force exerted by the center, which is overestimated for an external observer (for example, on Earth) by a factor of $1/\sqrt{\alpha} \approx 11.7$. Naturally, since the influence of the singularity decreases as we move towards the periphery, its effects on observations will also diminish. Therefore, if a galaxy's mass is primarily due to the black hole, a linear background will be observed in the rotation curve, which can be removed using conversion factors. In this case (and only in this case), at the galaxy's edges, at the limits of the black hole's influence cone, where spacetime can be considered flat, there will be a ratio between the measured velocity (by an external or periphery observer) and the expected velocity, approximately equal to $b/a \approx 3.42$ (per component). In cases where the mass of other bodies present in the galaxy is not negligible, the observed peripheral velocity will be higher (with a ratio $b/a > 3.42$), making the measurement correction more challenging (since the background will contain as many small contributions as there are bodies in the galaxy, whose parameters appear distorted due to the central singularity). Indeed, in larger galaxies, a significant discrepancy is observed between expected and measured peripheral velocities [41].

2.4 Dark matter does not exist

To refute the existence of dark matter, it is essential to consider the conversion factor for force. Using only the conversion factor for mass is inadequate because mass is estimated through gravitational force measurements. This coefficient must then be divided by 2 (average value for a linear function). Calculating the average value is crucial because the influence of spacetime contraction on measurements decreases

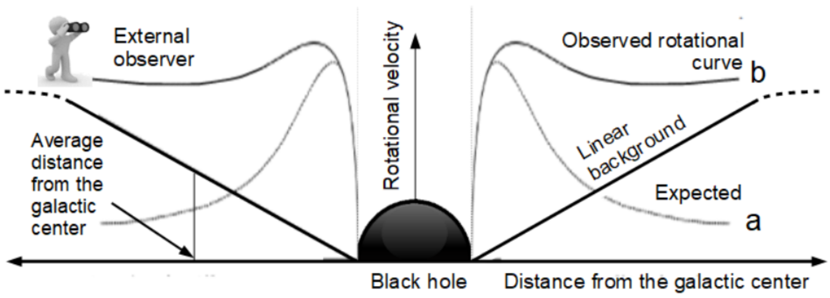


Fig.4

moving from the event horizon out to the periphery. The average value is the same, whether we consider a single galaxy or the universe, so the calculation is the same.

$$\bar{f}^{-1}\left[m(\boldsymbol{F}_g)\right] = \frac{1}{2\sqrt{\alpha}} \approx \frac{11,7}{2} \approx 5.85 \tag{2.3}$$

We are told that dark matter contributes to 27% of the observed gravitational effects in the entire universe and constitutes approximately 85% of the mass of a galaxy [42].

Dividing these values by the found conversion factor (5.85), we obtain exactly the percentage of ordinary matter that makes up, respectively, the universe and galaxies.

$$Ordinary\ matter\ in\ the\ universe = 27\% \cdot 2\sqrt{\alpha} \approx 27\% \cdot \frac{2}{11.7} \approx 4.6\% \quad (2.4)$$

$$Ordinary\ matter\ in\ a\ galaxy = 85\% \cdot 2\sqrt{\alpha} \approx 85\% \cdot \frac{2}{11.7} \approx 15.5\% \quad (2.5)$$

This implies that, both for the universe as a whole and within the context of a single galaxy, 85% of the mass (on average) does not exist, and the gravitational effects attributed to it are actually caused solely by ordinary matter. The influence of ordinary matter diminishes with distance less than expected, due to the effects related to spacetime (matter) contraction that takes place between the event and the observer.

2.5 Matter and energy of the universe

By summing the percentage values of ordinary mass (4.6%) and energy (1%) of the entire universe derived from measurements of dark energy and dark matter, we obtain a total of 5.6%, which approximates the 5% of the Λ-CDM model [43]. The remaining 95% does not exist as matter, but only as effects due to the distance of observation.

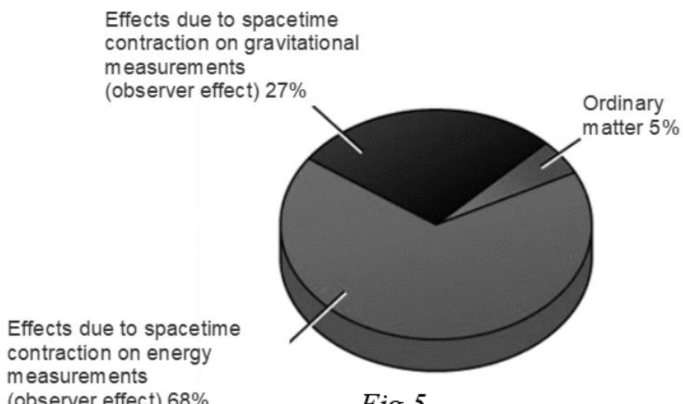


Fig.5

Normalizing these values relative to 100%, we obtain a new estimate, derived from measurements of dark matter and dark energy, of the quantities of ordinary matter and ordinary energy (which includes all forms of ordinary 'non-material' energy, kinetic, gravitational potential, thermal, radiant, chemical) present in the universe.

$$Ordinary\ matter\ in\ the\ universe = \left(\frac{100\%}{1.0\% + 4.6\%}\right) \cdot 4.6\% \approx 82.0\% \quad (2.6)$$

$$Ordinary\ energy\ in\ the\ universe = \left(\frac{100\%}{1.0\% + 4.6\%}\right) \cdot 1.0\% \approx 18.0\% \quad (2.7)$$

3. Newtonian Electrogravitational Theory

3.1 CHARGE-ENERGY-MASS EQUIVALENCE

In 1874, George Johnstone Stoney proposed units of measurement based solely on the charge of the electron and the physical constants G, K, c [17]. Unlike Planck units, these units are based solely on classical physics concepts. Stoney's idea stemmed from the observation that electric charge always appears as a multiple of a minimum quantity, meaning it is quantized. He hypothesized the existence of an irreducible quantity for each physical entity. Stoney defined his unit of length l_S by combining the constants G, K, c and the charge of the electron (elementary electric charge) q_e.

$$l_S = \sqrt{\frac{GK}{c^4} q_e^2} \approx 1.38 \cdot 10^{-36}\, m \tag{3.1}$$

Now, given two elementary electric charges of opposite sign (arranged in a dipole configuration) separated by a distance equal to the Stoney lenght l_S, the binding energy of such a system is called the Stoney energy $E_S = -U_S$, which is the amount of energy required to separate the two charges that constitute the elementary dipole.

$$E_S = -U_S = -\,K \frac{q_e^+ q_e^-}{l_S} \approx 1.7 \cdot 10^8 \text{ J} \tag{3.2}$$

From the theory of special relativity [5], we know that there is a close relationship between mass and energy (expressed by the mass-energy equivalence). Therefore, we can associate a corresponding mass to the Stoney energy, the Stoney mass m_S.

$$m_S = -\frac{K}{c^2} \frac{q_e^+ q_e^-}{l_S} \approx 1.86 \cdot 10^{-9}\, kg \tag{3.3}$$

Stoney's mass represents the maximum value for the mass of an elementary dipole: all other masses can be expressed in relation to m_S. This equation connects mass and energy to the charge. Therefore, a generic mass m_z can be expressed in terms of m_S.

$$m_z = -\sum_{j=1}^{n} \frac{K}{c^2} \frac{q_e^+ q_e^-}{a_k l_S} = m_S \sum_{j=1}^{n} \frac{1}{a_k} \qquad (a_k \in \mathbb{N})^* \tag{3.4}$$

In the case where $a_k = 1$, it tells us that the mass of a system consisting of elementary electric dipoles considered non-interacting (since the distance between one dipole and another is always several orders of magnitude greater than the Stoney lenght), must be an integer multiple n_i (where $n_i \in \mathbb{N}$ is the number of dipoles) of the Stoney mass. *The Stoney m_S (or Planck m_P) mass, taken with the positive sign, represents the "proper" mass of the photon. Taken instead with the negative sign, $-m_S$ (or Planck $-m_P$), it represents a negative mass component due to the potential energy U_S/c^2 (or U_P/c^2), which cancels the first, so that the photon's mass is identically zero. As we will see later, the mass of the photon (graviphoton) has two components, a positive "proper" mass equal to $2M_{qs} = m_S$ (or m_P), related to the fact that the photon is made up of two quantum singularities (two elementary electric charges $q_e^- \ / \ q_e^+$) with a radius equal to the Stoney/Planck length, and a negative one, associated with the electric potential U_S/U_P between the two charges $q_e^- \ / \ q_e^+$.

3.2 NEWTONIAN ELECTROGRAVITAZIONAL THEORY

The classical theory of gravitation is based on Newton's law [2]. It states that the gravitational force of attraction between two bodies is directly proportional to their masses and inversely proportional to the square of their distance between them:

$$\boldsymbol{F} = -\,G\frac{m_1 m_2}{r^3}\boldsymbol{r} \tag{3.5}$$

This can be reformulated [44] as a field theory, in terms of the field vector **g**:

$$\nabla \times \mathbf{g} = 0 \tag{3.6}$$

$$\nabla \cdot \mathbf{g} = -4\pi G\rho \tag{3.7}$$

In the second equation, $\rho = dm/dV'$ represents the mass density, which is given by the ratio between the mass element dm and the volume element dV' that contains it. Now, having introduced the charge-energy-mass equivalence, we can integrate it into Newton's equation, in order to obtain a partially quantized expression (numerator). In the case of systems consisting of non-interacting dipoles, Newton's law becomes:

$$\boldsymbol{F} = -\,G\left[n_1\left(-\frac{K}{c^2}\frac{q_e^+ q_e^-}{l_S}\right)\right]\left[n_2\left(-\frac{K}{c^2}\frac{q_e^+ q_e^-}{l_S}\right)\right]\frac{\boldsymbol{r}}{r^3} \quad (n_i \in \mathbb{N}) \tag{3.8}$$

The quantization is applied only to the masses, as this allows us to develop the theory so that it can later be fully integrated into general relativity. In general, the force $\boldsymbol{F}$ acting on a mass with dipole density ρ''_n located in the gravitational field **g** is given by the modified Jefimenko equation [45], which is also semi-quantized for masses:

$$\boldsymbol{F} = \int \rho\mathbf{g}\,dV = \frac{K}{c^2}\frac{q_e^2}{l_S}\int \rho''_n\left[-\frac{GK}{c^2}\frac{q_e^2}{l_S}\int\frac{\rho'_n}{r^3}\,\boldsymbol{r}\,dV'\right]dV \tag{3.9}$$

In this equation the integration is extended over the space occupied by the mass experiencing the force due to the gravitational field **g** created by the dipoles with density ρ'_n. In this way, we can define the gravitational field vector as follow:

$$\mathbf{g} = -\frac{GK}{c^2}\frac{q_e^2}{l_S}\int \frac{\rho'_n}{r^3}\,\boldsymbol{r}\,dV' \tag{3.10}$$

here r is the distance from the source point where **g** is measured or calculated. The integral is extended over all space. The mass density ρ and the dipole density ρ_n are related by the following mass density - dipole (or graviphotons) density relation.

$$\rho = -\frac{K}{c^2}\frac{q_e^+ q_e^-}{l_S}\,\rho_n = \frac{K}{c^2}\frac{q_e^2}{l_S}\rho_n \tag{3.11}$$

where $\rho_n = dn/dV'$ is given by the ratio between the dipole element dn and the volume element dV' that contains it. For practical applications of Newton's theory, and particularly in celestial mechanics, the vector **g** is rarely determined directly. Often, the gravitational potential φ is calculated, which is related to **g** through:

$$\mathbf{g} = -\nabla\varphi \tag{3.12}$$

The potential is related to the dipole density ρ_n by the equation:

$$\nabla^2\varphi = 4\pi G\rho = \frac{4\pi GK}{c^2}\frac{q_e^2}{l_S}\rho_n \tag{3.13}$$

By integrating (3.13), we obtain the equation for the electrogravitational potential:

$$\varphi = -\frac{GK}{c^2}\frac{q_e^2}{l_S}\int \frac{\rho_n}{r}\,dV' \tag{3.14}$$

which, for a "point-like" mass (n represents the number of elementary dipoles), is:

$$\varphi = -\frac{GK}{c^2}\frac{q_e^2}{l_S}\frac{n}{r} \tag{3.15}$$

The equations presented so far have intentionally not been simplified in order to show both “constants”, the gravitational constant “G” and the Coulomb’s constant “K”. The same approach has been adopted in all equations found throughout the text.

3.3 Electrogravitational force

Newton's Law of gravitation states that every particle in the universe attracts every other particle with a force proportional to the product of their masses and inversely proportional to the square of the distance between their centers of mass. It was presented in Newton's work *Philosophiæ Naturalis Principia Mathematica* (1687).

$$F_g = G\frac{m_1 m_2}{r^2} \tag{3.16}$$

Here F_g is the gravitational force acting between two bodies, m_1 and m_2 are their masses, r is the distance between their centers of mass, and G is the gravitational constant. Newton's law of gravitation closely resembles Coulomb's law of electric forces, which determines the magnitude of the force F_e between two charged bodies:

$$F_e = K\frac{q_1 q_2}{r^2} \tag{3.17}$$

Here, K is the Coulomb constant, q_1 and q_2 are the charges, and the scalar r is the distance between the charges. Now, based on what we have seen, we ask ourselves whether it is possible to merge the two forces into a single entity, a single force in which only the constant K or G appears. Let us start from equation (3.8), in which we set $n = 1$ and $r = l_S$. To the gravitational potential energy U_g is associated a mass:

$$F_g = G\frac{m_S\, m_S}{l_S^2} \quad \rightarrow \quad U_g = G\frac{m_S\, m_S}{l_S} = m_S c^2 \tag{3.18}$$

By isolating G from this relation, which remains valid even if we use Planck units: [even the ratio between the Hubble radius $R_H = R_{uT} \approx 13.6$ Gly $\approx 1.29 \cdot 10^{26}$ m and the Hubble mass $M_H \approx 1.73 \cdot 10^{53}$ kg can be used; $H_0 \approx 70\ km/(s \cdot Mpc)$].

$$G = c^2\frac{l_S}{m_S} = \frac{1}{\varepsilon_e \mu_e}\frac{l_S}{m_S} = K\left(\frac{4\pi}{\mu_e}\frac{l_S}{m_S}\right) \tag{3.19}$$

$$G = K\left(\frac{4\pi}{\mu_e}\frac{l_S}{m_S}\right) = K\left(\frac{4\pi}{\mu_e}\frac{l_P}{m_P}\right) = K\left(\frac{4\pi}{\mu_e}\frac{R_H}{M_H}\right) \tag{3.20}$$

In this way, the constants G and K can be transformed into each other. Consequently, the Newtonian gravitational attraction force F_g can be expressed in terms of K, while the Coulombian force F_e in terms of G. Obviously, as we have seen, this introduces three additional constants, the magnetic permeability and the mass and length units.

$$F_g = K\left(\frac{4\pi}{\mu_e}\frac{l_S}{m_S}\right)\frac{m_1 m_2}{r^2} = K\left(\frac{4\pi}{\mu_e}\frac{l_P}{m_P}\right)\frac{m_1 m_2}{r^2} = K\left(\frac{4\pi}{\mu_e}\frac{R_H}{M_H}\right)\frac{m_1 m_2}{r^2} \tag{3.21}$$

$$F_e = G\left(\frac{\mu_e}{4\pi}\frac{m_S}{l_S}\right)\frac{q_1q_2}{r^2} = G\left(\frac{\mu_e}{4\pi}\frac{m_P}{l_P}\right)\frac{q_1q_2}{r^2} = G\left(\frac{\mu_e}{4\pi}\frac{M_H}{R_H}\right)\frac{q_1q_2}{r^2} \tag{3.22}$$

Thus, the total force $F_T = F_g + F_e$ acting between two massive charged bodies is:

$$F_T = F_g + F_e = K\left(\frac{4\pi}{\mu_e}\frac{l_S}{m_S}\right)\frac{m_1m_2}{r^2} + K\frac{q_1q_2}{r^2} = G\frac{m_1m_2}{r^2} + G\left(\frac{\mu_e}{4\pi}\frac{m_S}{l_S}\right)\frac{q_1q_2}{r^2} \tag{3.23}$$

$$F_T = F_g + F_e = K\left(\frac{4\pi}{\mu_e}\frac{l_P}{m_P}\right)\frac{m_1m_2}{r^2} + K\frac{q_1q_2}{r^2} = G\frac{m_1m_2}{r^2} + G\left(\frac{\mu_e}{4\pi}\frac{m_P}{l_P}\right)\frac{q_1q_2}{r^2} \tag{3.24}$$

This leads to the conclusion that, in a laboratory, we can calculate - using a torsion balance like the one employed in 1785 by Charles Coulomb (or that used by Henry Cavendish) - the ratios between the units of mass and length m_S/l_S, m_P/l_P, and M_H/R_H, and thus the ratio between the mass and the radius of the (Hubble) universe.

3.4 Supplementary relations

Moreover, by substituting the various units of mass and length into (3.16), it becomes possible to define an extended equivalence, which allows us (by inverting each relation and taking its square root) to express c as a function of the various potentials.

$$F_g = G\frac{m_Sm_S}{l_S^2} = G\frac{m_Pm_P}{l_P^2} = G\frac{M_HM_H}{R_H^2} = G\frac{M_{H(I)}M_{H(I)}}{R_{H(I)}^2} = \frac{c^4}{G} \tag{3.25}$$

Here, c^4/G is the Planck force, $R_{H(I)} = R_{uI} \approx 46.5$ Gly $\approx 4.399 \cdot 10^{26}\ m$ is the radius of the observable universe, while $M_{H(I)} = 1/\sqrt[4]{\alpha}\ M_H \approx 3.42 \cdot 1.73 \cdot 10^{53}\ kg$ is a mass that has no real counterpart. Moreover, if we consider two electric charges separated by a distance equal to the radius of the universe, theoretical $R_H = R_{uT} \approx$ 13.6 Gly, and observed $R_{H(I)} = R_{uI} \approx 46.5$ Gly, we obtain two other relations:

$$G\frac{M_HM_H}{R_H^2} = G\frac{M_HM_H}{R_{uT}^2} = K\frac{q_e^2}{r^2}, \qquad G\frac{M_HM_H}{R_{H(I)}^2} = G\frac{M_HM_H}{R_{uI}^2} = K\frac{q_e^2}{(\sqrt[4]{\alpha}\,r)'^2} \tag{3.26}$$

By inverting these relations, we can derive r and r', which turn out to be exactly $r = l_S \approx 1.38 \cdot 10^{-36}\ m$ and $r' = l_P \approx 1.62 \cdot 10^{-35}\ m$. This confirms that the reasoning carried out in the case of the constant α is correct. Moreover, by substituting $R_{uT} = cT$, where $T \approx 13.6$ Gy, we can see how c depends on the age of the universe, and therefore its value must have been different in the past (and so in the future).

$$U_g = G\frac{M_HM_H}{R_{uT}} = G\frac{M_HM_H}{cT} = M_Hc^2 \quad \rightarrow \quad c = \sqrt[3]{G\frac{M_H}{T}} \tag{3.27}$$

3.5 Conversion factors: clarifications

We have defined conversion factors as coefficients that allow one to move consistently from one system for describing the universe to another ($uT \rightleftarrows uI$). In the case of the transition between cosmological models (from the light metric to the matter metric, and vice versa), time does not require any conversion factor, because the age of the universe is kept constant. By contrast, in the transition between Stoney units and Planck units, those that remain invariant are the various physical constants. This entails the introduction of a conversion factor for time as well (indeed, Stoney time t_S and Planck time t_P are related by $t_S = \sqrt{\alpha}\, t_P$). This distinction clarifies how conversion factors depend on which physical quantity is chosen to be fixed. In the following paragraphs, no distinction will be made between the two sets of conversion factors. When the physical constants are variable, time is kept fixed; conversely, when a conversion factor is applied to time, the constants are then held invariant.

3.6 The Universe as "scaled planckian object"

From the relationships reported in paragraphs 3.3 and 3.4, a deep connection emerges between the microcosm and the macrocosm: the universe is a "scaled" planckian object. The same relationships that hold at the Stoney/Planck scale for quantum singularities, also apply to the entire observable universe. In this way, we can use the same set of conversion factors for the microcosm (Stoney/Planck scale) and the macrocosm (entire observable universe): we find that the ratio between the various units ($uT \rightleftarrows uI$ and Stoney $\rightleftarrows$ Planck) remains unchanged. In particular, equation 3.20, which connects the constants G and K, holds whether we use the ratios l_S/m_S, l_P/m_P, or the ratios R_H/M_H, where $R_H = R_{uT}$ and M_H are the values of the radius and mass of the observable universe (obtained by keeping the constants invariant).

$$\frac{l_S}{m_S} = \frac{l_P}{m_P} = \frac{R_H}{M_H} \tag{3.28}$$

As we saw and as we will see, this arises from the fact that our universe, relative to a higher universe that contains it, is itself a singularity (Matryoshka multiverse). From equation 3.28, since $R_H = R_{uT}$ and R_{uI} are related by the inverse of the fourth root of the fine-structure constant, $1/\sqrt[4]{\alpha} \approx \sqrt[4]{137} \approx 3.42$, it is possible to derive the radius of the observable universe R_{uI}, which turns out to be approximately 47.2 Gly.

$$R_{uI} \approx 3.42 \cdot 13.79\, Gly \approx 47.2\, Gly \tag{3.29}$$

In summary, the conversion factors reveal a connection between all scales of reality, from quantum singularities to the entire observable universe, suggesting a self-similar structure (recursive) between the microcosm and the macrocosm. This is linked to the mechanism by which our universe originated from the Big Bang.

4. Generalized Electrogravitational Theory

4.1 Limitations of Newtonian theory

We know that Newton's Theory of Gravitation has clear shortcomings [45], among which is its inability to explain certain fine details of planetary motions. In fact, it represents a theory of gravitational state rather than a theory of gravitational process, as it does not provide any information about the temporal aspect of gravity (i.e., it assumes instantaneous action at a distance). Therefore, when applied to time-dependent systems, it is incompatible both with the principle of causality and with the conservation law of momentum (when fine corrections are taken into account).

4.2 Cogravitational field

It is well known that there is a strong resemblance between the equations of Newton's gravitational theory and the equations of electrostatics. It is also well known that in Maxwell's electromagnetic theory, the conservation law of momentum is satisfied because time-dependent electromagnetic interactions involve not only the electric field but also the magnetic field. Therefore, we can suppose [45] that time-dependent gravitational interactions, just like electromagnetic interactions, are also mediated by a second force field, the "cogravitational (gravitomagnetic) field," denoted by the symbol **K**. This field is created only by moving masses and acts exclusively on moving masses. This field, not considered in Newtonian theory, was proposed for the first time in 1893 by Oliver Heaviside [46]. In this way, it is possible to generalize Newton's theory of gravitation, thereby eliminating the mentioned shortcomings and making it fully applicable to all possible gravitational systems and interactions.

4.3 Generalized electrogravitational theory

Accepting the existence of the cogravitational field, and expressing the fields **g** and **K** in terms of retarded integrals, it is possible to develop and reformulate Newton's single-field theory so that it becomes a special case of the generalized gravitational theory. In this way, the generalized theory of gravitation, made coherent with the special theory of relativity, becomes fully compatible (when fine corrections are considered) with the laws of conservation of energy and momentum. The generalized theory of gravitation therefore assumes that gravitational interactions are mediated by two force fields, the gravitational field **g** and the cogravitational field **K**, which are defined as shown below (by Jefimenko in "*Gravitation and Cogravitation*") [45]:

$$\mathbf{g} = -G\int\left\{\frac{[\rho]}{r^3}+\frac{1}{r^2 c}\left[\frac{\partial\rho}{\partial t}\right]\right\}\boldsymbol{r}\,dV' + \frac{G}{c^2}\int\frac{1}{r}\left[\frac{\partial(\rho\boldsymbol{v})}{\partial t}\right]dV' \qquad (4.1)$$

$$\mathbf{K} = -\frac{G}{c^2}\int \left\{\frac{[\rho \boldsymbol{v}]}{r^3} + \frac{1}{r^2 c}\frac{\partial[\rho \boldsymbol{v}]}{\partial t}\right\} \times \boldsymbol{r}\, dV' \tag{4.2}$$

where $G, \rho, r, \boldsymbol{r},$ and dV' assume their usual meanings, $\boldsymbol{v}$ is the velocity at which the mass distribution ρ moves, and $p\boldsymbol{v}$ constitutes the "mass current density". From the second equation (4.2), it is evident that the field **K** is created only by moving masses and acts only on moving masses. The square brackets indicate that the enclosed quantities must be evaluated at the "retarded time" $t' = t - r/c$, where t is the time at which **g** and **K** are evaluated, and c is the speed of propagation of the fields **g** and **K**, equal to the speed of light. According to these equations, the gravitational field has three causal sources: the mass density ρ, the temporal derivative of ρ, and the temporal derivative of the mass current density $\rho\boldsymbol{v}$; while the cogravitational field has two causal sources: the mass current density $\rho\boldsymbol{v}$ and the temporal derivative of $\rho\boldsymbol{v}$. It is important to note that for stationary masses, hence independent of time, the cogravitational field calcels out ($\mathbf{K} = 0$). Furthermore, since the derivatives of ρ_n are zero, **g** reduces to the ordinary gravitational field equation of Newton's theory.

$$\mathbf{g} = -G\int \frac{\rho}{r^3}\, \boldsymbol{r}\, dV' \tag{4.3}$$

Therefore, Newton's gravitational theory represents a limiting case of the generalized theory. Finally, it is important to note that the retardation can often be neglected, and these equations can be used with non-retarded mass density and current. As in the Newtonian case, it is possible to reformulate the generalized theory in terms of fields, **g** and **K**. Thus, we obtain four differential equations (GEM or Jefimenko's equations) [45], which constitute the gravitational equivalent of Maxwell's equations [3].

$$\nabla \cdot \mathbf{g} = -\,4\pi G\rho \tag{4.4}$$

$$\nabla \cdot \mathbf{K} = 0 \tag{4.5}$$

$$\nabla \times \mathbf{g} = -\frac{\partial \mathbf{K}}{\partial t} \tag{4.6}$$

$$\nabla \times \mathbf{K} = -\,\frac{4\pi \boldsymbol{J}}{c^2} + \frac{1}{c^2}\frac{\partial \mathbf{g}}{\partial t} \tag{4.7}$$

Formulated in this way, the generalized theory of gravitation predicts a wide range of phenomena, one of the most significant being gravitational waves. By introducing the unit of mass (Stoney m_S or Planck mass $m_P = m_S/\sqrt{\alpha}$) into these equations, we obtain the electrogravitational equations (Generalized Electrogravitational Theory).

$$\nabla \cdot \mathbf{g} = -\frac{4\pi GK}{c^2}\frac{q_e^2}{l_S}\rho_n \tag{4.8}$$

$$\nabla \cdot \mathbf{K} = 0 \tag{4.9}$$

$$\nabla \times \mathbf{g} = -\frac{\partial \mathbf{K}}{\partial t} \tag{4.10}$$

$$\nabla \times \mathbf{K} = -\frac{4\pi GK}{c^4}\frac{q_e^2}{l_S}\boldsymbol{J}_n + \frac{1}{c^2}\frac{\partial \mathbf{g}}{\partial t} \tag{4.11}$$

These equations are "invertible" and, for completeness, must always be accompanied by the gravitoelectric equations (4.8b, 4.9b, 4.10b, 4.11b; paragraph 4.6). Here the fields **g** and **K**, defined by Jefimenko for the continuous case (4.1-4.2), are described by the following relationships (locally, the generic velocity $\boldsymbol{v}$ reduces to c):

$$\mathbf{g} = -\frac{GK}{c^2}\frac{q_e^2}{l_S}\int\left\{\frac{[\rho_n]}{r^3} + \frac{1}{r^2 c}\left[\frac{\partial \rho_n}{\partial t}\right]\right\}\boldsymbol{r}\,dV' + \frac{GK}{c^4}\frac{q_e^2}{l_S}\int\frac{1}{r}\left[\frac{\partial(\rho_n \boldsymbol{v})}{\partial t}\right]dV' \tag{4.12}$$

$$\mathbf{K} = -\frac{GK}{c^4}\frac{q_e^2}{l_S}\int\left\{\frac{[\rho_n \boldsymbol{v}]}{r^3} + \frac{1}{r^2 c}\left[\frac{\partial \rho_n \boldsymbol{v}}{\partial t}\right]\right\}\times\boldsymbol{r}\,dV' \tag{4.13}$$

4.4 ELECTROGRAVITATIONAL WAVES

Analogously to Maxwell's equations and those of Jefimenko, electrogravitational equations also admit wave solutions, which we can call electrogravitational waves. These tell us that electromagnetic and gravitational waves represent two aspects of the same physical phenomenon. *See paragraph 4.6 for a detailed explanation of electrogravitational waves. The photon γ^0, a particle with $Spin$ 1, is associated with the electric **E** and magnetic **B** fields, while the graviton g^0, a particle with $Spin$ 2, is associated with the gravitational **g** and cogravitational **K** fields. The elementary charge q_e, whose behavior is governed by Maxwell's equations, represents the integral of the oscillating charge q over half a period. The transfer of net charge (q_T) and mass (m_T) from one system to another is always zero (4.14-4.15). The situation is different in the case of the total number of transferred charges, given by $(q_e^+ + |q_e^-|)vt$. In the case of transferred mass, the proper mass of the photon $2M_{qs(f)} = m_S$ (fields **g** and **K**) is compensated by the negative mass (fields **g'** and **K'**) associated with the potential energy $U_S/c^2 = -m_S$, and therefore $m_T = 0$ (Fig.6). *For further details on the structure of the photon (graviphoton), refer to Section 8.7.

$$m_{T(f)} = \left[2M_{qs(f)} + \frac{U_{S(f)}}{c^2}\right]vt = \left[m_{S(f)} - m_{S(f)}\right]vt = 0 \tag{4.14}$$

$$q_{T(f)} = (q_e^+ + q_e^-)vt = 0 \tag{4.15}$$

In these relations, for an electrogravitational wave propagating in flat spacetime, the Stoney mass m_S must be replaced with the Planck mass m_P and the Stoney or elementary electric charge q_e with the Planck charge q_P. In conclusion, graviphotons (elementary dipoles) act as mediators of both the gravitational and electromagnetic fields. The behavior of electromagnetic components are described by Maxwell's equations (or by their gravitoelectric extension), whereas when the phenomenon is observed from the gravitational perspective, Jefimenko's (GEM) equations or general relativity must be used. If we consider Born's interpretation [47] of the wave function, the electrogravitational wave assumes the meaning of a probability map.

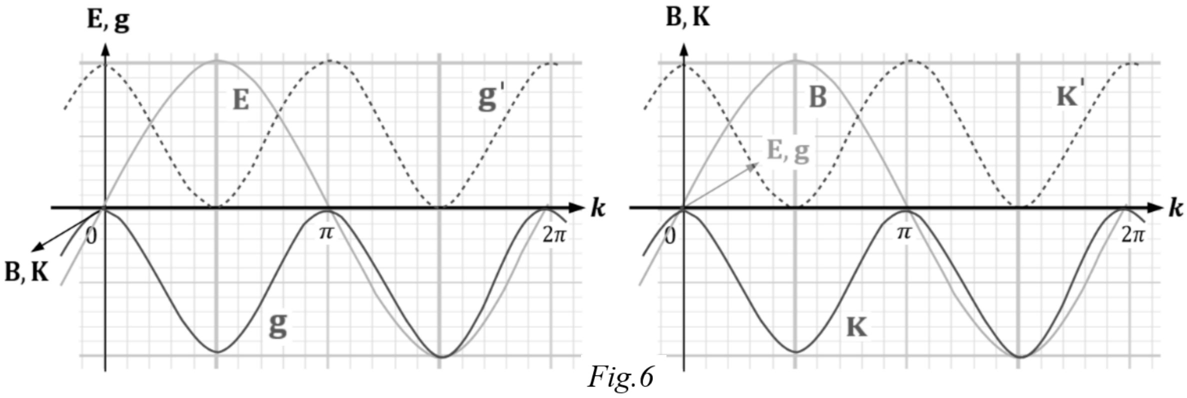


Fig.6

In electrogravitational waves, the $|\mathbf{K}|$ field is in phase with the $|\mathbf{g}|$ field, and both are in phase* with the $|\mathbf{E}|$ and $|\mathbf{B}|$ fields. In contrast, the fields $\mathbf{g}'$ and $\mathbf{K}'$ (related to the negative mass associated with the electric potential energy) have a phase of $\pi/2$. Fields $\mathbf{g}'$ and $\mathbf{K}'$, along with $\mathbf{g}$ and $\mathbf{K}$, constitute the characteristic quadrupole pattern of gravitational waves (Fig.6). "*The electrogravitational wave also reveals that the smallest fluctuation of spacetime coincides with the elementary electric charge*". As we will see in Chapter 7, the elementary electric charge represents the *"quantum of curvature"* of spacetime, with its sign corresponding to that of the fluctuation. If we consider spacetime as a vast ocean, elementary electric charges can be seen as bubbles/antibubbles. The total curvature of the field (mass) is given by the totality of the charges, regardless of their sign. The graviphoton $g\gamma^0$ (Fig.7, Section 8.7), is therefore that elementary particle formed by the union of two elementary charges of opposite sign. Furthermore, since all matter can be converted into graviphotons, in the universe there exists nothing but elementary electric charges q_e^- / q_e^+ (quantum singularities), which, combined in various ways, form all the particles and thus the entire reality (as we will see in subsequent chapters, all the elementary particles of the Standard Model will be shown to be composed of elementary electric charges).

4.5 LAWS OF ELECTROGRAVITATIONAL THEORY

The ***law of conservation of graviphotons*** (or consevation law of charge-energy-mass) states that the total number "n" of graviphotons is conserved. On cosmological scales, we have the generic velocity $\boldsymbol{v}$, which locally reduces to the speed of light c.

$$\frac{K}{c^2}\frac{q_e^2}{l_S}\nabla\cdot(\rho_n\boldsymbol{v}) = -\frac{K}{c^2}\frac{q_e^2}{l_S}\frac{\partial\rho_n}{\partial t} \tag{4.16}$$

The ***electrogravitational Lorentz force*** acting on a distribution of graviphotons with density ρ_n describes the behavior of graviphotons when they are in the presence of gravitational and/or cogravitational fields. The integral is extended over the region of space containing the distribution under consideration. Locally $\boldsymbol{v}$ reduces to c.

$$\mathbf{F} = \frac{K}{c^2}\frac{q_e^2}{l_S}\int \rho_n(\mathbf{g}+\boldsymbol{v}\times\mathbf{K})dV \tag{4.17}$$

The ***electrogravitational Poynting vector***, described by the cross product of the **g** and **K** fields, expresses the energy flux (energy per unit area per unit time) associated with the propagation of the electrogravitational field.

$$\mathbf{S} = \frac{\mu_e c^4}{16\pi^2 GK}\,\mathbf{g}\times\mathbf{K} \tag{4.18}$$

From the Poynting vector, we can derive the ***electrogravitational momentum density*** of the electrogravitational field, which is proportional to the Poynting vector according to the relation:

$$\rho_{\mathbf{p}} = \frac{\mathbf{S}}{c^2} = \frac{\mu_e c^2}{16\pi^2 GK}\,\mathbf{g}\times\mathbf{K} \tag{4.19}$$

where the integration is extended over the region under consideration, as well as the ***electrogravitational energy density*** of the field, given by the norm of the Poynting vector divided by c.

$$\rho_E = \frac{|\mathbf{S}|}{c} = \frac{\mu_e c^3}{16\pi^2 GK}\,|\mathbf{g}\times\mathbf{K}| \tag{4.20}$$

As can be seen, most of the equations of the electrogravitational theory are essentially transformations of expressions from Maxwell's electrodynamics, obtained through a simple substitution of symbols.

4.6 ELECTROGRAVITATIONAL COUPLING

Electrogravitational equations (4.8–4.11) inherently contain ***Maxwell's equations***; in fact, it is possible to express the gravitational **g** and the cogravitational **K** fields in terms of the electric **E** and magnetic **B** fields. The same applies to ***Gravitoelectric equations*** (4.8b–4.11b; paragr. 5.4), which include ***Jefimenko's (GEM) equations***.

$$\nabla \cdot \mathbf{g} = -\frac{4\pi G K}{c^2}\frac{q_e^2}{l_S}\rho_n = -\frac{8\pi G}{c^2}K\frac{q_e^2}{l_S}\rho_z = -\frac{2G}{c^2}\frac{q_e}{l_S}\nabla \cdot \mathbf{E} \tag{4.8}$$

$$\nabla \cdot \mathbf{K} = -\frac{2G}{c^2}\frac{q_e}{l_S}\,\nabla \cdot \mathbf{B} = 0 \tag{4.9}$$

$$\nabla \times \mathbf{g} = -\frac{2G}{c^2}\frac{q_e}{l_S}\,\nabla \times \mathbf{E} \;= -\frac{\partial \mathbf{K}}{\partial t} = \frac{2G}{c^2}\frac{q_e}{l_S}\frac{\partial \mathbf{B}}{\partial t} \tag{4.10}$$

$$\nabla \times \mathbf{K} = -\frac{4\pi G K}{c^4}\frac{q_e^2}{l_S}\boldsymbol{J}_n + \frac{1}{c^2}\frac{\partial \mathbf{g}}{\partial t} = -\frac{8\pi G}{c^4}K\frac{q_e^2}{l_S}\boldsymbol{J}_z + \frac{1}{c^2}\frac{\partial \mathbf{g}}{\partial t} = -\frac{2G}{c^4}\frac{q_e}{l_S}\frac{q_e}{\varepsilon_e}\boldsymbol{J}_z + \frac{2G}{c^4}\frac{q_e}{l_S}\frac{\partial \mathbf{E}}{\partial t} \tag{4.11}$$

$$\nabla \cdot \mathbf{E} = 4\pi\sqrt{K m_S c^2 l_S}\,\rho_z = -\frac{c^2}{2G}\frac{l_S}{q_e}\nabla \cdot \mathbf{g} \tag{4.8b}$$

$$\nabla \cdot \mathbf{B} = -\frac{c^2}{2G}\frac{l_S}{q_e}\nabla \cdot \mathbf{K} = 0 \tag{4.9b}$$

$$\nabla \times \mathbf{E} = -\frac{c^2}{2G}\frac{l_S}{q_e}\nabla \times \mathbf{g} = -\frac{\partial \mathbf{B}}{\partial t} = \frac{c^2}{2G}\frac{l_S}{q_e}\frac{\partial \mathbf{K}}{\partial t} \tag{4.10b}$$

$$\nabla \times \mathbf{B} = \frac{4\pi}{c^2}\sqrt{K m_S c^2 l_S}\,\boldsymbol{J}_z + \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} = -\frac{2}{c^2}\frac{q_e}{\varepsilon_e}\boldsymbol{J}_n + \frac{1}{2G}\frac{l_S}{q_e}\frac{\partial \mathbf{g}}{\partial t} \tag{4.11b}$$

The sign of q_e depends on that of the electric (or magnetic) field, in order to maintain equation consistency.

Quantity	Meaning	Relation	Units
ρ_n	Number density of dipoles	$\rho_n = 2\rho_z$	$1/m^3$
ρ_z	Number density of charges	$\rho_z = \rho_n/2$	$1/m^3$

In this way, one can transition from a gravitational description to an electromagnetic one. Similarly, the electrogravitational Poynting vector **S** can be reduced to either the standard electromagnetic Poynting vector $\mathbf{S_E}$ or to Jefimenko's (GEM) $\mathbf{S_g}$ form.

$$\mathbf{S_E} = \frac{\mu_e c^4}{16\pi^2 G K}\,\mathbf{g} \times \mathbf{K} = \frac{c^2}{4\pi K}\left[\frac{\mu_e c^2}{4\pi G}\mathbf{g} \times \mathbf{K}\right] = \frac{c^2}{4\pi K}\,\mathbf{E} \times \mathbf{B} \tag{4.18b}$$

$$\mathbf{S_g} = \frac{\mu_e c^4}{16\pi^2 G K}\,\mathbf{g} \times \mathbf{K} = \frac{c^2}{4\pi G}\left[\frac{\mu_g c^2}{4\pi K}\mathbf{E} \times \mathbf{B}\right] = \frac{c^2}{4\pi G}\,\mathbf{g} \times \mathbf{K} \tag{4.18c}$$

This system of 8 equations admits waves as solutions both in the electromagnetic sector and in the gravitational one. The number densities ρ_z and $\rho_n = 2\rho_z$ (measured in m^{-3}) represent, respectively the number of charges and dipoles per unit volume, and the currents $\boldsymbol{J}_z$ and $\boldsymbol{J}_n$ do not cancel out by being set to zero, but by taking into account their negative counterparts (0*). In this way, we obtain oscillating masses and charges, which are not zero, but when summed over the oscillation, cancel out.

$$\nabla^2\mathbf{E} - \frac{1}{c^2}\frac{\partial^2\mathbf{E}}{\partial t^2} = 0^* \qquad \nabla^2\mathbf{g} - \frac{1}{c^2}\frac{\partial^2\mathbf{g}}{\partial t^2} = 0^* \tag{4.21}$$

Since the fields **E** and **g**, as well as **B** and **K**, are related through the relations:

$$\mathbf{E} = -\frac{c^2}{2G}\frac{l_S}{q_e}\mathbf{g} \qquad \mathbf{g} = -\frac{2G}{c^2}\frac{q_e}{l_S}\mathbf{E} \tag{4.22}$$

$$\mathbf{B} = -\frac{c^2}{2G}\frac{l_S}{q_e}\mathbf{K} \qquad \mathbf{K} = -\frac{2G}{c^2}\frac{q_e}{l_S}\mathbf{B} \tag{4.23}$$

This means that there exists a direct linear coupling between the two wave solutions:

$$-\frac{2G}{c^2}\frac{q_e}{l_S}\left(\nabla^2\mathbf{E} - \frac{1}{c^2}\frac{\partial^2\mathbf{E}}{\partial t^2}\right) = 0^* \qquad -\frac{c^2}{2G}\frac{l_S}{q_e}\left(\nabla^2\mathbf{g} - \frac{1}{c^2}\frac{\partial^2\mathbf{g}}{\partial t^2}\right) = 0^* \tag{4.24}$$

Thus, the fields **g** and **K** satisfy the same wave equation as the fields **E** and **B**, and vice versa. In conclusion, the entire system of 8 equations can be reduced to a single mixed electrogravitational wave solution. Visually, we have an electromagnetic wave coupled to a quadrupolar gravitational wave, which together form the *electrogravitational wave* (Fig. 6). The fields **g** and **K**, oscillating in the lower part of the plane since they depend on $-(q_e^2)$, represent the fields associated with the energy of the electromagnetic field carried by **E** and **B** (since, according to relativity, every mass/energy produces gravitational effects). Considering only this part would suggest that the electromagnetic wave transports mass; however, this cannot be true. Hence, there must be two fields, **g′** and **K′**, oscillating in the upper plane, which perfectly counterbalance the fields **g** and **K**. The fields **g** and **K**, together with **g′** and **K′**, constitute the quadrupole of the gravitational component of the wave. Only the simultaneous presence of both ensures that the EM wave remains overall massless, as it must be. Therefore, the four fields must coexist as *complementary components* (not as mutually exclusive alternatives) in order to maintain the physical consistency of the model: together, they cancel the net mass while allowing the transport of electromagnetic energy. Moreover, the presence of the electric charge in the coefficients (4.22–4.23) indicates that the electric and magnetic fields are tied to its oscillation, whose integral over a half-period is exactly equal to $|q_e|$. Furthermore, since **g**, **g′**, **K**, **K′** also depend on it, this means that the integral of the **g′** and **K′** fields depends on q_e^2, whereas that of the **g** and **K** fields depends on $-(q_e^2)$. Additionally, since the coupling constants depend on l_S/l_P, this implies that the charges are separated by a distance equal to the Stoney/Planck length. Among these, $q_e^+ q_e^- / l_S$ represents the real dipole, being formed by two opposite elementary electric charges:

$$U_S = E_S = K \frac{q_e^+ q_e^-}{l_S} \approx -1.7 \cdot 10^8 \text{ J} \tag{3.2b}$$

Its potential energy corresponds to the Stoney mass m_S taken with a negative sign.

$$-m_S = \frac{K}{c^2} \frac{q_e^+ q_e^-}{l_S} \approx -1.86 \cdot 10^{-9} \, kg \tag{3.3b}$$

As mentioned, this negative mass must be balanced by a corresponding positive mass m_S associated with the **g** and **K** (negative) fields, which can be expressed in terms of dipole as $-(q_e^2)$, given by the square of the electric field. This can only be the proper mass of the photon (graviphoton). Moreover, since the photon is composed of two electric charges, this means that each of the two electric charges carries half of the Stoney/Planck mass. But if the radius of each charge is equal to the Stoney/Planck length, then this implies that each charge is a singularity, since this is precisely the Schwarzschild radius associated with a mass equal to half the Stoney/Planck mass. See paragraph 8.7. Furthermore, such a system can be stable only if one of the two singularities in addition to being positively charged is also a *quantum white hole*, and the other in addition to being negatively charged is also a *quantum black hole*. ***Here the terms black hole and white hole (related by CPT symmetry) are used to refer to the spacetime flux entering or exiting the singularity in relation to the sign of the electric field, treated here as a spacetime phenomenon (Section 7.7)***. The rotation of the singularities around their center of charge generates a magnetic $\nabla \cdot \mathbf{B} = 0$ and a cogravitational $\nabla \cdot \mathbf{K} = 0$ fields. This implies that magnetic and gravitomagnetic monopoles do not exist. We can now calculate the mass $M_{g\gamma^0}$ of the graviphoton by adding the masses of the quantum black hole M_{qbh} and quantum white hole M_{qwh}, from which the mass associated with the electrostatic energy $-m_S$ must be subtracted:

$$M_{g\gamma^0} = (M_{qbh} + M_{qwh}) - m_S = 2M_{qs} - m_S = 0 \tag{8.5}$$

Thus, the mass of the photon is zero $M_{g\gamma^0} = 0$, in accordance with the special theory of relativity and QED. Its electric charge is also zero, since the photon (graviphoton) is composed of two electric charges of opposite sign $q_{g\gamma^0} = 0$. *Obviously, the calculations can be performed using Planck units, since all the parameters of the photon depend on the conversion factors. Paragraph 8.7 discusses this in more detail.

Since the charge density is related to the dipole density by $\rho_n = 2\rho_z$, and the currents are therefore $\boldsymbol{J}_n = 2\boldsymbol{J}_z$, we can express the electrogravitational equations solely in terms of ρ_z and $\boldsymbol{J}_z$. In this way, the Einsteinian gravitational coupling constant $8\pi G/c^4$ naturally appears, in both equations 4.8 (as $8\pi G/c^2$) and 4.11 (as $8\pi G/c^4$). Furthermore, the solutions for electrogravitational waves are expressed by equations:

$$\nabla^2\mathbf{E} - \frac{1}{c^2}\frac{\partial^2\mathbf{E}}{\partial t^2} = \frac{4\pi\sqrt{Km_S c^2 l_S}}{c^2}\left[c^2\nabla(\rho_z^+ + \rho_z^-) + \frac{\partial}{\partial t}(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-) + c\nabla\times(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-)\right] \tag{4.25}$$

$$\nabla^2\mathbf{B} - \frac{1}{c^2}\frac{\partial^2\mathbf{B}}{\partial t^2} = \frac{4\pi\sqrt{Km_S c^2 l_S}}{c^2}\left[c\,\nabla(\rho_z^+ + \rho_z^-) + \frac{1}{c}\frac{\partial}{\partial t}(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-) - \nabla\times(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-)\right] \tag{4.26}$$

$$\nabla^2\mathbf{g} - \frac{1}{c^2}\frac{\partial^2\mathbf{g}}{\partial t^2} = -\frac{4\pi GK}{c^4}\frac{q_e^2}{l_S}\left[c^2\nabla(\rho_n^+ + \rho_n^-) + \frac{\partial}{\partial t}(\boldsymbol{J}_n^+ + \boldsymbol{J}_n^-) + c\nabla\times(\boldsymbol{J}_n^+ + \boldsymbol{J}_n^-)\right] \tag{4.27}$$

$$\nabla^2\mathbf{K} - \frac{1}{c^2}\frac{\partial^2\mathbf{K}}{\partial t^2} = -\frac{4\pi GK}{c^4}\frac{q_e^2}{l_S}\left[c\,\nabla(\rho_n^+ + \rho_n^-) + \frac{1}{c}\frac{\partial}{\partial t}(\boldsymbol{J}_n^+ + \boldsymbol{J}_n^-) - \nabla\times(\boldsymbol{J}_n^+ + \boldsymbol{J}_n^-)\right] \tag{4.28}$$

takes the form of multiple waves in which not only the electromagnetic and electrogravitational fields oscillate, but also the currents, the charge density, the dipole density (related as $\rho_n = 2\rho_z$), and therefore the electric charges themselves.

$$\nabla^2\mathbf{E} - \frac{1}{c^2}\frac{\partial^2\mathbf{E}}{\partial t^2} = \frac{4\pi K}{c^2}\,q_e\left[c^2\nabla(\rho_z^+ + \rho_z^-) + \frac{\partial}{\partial t}(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-) + c\nabla\times(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-)\right] \tag{4.25b}$$

$$\nabla^2\mathbf{B} - \frac{1}{c^2}\frac{\partial^2\mathbf{B}}{\partial t^2} = \frac{4\pi K}{c^2}\,q_e\left[c\,\nabla(\rho_z^+ + \rho_z^-) + \frac{1}{c}\frac{\partial}{\partial t}(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-) - \nabla\times(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-)\right] \tag{4.26b}$$

$$\nabla^2\mathbf{g} - \frac{1}{c^2}\frac{\partial^2\mathbf{g}}{\partial t^2} = -\frac{8\pi G}{c^4}K\frac{q_e^2}{l_S}\left[c^2\nabla(\rho_z^+ + \rho_z^-) + \frac{\partial}{\partial t}(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-) + c\nabla\times(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-)\right] \tag{4.27b}$$

$$\nabla^2\mathbf{K} - \frac{1}{c^2}\frac{\partial^2\mathbf{K}}{\partial t^2} = -\frac{8\pi G}{c^4}K\frac{q_e^2}{l_S}\left[c\,\nabla(\rho_z^+ + \rho_z^-) + \frac{1}{c}\frac{\partial}{\partial t}(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-) - \nabla\times(\boldsymbol{J}_z^+ + \boldsymbol{J}_z^-)\right] \tag{4.28b}$$

As can be seen, the Einstein gravitational coupling constant ($8\pi G/c^4$) appears even in equations 4.27b and 4.28b. Moreover, in equations 4.25b and 4.26b the charge q_e appears, while in 4.27b and 4.28b the elementary electric dipole $K(q_e^2/l_S)$ emerges, together representing the coupling constants of the electrogravitational wave.

4.8 WAVE-PARTICLE DUALITY?

In the late 17th century, Sir Isaac Newton proposed a corpuscular (particle-like) nature of light, while Christiaan Huygens argued for a wave description. Although Newton favored a particle view, he was the first to attempt a reconciliation of the wave and particle theories of light, and the only one of his time to consider both, thus anticipating the modern concept of wave-particle duality. Thomas Young's interference experiments in 1801 and François Arago's observation of the Poisson spot in 1819 confirmed Huygens' wave model. However, the wave theory faced challenges in 1900 with Planck's law of black-body radiation. Max Planck heuristically derived a formula for the observed spectrum by assuming that a hypothetical quantized mechanical oscillator in a cavity containing black-body radiation could only change its energy in discrete amounts, proportional to the frequency of the associated electromagnetic wave. In 1905, Albert Einstein interpreted the photoelectric effect in terms of discrete photon energies. Both results pointed to particle-like behavior. Despite experimental support, the photon theory remained controversial until Arthur Compton conducted experiments between 1922 and 1924 demonstrating the momentum of light. These observations of particle-like momentum and energy appeared to contradict earlier experiments showing wave-like interference. In conclusion, wave–particle duality is a concept in quantum mechanics stating that fundamental entities, such as photons, can exhibit either particle-like or wave-like behavior depending on the experimental context. We are told that this reflects the failure of classical concepts, particle or wave, to fully describe the behavior of quantum objects, but we will show that this is not the case. Let us imagine positioning ourselves alongside an electrogravitational wave, like the one shown in Fig. 6. From an electric and magnetic perspective, what we observe is a crest and a trough propagating along the direction of the wave vector $\boldsymbol{k}$. The crest corresponds to the function describing the amplitude of the electric field E^{+} (associated with the positive elementary electric charge q^{+}), while the trough corresponds to the function describing the amplitude of the electric field E^{-} (associated with the negative elementary electric charge q^{-}). Together, the crest and trough represent the residual distributions (halos) of the two electric charges, which balance each other and are arranged to form the dipole of the photon (paragraph 8.7). The sum of the absolute values of the two electric fields $E_{tot} = E^{+}+|E^{-}|$, and thus of the two charges $q_{tot} = q^{+}+|q^{-}|$, reaches its maximum at the inflection point of the electromagnetic component of the wave. It is at this inflection point that we can say the photon (graviphoton) is located. Therefore, there is no wave-particle duality. The halos of the electric charges, which for an isolated photon would be represented by two cones opening in opposite directions, take a sinusoidal shape within the wave. This happens because each charge of a given sign is flanked by two charges of the opposite sign. These halos, which constitute the wave, are essentially the tail of the dipole, located at the inflection point, where $\mathbf{E}$ and $\mathbf{B}$ vanish and the fields $\mathbf{g}'$ and $\mathbf{K}'$, associated with the electric potential energy between the elementary electric charges, reach their maximum. The same principle applies to other particles as well.

5. Derivation of Planck's Relation

5.1 Derivation of Planck's relation

Each particle can be seen as a point-like, isotropic emitter of electrogravitational waves (graviphotons). It is assumed that the radiated power is uniformly distributed over a spherical wavefront with surface area $A = 4\pi r^2$, where r represents the distance from the point of emission. We want to determine the amount of energy radiated by the particle (emitter) in the case of monochromatic emission. In this case, it is possible to use a "simplified" version of the two fields **g** (4.12) and **K** (4.13).

$$\mathbf{g} = -\frac{GK}{c^2 r^2}\frac{q_e^2}{l_S}\, n\, \hat{\mathbf{k}}_{\mathbf{1}} = -\mathbf{g}_S n \tag{5.1}$$

$$\mathbf{K} = -\frac{GK}{c^3 r^2}\frac{q_e^2}{l_S}\, n\, \hat{\mathbf{k}}_{\mathbf{2}} = -\mathbf{K}_S n \tag{5.2}$$

Here, $\hat{\mathbf{k}}_{\mathbf{1}}$ and $\hat{\mathbf{k}}_{\mathbf{2}}$ represent the unit vectors associated with the fields **g** and **K**, and n is the number of graviphotons. Additionally, $\mathbf{g}_S$ and $\mathbf{K}_S$ are the gravitational and cogravitational fields in Stoney units. Given the electrogravitational Poynting vector:

$$\mathbf{S} = \frac{\mu_e c^4}{16\pi^2 GK}\, \mathbf{g} \times \mathbf{K} \tag{4.18}$$

To determine the emitted power from the source, it is necessary to integrate over the entire wavefront, which is equivalent to multiplying by the surface area ($A = 4\pi r^2$).

$$P_S = \int_A \mathbf{S} \cdot \hat{\boldsymbol{n}}\, dA = (4\pi r^2)\frac{\mu_e c^4}{16\pi^2 GK}\left(\frac{GK}{c^2 r^2}\frac{q_e^2}{l_S} n \cdot \frac{GK}{c^3 r^2}\frac{q_e^2}{l_S} n\right) \tag{5.3}$$

Considering that locally $r^2 = c^2 t^2$, we obtain the power associated with the wave:

$$P_S = \frac{\mu_e GK}{4\pi c^3}\left(\frac{q_e^2}{l_S}\right)^2 \frac{n^2}{t^2} \tag{5.4}$$

Given that $n/t = v$ represents the emission frequency of graviphotons, multiplying by $2\pi/v$ gives us the Stoney energy carried by the electrogravitational wave. Furthermore, substituting Stoney length l_S, defined (3.1) in terms of other physical constants, we derive the relation that defines the energy of the electrogravitat. wave:

$$E_S = \frac{\mu_e GK}{2c^3}\left(\frac{q_e^2}{l_S}\right)^2 v = \mu_e c \frac{q_e^2}{2} v = \frac{Z_0 q_e^2}{2} v = h_S v \tag{5.5}$$

Here, h_S represents the Stoney constant, whose value is approximately $\approx 4.84 \cdot 10^{-36} J \cdot s$, and Z_0 is the impedance of free space. This is the energy possessed by the graviphoton when the wave propagates on the horizon of a singularity (for example, on the quantum horizon). In fact, this value is derived from the "constants" G and K, which depend on the interaction between particles. On the other hand, when the graviphoton is in a region of locally flat spacetime, its energy is approximately $f^{-4}[E] = 1/\alpha$ times higher, $E_P \approx 137 \cdot E_S$, as it does not experience the effects due to the singularity (the situation is apparently opposite to that predicted by applying conversion factors, however, the graviphoton itself is composed of two singularities, therefore, a double conversion occurs). This is the value that emerged from Planck's calculations. The energy carried by the electrogravitational wave in flat spacetime is:

$$E_P = \frac{1}{\alpha}\frac{\mu_e GK}{2c^3}\left(\frac{q_e^2}{l_S}\right)^2 v = \mu_e c \frac{q_e^2}{2\alpha} v = \frac{Z_0 q_e^2}{2\alpha} v = \frac{h_S}{\alpha} v = h_P v \tag{5.6}$$

Here, h_P represents the Planck constant, whose value is approximately $\approx 6.626 \cdot 10^{-34} J \cdot s$. To this wave is associated the Poynting vector, expressed in Stoney units:

$$\mathbf{S} = \frac{1}{\sqrt[4]{\alpha^3}} \frac{\mu_e c^4}{16\pi^2 GK} \mathbf{g} \times \mathbf{K} \tag{5.7}$$

When an elementary particle (such as an electron) absorbs a graviphoton, the energy it brings to the system is (apparently) 137 times smaller than the energy it possesses when propagating in vacuum (flat spacetime). Thus, the electron will absorb an energy equal to $E_S = h_S v$. In fact, if we use the Stoney quantum instead of the Planck quantum in calculating the energy levels of the atom, we do not need (*) to introduce the fine structure constant α. The general form of the Poynting vector is given by:

$$\mathbf{S}_{(f)} = \frac{\mu_{e(f)} c_{(f)}^4}{16\pi^2 G_{(f)} K_{(f)}} \mathbf{g}_{(f)} \times \mathbf{K}_{(f)} \tag{5.8}$$

Here (f) indicates the dependence of the various terms in the equation on their respective conversion factors. The generic Poynting vector can take values between the vector obtained by substituting Stoney units inside it, and that obtained through Planck units. The same applies to the relationship between frequency and energy of the electrogravitational wave, and generally for all other equations present in the text.

$$E_{(f)} = h_{(f)} v \tag{5.9}$$

5.2 Derivation of Planck's relation: explanation

Let us explain more clearly and in detail how we derived Planck's relation. We started from equations (5.1–5.2), which are simplifications of relations (4.12–4.13). We assumed an isotropic emitter of electrogravitational waves, and therefore of *gravitophotons*. This allows us to work in spherical symmetry. If we hypothesize that the entire system, consisting of the point-like emitter and the spherical wavefront, is arbitrarily small, we can place the vector triad, made up of the Poynting vector and the field vectors **g** and **K**, directly at the center of the sphere, i.e., at the emitter itself. **g** and **K** are effective (RMS) fields, in the sense that they are continuous fields producing the same effects as oscillating fields. The only difference with classical fields is that they are multiples of a minimum field, which is obtained by setting $n = 1$. In this way, they decrease with the square of the distance, just like classical fields. Now, we only need to insert them into the Poynting vector and integrate over the surface of the entire wavefront (equation 5.3). Since the distance from the emission point to the wavefront can also be expressed in terms of time, because the fields propagate at the speed of light, we use the relation $r^2 = c^2t^2$, so that t appears in equation (5.4). Next, since we know that the fields are multiples of a minimal entity n, if we divide n, the number of dipoles emitted isotropically and monochromatically, by t, the time in seconds separating the emission point from the wavefront, we obtain the frequency $n/t = \nu$. Then, by dividing (5.4) by the frequency and multiplying by 2π, and considering a single complete oscillation of the field, we obtain Stoney's energy, equation (5.5).To obtain equation (5.6), we simply transform this value using the energy conversion factor for each of the four spacetime dimensions. That's all!

5.3 The Meaning of the Uncertainty Principle

The uncertainty principle, introduced by Heisenberg in 1927, states that it is not possible to know simultaneously and with absolute precision certain pairs of properties of a particle, such as its position and its momentum. Mathematically, this relation is expressed through the inequality $\Delta x \cdot \Delta p \geq \hbar/2$, where Δx denotes the uncertainty in position, Δp the uncertainty in momentum, and $\hbar \approx 1.054 \times 10^{-34}\, J \cdot s$ is the reduced Planck constant. From a physical perspective, this principle implies that attempting to determine the position of a particle with high precision inevitably leads to a large uncertainty in its momentum, and vice versa. It is important to emphasize that this limitation is an intrinsic feature of quantum reality. The Kennard -Robertson inequalities provide a deeper interpretation of this principle. While Heisenberg's inequalities are always tied to an act of measurement and to the resulting disturbance inflicted upon the conjugate observable (operational indeterminacy), the Kennard-Robertson inequalities highlight intrinsic properties of quantum systems (intrinsic indeterminacy). The uncertainty principle can be simply explained by referring to Fig.6. In fact, $h/2$ represents the equal partition of action (energy) between the two elementary electric charges (or equipartition of angular momentum if we consider $\hbar/2$), to emphasize that reality cannot be determined with a precision below the action associated with each elementary electric charge.

5.4 GRAVITOELECTRIC EQUATIONS AND PLANCK'S RELATION

It is possible to invert the relationship (3.4) to define the charges of the graviphoton in relation to its mass, but this results in the loss of information about the sign.

$$q_i = z_i q_e = z_i \sqrt{\frac{m_S c^2 l_S}{K}} \qquad (z_i \in \mathbb{Z}) \tag{3.4b}$$

We can then substitute this relationship into Maxwell's equations [3], in order to obtain the gravitoelectric equations, which are dual to the electrogravitational ones.

$$\nabla \cdot \mathbf{E} = 4\pi\sqrt{K m_S c^2 l_S}\, \rho_z \tag{4.8b}$$

$$\nabla \cdot \mathbf{B} = 0 \tag{4.9b}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \tag{4.10b}$$

$$\nabla \times \mathbf{B} = \frac{4\pi}{c^2}\sqrt{K m_S c^2 l_S}\, \boldsymbol{J}_z + \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} \tag{4.11b}$$

Here the fields **E** and **B**, defined by Jefimenko in "Electricity and Magnetism" for the continuous case, are described by the relationships (locally $\boldsymbol{v}$ reduces to c):

$$\mathbf{E} = \sqrt{K m_S c^2 l_S} \int \left\{ \frac{[\rho_z]}{r^3} + \frac{1}{r^2 c}\left[\frac{\partial \rho_z}{\partial t}\right] \right\} \boldsymbol{r}\, dV' - \frac{\sqrt{K m_S c^2 l_S}}{c^2} \int \frac{1}{r}\left[\frac{\partial(\rho_z \boldsymbol{v})}{\partial t}\right] dV' \tag{4.12b}$$

$$\mathbf{B} = \frac{\sqrt{K m_S c^2 l_S}}{c^2} \int \left\{ \frac{[\rho_z \boldsymbol{v}]}{r^3} + \frac{1}{r^2 c}\left[\frac{\partial \rho_z \boldsymbol{v}}{\partial t}\right] \right\} \times \boldsymbol{r}\, dV' \tag{4.13b}$$

Among the solutions of the gravitoelectric equations there are the gravitoelectric waves. These describe the behavior of the electric **E** and magnetic **B** fields. Given the simplified versions of the (4.12b) and (4.13b), we can derive Planck's relation.

$$\mathbf{E} = \frac{\sqrt{K m_S c^2 l_S}}{r^2}\, z\, \hat{\mathbf{k}}_\mathbf{1} = \mathbf{E}_S z \tag{5.1b}$$

$$\mathbf{B} = \frac{\sqrt{K m_S c^2 l_S}}{c\, r^2}\, z\, \hat{\mathbf{k}}_\mathbf{2} = \mathbf{B}_S z \tag{5.2b}$$

Here $\hat{\mathbf{k}}_1$ and $\hat{\mathbf{k}}_2$ represent the unit vectors associated with the **E** and **B** fields, and z the number of charges (the sign of z is that of the charges). Additionally, $\mathbf{E}_S$ and $\mathbf{B}_S$ are the electric and magnetic fields in Stoney units. Given the e.m. Poynting vector:

$$\mathbf{S} = \frac{c^2}{4\pi K}\,\mathbf{E} \times \mathbf{B} \tag{4.18b}$$

To determine the power emitted by the source, it is necessary to integrate over the entire surface of wavefront, which is equivalent to multiplying by the surface area.

$$P_S = \int_A \mathbf{S} \cdot \hat{\boldsymbol{n}}\, dA = (4\pi r^2)\frac{c^2}{4\pi K}\left(\frac{\sqrt{Km_S c^2 l_S}}{r^2}\, z \cdot \frac{\sqrt{Km_S c^2 l_S}}{c\, r^2}\, z\right) \tag{5.3b}$$

Taking into account that locally $r^2 = c^2 t^2$, the power associated with the wave is:

$$P_S = c\, m_S l_S \frac{z^2}{t^2} \tag{5.4b}$$

Given that $|z|/t = v$ represents the emission frequency of elementary electric charges, if we multiply by $2\pi/v$ (by multiplying by 2π, we are considering both charges of the graviphoton), we obtain the Stoney energy of the gravitoelectric wave:

$$E_S = 2\pi c\, m_S l_S v = h_S v \tag{5.5b}$$

Here h_S represents the Stoney constant, m_S is the Stoney mass, and l_S is the Stoney length. On the other hand, as we saw in Section 5.1, when the graviphoton is in a region of locally flat spacetime, its energy is approximately 137 times greater. Thus, the Planck energy carried by the gravitoelectric wave in locally flat spacetime is:

$$E_P = \frac{2\pi c\, m_S l_S}{\alpha} v = 2\pi c\, m_P l_P v = h_P v \tag{5.6b}$$

Here h_P represents the Planck constant, m_P the Planck mass, and l_P the Planck length. [Chapter 7: As in the electrogravitational case, gravitoelectric fields can also be described in terms of scalar and vector potentials. Similarly, it is possible to define a gravitoelectric-type stress-energy tensor. Even in this case, the quantization of the field equation is achieved by taking the length unit from the denominator of the various terms of the stress-energy tensor and placing them in the numerator on the left side of the equation, thereby reaching a situation analogous to the previous one.]

5.5 ELECTROMAGNETISM AND PLANCK'S RELATION

Planck's relation can be derived using electromagnetism alone. Given a generic charge q_i, it can be expressed as a multiple of the elementary electric charge q_e.

$$q_i = z_i q_e \quad (z_i \in \mathbb{Z}) \tag{3.4c}$$

We can substitute this relationship into Maxwell's equations, so that they depend on the number density of charges ρ_z. Among the solutions of Maxwell's equations are electromagnetic waves. These describe the behavior of the electric **E** and magnetic **B** fields, which locally are expressed by the following “simplified” relationships:

$$\mathbf{E} = \frac{Kq_e}{r^2}\, z\, \hat{\mathbf{k}}_\mathbf{1} \tag{5.1c}$$

$$\mathbf{B} = \frac{Kq_e}{c\, r^2}\, z\, \hat{\mathbf{k}}_\mathbf{2} \tag{5.2c}$$

Here $\hat{\mathbf{k}}_\mathbf{1}$ and $\hat{\mathbf{k}}_\mathbf{2}$ represent the unit vectors associated with the fields **E** and **B**, and z the number of charges (the sign of z is that of the charges). Given the Poynting vector:

$$\mathbf{S} = \frac{c^2}{4\pi K}\, \mathbf{E} \times \mathbf{B} \tag{4.18b}$$

To determine the power radiated by a point source, in the case of monochromatic emission, it is necessary to integrate over the surface area $4\pi r^2$ of the wavefront.

$$P_S = \int_A \mathbf{S} \cdot \hat{\boldsymbol{n}}\, dA = (4\pi r^2) \frac{c^2}{4\pi K} \left(\frac{Kq_e}{r^2}\, z \cdot \frac{Kq_e}{c\, r^2}\, z \right) \tag{5.3c}$$

Taking into account that locally $r^2 = c^2 t^2$, the power associated with the wave is:

$$P_S = \frac{Kq_e^2}{c} \frac{z^2}{t^2} \tag{5.4c}$$

Given that $|z|/t = v$ represents the emission frequency of elementary electric charges, if we multiply by $2\pi/\alpha v$ (by multiplying by 2π, we are considering both charges of the photon), we obtain the Planck energy of the electromagnetic wave:

$$E_P = \frac{2\pi K q_e^2}{c\alpha} v = \frac{Z_0 q_e^2}{2\alpha} v = h_P v \tag{5.6c}$$

5.6 THE EMISSION PROCESS OF GRAVIPHOTONS

The derivation of Planck's relation presented in Section 5.1 was obtained by adopting a simplified form of the **g** and **K** fields. The complete gravitational and cogravitational fields (4.12-4.13), however, provide additional informations on the physical mechanism responsible for the emission of graviphotons. When the complete fields are substituted into the electrogravitational Poynting vector (4.18), the resulting energy flux is composed of six contributions. The vector **S** is given by:

$$\mathbf{S} = \frac{\mu_e c^4}{16\pi^2 GK} (\mathbf{g}_1+\mathbf{g}_2+\mathbf{g}_3) \times (\mathbf{K}_1 + \mathbf{K}_2) \qquad (4.18c)$$

These can be grouped into three components: a bound field, an induction field, and a radiative field, corresponding to the freely propagating wave (graviphotons). The bound field represents the energy associated with the emitter. The induction field is generated while the source changes in time and represents the transition between the bound configuration and the outgoing wave. Like the bound field, it exchanges energy with the source but does not produce a net outward energy flux at large distances. Only the radiative component maintains a constant energy flux through spherical surfaces of increasing radius and therefore corresponds to the energy effectively carried away by the graviphoton. Consequently, the total energy associated with the complete electrogravitational field can be written as follows:

$$E(v,r) = hv + \frac{b}{r} + \frac{c}{vr^2} \qquad (5.7)$$

where h is the Stoney cons. $h_S \approx 4.84 \cdot 10^{-36} J \cdot s$ or the Planck cons. $h_P \approx 6.626 \cdot 10^{-34} J \cdot s$ constant, depending on the adopted system of units, v is the frequency, r the distance, while b and c are constants. As the distance from the source increases, the bound and induction contributions vanish, leaving only the radiative component $E = hv$. From this point of view, the emission of graviphotons can be interpreted as a continuous transition from a bound configuration to a freely propagating wave. Initially, the energy is confined to the emitter; during the emission process, part of this energy is transferred through the induction field; finally, only the radiative component separates from the source and propagates through space, carrying the energy. During the emission, conservation of energy requires that the decrease in the local field energy equals the energy carried away by the emitted graviphoton:

$$\frac{b}{r} + \frac{c}{vr^2} = -hv \qquad (5.8)$$

A completely analogous result is obtained if the calculation is performed using the electromagnetic Poynting vector (4.18b) and the gravitoelectric fields (4.12b-4.13b).

6. Electrogravitodynamic equations

6.1 Relativistic tensorial form and stress-energy tensor

Electrogravitational equations can be represented through the use of field potentials. However, this formulation introduces a certain arbitrariness in the precise form of the potentials. To ensure invariance under Lorentz transformations and obtain a relativistic formulation, the Lorenz gauge is adopted. To derive the four scalar equations that define the generalized potentials, we start from the field flux equation:

$$\nabla \cdot \left(-\nabla\phi - \frac{\partial \mathbf{A}}{\partial t}\right) = -\frac{4\pi GK}{c^2}\frac{q_e^2}{l_S}\rho_n \tag{6.1}$$

After a few steps [48], we obtain the electrogravitodynamic equations:

$$-c^2\,\nabla^2\mathbf{A} + c^2\nabla(\nabla\cdot\mathbf{A}) \;+\; \nabla\frac{\partial\phi}{\partial t} + \frac{\partial^2\mathbf{A}}{\partial t^2} = -\frac{4\pi GK}{c^2}\frac{q_e^2}{l_S}\boldsymbol{J}_n \tag{6.2}$$

They describe the propagation of the two potentials, scalar and vector. These relations can be decoupled by exploiting the fact that the curl of a gradient is zero, and by performing the following gauge transformation [48]:

$$\mathbf{A} \rightarrow \mathbf{A} + \nabla\Psi \qquad \phi \rightarrow \phi - \frac{\partial\Psi}{\partial t} \tag{6.3}$$

where Ψ is any sufficiently regular scalar field. The new potentials satisfy the same equations as the old potentials, and in this way, the expressions for the $\mathbf{g}$ and $\mathbf{K}$ fields also remain unchanged. Through gauge invariance, it is possible to choose $\mathbf{A}$ such that it satisfies the Lorenz condition, obtained by choosing Ψ such that:

$$\nabla\cdot\mathbf{A} = -\frac{1}{c^2}\frac{\partial\phi}{\partial t} \tag{6.4}$$

This condition allows the electrogravitational equations for the field potentials to be written in covariant form. If the potentials satisfy the Lorenz condition, they are said to belong to the Lorenz gauge. If the Lorenz condition is satisfied, the non-decoupled electrogravitodynamic equations become two decoupled equations (6.5-6.6), corresponding to four differential equations in four unknown scalar functions [49].

$$\nabla^2 \phi - \frac{1}{c^2}\frac{\partial^2 \phi}{\partial t^2} = \frac{4\pi GK}{c^2}\frac{q_e^2}{l_S}\rho_n = \frac{8\pi G}{c^2}K\frac{q_e^2}{l_S}\rho_z \tag{6.5}$$

$$\nabla^2 \mathbf{A} - \frac{1}{c^2}\frac{\partial^2 \mathbf{A}}{\partial t^2} = \frac{4\pi GK}{c^4}\frac{q_e^2}{l_S}\boldsymbol{J}_n = \frac{8\pi G}{c^4}K\frac{q_e^2}{l_S}\boldsymbol{J}_z \tag{6.6}$$

Let us recall that the charge density is related to the dipole density by $\rho_n = 2\rho_z$, and the currents are therefore $(\boldsymbol{J}_n = \rho_n \boldsymbol{v}_i) = 2\ (\boldsymbol{J}_z = \rho_z \boldsymbol{v}_i)$. It is also demonstrated that, given a particular electrogravitational problem, perfectly defined in its initial and boundary conditions, the solution is unique. More precisely, the solution to the wave equations is the retarded potentials, which in the Lorenz gauge take the form [48]:

$$\phi(\mathbf{x}, t) = -\frac{GK}{c^2}\frac{q_e^2}{l_S}\int \frac{\rho_n(\boldsymbol{r}_0, t')}{\boldsymbol{r}} dV \tag{6.7}$$

$$\mathbf{A}(\mathbf{x}, t) = -\frac{GK}{c^4}\frac{q_e^2}{l_S}\int \frac{\boldsymbol{J}_n(\boldsymbol{r}_0, t')}{\boldsymbol{r}} dV \tag{6.8}$$

where $\boldsymbol{r}$ is the distance from the observation point to the element dV, and $t' = t - r/c$ is the retarded time. The source densities and potentials can be expressed through two different four-vectors. The current density is represented by the four-current:

$$J^\mu = (\rho_n c, \boldsymbol{J}_n) \tag{6.9}$$

where ρ_n is the dipole density (graviphotons) measured in a system external to the distribution, and $\boldsymbol{J}_n$ is the dipole current density. The four-potential is defined as:

$$A^\mu = \left(\frac{\phi}{c}, \mathbf{A}\right) \tag{6.10}$$

Considering the definition of the divergence of the vector potential **A** in Minkowski spacetime, which must be zero to satisfy the Lorenz condition for the invariance of a four-vector, the gauge operation introduced earlier thus establishes the invariance of the four-vector formed by the components of $\mathbf{A}$ and ϕ. It follows that the electrogravitational field is a gauge theory. If we consider the d'Alembertian, the electrogravitodynamic equations can be written very succinctly in the form [49]:

$$\Box A^\mu = \mu_g J^\mu \tag{6.11}$$

Derivatives of the components of the four-potential form a second-order tensor [50], generated by a polar vector (gravitational) $\mathbf{g}$ and an axial one (cogravitational) $\mathbf{K}$. This results in the electrogravitational tensor.

$$F^{\mu\nu} = \partial^{\mu}A^{\nu} - \partial^{\nu}A^{\mu} \tag{6.12}$$

$$F^{\mu\nu} = \begin{pmatrix} 0 & \mathrm{g_x}/\mathrm{c} & \mathrm{g_y}/\mathrm{c} & \mathrm{g_z}/\mathrm{c} \\ -\mathrm{g_x}/\mathrm{c} & 0 & -\mathrm{K_z} & \mathrm{K_y} \\ -\mathrm{g_y}/\mathrm{c} & \mathrm{K_z} & 0 & -\mathrm{K_x} \\ -\mathrm{g_z}/\mathrm{c} & -\mathrm{K_y} & \mathrm{K_x} & 0 \end{pmatrix} \tag{6.13}$$

Finally, the stress-energy tensor [50], which describes the flow of electrogravitational energy and momentum in flat spacetime, is given by:

$$T^{\mu\nu} = -\frac{\mu_e c^4}{16\pi^2 GK}\left[F^{\mu\alpha}F^{\nu}{}_{\alpha} - \frac{1}{4}\eta^{\mu\nu}F_{\alpha\beta}F^{\alpha\beta}\right] \tag{6.14}$$

Where $F^{\mu\nu}$ is the electrogravitational tensor and $\eta_{\mu\nu}$ is the Minkowski metric tensor with signature $(- + + +)$. This tensor can be expressed in matrix form as:

$$T^{\mu\nu} = \frac{1}{c}\begin{bmatrix} \frac{c}{2}\left(\varepsilon_{\mathrm{g}}\mathrm{g}^2 + \frac{1}{\mu_{\mathrm{g}}}\mathrm{K}^2\right)\delta_{ij} & \mathrm{S}x & \mathrm{S}y & \mathrm{S}z \\ \mathrm{S}x & c\sigma_{xx} & c\sigma_{xy} & c\sigma_{xz} \\ \mathrm{S}y & c\sigma_{yx} & c\sigma_{yy} & c\sigma_{yz} \\ \mathrm{S}_z & c\sigma_{zx} & c\sigma_{zy} & c\sigma_{zz} \end{bmatrix} \tag{6.15}$$

where the S_i are the components of the Poynting vector (4.18), $\mathbf{g}$ and $\mathbf{K}$ are the gravitational and cogravitational fields given by equations (4.12-4.13), and σ_{ij} is the electrogravitational stress tensor, which takes the form:

$$\sigma_{ij} = \frac{\mu_e c^4}{16\pi^2 GK}\mathbf{g}_{\mathrm{i}}\mathbf{g}_{\mathrm{j}} + \frac{\mu_e c^6}{16\pi^2 GK}\mathbf{K}_{\mathrm{i}}\mathbf{K}_{\mathrm{j}} - \frac{1}{2}\frac{\mu_e c^4}{16\pi^2 GK}(\mathbf{g}^2 + c^2\mathbf{K}^2)\,\delta_{ij} \tag{6.16}$$

$$\sigma_{ij} = \varepsilon_{\mathrm{g}}\mathbf{g}_i\mathbf{g}_j + \frac{1}{\mu_{\mathrm{g}}}\mathbf{K}_i\mathbf{K}_j - \frac{1}{2}\left(\varepsilon_{\mathrm{g}}\mathbf{g}^2 + \frac{1}{\mu_{\mathrm{g}}}\mathbf{K}^2\right)\delta_{ij} \tag{6.17}$$

The dependence on conversion factors, and consequently on the fine-structure constant α, of all the terms present in the equations presented so far, is implicit.

6.2 Derivation of the Electrogravitational Field Equations

In the last months of 1915, Hilbert sought to provide an elegant and general formulation of gravity based on the principle of least action, drawing inspiration both from differential geometry and from Einstein's parallel work. His idea was to find a Lagrangian that was a scalar constructed from the metric $g_{\mu\nu}$ and its derivatives up to second order, in order to ensure general covariance and to produce equations containing second derivatives, as required by the physics of gravity. Analyzing the possibilities offered by geometry, Hilbert realized that the only natural scalar satisfying these requirements was the curvature scalar R, obtained by contracting the Ricci tensor, which in turn derives from the Riemann tensor. Furthermore, to ensure that the action integral was invariant under general coordinate transformations, Hilbert included the factor $\sqrt{-g}$, thus obtaining his famous Lagrangian $\mathcal{L}_{grav} = \sqrt{-g}R$. Hilbert chose the simplest and most consistent Lagrangian suggested by the geometric structure and physical principles. Later, by adding the matter Lagrangian $\mathcal{L}_{mat}$, he obtained the complete action, from which, using the principle of variation, the Einstein field equations can be derived. In the electrogravitational case, we can start directly from the Lagrangian of the electrogravitational field $\mathcal{L}_{EG}$, which is:

$$\mathcal{L}_{EG} = \frac{\mu_e c^4}{16\pi^2 GK}\frac{1}{4}F_{\alpha\beta}F^{\alpha\beta} \tag{6.18}$$

In the weak-field limit, it is assumed that spacetime is nearly flat:

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu}, |\, h_{\mu\nu} \,| \ll 1 \tag{6.19}$$

where $\eta_{\mu\nu}$ represents the flat Minkowski metric and $h_{\mu\nu}$ is a small perturbation of the electrogravitational field. In this limit, the curvature is linear in the second derivatives of $h_{\mu\nu}$. The electrogravitational potentials are defined as:

$$A^0 = \frac{\phi}{c}, A^i = (A_x, A_y, A_z) \tag{6.20}$$

The gravitational field **g** and the cogravitational (gravitomagnetic) field **K** are:

$$\mathbf{g} = -\nabla\phi - \frac{\partial \mathbf{A}}{\partial t}, \mathbf{K} = \nabla \times \mathbf{A} \tag{6.21}$$

These are exactly the components of $F_{\alpha\beta}$:

$$F_{0i} = -\frac{\mathrm{g}_i}{c}, F_{ij} = -\epsilon_{ijk}\mathrm{K}_k \tag{6.22}$$

In the weak-field limit, the curvature scalar R can be written in terms of $h_{\mu\nu}$ as:

$$R \approx \partial_i \, \partial_i h_{00} - \partial_i \, \partial_j h_{ij} \text{ (linearized)} \tag{6.23}$$

Here $h_{00} \sim 2\phi/c^2$, and $h_{0i} \sim A_i/c$. Substituting the relations with **g** and **K**:

$$R \sim \nabla \cdot \mathbf{g} + (\nabla \times \mathbf{A})^2 \sim \frac{\mathbf{g}^2}{c^2} - \mathbf{K}^2 \tag{6.24}$$

Recalling that these fields are related to $F_{\alpha\beta}F^{\alpha\beta}$as follows:

$$\frac{1}{4} F_{\alpha\beta}F^{\alpha\beta} = \frac{1}{2}\left(\frac{\mathbf{g}^2}{c^2} - \mathbf{K}^2\right) \tag{6.25}$$

One then obtains:

$$R \sim \ \frac{1}{2c^2} F_{\alpha\beta}F^{\alpha\beta} \tag{6.26}$$

In conclusion, the electrogravitational Lagrangian $\mathcal{L}_{EG}$ and the electrogravitational Hilbert Lagrangian $\mathcal{L}_H$ are related, with the latter being derivable from the former.

$$\mathcal{L}_H = \frac{\mu_e c^6}{32\pi^2 GK} R \tag{6.27}$$

This Lagrangian is inserted into the action integral:

$$S = \int \mathcal{L}_H \sqrt{-g} \, d^4x \tag{6.28}$$

By varying it with respect to the metric, $\delta S/\delta g_{\mu\nu} = 0$, we obtain the field equations:

$$\frac{\mu_e c^6}{32\pi^2 GK}\left(R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R\right) = T_{\mu\nu} \tag{6.29}$$

By inverting this, we obtain the electrogravitational Einstein field equations.

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = \frac{32\pi^2 GK}{\mu_e c^6} T_{\mu\nu} \tag{6.30}$$

The constant can be simplified, and thus it reduces to the Einsteinian one. *Of course, the dependence of the various terms on their respective conversion factors is implicit.

7. Quantization of Einstein's field equations

7.1 ELECTROGRAVITATIONAL FIELD EQUATIONS

Einstein's field equations [6] describes the gravitational field through the curvature of spacetime caused by the presence of matter and energy (stress-energy tensor $T_{\mu\nu}$).

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \tag{7.1}$$

Here, $R_{\mu\nu}$ represents the Ricci curvature tensor, R is the scalar curvature, $g_{\mu\nu}$ is the metric tensor, $T_{\mu\nu}$ is the stress-energy tensor, and Λ is the cosmological constant. The term Λ was introduced by Einstein to account for a static universe. However, observations by Hubble [23] in subsequent years showed that the universe was expanding, leading to the removal of the Λ term. In the current view [43], the cosmological constant plays the role of a large-scale antigravitational force (dark energy). However, its interpretation as dark energy is misleading. Firstly, we have seen that dark energy does not exist, and moreover, the universe is not expanding but contracting. Finally, the effects attributable to the cosmological constant manifest not only on a large scale but at every level of physical reality. Therefore, it is necessary to make each term depend on its respective conversion factor, subscript (f), and hence on the fine structure constant α. This way, the cosmological constant Λ is spread across the entire field equation (a constant term $\xi_{(f)}$ can be retained and interpreted as a multiverse constant within the Matrioshka Multiverse Theory; 11.2). Furthermore, in electrogravitational theory, the proportionality constant is rearranged to emphasize the constants K and μ_e, which are characteristic of electromagnetism.

$$R_{\mu\nu(f)} - \frac{1}{2} g_{\mu\nu(f)} R_{(f)} = \frac{32\pi^2 G_{(f)} K_{(f)}}{\mu_{e(f)} c_{(f)}^6} T_{\mu\nu(f)} \tag{7.2}$$

The left-hand side of the equation remains unchanged (even in its derivation, as we just saw [6]) compared to that developed by Einstein: all terms present are continuous quantities. The right-hand side, however, is quantized. Quantization of the left-hand side is achieved by taking the length unit l_u from the tensor $T_{\mu\nu}$ (which can only take values between l_S and l_P), and placing its square in the numerator on the left-hand side, allowing for discretization of the elements $R_{\mu\nu}$, $g_{\mu\nu}$ and R. This results in a fully quantized (and dimensionless) version of the electrogravitational field equation. We proceed by substituting the expressions for the fields **g** and **K** (4.12-4.13) into the Poynting vector (4.18) and into the stress tensor (6.16-6.17), and then insert these into the stress-energy tensor $T_{\mu\nu}$ (6.15). This ensures that the square of the length unit appears in the denominator of all components present in the stress-energy tensor.

$$l_{u(f)}^2 R_{\mu\nu(f)} - \frac{l_{u(f)}^2}{2} g_{\mu\nu(f)} R_{(f)} = \frac{32\pi^2 G_{(f)} K_{(f)}}{\mu_{e(f)} c_{(f)}^6} l_{u(f)}^2 T_{\mu\nu(f)} \tag{7.3}$$

These electrogravitational field equations can then be expressed in a compact form, with the proportionality constant included within the stress-energy tensor $\bar{T}_{\mu\nu}$:

$$l_{u(f)}^2 G_{\mu\nu(f)} = l_{u(f)}^2 \bar{T}_{\mu\nu(f)} \tag{7.4}$$

In this equation, $1/l_{u(f)}^2$ represents the "curvature quantum", expressed in terms of the minimum measurable length (l_u represents both the radius of the elementary electric charge, and the binding distance between the charges of the graviphoton, see 8.7), $G_{\mu\nu}$ is the Einstein tensor, and $\bar{T}_{\mu\nu}$ is the stress-energy tensor, which includes the proportionality constant. Additionally, it is possible to discretize the terms $R_{\mu\nu}$ and $g_{\mu\nu}$ based on the wavelength λ of the electrogravitational wave. Thus, since the proportionality constant includes the speed of light c^6 in the denominator, it suffices to substitute $c^2 = \lambda^2 v^2$, and then bring the term λ^2 to the denominator on the left-hand side. The solutions [51] of Einstein's field equation are represented by spacetime metrics. In the electrogravitational case, since the field equation is quantized, the solutions are also found to be quantized. These solutions enable the treatment of phenomena from both relativistic and quantum-mechanical perspectives.

7.2 Gravitoelectric field equations

In Chapter 4, we saw that the electrogravitational equations (4.8-4.11) can be inverted into gravitoelectric equations (4.8b-4.11b; paragraph 5.4). These are derived

$$q_i = z_i q_e = z_i \sqrt{\frac{m_S c^2 l_S}{K}} \qquad (z_i \in \mathbb{Z}) \tag{3.4b}$$

by inverting the formula for the electric potential energy (3.3). Since the quantities under the square root are positive, and the square root of a positive quantity is always positive, both signs can be considered by letting ($z_i \in \mathbb{Z}$). *Alternatively, it is possible to vary the sign of m_S. As in the electrogravitational case, gravitoelectric fields can also be described in terms of scalar and vector potentials. Similarly, it is possible to define a gravitoelectric-type stress-energy tensor. In this case as well, the quantization of the field equation is achieved by isolating the length unit from the various terms of the stress-energy tensor and placing it in the numerator on the left side of the equation, thereby reaching a situation analogous to the previous one (7.3).

7.3 NEWTONIAN AND COULOMBIAN LIMITS

To obtain Newton's law (and then Coulomb's law), we consider the case in which the gravitational field is weak and the velocities are much smaller than *c*. In this case, the metric tensor can be written as a small perturbation of the Minkowski tensor:

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu}, | h_{\mu\nu} | \ll 1 \tag{7.5}$$

where $\eta_{\mu\nu} = \mathrm{diag}(-1, +1, +1, +1)$ is the flat metric. To first approximation (that is, neglecting quadratic terms in $h_{\mu\nu}$), Einstein's equation becomes linearized as:

$$\Box \bar{h}_{\mu\nu} = -\frac{64\pi GK}{\mu_e c^6} T_{\mu\nu} = -\frac{16\pi G}{c^4} T_{\mu\nu} \tag{7.6}$$

where $\bar{h}_{\mu\nu} = h_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu} h$ (con $h = h^{\alpha}_{\alpha}$). Let us consider the static and non-relativistic case. For a static field and for non-relativistic matter, the only relevant component of the energy–momentum tensor is $T_{00} \approx \rho_m c^2$, where ρ_m is the mass density. Under these conditions, the only relevant component of the equation is:

$$\nabla^2 \bar{h}_{00} = -\frac{64\pi GK}{\mu_e c^4} \rho_m = -\frac{16\pi G}{c^2} \rho_m \tag{7.7}$$

From the weakly perturbed metric, the proper time of a particle at rest is:

$$ds^2 = g_{00} c^2 dt^2 \approx -(1 - h_{00}) c^2 dt^2 \tag{7.8}$$

In Newtonian case, the gravitational potential Φ appears in the slow-motion limit as:

$$ds^2 \approx -(1 + 2\Phi/c^2) c^2 dt^2 \tag{7.9}$$

where $h_{00} = -2\Phi/c^2$. Since that in the harmonic gauge $\bar{h}_{00} \approx h_{00}/2$, we obtain:

$$\nabla^2 \Phi = 4\pi G \rho_m = \frac{4\pi GK}{c^2} \frac{q_e^2}{l_S} \rho_n \tag{7.10}$$

that is the gravitational Poisson equation. From this, Newton's law can be derived, since $\boldsymbol{F}_g = -m\nabla\Phi$. In the electrogravitational case, given that $\rho_n = 2\rho_z$, we can rearrange relation 7.10 to obtain 7.11. We then derive Coulomb's law, $\boldsymbol{F}_e = -q\nabla\Phi'$.

$$\nabla^2 \Phi' = -4\pi\sqrt{K m_S c^2 l_S}\, \rho_z = -4\pi K \rho_q \tag{7.11}$$

7.4 Gravitational waves

In the classical treatment of gravitational waves, one usually starts by linearizing the metric around a flat background, considering a small perturbation $h_{\mu\nu}$ relative to the Minkowski metric $\eta_{\mu\nu}$. In this context, it is often assumed that $T_{\mu\nu} = 0$. This corresponds to free waves propagating in vacuum. This approximation is consistent at the linear order and allows for simple propagation equations in which the perturbations oscillate without direct involvement of matter. However, this derivation overlooks several fundamental features of gravitational waves and their relation to matter and spacetime. When matter loses energy to gravitational waves, the divergence $\nabla^{\mu} T_{\mu\nu}$ must have a positive component, as part of the energy and momentum of the matter is transferred to the gravitational field. This transfer is quantized in electrogravitational theory in terms of gravitons (graviphotons), making it clear that the condition $T_{\mu\nu} = 0$ can only be applied globally. Furthermore, the propagation of the gravitational wave itself involves a self-sourcing mechanism: the wave carries energy and momentum through spacetime and, due to the curvature it generates, effectively acts as a source for its own propagation. In this sense, spacetime cannot be considered "empty" even far from material sources. Therefore, while the classical derivation assuming $T_{\mu\nu} = 0$ is useful for studying linear free waves, it represents an approximation that does not capture the local conversion of matter into gravitational energy, the quantized nature of this transfer, nor the self-sourcing mechanism inherent in its propagation. From the electrogravitational perspective, this can be solved in terms of positive and negative divergence of the stress energy tensor $\nabla^{\mu} T_{\mu\nu} = 0^{*}$. The positive divergence corresponds to localized generation of energy and momentum by the propagating wave itself, whereas the negative divergence reflects the traditional attractive curvature associated with mass or components of the wave that locally "pull" spacetime. Over sufficiently large scales, these contributions compensate, yielding a net divergence of zero 0^{*}. This does not imply that the field vanishes; rather, it illustrates that gravitational waves maintain their energy-momentum through an intrinsic, self-sustaining mechanism. In particular, when gravitational waves are generated, for example by a system composed of two rotating black holes, they cannot simply evaporate into waves of nothing. Instead, as we have seen, since the tensor $T_{\mu\nu}$ is quantized, they can emit radiation only as multiples of the elementary electric dipole (a couple of charged singularities), and therefore as *gravitophotons*. A positive term in the divergence indicates that the mass (in the example, that of a couple of massive black holes) is evaporating, and since this process is quantized, it can only occur as a multiple of elementary dipoles. Thus, any mass emitting gravitational waves is in fact giving up part of itself in the form of photons. In conclusion, the only factors that "distinguish" gravitational waves from electromagnetic waves are their wavelength and mutual coherence. When electrogravitational waves have a small λ, electromagnetic effects dominate, whereas when λ is large, variations in the **E** and **B** fields become imperceptible, and gravitational effects (spacetime deformations) prevail.
*Obviously, being the same phenomenon, the gravitational wave energy is $E = h\nu$.

7.5 Gravity as an emergent phenomenon

Newton's theory of gravitation describes with great precision most phenomena within the Solar System, but it presents experimental limitations: it assumes instantaneous action at a distance and relies on absolute space and time, concepts later superseded by special relativity, which shows that simultaneity is relative and interactions must propagate through fields at finite speed. Moreover, Newtonian gravity does not correctly explain the precession of Mercury's perihelion or the deflection of light by massive bodies, nor does it clarify the equivalence principle between inertial and gravitational mass. Einstein, with general relativity, redefined gravity not as a force, but as the curvature of spacetime caused by mass and energy, where bodies follow geodesic trajectories that determine their motion. This theory successfully explains Mercury's precession and phenomena such as gravitational lensing, in which light is bent by concentrated masses. In recent decades, alternative theories have been proposed to reconcile gravity and quantum mechanics, such as string theory, loop quantum gravity, and Erik Verlinde's hypothesis, according to which gravity is an emergent phenomenon of entropic nature, arising from the tendency of systems to evolve toward states of greater disorder. In this framework, spacetime and gravity are the result of microscopic statistical processes: when a mass moves or occupies a certain position, it alters the distribution of microscopic information and the entropic state of the surrounding spacetime, and this variation generates a macroscopic effect that we perceive as gravity. This approach draws inspiration from statistical mechanics and thermodynamics, in much the same way that concepts such as temperature or pressure emerge from the collective behavior of molecules, which individually do not possess these properties. Even within electrogravitational theory, gravity can be interpreted as an emergent phenomenon, arising from electromagnetic interactions at the elementary level. As previously anticipated, and as we will explore in greater detail in the next chapter, all particles, and therefore all matter, are composed of elementary electric charges (quantum singularities). From this perspective, gravity is nothing more than the collective effect of electric and magnetic interactions among these elementary charges. We have already seen that gravitational and electromagnetic waves represent two aspects of the same phenomenon, the electogravitational waves. Whether the behavior manifests as "gravitational" or "electromagnetic" depends solely on wavelength and relative phases, which can lead to the dilution or even cancellation of electromagnetic fields. The same principle also applies to macroscopic masses. Since all matter is made up of elementary charges and is, on average, electrically neutral (a macroscopic electric field arises only when there is a slight imbalance in the distribution of charges), what emerges are the gravitational effects of elementary electric charges. In this way, what Einstein described as a deformation of the spacetime fabric can be understood, at the quantum level, as the effect of many small deformations produced by individual quantum singularities. Consequently, the macroscopic curvature of spacetime (i.e., the gravitational field) emerges as a phenomenon resulting from the collective cancellation of electric and magnetic fields of charges at the quantum level.

7.6 Quantum Singularities

Einstein's field equations describe how space and time are deformed by matter and energy. In general, solving them means finding mathematical models of spacetime that are consistent with a certain distribution of matter or with a vacuum. Some solutions have become milestones in physics, as they represent ideal situations that help us understand real phenomena. The Schwarzschild solution is the simplest and most famous one. It describes spacetime around a spherical, motionless, and non-rotating body. The Reissner–Nordström solution is a version of the Schwarzschild solution for an object that carries an electric charge. When one instead considers a body that, in addition to being massive, also rotates on itself, one obtains the Kerr solution. Astrophysical black holes are very well described by this solution. Then there is the Kerr–Newman metric, which extends the Kerr metric to a charged black hole. It represents the most general, asymptotically flat, and stationary solution of the Einstein–Maxwell equations in general relativity. We are told that the Kerr–Newman metric has mainly a theoretical role, since observed celestial objects do not show a significant net charge. In the case of elementary electric charges, which constitute elementary particles and, by combining, the entire reality, since these are Spin-0 charged singularities, they are described by the Reissner–Nordström metric.

7.7 Spacetime as Water in an Aquifer

In electrogravitational theory, spacetime behaves like a fluid, analogous to water flowing through an aquifer, except here we are in four dimensions. Electric fields emerge from spacetime flows toward or away from singularities: an excess of negative charges (quantum black holes) generates a converging flow, while an excess of positive charges (quantum white holes) generates a diverging flow. In fact, the divergence of the electric field is physically the divergence of a force normalized with respect to a test charge. The greater is the electric field, the greater is the flow of spacetime (incoming or outgoing), analogous to water being emitted from springs or falling into wells. When positive and negative charges are present in large numbers, electromagnetic effects tend to cancel out, allowing gravitational ones to emerge. In general relativity, the spacetime curvature is illustrated as a deformed surface, which in this case is identified with the piezometric surface. Since springs and wells are the ones deforming the piezometric surface through their flows, which remain deformed even when the flows are mutually balanced, this implies that electromagnetic fields are the ones responsible for the emergence of gravity. Dark matter and dark energy are also phenomena related to spacetime. Dark matter (it would be more accurate to call it dark gravity) is due to the slope of spacetime as it falls toward black holes, whereas in the case of white holes (the two are equivalent) the slope of spacetime causes, as in the case of the universe, a negative outward slope (dark energy). Finally, the connection between two correlated quantum singularities ($ER = EPR$) can be interpreted as flows of spacetime infiltrating another "parallel" dimension (still four-dimensional) through a (quantized) wormhole (shortcut), and then re-emerging on the other side while carrying correlated (dual) information.

7.8 Singularities as Sources and Sinks of Spacetime

We have seen how black holes produce a depression in the fabric of spacetime, similar to the cone of depression that forms on the piezometric surface around a pumping well. To simplify the analysis, we have assumed that this cone converges linearly (and therefore the conversion factors as well). *In the case of the entire observable universe, this is an excellent approximation even for enormous distances. In reality, it is characterized by a formula analogous to the *Dupuit-Thiem equation* (which in hydrogeology describes groundwater flow toward a well in an unconfined aquifer under steady-s. conditions) and to the *coupling constants* in QED/QCD. This is because, in this case, both describe the exact same phenomenon! Spacetime can be treated as a fluid that either flows into or emerges from a singularity. In this sense, white and black holes behave, respectively, as sources or sinks of spacetime (it is precisely these flows of spacetime that generate the local electric fields $\boldsymbol{E}^{+/-}$, which are then transmitted through photons). Once the cone of influence of the singularity is known, by treating the speed of the light (or the difference between the effective $c_{(f)}$ and local speed c) as the analogue of hydraulic conductivity (both have units of m/s), it is possible to calculate the spacetime flow rate Q, expressed in m^3/s, and then the spacetime "volume" in m^3 flowing into or emerging from that singularity.

$$Q = \frac{\pi K(H^2 - h_{(r)}^2)}{\ln\left(\frac{R}{r}\right)} = \frac{\pi c(H^2 - h_{(r)}^2)}{\ln\left(\frac{R}{r}\right)} \tag{2.8}$$

Here, Q is the spacetime flux, which is positive for a black hole and negative for a white hole, $K = c$ is the spacetime conductivity, analogous to hydraulic one, H is the undisturbed "thickness" of the spacetime (at a distance R, equal to the radius of influence, which is the distance at which the effects related to the singularity are no longer felt), $h(r)$ is the "thickness" of the spacetime at radial distance R from the black hole (white hole) with radius r. Inverting this equation, we obtain the relation:

$$h(r) = \sqrt{H^2 - \frac{Q}{\pi K}\ln\left(\frac{R}{r}\right)} = \sqrt{H^2 - \frac{Q}{\pi c}\ln\left(\frac{R}{r}\right)} \tag{2.9}$$

which describes the height $h(r)$ of the spacetime slope at distance r. Obviously, if Q is positive (black hole), a depression cone occurs; otherwise, there is an elevation (white hole). Thus, the only difference between the two is the sign preceding the second term, which reflects whether the flux is divergent (source) or convergent (sink). The connection between a black hole and a white hole ($ER = EPR$) gives rise to a net zero flow. Clearly, it is possible to define an equation analogous to 2.9 for every constant and physical quantity, thereby obtaining a precise characterization of the variation in conversion factors relative to the observation distance. In this manner, it is also possible to define an equation for the fine structure contsant α.

7.9 THE EQUIVALENCE PRINCIPLE

The equivalence principle constitutes one of the conceptual foundations of general relativity. Its formulation originated from the empirical observation of the equality between inertial mass and gravitational mass, from which the universality of free fall follows. Einstein elevated this experimental evidence to the status of a fundamental physical principle, recognizing that a freely falling observer, within a sufficiently small region of spacetime, cannot locally distinguish between the effects of a gravitational field and those experienced in a gravity-free inertial frame. Equivalently, the effects of a uniformly accelerated reference frame are locally indistinguishable from those produced by a uniform gravitational field. It follows that, within a sufficiently small region of spacetime, it is always possible to introduce a locally inertial reference frame in which the laws of physics assume the form of special relativity. Several formulations of the equivalence principle can be distinguished. The weak equivalence principle states that the trajectory of a freely falling test body is independent of its internal structure and composition, expressing the principle of the universality of free fall. The Einstein equivalence principle extends this property to all local non-gravitational experiments, requiring local Lorentz invariance and local position invariance. Finally, the strong equivalence principle generalizes the principle by including gravitational experiments and self-gravitating bodies, requiring that the same properties hold independently of the gravitational binding energy of the system. In conclusion, the equivalence principle implies that the gravitational field can be locally eliminated through an appropriate choice of reference frame. In the electrogravitational theory, the fundamental constituents are the elementary electric charges (quantum singularities). Therefore, within this framework, there is no ontological distinction between "particles" and "spacetime". Furthermore, all information is encoded in the global parameters of mass and charge, and there are no additional contributions arising from internal configurations or non-geometrical parameters. The dynamics of the interaction between charges is therefore reduced to the interaction between spacetime curvature (gravitational fields) and flows (electric fields). In this context, the equivalence principle emerges as a direct consequence of the fundamental geometrical nature of the quantum singularities. In conclusion, the weak equivalence principle (all trajectories are independent of composition) is automatically satisfied, since all matter is constituted by elementary electric charges. Furthermore, the Einstein equivalence principle (the standard formulation within general relativity), which implies free fall independent of the type of test body and the local equivalence between inertial and gravitational motion is also satisfied. Moreover, within electrogravitational theory, something even stronger occurs: there are no physical entities capable of violating the principle itself, since all matter is constituted by quantum singularities (quanta of spacetime curvature). The dynamics is therefore necessarily described by spacetime geodesics. In this way, the eq. principle is neither a hypothesis nor an emergent property, but a structural identity, and the principle is transformed into an "equivalence theorem".

8. Elementary particles

8.1 Introduction

Throughout history, our understanding of the structure of matter has undergone a gradual evolution. Around 450 BC, the philosopher Empedocles proposed the hypothesis that the world was composed of four fundamental elements: fire, earth, water, and air. He suggested that by combining these four elements, it was possible to generate every type of substance. Almost simultaneously, Democritus proposed the idea that matter was instead made up of indivisible particles which he called atoms. The existence of atoms was confirmed in the early 1900s [7]. With this discovery, it seemed that the mystery of matter had finally been solved. However, subsequent experiments revealed that atoms themselves had an internal structure consisting of protons, neutrons, and electrons. It was later discovered that even protons and neutrons could be further divided. Gradually, numerous other particles were discovered, especially through the use of accelerators. These particles were then classified into elementary and non-elementary based on whether they have an internal structure. This led to the formulation of what we now know as the Standard Model [52]. As currently formulated, however, this theory is incomplete. Firstly, it describes only three of the four fundamental interactions separately: electromagnetic, weak, and strong nuclear forces (*actually, an electroweak unification has already been defined). Within it are classified particles such as quarks and gluons, which, as we will see, are not "elementary". Furthermore, the photon and the graviton represent the same particle, the graviphoton $g\gamma^0$: thus, it is possible to include gravitational interaction and General Relativity in the Standard Model. Additionally, elementary electric charge must also be included in the model, as it is a fundamental unit from which all other particles derive. Morover, we also know that the Standard Model fails to predict certain physical phenomena, including baryon asymmetry: in fact, on average, at the elementary level, there is as much matter as antimatter (the number of negatively charged elementary electric charges is exactly* equal to the number of positively charged elementary electric charges). In this way baryon asymmetry reduces to positional asymmetry (mutual arrangement of elementary electric charge and particles). Furthermore, the Standard Model does not account for the accelerated expansion (contraction) of the universe (matter), as it does not propose any particle for dark matter: as we have seen, such a particle cannot exist, simply because dark matter does not exist. Finally, it does not provide any explanation as to why elementary particles are exactly those and why they have those characteristics.

8.2 The internal structure of elementary particles

The electrogravitational theory tells us that the graviphoton $g\gamma^0$ is formed by the union of two elementary electric charges of opposite sign. Therefore, since all matter can be converted into graviphotons (photons), everything that exists in the universe is composed of elementary electric charges. In this way, analogous to atoms, which can be traced back to their progenitor, the hydrogen atom, elementary particles can be traced back to the elementary electric charge $q_e^{-/+}$. Inside atoms, electrons are distributed in orbitals. The s orbitals have a spherical shape and are isotropically distributed around the atomic nucleus. In contrast, p orbitals have a dumbbell shape and have three distinct orientations along the coordinate axes. There are also d and f orbitals, although at the elementary level they are not important (?). The difference in shape in the electronic cloud of s and p orbitals is crucial for understanding chemical interactions (bonds). Each s orbital and each p orbital can contain a maximum of 2 electrons, which must necessarily have opposite spins (Pauli exclusion principle). In the case of elementary particles, we find ourselves in a similar scenario (see Paragraph 8.3). Firstly, they do not possess a nucleus (the role of the nucleus is assumed by the charge center). Another distinction lies in the fact that, instead of hosting electrons, the orbitals are filled with elementary electric charges $q_e^{-/+}$. Furthermore, considering that filling occurs at the elementary level, we have only 10 available slots (?), given by the $1s$, $2p$, and $2s$ orbitals (because of the strong force $2p$ level has lower energy than $2s$). In this context, a principle similar to exclusion applies to the sign of charges (and not to spin): in the same orbital, only elementary charges (bosons) of opposite sign (-/+) can coexist. If an orbital is fully filled, we have a neutral elementary particle; if there is an unpaired charge, we have a particle (-) or an antiparticle (+), respectively. With only 10 slots available, there are 10 possible elementary particles (?), 4 bosons and 6 leptons. Quarks are not elementary particles, but "overlapped states" (quasiparticles). The same applies to Gluons. The Higgs boson represents the particle obtained from the hybridization the three $2p$ and the $2s$ orbitals of the Z^0 (from which it derives). His energy* can, at most, be converted into another Z^* boson ($H^0 \rightarrow ZZ^*$ channel). The Higgs boson, being rotationally invariant, has Spin 0. Filling the orbitals of elementary particles leads to a difference of a single electric charge between one particle and the next. Therefore, we can assign to particles (elementary and non-elementary) a parameter analogous to atomic number, the charge number (n_c). This parameter tells us how many charges a particle is composed of, regardless of their sign. The elementary electric charge $q_e^{-/+}$ has ($n_c = 1$), the graviphoton $g\gamma^0$ ($n_c = 2$), the electron $e^{-/+}$ ($n_c = 3$), the electron neutrino ν_e ($n_c = 4$), the muon $\mu^{-/+}$ ($n_c = 5$), the muon neutrino ν_μ ($n_c = 6$), the tauon $\tau^{-/+}$ ($n_c = 7$), and the tau neutrino ν_τ ($n_c = 8$). The $W^{-/+}$ ($n_c = 9$) and Z^0 ($n_c = 10$). The Higgs boson, deriving from the Z^0 boson, also has ($n_c = 10$). For Quarks and Gluons, we will see later how to calculate their charge numbers (we can anticipate that the charge numbers of quarks are fractional).

8.3 ELEMENTARY ORBITALS

In 1924, Louis de Broglie proposed that each particle could be associated with a wave. This work [10] inspired Schrödinger in formulating his equation, which, in its time-independent form, can be derived directly from the wave equation. Taking into account equation (5.6), time-independent Schrödinger equation is expressed as:

$$-\frac{Z_0^2 q_e^4}{32\pi^2\alpha^2 m}\nabla^2\psi(\boldsymbol{r}) + V(\boldsymbol{r})\psi(\boldsymbol{r}) = E\psi(\boldsymbol{r}) \tag{8.1}$$

In the case of an atom, among the solutions of the Schrödinger equation there are the atomic orbitals. These tell me in which region of space an electron is most likely to be found (the square of the wave function represents the probability density of finding an electron in a particular position). Similarly, when we apply this equation to elementary particles, the solutions include elementary orbitals. These indicate the regions of space where an elementary electric charge is most likely to be found. Thus, analogous to atomic orbitals, elementary orbitals can also be defined. At the elementary level, the electric potential $V(\boldsymbol{r})$ is determined by the electric charges relative to the charge center (elementary particles do not have a nucleus). The number and type of elementary orbitals can be deduced by solving the Schrödinger equation. Here too, we have s and p type orbitals, with the $2p$ level having lower energy than the $2s$. Elementary d and f orbitals are not significant (?). Analogous to atoms, we can define a ***principal quantum number*** n, which determines the orbital's energy, size, and number of radial nodes; an ***azimuthal quantum number*** l, which defines the orbital's shape, angular symmetry, and number of angular nodes; and a ***magnetic quantum number*** m_l, which specifies the orbital's spatial orientation; According to the Pauli exclusion principle, each atomic orbital can contain at most two electrons with opposite spins, as they are fermions. In the elementary case, a similar principle applies to the ***sign of elementary charges***, which can only take two values, ±1. This means that each elementary orbital can contain at most two elementary electric charges of opposite sign. At the elementary level, the Aufbau principle also applies: orbitals are filled starting from those with the lowest energy (ground state), and proceeding towards those with higher energy; if there are "degenerate" orbitals (multiple eigenstates for a single eigenvalue, such as the three p orbitals), Hund's rule applies also in this case (?); according to this rule, in the atomic case, electrons preferentially occupy orbitals to maximize the number of unpaired electrons. The arrangement of elementary electric charges in the orbitals of elementary particles constitutes their electronic configuration, which determines their geometry and interaction capability (type of force) of the elementary particle.

8.4 ELEMENTARY PARTICLES

Bosons are *elementary particles* whose outer shell is formed by s-type (spherical) orbitals. The spherical shape of the orbital gives bosons integer spin. These characteristics allow them to adhere to Bose-Einstein statistics and to interact more easily with other particles: they are carriers of the four fundamental forces. In the case of force interactions, bosons act as carriers of charges and masses, binding other particles together. There are 4 bosons: the elementary electric charge $q_e^{-/+}$ $(1s^1)$, the graviphoton $g\gamma^0$ $(1s^2)$, the $W^{-/+}$ $(1s^2 2p^6 2s^1)$, and the Z^0 $(1s^2 2p^6 2s^2)$. If the s orbital is fully occupied, we have a neutral boson; otherwise, a charged one (whether it is a particle or antiparticle depends on the sign of the unpaired charge). **Leptons** are *elementary particles* whose outer shell is composed of p-type (double-lobed) orbitals. The elongated shape of the orbital gives leptons half-integer spin. These characteristics allow them to adhere to Fermi-Dirac statistics. There are 6 leptons: the electron $e^{-/+}$ $(1s^2\,2p^1)$, the electron neutrino ν_e $(1s^2\,2p^2)$, the muon $\mu^{-/+}$ $(1s^2\,2p^3)$, the muon neutrino ν_τ $(1s^2\,2p^4)$, the tauon $\tau^{-/+}$ $(1s^2\,2p^5)$, and the tau neutrino ν_τ $(1s^2\,2p^6)$. If the orbital is fully occupied, we have a neutral lepton; otherwise, a charged one. Complete filling of a p orbital gives neutrinos a strong directionality, making them less likely to interact with other particles. The nature of the charged lepton depends on the sign of the unpaired charge in the orbital, resulting in a particle if negative and an antiparticle if positive. Leptons also act as mediators: the electron mediates in bonds and chemical reactions by carrying the bonding force. The **Higgs Boson** corresponds to the *elementary particle* obtained from the Z^0 boson through the hybridization of the $3p$ orbitals with the $2s$ orbital. To hybridize the Z^0 boson, energy must be supplied to overcome the energy barrier required to mix the orbitals. The Higgs particle has a body-centered cubic configuration (?), with the center occupied by the $1s$ orbital. In the outer shell, $sp3$ hybridization gives the particle a symmetry that is invariant under rotation (at quantum level) in a 3+1-dimensional space (Spin 0). In the Higgs boson, all 8 states, the 8 vertices of the cubic elementary cell, are occupied, making it physically impossible to occupy others to “create” additional elementary particles?. Quarks are quasiparticles. In fact, breaking down a proton or neutron into three parts (asymmetrically) is like breaking down a cyclopropene molecule into three parts (a molecule with asymmetric electron sharing) and saying that the carbon atom not involved in the double bond (which has a lower charge density) is different from the other two carbon atoms. This is true only in the cyclopropene molecule. The same applies to the elementary particles constituting protons and neutrons (leptons with $n_c = 3$). Therefore, to continue using the rules of Quantum Chromodynamics (QCD), we must redefine both the concept of Quark and Gluon. Quarks are simply leptons that share a free elementary electric charge (quantum singularity). Thus, the free electric charge is shared (delocalized) among the leptons (3 in the case of protons and neutrons). **Quarks**. The *up quark* is that quasiparticle (overlapping state) that spends $2/3$ of its existence as a free lepton, a free positron ($n_c = 3$), and $1/3$ bound to the delocalized negative charge, and thus as a gluon ($n_c = 3 + 1$). Thus, the average charge of the up quark is $+2/3$ and its average charge number ($n_c = 3.3\overline{3}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the positron (Spin 1/2). The *down quark* is that quasiparticle that spends $1/3$ of its existence as a free lepton, a free electron ($n_c = 3$), and $2/3$ bound to the positive delocalized charge, and thus as a gluon ($n_c = 3 + 1$). Thus, its average charge is $-1/3$ and its average charge number ($n_c = 3.6\overline{6}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the electron (Spin 1/2). The *charm quark* is that quasiparticle that spends $2/3$ of its existence as a lepton, a free muon μ^+ ($n_c = 5$), and $1/3$ bound to the delocalized negative charge, and thus as a gluon ($n_c = 5 + 1$). Thus, its average charge is $+2/3$ and its average charge number ($n_c = 5.3\overline{3}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the muon μ^+ (Spin 1/2). The *strange quark* is that quasiparticle that spends $1/3$ of its existence as a lepton, a free muon μ^- ($n_c = 5$), and $2/3$ bound to the positive delocalized charge, and thus as a gluon ($n_c = 5 + 1$). Thus, its average charge is $-1/3$ and its average charge number ($n_c = 5.6\overline{6}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the muon μ^- (Spin 1/2). The *top quark* is that quasiparticle that spends $2/3$ of its existence as a lepton, a free tauon τ^+ ($n_c = 7$), and $1/3$ bound to the delocalized negative charge, and thus as a gluon ($n_c = 7 + 1$). Thus, the average charge of the quark is $+2/3$ and its average charge number ($n_c = 7.3\overline{3}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the tauon τ^+ (Spin 1/2). The *bottom quark* is that quasiparticle that spends $1/3$ of its existence as a lepton, a free tauon τ^- ($n_c = 7$), and $2/3$ bound to the delocalized positive charge, and thus as a gluon ($n_c = 7 + 1$). Thus, its average charge is $-1/3$ and its average charge number ($n_c = 7.6\overline{6}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the tauon τ^- (Spin 1/2). **Antiquarks**. The *antiquark up* is that quasiparticle (overlapping state) that spends $2/3$ of its existence as a free lepton, a free electron ($n_c = 3$), and $1/3$ bound to the delocalized positive charge, and thus as a gluon ($n_c = 3 + 1$). Thus, the average charge of the antiquark up is $-2/3$ and its average charge number ($n_c = 3.3\overline{3}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the electron (Spin 1/2). The *antiquark down* is that quasiparticle that spends $1/3$ of its existence as a free lepton, a free positron ($n_c = 3$), and $2/3$ bound to the negative delocalized charge, and thus as a gluon ($n_c = 3 + 1$). Thus, its average charge is $+1/3$ and its average charge number ($n_c = 3.6\overline{6}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the positron (Spin 1/2). The *antiquark charm* is that quasiparticle that spends $2/3$ of its existence as a lepton, a free muon μ^- ($n_c = 5$), and $1/3$ bound to the delocalized positive charge, and thus as a gluon ($n_c = 5 + 1$). Thus, its average charge is $-2/3$ and its average charge number ($n_c = 5.3\overline{3}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the muon μ^- (Spin 1/2). The *antiquark strange* is that quasiparticle that spends $1/3$ of its existence as a lepton, a free muon μ^+ ($n_c = 5$), and $2/3$ bound to the negative delocalized charge, and thus as a gluon ($n_c = 5 + 1$). Thus, its average charge is $+1/3$ and its average charge number ($n_c = 5.6\overline{6}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the muon μ^+ (Spin 1/2). The *antiquark top* is that quasiparticle that spends $2/3$ of its existence as a lepton, a free tauon τ^- ($n_c = 7$), and $1/3$ bound to the delocalized positive charge, and thus as a gluon ($n_c = 7 + 1$). Thus, the average charge of the antiquark is $-2/3$ and its average charge number

($n_c = 7.3\overline{3}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the tauon τ^- (Spin 1/2). The *antiquark bottom* is that quasiparticle that spends $1/3$ of its existence as a lepton, a free tauon τ^+ ($n_c = 7$), and $2/3$ bound to the delocalized negative charge, and thus as a gluon ($n_c = 7 + 1$). Thus, its average charge is $+1/3$ and its average charge number ($n_c = 7.6\overline{6}$). The delocalized charge does not contribute (**) to the spin of the quasiparticle, which therefore is that of the tauon τ^+ (Spin 1/2). **Gluons** can be interpreted as momentarily bound states (which we can consider analogous to what delocalized electrons form in some organic molecules), of a lepton with a delocalized elementary electric charge (quantum singularity). Their charge number is ($n_{c\,(gluon)} = n_{c\,(lepton)} + 1$), therefore equal to that of the starting charged lepton, to which an additional unit given by the elementary charge must be added. There are three types of gluons: those formed from the electron $e^{-/+}$ ($n_c = 3 + 1$), those formed from the muon $\mu^{-/+}$ ($n_c = 5 + 1$), and those formed from the tauon $\tau^{-/+}$ ($n_c = 7 + 1$). Their charge is always zero, regardless of the type of gluon. Their spin is always one (1), because it depends on the bond. When elementary electric charges are exchanged between leptons, there can be 3·3 = 9 color/anticolor combinations, so the 3 mentioned gluons become 9 (red–red, green–green, blue–blue, etc.). Due to SU(3) symmetry, out of these, 8 gluons are independent, and 1 is the singlet gluon.

8.5 CENTER OF CHARGE AND QUANTUM SINGULARITY

We have seen that elementary particles do not have a true nucleus, and this role is taken by the charge center, located at the center of the spherical $1s$ orbital. In the case of the elementary electric charge, the charge center coincides with the charge itself (each elementary electric charge contracts at speeds greater than that of light). The leptons that make up subatomic particles (protons and neutrons), in turn composed of elementary electric charges, share a central singularity (free elementary electric charge), arranged like celestial bodies in a galaxy, with the difference that, in the case of the quantum singularity, the charges always arrange themselves on the horizon of the singularity. In fact, the rotational velocity of leptons around the singularity is lower (for an external observer) by a factor of about 3.42 per component ($1/\alpha \approx 137$ in total), and their mass is higher by a factor of about 40, because the force that holds them together increases with distance (it can be said that they are subject to the strong force). Another obvious difference is that in galaxies, celestial bodies are bound to each other through the force of gravitational attraction, while the constituents of particles are bound by electric forces. A component that increases with distance is present in both cases (strong or singularity force), due respectively to the black hole and the free elementary electric charge (elementary electric charges are precisely quantum singularities). As we will see, the mass of the proton, much greater than that of the electron, is due to the fact that the 3 leptons (in the form of quarks) constituting the subatomic particle each fall into the cone of influence of the adjacent lepton/quark, (*which does not happen in the case of the

3 charges of the electron as they rotate around their charge center). In this way, the leptons constituting the proton will appear more massive to an external observer. *Actually, it depends on the ratio of the charge numbers between the proton and the electron, since each charge is a singularity, but this explanation is sufficient for now.

8.6 The origin of the elementary electric charges

We have seen that elementary electric charges are quantum singularities. The formation of a black hole (and its CPT-symmetric counterpart white hole) requires the concentration of mass or energy within the corresponding Schwarzschild radius. Zel'dovich and Novikov were the first to hypothesize that, shortly after the Big Bang, the universe was dense enough to allow any given region of space to collapse within its Schwarzschild radius. On the other hand, the Compton wavelength represents the lower limit of the region within which a particle of mass M can be localized. If M is sufficiently small, the Compton wavelength becomes larger than the Schwarzschild radius, preventing the formation of a black hole. For this reason, the theoretical minimum mass of a primordial black (white) hole is approximately the Planck mass. *As we will see later, the mass of a quantum singularity M_{qs} is equal to half of the Stoney/Planck mass, and this leads us to think that elementary electric charges are precisely the singularities (black and white holes) that were supposed to have formed shortly after the Big Bang. Moreover, since by combining they form all visible matter, everything that exists is made of primordial black and white holes. All that the universe has to offer us are black and white holes, which, by combining in various ways, first form elementary particles, then atoms, and finally everything we observe and touch. It may seem strange, but the chair you are sitting on, the desk you are leaning against, the landscape outside your window, the stars in the sky, the water in the bottle at the corner of the table, your computer, the photons reaching your eyes, and even you—all of it is made of quantum black and white holes! Absurd, isn't it?

8.7 The internal structure of the photon (graviphoton)

As we have seen, the photon (graviphoton) is composed of two elementary electric charges of opposite sign (quantum singularities). The positive electric charge is the quantum white hole, while the negative one corresponds to the quantum black hole.

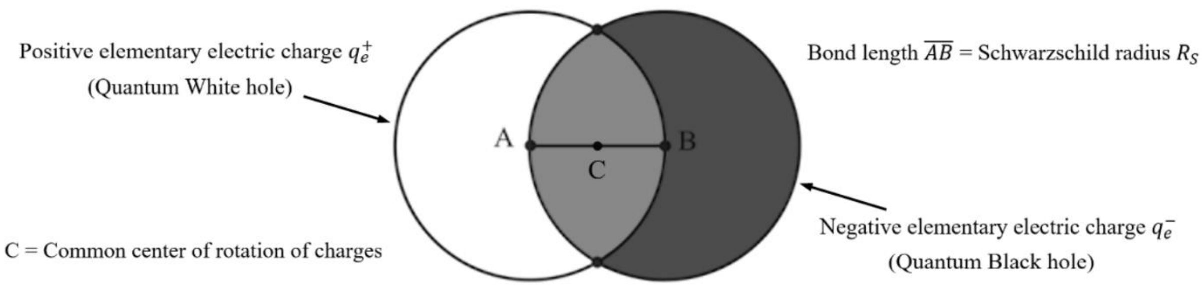


Fig. 7

$$-m_S = \frac{K}{c^2}\frac{q_e^+ q_e^-}{l_S} \approx -1.86 \cdot 10^{-9}\, kg \tag{8.2}$$

We know that the mass of the photon (graviphoton) is zero. This means that there must be a positive component equal to m_S that cancels out $-m_S$. Now, we have said that the two electric charges are quantum singularities (a couple of black and white holes), therefore we can calculate their mass using the Schwarzschild radius formula.

$$R_S = \frac{2GM}{c^2} \tag{8.3}$$

By inverting this formula, we can calculate the mass of the quantum singularity $M = M_{qs} = M_{qbh}$ by substituting into the equation $R_S = l_S \approx 1.38 \cdot 10^{-36}\, m$, given that their radius is equal to the Stoney length l_S. This equation is also valid for white holes $M = M_{qs} = M_{qwh}$, since a white hole is mathematically the CPT-reversed solution of the Schwarzschild metric. Thus, the mass of the quantum singularities is:

$$M_{qs} = \frac{R_S c^2}{2G} = \frac{l_S c^2}{2G} = \frac{m_S}{2} \approx 9{,}29 \cdot 10^{-10}\, kg \tag{8.4}$$

This mass is equal to half of the Stoney mass ($M_{qs} = m_S/2$). We can now calculate the mass $M_{g\gamma^0}$ of the photon (graviphoton) by adding the masses of the quantum black hole M_{qbh} and quantum white hole M_{qwh}, from which the mass associated with the electrostatic energy $-m_S$ must be subtracted. The mass of the photon $M_{g\gamma^0}$ is:

$$M_{g\gamma^0} = (M_{qbh} + M_{qwh}) - m_S = 2M_{qs} - m_S = 0 \tag{8.5}$$

Thus, the mass of the photon is zero $M_{g\gamma^0} = 0$, in accordance with the theory of special relativity. Its net electric charge is also zero, since the photon (graviphoton) is composed of two electric charges of opposite sign $q_{g\gamma^0} = 0$. Each of the two elementary electric charges that compose it has a radius (Schwarzschild radius) equal to the Stoney length $R_S = l_S \approx 1.38 \cdot 10^{-36}\, m$, which also represents the binding distance between them. * Obviously, the calculations can be performed using Planck units instead of Stoney units, since all the parameters of the photon depend on the conversion factors. In this way, the Schwarzschild radius equals the Planck length, the mass of the quantum singularities equals half the Planck mass, and the mass associated with the electric potential energy equals minus the Planck mass. The choice of one set of units or the other (Stoney/Planck) depends on the location of the photon (graviphoton). Thus, when it propagates in locally flat spacetime, Planck units should be used, whereas when it is near another quantum singularity or a black hole, an external observer must use Stoney units. But that’s not all. As we have seen, the photon (or graviphoton) is composed of two elementary electric charges, each with a mass equal to half of the Stoney/Planck mass, which is balanced by the electric potential energy between them, so that the effective mass of the photon (graviphoton) is zero. The (negative) potential energy can also be expressed as the kinetic energy of the charges relative to a common center of rotation. In this way, we can write:

$$-\frac{1}{2}\,K\frac{q_e^+ q_e^-}{l_S} = M_{qs}v^2 \tag{8.6}$$

Carrying out the calculations (if we use Stoney units, the mass to use is $M_{qs} \approx 9{,}29 \cdot 10^{-10}\ kg$, we obtain $v = c$). Therefore, the two singularities of the photon rotate around their common center of rotation C at a speed equal to that of light. In this way, we can also calculate the rotation frequency (in Stoney units) of the two charges around the center of rotation by dividing c by $R_S = l_S \approx 1.38 \cdot 10^{-36}\ m$:

$$\nu_r = \frac{c}{l_S} \approx \frac{299792458\ m/s}{1.38 \cdot 10^{-36}\ m} \approx 2.172 \cdot 10^{44}\ Hz \tag{8.7}$$

Thus the rotation period, given by the inverse of the rotation frequency $T_r = 1/\nu_r$:

$$T_r = \frac{1}{\nu_r} \approx \frac{1}{2.172 \cdot 10^{44}\ Hz} \approx 4.605 \cdot 10^{-45}\ s \tag{8.8}$$

Since in the calculation we used $R_{S(S)} = l_S \approx 1.38 \cdot 10^{-36}\ m$, the rotation period corresponds to the Stoney time $T_r = t_S \approx 4.605 \cdot 10^{-45}\ s$, as the two quantities are related by the relation $c = l_S/t_S$. On the other hand, if we use the Planck length in the calculations, $R_{S(P)} = l_P \approx 1.616 \cdot 10^{-35}\ m$, the rotation period corresponds to the Planck time $T_r = t_P \approx 5.391 \cdot 10^{-44}\ s$, as the two quantities are related by the relation $c = l_P/t_P$. The Planck frequency is given by the inverse of the Planck time. We also recall once again that it is possible to convert from one set of units to another through conversion factors expressed in terms of the fine-structure constant α.

8.8 The meaning of Stoney and Planck units

First, the electrogravitational theory, and then the study of the structure of the photon (graviphoton), revealed to us the meaning of Stoney/Planck units. The Stoney/Planck mass taken with a negative sign corresponds to the mass associated with the electric potential energy exerted between the two charges of the photon (graviphoton). Taken with a positive sign, it represents the mass of the two quantum singularities of the photon, half belonging to the quantum black hole and half to the quantum white hole. The Stoney/Planck length represents both the bond length and the Schwarzschild radius of each of the two quantum singularities. The Stoney/Planck time, instead, represents the rotation period of each singularity around the photon's charge center. Its inverse gives the Stoney/Planck frequency, the number of rotations per second of the two charged quantum singularities around their common charge center. The Planck force represents the force required to separate the two charges of the graviphoton in locally flat spacetime. The Stoney/Planck charge represents the integral of the oscillating charge q over half a period of the electrogravitational wave. All other Stoney/Planck units can be derived from those listed above and converted into one another using appropriate conversion factors provided in the appendix.

8.9 THE MEANING OF BOLTZMANN CONSTANT k_B

The Planck entropy S_P, equal to $k_B \approx 1.38 \cdot 10^{-23}\, J/K$, and thus the Boltzmann constant, represents the entropy associated with the quantum black hole singularity q_e^-. The quantum white hole singularity q_e^+, on the other hand, has an entropy of $-k_B$. In this way, the entropy of the photon is zero $S_{g\gamma^0} = k_B - k_B = 0$. The entropy of the white hole is negative because it is defined as $[-(m_P c^2/2)/(T_P/2)] = -k_B$, where T_P is the Planck temperature, the temperature associated with the energy equivalent of the Planck mass. In conclusion, Boltzmann's constant k_B represents the entropy associated with the quantum black hole S_{qbh}, whereas $-k_B$ corresponds to the entropy linked to the quantum white hole S_{qwh}. In the photon, their sum is zero. Even in this case, we can define an eq. similar to 4.14-4.15, $S_{T(f)} = (k_B - k_B)\nu t = 0$. The scenario changes if charge signs are neglected, yielding $k_B + |-k_B| = 2k_B$.

8.10 BEKENSTEIN-HAWKING FORMULA

The Bekenstein-Hawking formula tells us that the entropy of a black hole, S_{BH}, is proportional to the area of its event horizon (not its volume!), indicating that the information it contains is related to the surface of the black hole. If $A_{BH} = 4\pi {R_{BH}}^2$, (R_{BH} is the black hole radius) the Bekenstein-Hawking formula can be expressed as:

$$S_{BH} = \frac{k_B A_{BH}}{4\pi l_P^2} = S_{qbh}\frac{A_{BH}}{A_{qbh}} \tag{8.9}$$

where $S_{qbh} = k_B$ is the entropy associated with the quantum black hole, A_{qbh} represents its surface area, and l_P the Planck length, corresponds to its Schwarzschild radius. In this way, the Bekenstein-Hawking formula tells us that the entropy of a black hole is a multiple of the entropy of the quantum black hole, S_{qbh}. To calculate the entropy of a black hole, it is sufficient to multiply S_{qbh} by the ratio of the areas (or squared radii) A_{BH}/A_{qbh}. This shows that each unit of area contributes one unit of entropy k_B. *White holes cannot increase their mass, as they are unstable when not linked to a quantum black hole (?). Therefore, only quantum white holes exist. Hypothetically, a larger white hole would have an entropy equal to $S_{WH} = -S_{BH}$.

8.11 HAWKING TEMPERATURE

The equation for the Hawking temperature $T_H = \hbar c^3/8\pi GMk_B$ can be simplified by noting that $m_P = \sqrt{\hbar c/G}$, giving $T_H = m_P^2 c^2/8\pi M k_B$. Then, since the Planck temperature is $T_P = m_P c^2/k_B$, we can write $T_H = T_P m_P/8\pi M$. Ignoring the 8π factor, we obtain $T_H/T_P = m_P/M$. The ratio of the Hawking temperature to the Planck temperature is equal to the ratio of the Planck mass to the black hole mass.

8.12 THE MASS OF THE ELEMENTARY ELECTRIC CHARGES

In the case of the graviphoton we have seen that each of the elementary electric charges composing it has a mass of $M_{qs(S)} \approx 9{,}29 \cdot 10^{-10}\ kg$ in Stoney units, or $M_{qs(P)} \approx 1{,}088 \cdot 10^{-8}\ kg$ in Planck units. This is the mass of the elementary electric charges (quantum singularities) when they are not subject to any electric potential.

8.13 THE MASS OF ELEMENTARY PARTICLES

The mass of elementary particles (the same applies to antiparticles) is calculated by summing the mass of the elementary electric charges/quantum singularities, from which the equivalent mass due to the electric potential energy must be subtracted. Thus, the mass of particles is composed of two contributions, one given by the product between the particle's charge number n_c and the mass of the quantum singularity M_{qs}. We may call this mass the proper mass of the particle/antiparticle.

$$M_{proper} = n_c\, M_{qs} \tag{8.10}$$

From the proper mass of the particles, one must subtract the equivalent mass due to the electrostatic energy between elementary electric charges of opposite sign, and add the equivalent mass arising from interactions between elementary electric charges of the same sign. In this way, to calculate the total mass of an elementary particle, it is necessary to consider all possible combinations of interactions among its elementary electric charges. This is because interactions between charges of the same sign provide a positive contribution to the mass, while interactions between charges of opposite sign provide a negative contribution. For example, in the case of the electron neutrino, since it is composed of 4 elementary electric charges ($n_c = 4$), there are 4 interactions between opposite charges (since each charge, e.g., positive, interacts with each of the 2 negative ones) and 2 interactions between charges of the same sign (positive with positive, and negative with negative). In this way, in the electron neutrino there are 4 negative contributions and 2 positive contributions to the electrostatic energy, which must be subtracted or added to the proper mass in order to obtain the total mass. In general, the total mass is given by the formula:

$$M_{total\,(f)} = M_{proper(f)} + \left(\frac{\sum E_{(f)\,+/+}}{c_{(f)}^2} + \frac{\sum E_{(f)\,-/-}}{c_{(f)}^2} + \frac{\sum E_{(f)\,+/-}}{c_{(f)}^2}\right) \qquad (8.11)$$

where $\sum E_{+/+}$ is the total electric potential energy (positive) arising from all the x possible interactions of positive charges, $\sum E_{-/-}$ is the total electric potential energy (positive) arising from all the y possible interactions of negative charges, and $\sum E_{+/-}$ is the total electric potential energy (negative) arising from all the z possible interactions between charges of opposite sign. Obviously, when calculating the various components of the potential energy, one must take into account that the interaction distances vary. This is because there are interactions both between elementary charges belonging to the same energy level and between charges occupying different energy levels. Moreover, even when two charges belong to the same level, they may or may not occupy the same orbital (as in the case of p orbitals). *In equation 8.11, the conversion factors (strong force) must be taken into account.

8.14 Proper masses (calculated values)

Below are reported the values of the proper masses in Stoney units. We recall once again that $M_{qs(S)} = 1/2\, m_S$, where m_S is the Stoney mass. $M_{proper\,(S)} = n_c\, M_{qs\,(S)}$

$M_{proper\,(S)}\ q^{-/+} = M_{qs(S)} = 1/2\, m_S \approx 9.29 \cdot 10^{-10}\ kg$

$M_{proper\,(S)}\ g\gamma^0 = 2\, M_{qs(S)} \approx 2 \cdot 9.29 \cdot 10^{-10}\ kg \approx 1.858 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ e^{-/+} = 3\, M_{qs(S)} \approx 3 \cdot 9.29 \cdot 10^{-10}\ kg \approx 2.787 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ \nu_e = 4\, M_{qs(S)} \approx 4 \cdot 9.29 \cdot 10^{-10}\ kg \approx 3.716 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ \mu^{-/+} = 5\, M_{qs(S)} \approx 5 \cdot 9.29 \cdot 10^{-10}\ kg \approx 4.645 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ \nu_\mu = 6\, M_{qs(S)} \approx 6 \cdot 9.29 \cdot 10^{-10} kg \approx 5.574 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ \tau^{-/+} = 7\, M_{qs(S)} \approx 7 \cdot 9.29 \cdot 10^{-10}\ kg \approx 6.503 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ \nu_\tau = 8\, M_{qs(S)} \approx 8 \cdot 9.29 \cdot 10^{-10}\ kg \approx 7.432 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ W^{-/+} = 9\, M_{qs(S)} \approx 9 \cdot 9.29 \cdot 10^{-10}\ kg \approx 8.361 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ Z^0 = 10\, M_{qs(S)} \approx 10 \cdot 9.29 \cdot 10^{-10}\ kg \approx 9.29 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ H^0 = 10\, M_{qs(S)} \approx 10 \cdot 9.29 \cdot 10^{-10}\ kg \approx 9.29 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ u = 3.3\overline{3}\, M_{qs(S)} \approx 3.3\overline{3} \cdot 9.29 \cdot 10^{-10}\ kg \approx 3.097 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ d = 3.6\overline{6}\, M_{qs(S)} \approx 3.6\overline{6} \cdot 9.29 \cdot 10^{-10}\ kg \approx 3.407 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ c = 5.3\overline{3}\, M_{qs(S)} \approx 5.3\overline{3} \cdot 9.29 \cdot 10^{-10}\ kg \approx 4.955 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ s = 5.6\overline{6}\, M_{qs(S)} \approx 5.6\overline{6} \cdot 9.29 \cdot 10^{-10}\ kg \approx 5.264 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ t = 7.3\overline{3}\, M_{qs(S)} \approx 7.3\overline{3} \cdot 9.29 \cdot 10^{-10}\ kg \approx 6.813 \cdot 10^{-9}\ kg$

$M_{proper\,(S)}\ b = 7.6\overline{6}\, M_{qs(S)} \approx 7.6\overline{6} \cdot 9.29 \cdot 10^{-10}\ kg \approx 7.122 \cdot 10^{-9}\ kg$

They can likewise be expressed as a function of the Planck mass, where $M_{qs(P)} = 1/2\, m_P$, where $\sqrt{\alpha}\, m_P = m_S$ is the Planck mass. $M_{proper\,(P)} = n_c M_{qs\,(P)}$

$M_{proper\,(P)}\ q^{-/+} = M_{qs(P)} = 1/2\, m_P \approx 1.088 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ g\gamma^0 = 2\, M_{qs(P)} \approx 2 \cdot 1.088 \cdot 10^{-8}\, kg \approx 2.176 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ e^{-/+} = 3\, M_{qs(P)} \approx 3 \cdot 1.088 \cdot 10^{-8}\, kg \approx 3.264 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ \nu_e = 4\, M_{qs(P)} \approx 4 \cdot 1.088 \cdot 10^{-8}\, kg \approx 4.352 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ \mu^{-/+} = 5\, M_{qs(P)} \approx 5 \cdot 1.088 \cdot 10^{-8}\, kg \approx 5.440 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ \nu_\mu = 6\, M_{qs(P)} \approx 6 \cdot 1.088 \cdot 10^{-8}\, kg \approx 6.528 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ \tau^{-/+} = 7\, M_{qs(P)} \approx 7 \cdot 1.088 \cdot 10^{-8}\, kg \approx 7.616 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ \nu_\tau = 8\, M_{qs(P)} \approx 8 \cdot 1.088 \cdot 10^{-8}\, kg \approx 8.704 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ W^{-/+} = 9\, M_{qs(P)} \approx 9 \cdot 1.088 \cdot 10^{-8}\, kg \approx 9.792 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ Z^0 = 10\, M_{qs(P)} \approx 10 \cdot 1.088 \cdot 10^{-8}\, kg \approx 1.088 \cdot 10^{-7}\, kg$

$M_{proper\,(P)}\ H^0 = 10\, M_{qs(P)} \approx 10 \cdot 1.088 \cdot 10^{-8}\, kg \approx 1.088 \cdot 10^{-7}\, kg$

$M_{proper\,(P)}\ u = 3.3\bar{3}\, M_{qs(P)} \approx 3.3\bar{3} \cdot 1.088 \cdot 10^{-8}\, kg \approx 3.627 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ d = 3.6\bar{6}\, M_{qs(P)} \approx 3.6\bar{6} \cdot 1.088 \cdot 10^{-8}\, kg \approx 3.989 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ c = 5.3\bar{3}\, M_{qs(P)} \approx 5.3\bar{3} \cdot 1.088 \cdot 10^{-8}\, kg \approx 5.803 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ s = 5.6\bar{6}\, M_{qs(P)} \approx 5.6\bar{6} \cdot 1.088 \cdot 10^{-8}\, kg \approx 6.165 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ t = 7.3\bar{3}\, M_{qs(P)} \approx 7.3\bar{3} \cdot 1.088 \cdot 10^{-8}\, kg \approx 7.979 \cdot 10^{-8}\, kg$

$M_{proper\,(P)}\ b = 7.6\bar{6}\, M_{qs(P)} \approx 7.6\bar{6} \cdot 1.088 \cdot 10^{-8}\, kg \approx 8.341 \cdot 10^{-8}\, kg$

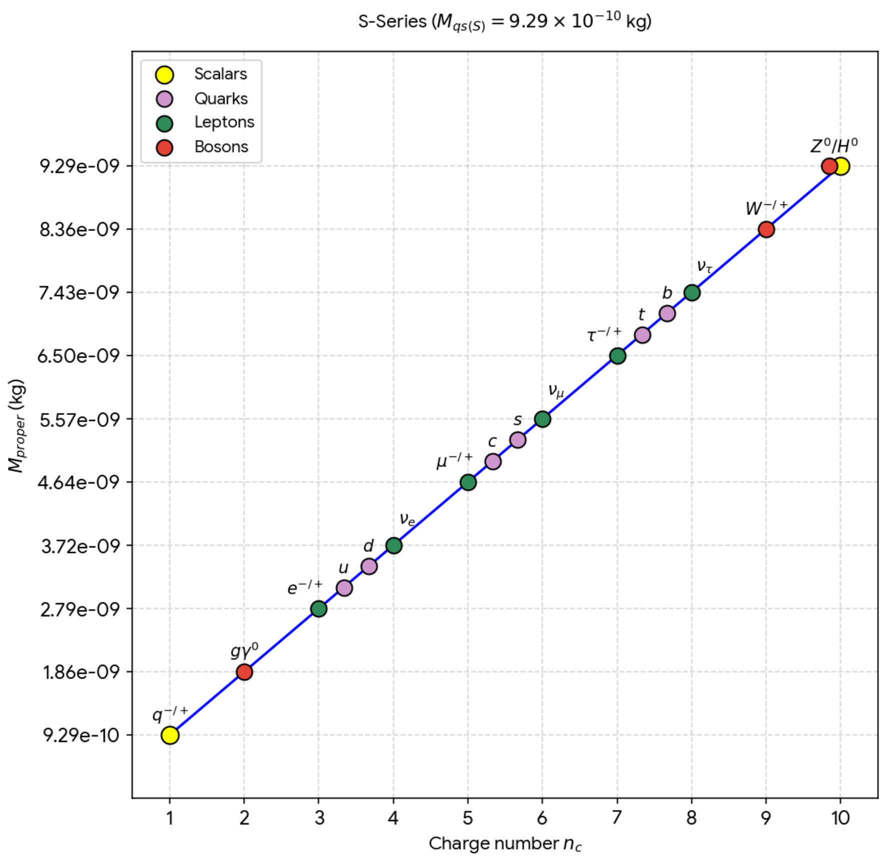
Since the proper masses are multiples of that of the singularity, the relationship increases linearly with the charge number for both elementary particles and quarks. It is precisely this linearity that allows us to determine the mass ratios of particles directly from the ratios of their charge numbers, as illustrated in paragraphs 8.18, 8.19, 8.20, 8.21, and 9.1. The graphs showing this relationship are on the next page.

8.15 Total masses (calculated values)

The calculated masses are presented in paragraph 8.23. The masses in 8.17 are the measured ones, with the exception of those of the elementary charge and the photon.

8.16 Majorana Neutrinos

In the 1930s, Majorana proposed that neutrinos could be their own antiparticles. Electrogravitational theory suggests that neutrinos are indeed Majorana particles, ($\nu_e = \bar{\nu}_e, \nu_\mu = \bar{\nu}_\mu, \nu_\tau = \bar{\nu}_\tau$). Moreover, there is no need to invoke any exotic mechanism, since their masses can be fully explained by applying equation 8.11.



S-Series ($M_{qs(S)} = 9.29 \times 10^{-10}$ kg)
Scalars
Quarks
Leptons
Bosons
M_{proper} (kg)
Charge number n_c
$q^{-/+}$
$g\gamma^0$
$e^{-/+}$
u
d
ν_e
$\mu^{-/+}$
c
s
ν_μ
$\tau^{-/+}$
t
b
ν_τ
$W^{-/+}$
Z^0/H^0
9.29e-09
8.36e-09
7.43e-09
6.50e-09
5.57e-09
4.64e-09
3.72e-09
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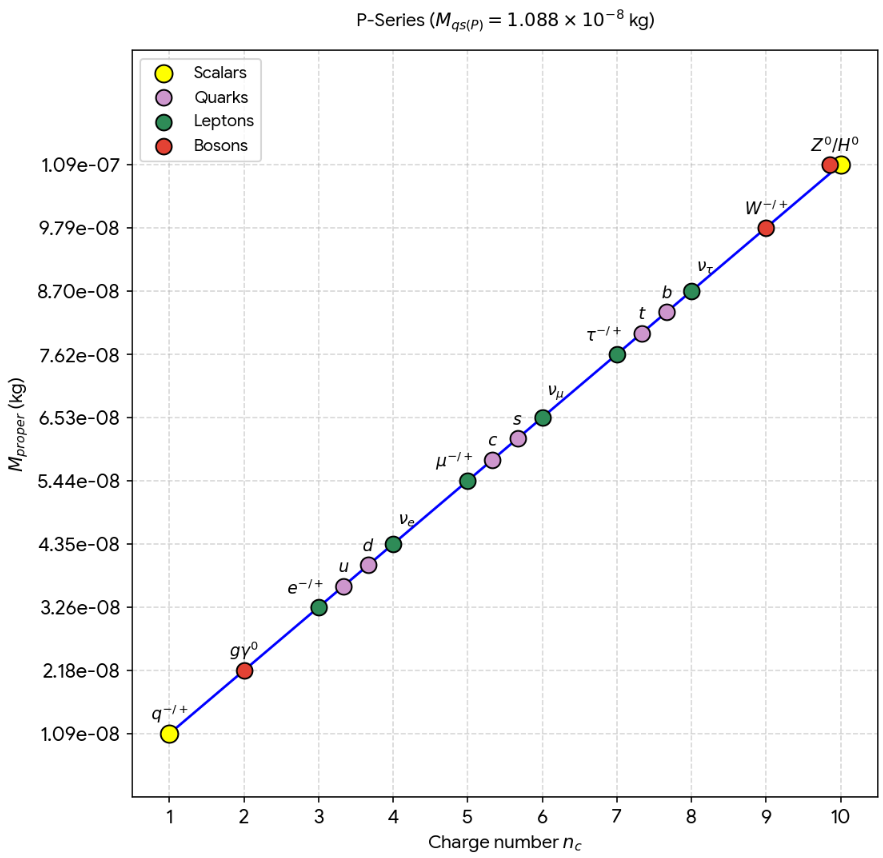
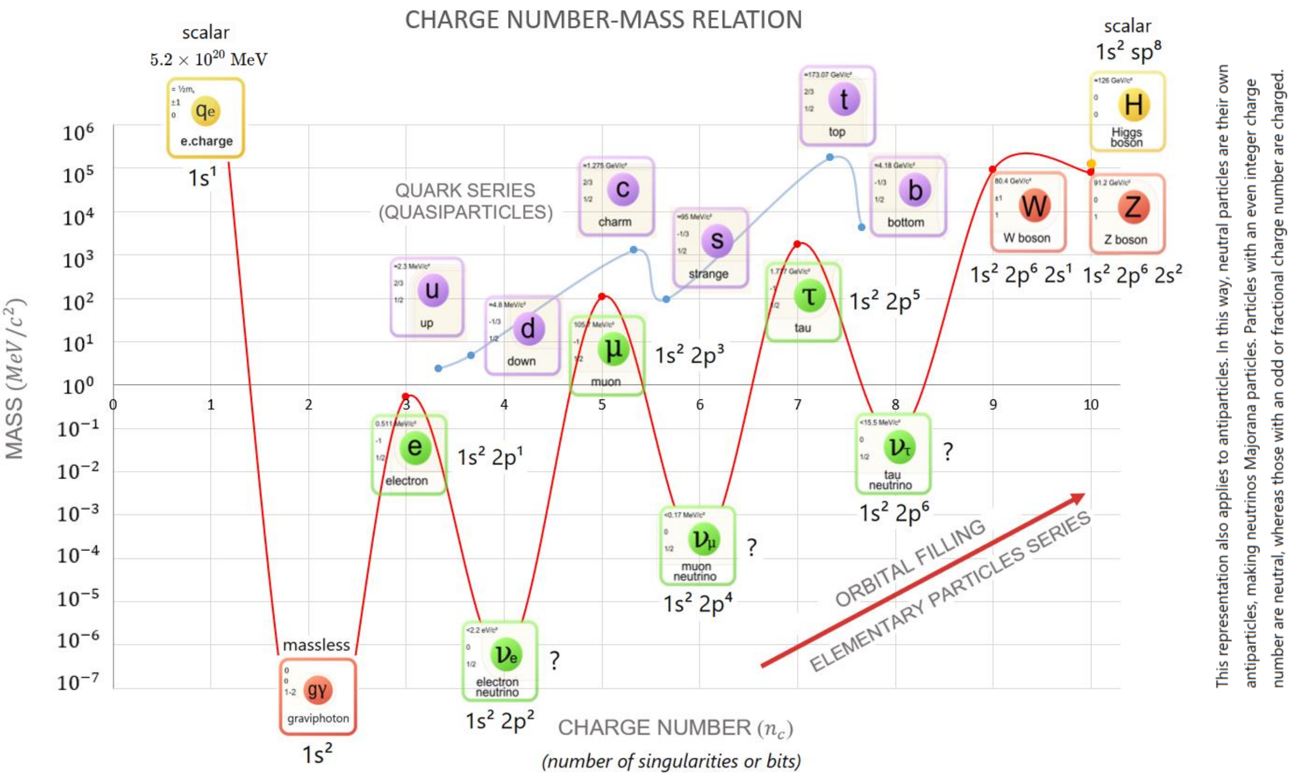


P-Series ($M_{qs(P)} = 1.088 \times 10^{-8}$ kg)
Scalars
Quarks
Leptons
Bosons
M_{proper} (kg)
Charge number n_c
$q^{-/+}$
$g\gamma^0$
$e^{-/+}$
u
d
ν_e
$\mu^{-/+}$
c
s
ν_μ
$\tau^{-/+}$
t
b
ν_τ
$W^{-/+}$
Z^0/H^0
1.09e-07
9.79e-08
8.70e-08
7.62e-08
6.53e-08
5.44e-08
4.35e-08
3.26e-08
2.18e-08
1.09e-08
1
2
3
4
5
6
7
8
9
10

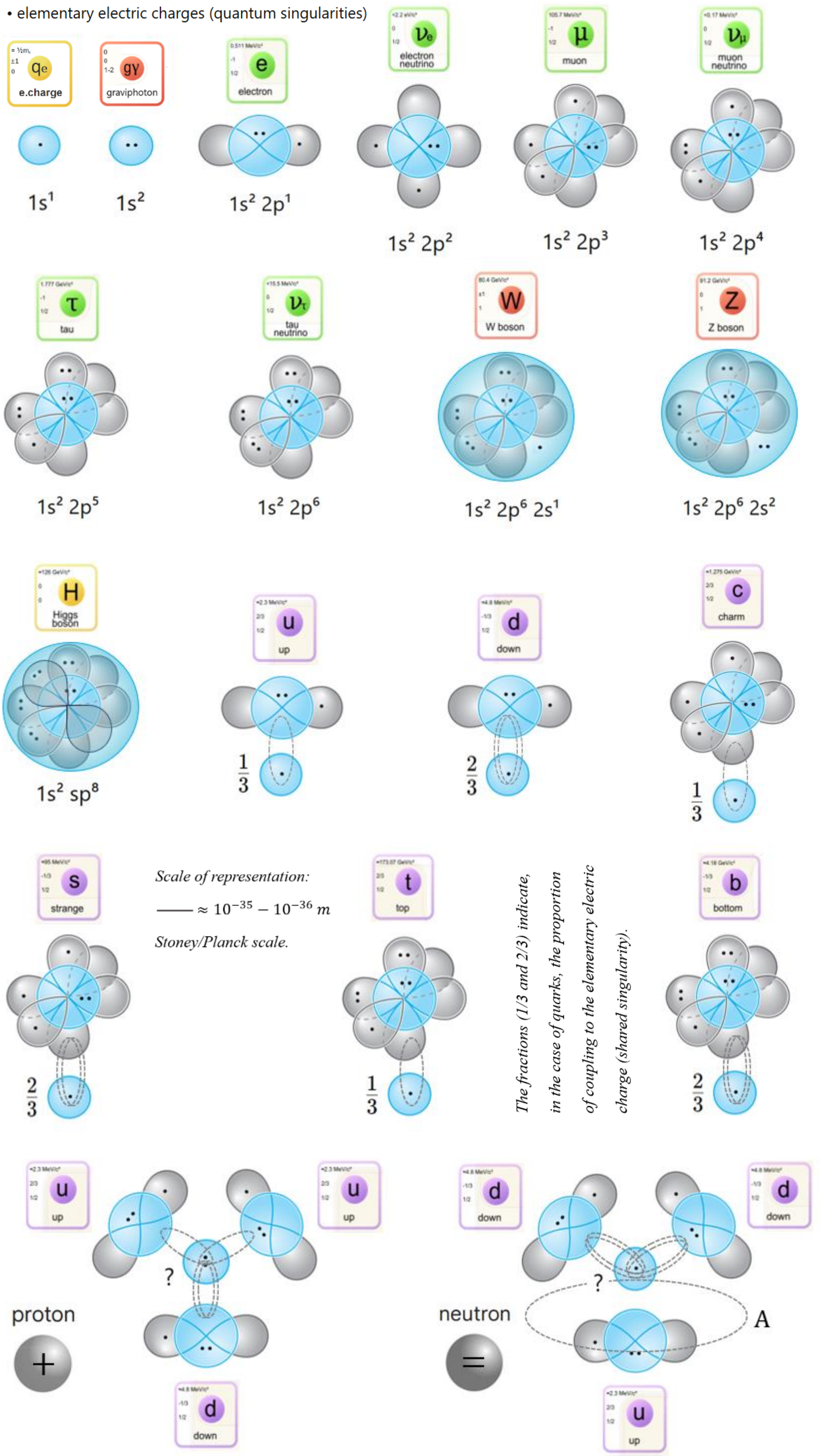
8.17 Charge number-mass relation

To describe an atom, two characteristics are fundamental, its mass and its atomic number. The relationship between atomic number and atomic mass shows significant linearity. However, in the case of elementary particles, the situation is more complex. As the charge number increases, up to the Higgs boson, there is an exponential (oscillating) increase in mass observed. Two main trends can be identified: one for neutral particles (the 3 neutrinos, the Z^0 boson, and the Higgs boson) with lower mass/energy, and another for charged particles (the 3 charged leptons and the $W^{-/+}$ boson). The proper mass of the graviphoton (boson) varies depending on its position (it can range between the Stoney and Planck masses), yet its total mass is zero because it is perfectly balanced by the negative mass associated with the electric potential energy. The mass of the free (unshielded) elementary electric charge (boson) is equal to half of the Stoney or Planck mass, which is the minimum mass required to form a quantum black or white hole. A black hole precisely coincides with an unshielded negative elementary electric charge because the force binding the two elementary charges in flat spacetime, within the graviphoton, equals the Planck force c^4/G, the force necessary to tear spacetime apart. Quarks are also indexed on the graph. The masses of quarks do not differ much from those of the leptons from which they derive. The electric configuration of each particle is indicated in the graph.



NOTE: There is abundant support for this type of schematization. First, the photon (graviphoton) is composed of two elementary electric charges, and therefore all other particles are made up of elementary electric charges. Moreover, as we have seen, the theory of elementary orbitals leads to a natural ordering of the elementary particles.

STRUCTURE OF ELEMENTARY PARTICLES



This representation also applies to antiparticles. In this way, neutral particles are their own antiparticles, making neutrinos Majorana particles. Particles with an even integer charge number are neutral, whereas those with an odd or fractional charge number are charged.

Illustrations based on *Organic Chemistry*, 5th Edition, Chapter 1.2 – Atoms and Atomic Orbitals, W. W. Norton & Company; Fig. 1.12

8.18 MASS RATIOS BETWEEN ELECTRON, MUON AND TAU

Leaving aside the bosons, which have an outer shell given by an s-type orbital, and the neutrinos, whose masses are unknown, we focus on the charged leptons. The (measured) masses of these particles are: electron ($m_e \approx 0.511\ MeV/c^2$), muon ($m_\mu \approx 105.658\ MeV/c^2$), and tau ($m_\tau \approx 1776.86\ MeV/c^2$). The mass ratios are $m_\mu/m_e \approx \mathbf{206.77}$; $m_\tau/m_\mu \approx \mathbf{16.82}$; $m_\tau/m_e \approx \mathbf{3477.22}$. We will now examine how the ratios between the masses of elementary particles can be calculated starting from the ratios between their charge numbers (taking into account the strong interactions that arise between the elementary electric charges/quantum singularities that constitute the elementary particles). Thus, calculating the ratios of charge numbers, is equivalent to calculating the mass ratios. We have seen that the outer shell of leptons is formed by three p-type orbitals which in the electron (positron), contain a single elementary electric charge, in the muon (antimuon) three, and in the tau (antitau) five. Neglecting the $1s$ orbital, which is common to all three particles, the electrons constituting the outer shell (p orbitals) experience not only an electric interaction but also a strong-type interaction (strong or singularity force). Consequently, the external charge of the electron/positron cannot interact strongly with any other charge. In the case of the muon (antimuon), however, since the outer shell contains three charges (singularities), two more than the electron, we have that the charge number of the muon $n_{c(\mu)}$ must be multiplied by the squared conversion factor of the force, $N = 3 - 1 = 2$. Thus, the charge number ratio is calculated as:

$$\frac{m_\mu}{m_e} \approx \frac{n_{c(\mu)}}{n_{c(e)}} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = \frac{5}{3} \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^2 \approx 1.6\bar{6} \cdot (11.7)^2 \approx \mathbf{228} \qquad (8.12)$$

Hence, the ratio between the masses, calculated from the ratio of the charge numbers taking into account the strong interaction, 228, does not differ significantly from the measured ratio, 206.77. We can therefore state that calculating the ratio between the masses of elementary particles is equivalent to calculating the ratio between their charge numbers. This is obvious, given that the actual mass of the particles is a multiple of the mass M_{qs}. The same procedure can be applied to the tau and the muon. In the case of the tau (antitau), since the outer shell contains 5 charges (singularities), 2 more than the muon, one would expect the exponent N to be again equal to 2, and thus that the charge number of the tau, $n_{c(\tau)}$, should be multiplied by the squared conversion factor of the force. However, in the case of the tau, one of the 5 electric charges of the outer shell lies outside the plane of the other 4 charges. As a result, it does not interact strongly with the other elementary charges. The exponent therefore turns out to be $N = 1$. We can now calculate the charge ratio:

$$\frac{m_\tau}{m_\mu} \approx \frac{n_{c(\tau)}}{n_{c(\mu)}} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = \frac{7}{5} \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^1 \approx 1.4 \cdot (11.7)^1 \approx \mathbf{16.38} \qquad (8.13)$$

Here too, the mass ratio calculated from the ratio between the charge numbers (taking into account strong interactions), which equals 16.38, does not differ significantly from the ratio derived from the measured masses, 16.82. Once again, we have confirmation that calculating the ratio between the masses of elementary particles is equivalent to calculating the ratio between their (equivalent) charge numbers. For completeness, let us also calculate the mass ratio between the tau and the electron:

$$\frac{m_\tau}{m_e} \approx \frac{n_{c(\tau)}}{n_{c(e)}} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = \frac{7}{3} \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^3 \approx 2.3\bar{3} \cdot (11.7)^3 \approx \mathbf{3740} \qquad (8.14)$$

Also in this case, the equivalence between the two calculation methods is confirmed. An equivalent result **is** obtained simply by multiplying the previous equations:

$$\frac{m_\tau}{m_e} \approx \left[\frac{n_{c(\tau)}}{n_{c(\mu)}} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^1\right] \cdot \left[\frac{n_{c(\mu)}}{n_{c(e)}} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^2\right] \approx 16.38 \cdot 228 \approx \mathbf{3740} \quad (8.15)$$

8.19 MASS RATIOS BETWEEN UP QUARK, DOWN QUARK, AND ELECTRON

Let us now move on to the trio of particles consisting of the up quark, the down quark, and the electron. The masses of these particles are: $m_e \approx 0.511\ MeV/c^2$ for the electron, $m_u \approx 2.2\ MeV/c^2$ for the up quark, and $m_d \approx 4.7\ MeV/c^2$ for the down quark. The measured mass ratios are $m_u/m_e \approx \mathbf{4.31}$; $m_d/m_e \approx \mathbf{9.20}$; $m_d/m_u \approx \mathbf{2.14}$. Here too, we can calculate mass ratios from charge number ratios:

$$\frac{m_u}{m_e} \approx \frac{n_{c(u)}}{n_{c(e)}} \cdot \left(\frac{1}{3} \cdot \frac{1}{f[\boldsymbol{F}]}\right) = \frac{3.3\bar{3}}{3} \cdot \left(\frac{1}{3} \cdot \frac{1}{\sqrt{\alpha}}\right) \approx 1.1\bar{1} \cdot \left(\frac{11.7}{3}\right) \approx \mathbf{4.32} \qquad (8.16)$$

$$\frac{m_d}{m_e} \approx \frac{n_{c(d)}}{n_{c(e)}} \cdot \left(\frac{2}{3} \cdot \frac{1}{f[\boldsymbol{F}]}\right) = \frac{3.6\bar{6}}{3} \cdot \left(\frac{2}{3} \cdot \frac{1}{\sqrt{\alpha}}\right) \approx 1.2\bar{2} \cdot \left(\frac{2}{3} \cdot 11.7\right) \approx \mathbf{9.53} \quad (8.17)$$

$$\frac{m_d}{m_u} \approx \frac{n_{c(d)}}{n_{c(u)}} \cdot \frac{\left(\frac{2}{3} \cdot \frac{1}{f[\boldsymbol{F}]}\right)}{\left(\frac{1}{3} \cdot \frac{1}{f[\boldsymbol{F}]}\right)} = \frac{3.6\bar{6}}{3.3\bar{3}} \cdot \frac{\left(\frac{2}{3} \cdot \frac{1}{\sqrt{\alpha}}\right)}{\left(\frac{1}{3} \cdot \frac{1}{\sqrt{\alpha}}\right)} \approx 1.1 \cdot \frac{\left(\frac{2}{3} \cdot 11.7\right)}{\left(\frac{1}{3} \cdot 11.7\right)} \approx \mathbf{2.20} \qquad (8.18)$$

We can see how the mass ratios, obtained from the ratios of the charge numbers, are close to the measured ones! ****The calculations in paragraph 8.18 tell us that the hypothesized charge numbers for the electron (3), the muon (5), and the tau (7) are correct! The calculations in paragraph 8.19 indicate that the hypothesized charge numbers for the up quark* (3.3$\bar{3}$) *and down* (3.6$\bar{6}$) *are also correct!***

8.20 KOIDE FORMULA

The Koide formula is an empirical relation discovered by the Japanese physicist Yoshio Koide in 1981. It concerns the masses of the three charged leptons: electron ($m_e \approx 0.511\ MeV/c^2$), muon ($m_\mu \approx 105.658\ MeV/c^2$), and tau ($m_\tau \approx 1776.86\ MeV/c^2$). Naturally, this relation also holds for their antiparticles (positron, antimuon, antitau), since their masses are the same. The Koide formula is as follows:

$$Q = \frac{m_e + m_\mu + m_\tau}{\left(\sqrt{m_e} + \sqrt{m_\mu} + \sqrt{m_\tau}\right)^2} \approx \frac{\mathbf{2}}{\mathbf{3}} \tag{8.19}$$

This formula (invariant with respect to the mass scale) is particularly fascinating. It is a simple numerical ratio that, for reasons still unknown, surprisingly approaches 2/3. Physicists have long wondered whether there might be a deep physical principle behind it, possibly related to an as-yet-unknown theory of the structure of lepton masses. We will see that this is indeed the case. In the electrogravitational theory, we have seen that the outer shell of leptons is composed of p orbitals, which in the electron (positron) contain a single elementary electric charge, in the muon (antimuon) three, and in the tau (antitau) five. Moreover, since the electron, muon, and tau are charged particles, this means they possess an unpaired electric charge in their outer orbital (as do their antiparticles). Neglecting the $1s$ orbital, a strong force (or singularity) interaction develops among the charges present in the outer shell. In this way, the external charge of the electron/positron, being alone, does not experience the strong force from any other charge. In the case of the muon (antimuon), however, since there are two charges in the outer shell more than in the electron, its mass must be multiplied by the squared conversion factor of the force. Finally, in the case of the tau, despite its charge number being more than 2 greater than that of the muon, the exponent N is equal to 3, because only one of the two additional charges participates in the strong interaction, the other being outside the plane of the other p charges. Let us now calculate the equivalent charge numbers:

$$n'_{c(e)} = n_{c(e)} = 3 \tag{8.20}$$

$$n'_{c(\mu)} = n_{c(\mu)} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = 5 \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^2 \approx 5 \cdot (11.7)^2 \approx 684 \tag{8.21}$$

$$n'_{c(\tau)} = n_{c(\tau)} \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = 7 \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^3 \approx 7 \cdot (11.7)^3 \approx 11211 \tag{8.22}$$

If we now substitute into Koide's formula the equivalent charge numbers (n'_c), which, as mentioned, take into account the strong interaction that arises between the elementary electric charges of the p orbitals, in place of the masses of the electron, muon, and tau, we see that Koide's formula yields approximately the same result:

$$Q = \frac{n'_{c(e)} + n'_{c(\mu)} + n'_{c(\tau)}}{\left(\sqrt{n'_{c(e)}} + \sqrt{n'_{c(\mu)}} + \sqrt{n'_{c(\tau)}}\right)^2} \tag{8.23}$$

$$Q \approx \frac{3 + 684 + 11211}{\left(\sqrt{3} + \sqrt{684} + \sqrt{11211}\right)^2} \tag{8.24}$$

$$Q \approx \frac{3 + 684 + 11211}{(1.732 + 26.15 + 105.88)^2} \approx \frac{11898}{17894} \approx \frac{\mathbf{2}}{\mathbf{3}} \tag{8.25}$$

In this way, Koide's formula turns out to be not a coincidence, but a consequence of the structure of the particles (and of the type of interaction that takes place between the elementary charges). ***Koide's relation confirms (again) that the hypothesized charge numbers for the electron (3), the muon (5), and the tau (7) are correct!*** *
*There are also numerous equations similar to Koide's, especially for quark triplets.

8.21 KOIDE-LIKE FORMULA FOR THE $W^{-/+}$, Z^0 AND HIGGS H^0 BOSONS

Relations similar to Koide's formula can be proposed for many other triplets of elementary particles. In particular, this one takes into account the masses of the bosons $m_{W^{-/+}} \approx 80.36\ GeV/c^2$, $m_{Z^0} \approx 91.18\ GeV/c^2$, and $m_{H^0} \approx 125.35\ GeV/c^2$.

$$Q_{W,Z,H} = \frac{m_W + m_Z + m_H}{\left(\sqrt{m_W} + \sqrt{m_Z} + \sqrt{m_H}\right)^2} \approx \frac{\mathbf{1}}{\mathbf{3}} \tag{8.26}$$

In the case of bosons, since their outer orbital is of type s, it is sufficient to substitute the charge numbers into the Koide-like formula. We recall that $n_{c(W)} = 9$, $n_{c(Z)} = 10$, $n_{c(H)} = 10$. In this way, by substituting the masses with the charge numbers:

$$Q_{W,Z,H} = \frac{n_{c(W)} + n_{c(Z)} + n_{c(H)}}{\left(\sqrt{n_{c(W)}} + \sqrt{n_{c(Z)}} + \sqrt{n_{c(H)}}\right)^2} \tag{8.27}$$

$$Q_{W,Z,H} = \frac{9 + 10 + 10}{\left(\sqrt{9} + \sqrt{10} + \sqrt{10}\right)^2} \approx \frac{29}{86.95} \approx \frac{\mathbf{1}}{\mathbf{3}} \tag{8.28}$$

This result is even more important than the one previously obtained for charged leptons, as it tells us that the hypothesized charge numbers for the bosons $n_{c(W)} = 9$, $n_{c(Z)} = 10$, ***and, above all, for the Higgs boson*** $n_{c(H)} = 10$ ***are indeed correct!***

8.22 Total masses (calculated values)

Now, using the information we have about mass ratios, charge, and the structure of elementary particles, we can calculate the value of their total masses. It is important to remember that, in electrogravitational theory, particles and antiparticles have the same mass. We start with the elementary electric charge, which has a mass equal to:

$$\boldsymbol{m_{q_e^{-/+}}} = \left(M_{qs}\right)_{1s1} \approx \mathbf{9.29 \cdot 10^{-10}}\ \boldsymbol{kg} \tag{8.29}$$

in Stoney units, or $m_{q_e^{-/+}} \approx 1.088 \cdot 10^{-8}\ kg$ in Planck units. When two elementary charges of opposite sign combine to form a photon (graviphoton), their proper mass, determined by the sum of the masses of the two elementary charges, is perfectly neutralized by the mass equivalent of the electric potential energy between them.

$$\boldsymbol{m_{g\gamma^0}} = \left(2M_{qs} + \frac{U_S}{c^2}\right)_{1s2} = \left(m_{S(f)} - m_{S(f)}\right)_{1s2} = \boldsymbol{massless} \tag{8.30}$$

Next, we have the electron, a particle composed of 3 elementary electric charges: 2 negative and 1 positive. Of these three charges, 2 belong to the 1s orbital and 1 to the $2p$ orbitals. The charges in the $1s$ orbital cancel out their mass through electric interaction (as in the case of the photon). The mass of the additional negative singularity (positive in the case of the positron), equal to M_{qs}, is also almost entirely canceled by its interaction with the positive charge of the nucleus (negative in the case of the positron), but not completely. However, the mass of the electron cannot be calculated directly, since we do not know either the distance of the additional charge from the charge of the $1s$ orbital or the value of the residual positive charge (of the $1s$ orbital) with which it interacts. Therefore, the value is the measured one.

$$\boldsymbol{m_{e^{-/+}}} = \left(2M_{qs} + \frac{U_S}{c^2}\right)_{1s2} + \left(M_{qs} + \frac{U_S}{c^2}\right)_{2p1} = (0)_{1s2} + \boldsymbol{m_{e^{-/+}}} \approx \mathbf{9.1 \cdot 10^{-31}}\ \boldsymbol{kg} \tag{8.31}$$

However, we can use the inverse formula to calculate both the radius of the p orbital (and thus the radius of the electron) and the fraction of residual charge q_r of the 1s orbital that interacts with the charge of the $2p$ level. Performing the calculations, assuming an almost equal distribution between the two effects, we obtain $q_r \approx 1.0 \cdot 10^{-19} C$ and $r_e \approx 1.73 \cdot 10^{-36}\ m$. In this way, we have obtained two fundamental values: the residual charge and the radius of the p orbital, or the electron radius, $\boldsymbol{r_e} \approx \mathbf{1.73 \cdot 10^{-36}}\ \boldsymbol{m}$. This value may never be measurable experimentally, and therefore cannot serve as a test of validity of the electrogravitational theory. We now move on to charged leptons. We have already discussed the electron/positron. The mass of the muon can be calculated directly from that of the electron, since the muon possesses

$N = 2$ additional singularities. Therefore, considering that the effect of the unpaired electric charge on the mass is the same as in the electron, it is sufficient to multiply the mass of the electron by $\alpha \approx 137$ and by 5/3, which is the singularity ratio R.

$$\boldsymbol{m}_{\mu^{-/+}} = \boldsymbol{m}_{e^{-/+}} \cdot R\left(\frac{1}{\sqrt{\alpha}}\right)^N = \boldsymbol{m}_{e^{-/+}} \cdot \frac{\mathbf{5}}{\mathbf{3}}\left(\frac{1}{\sqrt{\alpha}}\right)^2 \approx 228\, \boldsymbol{m}_{e^{-/+}} \approx \mathbf{2.08 \cdot 10^{-28}}\, \boldsymbol{kg} \quad (8.32)$$

In the case of the tauon, one would expect a mass equal to (7/5)·137 times that of the muon, where 7/5 is the singularity ratio R and 137 is the square of the force conversion factor. However, the mass ratio turns out to be about 11.7 times lower than expected. This discrepancy can be interpreted as follows. In the tauon, there are five elementary electric charges in the p orbital: four of them form a plane and cluster together, interacting via the strong force, while the fifth, the unpaired charge, being alone, does not interact strongly with the others. In this way, $R = 7/5$ and $N = 1$.

$$\boldsymbol{m}_{\tau^{-/+}} = \boldsymbol{m}_{\mu^{-/+}} \cdot R\left(\frac{1}{\sqrt{\alpha}}\right)^N = \boldsymbol{m}_{\mu^{-/+}} \cdot \frac{\mathbf{7}}{\mathbf{5}}\left(\frac{1}{\sqrt{\alpha}}\right)^1 \approx 16{,}4\, \boldsymbol{m}_{\mu^{-/+}} \approx \mathbf{3.41 \cdot 10^{-27}}\, \boldsymbol{kg} \quad (8.33)$$

We now move on to the trio of bosons: $W^{-/+}$, Z^0, and H^0. In theory, if we continued filling the same level (the p orbitals), the W boson would have a mass approximately $9/7 \cdot (1/\sqrt{\alpha})^N$ times that of the tauon. However, since the tauon has the structure $1s^2\ 2p^5$, while the W boson has $1s^2\ 2p^6\ 2s^1$, this means that, in order to obtain a ratio close to about 45, the mass ratio observed in nature, we must take into account the different geometry of the orbitals and, consequently, the different interaction between the p and s orbitals. In particular, since the ratio between the number of orbitals in the $2p$ level and those in the $2s$ level is 3 to 1, the electric charge of the $2s$ orbital interacts for one-third of the time with each pair of elementary charges in the $2p$ orbitals. In this way, we get $11.7/3 = 3.9$. Moreover, $R = 1$ is unitary.

$$\boldsymbol{m}_{W^{-/+}} = \boldsymbol{m}_{\tau^{-/+}} \cdot \left(\frac{1}{3\sqrt{\alpha}}\right)\left(\frac{1}{\sqrt{\alpha}}\right) \approx \boldsymbol{m}_{\tau^{-/+}} \cdot 45.65 \approx \mathbf{1.56 \cdot 10^{-25}}\, \boldsymbol{kg} \quad (8.34)$$

The Z^0 and H^0 bosons have approximately the same mass, since when an additional charge is added to the W boson, the $2s$ orbital becomes complete, and the additional charge compensates its mass through the negative mass arising from the electrostatic interaction. The Higgs boson, being a hybrid state of the Z^0 boson, has a mass that differs only slightly from the latter. This allows us to write, approximately $m_{W^{-/+}} \leq m_{Z^0} \leq m_{H^0}$. If we want to make a more precise calculation, we can use 8/7 as the coefficient for the ratio $m_{Z^0}/m_{W^{-/+}}$, since 8/7 is the ratio between the number of charges in the second level of the Z^0 boson and that of the $W^{-/+}$. Similarly, we can use 8/6 in calculating the ratio m_{H^0}/m_{Z^0}, since in the orbital mixing the number of el. charges in the outer shell increases from 6 in the Z^0 boson to 8 in the H^0 boson.

$$\boldsymbol{m_{Z^0}} = m_{w^{-/+}} \cdot \frac{8}{7} \approx m_{w^{-/+}} \cdot 1.14 \approx \mathbf{1.78 \cdot 10^{-25}\ kg} \tag{8.35}$$

$$\boldsymbol{m_{H^0}} = m_{Z^0} \cdot \frac{8}{6} \approx m_{Z^0} \cdot 1.3\overline{3} \approx \mathbf{2.38 \cdot 10^{-25}\ kg} \tag{8.36}$$

Let us now turn to neutrinos. Concerning the three neutrinos, only the squared mass differences are known: $\Delta m_{21}^2 = m_{\nu\mu}^2 - m_{\nu e}^2 \approx 7.53 \cdot 10^{-5} eV^2$; $\Delta m_{32}^2 = m_{\nu\tau}^2 - m_{\nu\mu}^2 \approx 2.57 \cdot 10^{-3} eV^2$; $\Delta m_{31}^2 = m_{\nu\tau}^2 - m_{\nu e}^2 \approx 2.5 \cdot 10^{-3} eV^2$. To calculate the masses from the squared differences, it is sufficient to set a single additional constraint. Since the mass ratio between the muon and the electron is about 137, we expect the same ratio between the muon neutrino and the electron neutrino. Thus:

$$\Delta m_{21}^2 = m_{\nu\mu}^2 - m_{\nu e}^2 \approx (137^2 - 1) m_{\nu e}^2 = (18769 - 1) m_{\nu e}^2 = 18768\, m_{\nu e}^2 \tag{8.37}$$

$$m_{\nu e}^2 \approx \frac{m_{\nu\mu}^2 - m_{\nu e}^2}{18768} \approx \frac{7.53 \cdot 10^{-5} eV^2}{18768} \approx 4.02 \cdot 10^{-9} eV^2 \tag{8.38}$$

$$\boldsymbol{m_{\nu e}} \approx \sqrt{4.02 \cdot 10^{-9} eV^2} \approx 6.33 \cdot 10^{-5} eV \approx \mathbf{1.13 \cdot 10^{-40}\ kg} \tag{8.39}$$

$$\boldsymbol{m_{\nu\mu}} \approx 137 \cdot m_{ne} \approx 137 \cdot 6.33 \cdot 10^{-5} eV \approx 8.67 \cdot 10^{-3} eV \approx \mathbf{1.55 \cdot 10^{-38}\ kg} \tag{8.40}$$

$$\boldsymbol{m_{\nu\tau}} \approx \sqrt{2.5 \cdot 10^{-3} eV^2 + 4.02 \cdot 10^{-9} eV^2} \approx 5.01 \cdot 10^{-2} eV \approx \mathbf{8.93 \cdot 10^{-38}\ kg} \tag{8.41}$$

The sum of the neutrino masses, about $\sum \boldsymbol{m_{\nu e}} + \boldsymbol{m_{\nu\mu}} + \boldsymbol{m_{\nu\tau}} \approx \mathbf{0.059\ eV}$, falls perfectly within the cosmological bound, which states that the sum of the neutrino masses must be below a certain value, oscillating, between 0.5 and 0.1 eV depending on the type of experiment and measurement performed. Moreover, from the neutrino masses we can derive their mass ratios, which turn out to be $m_{\nu\mu}/m_{\nu e} = 137$, imposed as the starting constraint, $m_{\nu\tau}/m_{\nu\mu} \approx 5.8$, and $m_{\nu\tau}/m_{\nu e} \approx 137 \cdot 5.8 \approx 795$. Now, as for the quarks: for the light quarks, up and down, we can use relations 8.16, 8.17, and 8.18. For the heavier quarks, however, the situation becomes more complex, probably due to secondary interactions arising among the elementary electric charges (quantum singularities). In this way, the strange and bottom quarks, which have a higher charge number than their counterparts charm and top, are nonetheless lighter due to the electric screening provided by the other charges (!/?).

8.23 TOTAL MASSES: SUMMARY

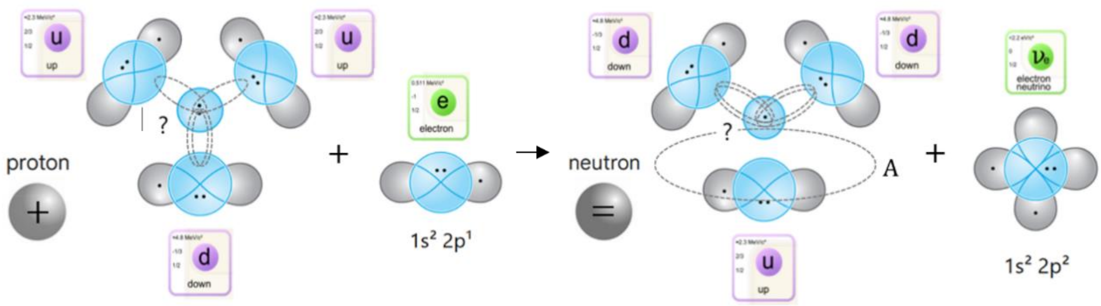
We started with the elementary electric charge ($\boldsymbol{m\, q_e^{-/+} \approx 9.29 \cdot 10^{-10}\, kg}$). When two opposite charges combine to form a photon (graviphoton), their masses cancel out ($\boldsymbol{m\, g\gamma^0 = massless}$). The electron consists of two negative charges and one positive charge: the interactions between these charges almost entirely reduce its mass ($\boldsymbol{m\, e^{-/+} \approx 9.1 \cdot 10^{-31}\, kg}$). Looking at the heavier leptons, such as the muon ($\boldsymbol{m\, \mu^{-/+} \approx 2.08 \cdot 10^{-28}\, kg}$) and tau ($\boldsymbol{m\, \tau^{-/+} \approx 3.41 \cdot 10^{-27}\, kg}$), their masses are calculated starting from that of the electron, which is multiplied by factors related to the singularity ratio R and to the strong interactions between charges. For the W, Z^0, and Higgs bosons H^0, the masses increase progressively: the W's mass comes from the interactions of its p orbitals ($\boldsymbol{m\, W^{-/+} \approx 1.56 \cdot 10^{-25}\, kg}$). The Z ($\boldsymbol{m\, Z^0 \approx 1.78 \cdot 10^{-25}\, kg}$) and Higgs ($\boldsymbol{m\, H^0 \approx 2.38 \cdot 10^{-25}\, kg}$) bosons are slightly heavier due to the addition of extra charges in their outer orbitals. As for neutrinos, we only know the differences between the squares of their masses. However, by assuming ratios similar to those of the charged leptons, we can estimate their masses ($\boldsymbol{m_{\nu e} \approx 1.13 \cdot 10^{-40}\, kg}$; $\boldsymbol{m_{\nu\mu} \approx 1.55 \cdot 10^{-38}\, kg}$; $\boldsymbol{m_{\nu\tau} \approx 8.93 \cdot 10^{-38}\, kg}$). For the light quarks, such as up and down, the masses are relatively easy to calculate. For the heavier quarks (strange, charm, top, bottom), the calculations are more complex.

PREDICTED MASSES FROM ELECTROGRAVITATIONAL THEORY

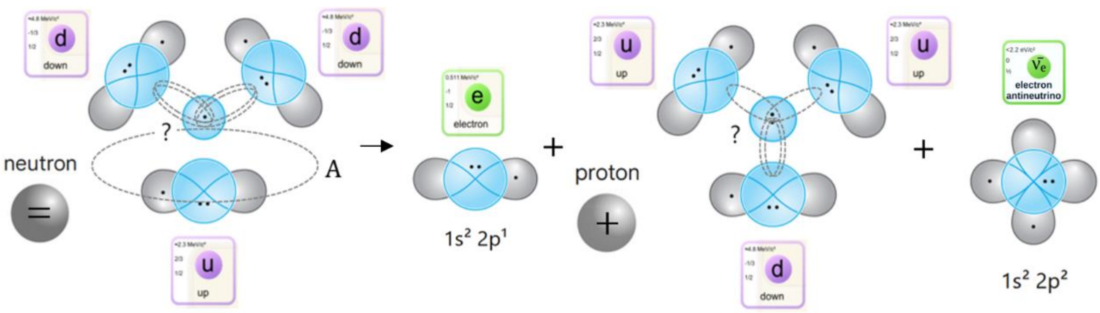
Particle	Symbol	Predicted Mass	Measured Mass
Elementary charge	$q_e^{-/+}$	$5.21 \cdot 10^{20}$ MeV/c^2	//
Photon / Graviphoton	$g\gamma^0$	0	0
Electron / Positron	$e^{-/+}$	?	0.511 MeV/c^2
Electron neutrino	ν_e	$6.33 \cdot 10^{-11}$ MeV/c^2	?
Muon / Antimuon	$\mu^{-/+}$	116.7 MeV/c^2	105.7 MeV/c^2
Muon neutrino	ν_μ	$8.69 \cdot 10^{-9}$ MeV/c^2	?
Tau / Antitau	$\tau^{-/+}$	1912 MeV/c^2	1776.9 MeV/c^2
Tau neutrino	ν_τ	$5.01 \cdot 10^{-8}$ MeV/c^2	?
$W^-/^+$ boson	$W^{-/+}$	87.5 GeV/c^2	80.4 GeV/c^2
Z^0 boson	Z^0	99.8 GeV/c^2	91.2 GeV/c^2
Higgs H^0	H^0	133 GeV/c^2	125 GeV/c^2

8.24 Conservation of the Charge Number

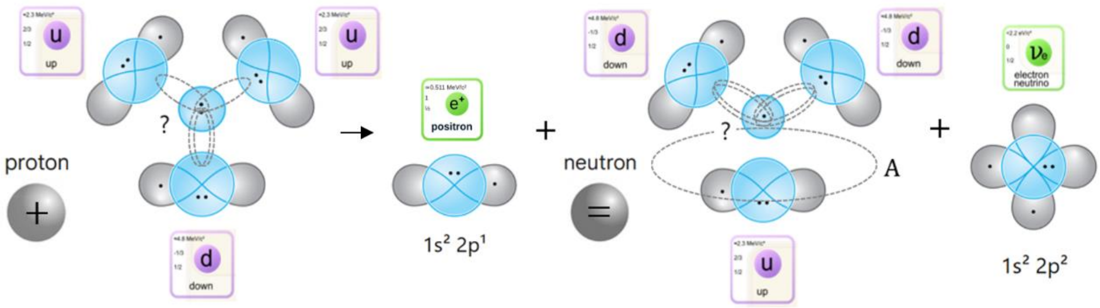
Below, some phenomena involving elementary particles will be taken as examples, in order to demonstrate how such processes involve the *conservation of the charge number* (particles can be converted into photons through annihilation, and thus what is actually conserved are the graviphotons; see equation 4.16). These represent further confirmation of the validity of the electrogravitational theory. Let us start with ***Electron capture***, sometimes also called *K-capture*, a nuclear transformation process in which an electron e^- is captured by the nucleus, causing a proton p^+ to be converted into a neutron n while an electron neutrino ν_e is simultaneously emitted. For an isolated proton, the reaction in its simplest form would be the following: $p^+ + e^- \rightarrow n + \nu_e$. However, this reaction is energetically forbidden; otherwise, the hydrogen atom would not be stable. In this process the conservation of electric charge is clearly satisfied, and both baryon number (one proton disappears and one neutron appears) and lepton number (one electron disappears and one electron neutrino appears) are also conserved, as well the charge number ($11 + 3 = 10 + 4$).



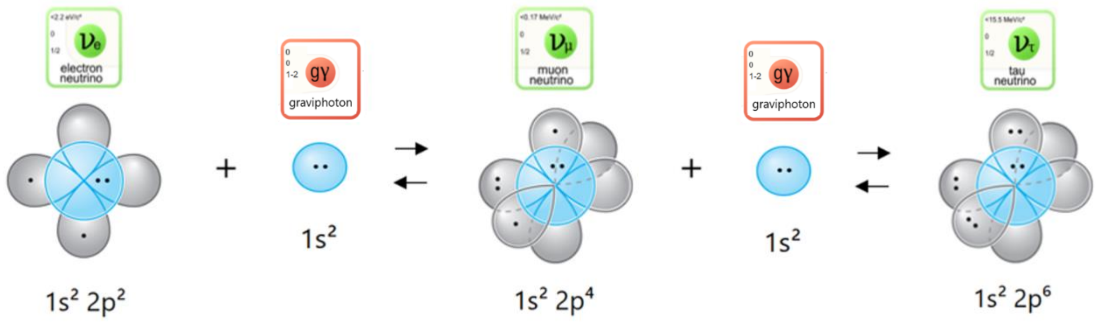
Beta decay is a type of radioactive decay, which is a spontaneous transformation through which a chemical element (radioactive) is converted into a different element with the emission of electrically charged particles (electrons or positrons) and neutral particles (neutrinos or antineutrinos), while conserving the mass number. Beta decay is classified as β^+ or β^- depending on the particular type of nuclear process that occurs. In the case of β^- decay (called "minus" because an electron, which has negative charge, is emitted), the neutron involved is normally located within the nucleus of an atom, and what occurs, in addition to the emission of the two particles, is that the atom is transformed into the one with the next atomic number Z. The mass number remains unchanged, as does the charge number (10 = 11 + 3 – 4; the charge numbers of antiparticles must be taken with a minus sign ?): $n \rightarrow p^+ + e^- + \bar{\nu}_e$.



In the case of β⁺ decay (called "plus" because a positron is emitted), a bound proton is transformed into a bound neutron, a positron, and a neutrino. It is important to emphasize that β⁺ decay can occur, for kinematic reasons of energy conservation, only for bound protons; it can therefore never occur for free protons. In this case as well, the charge number is conserved (11 = 10 − 3 + 4): $p^+ \rightarrow n + e^+ + \nu_e$.



In the 1960s and 1970s, experiments such as Homestake measured a number of electron neutrinos coming from the Sun that was far lower than predicted. The explanation for this "missing" flux was found in the fact that neutrinos change "flavor" during their journey to Earth, a phenomenon known as ***Neutrino oscillation***. In the standard theory, this flavor change occurs without any exchange of energy with the environment: the oscillation is simply a quantum interference effect. In the electrogravitational theory, however, the three flavors correspond to three different elementary particles with different masses; the mass difference between neutrinos is so small that the energy variation required for a flavor change is on the order of 10^{-2}-10^{-4} eV, meaning that CMB graviphotons are sufficient to induce the transmutation.



In the currently accepted theory, when a neutrino moves through space, the mass eigenstates evolve over time with different quantum phases. This evolution causes the combination of the three states to change over time, and therefore the observable flavor content oscillates. In the electrogravitational theory, this is interpreted as an exchange of graviphotons between flavors through the gravitational interaction. The probability that a neutrino emitted with a given flavor is detected as a different flavor after traveling a distance L, depends on the neutrino mass differences. If all the masses were equal (or all zero), there would be no oscillations. This supports the electrogravitational theory, which predicts neutrinos as 3 distinct massive particles.

8.25 THE MEANING OF ENERGY AND MASS

In contemporary physics, energy occupies a central position, but at the same time is a profoundly problematic one from a conceptual point of view. It is one of the most used, powerful, and universal quantities in physics, yet it does not correspond to "something" material or tangible. It is precisely this tension between operational importance and the absence of a clear ontological nature that characterizes the way energy is understood today. From an operational point of view, energy is defined as the quantity that measures the ability of a body or a physical system to perform work, regardless of whether such work is actually carried out. This definition does not say what energy is, but how it manifests itself and how it can be measured. One of the cornerstones of modern physics is the law of conservation of energy, according to which the total energy of an isolated system remains constant over time: it can be transformed, but it can neither be created nor destroyed. This law does not depend on the particular form that energy takes. In fact, energy appears in many different forms: kinetic, potential, elastic, chemical, up to the rest-mass energy introduced by special relativity, which do not exclude one another and can coexist and transform into one another. In this sense, energy appears as a property of the system that can be transferred from one body to another through work or heat. The conservation of energy is linked to a temporal symmetry of physical laws (according to Noether's theorem): if the laws do not change over time, then there exists a conserved quantity, which we call energy. Contemporary physics does not clarify what energy is, as clearly emphasized by Richard Feynman in *The Feynman Lectures on Physics*, "It is important to realize that in physics today, we have no knowledge of what energy is". So, what is energy? How do elementary particles, and therefore matter, acquire energy? If we make an analogy with molecules made up of atoms, particles gain energy by "forming", at the quantum level, "bonds" through their residual charges with photons (graviphotons). In this way, photons can be easily absorbed and emitted by matter. This process will appear at the macroscopic level as an exchange of energy between systems. When a body increases or decreases its energy, this means that it has "acquired" or "lost" photons. Whether through mechanical collisions, thermal exchanges, chemical reactions, or gravitational, electromagnetic, or nuclear interactions, what happens is that photons are exchanged. This is also proof of the fact that both the electromagnetic and the gravitational fields are mediated by photons (graviphotons). One might then ask: why can gravity pass through matter whereas electromagnetic fields cannot? This depends on the wavelength of the waves. That energy depends on the photons exchanged can also be inferred from the fact that when all matter is converted into energy, it is converted into photons (with energy $E = h\nu$). Mass, on the other hand, measures the inertia of a body. At the same time, mass determines the way in which a body interacts with the gravitational field and contributes to its generation. In particle physics, the mass of elementary particles is considered an emergent property arising from interaction with the Higgs field. However, as we have seen, there is no need (?) for any Higgs mechanism, since mass is linked to the total internal energy of particles. Moreover, elementary particles can vary their energy (mass) by absorbing and emitting photons.

9. Subatomic particles

9.1 Mass ratios between proton, electron and neutron

Quantum Chromodynamics (QCD) tells us that the proton consists of 2 up quarks and 1 down quark. The up quark has a charge number ($n_c = 3.3\overline{3}$), while the down quark has a charge number ($n_c = 3.6\overline{6}$). Remembering that the up quark is the quasi-particle that spends 2/3 of its existence as a positron and 1/3 as a gluon (3+1), while the down quark is the quasi-particle that spends 1/3 of its existence as an electron and 2/3 as a gluon (3+1); *at this stage we can overlook the mechanism that causes the charge to bind with the leptons. The average charge number of the quarks is calculated by averaging the charge numbers of the individual quarks in the proton:

$$\bar{n}_c = \left(\frac{3.3\overline{3} + 3.3\overline{3} + 3.6\overline{6}}{3}\right) \approx 3.44 \tag{9.1}$$

The ratio between the average charge number of one of the quasi-particles of the proton (which can be considered an elementary molecule) and that of the electron is:

$$R = \frac{\bar{n}_c}{n_c} \approx \frac{3.44}{3} \approx 1.1466 \tag{9.2}$$

This means that each quasi-particle constituting the proton, in terms of charges, is worth approximately 1.1466 times the electron. Finally, the ratio N between the number of constituents (number of elementary particles) of the two particles is:

$$N = \frac{constituents\ of\ proton}{constituents\ of\ electron} = \frac{3}{1} = 3 \tag{9.3}$$

The mass difference between the two subatomic particles arises from the fact that the 3 leptons (in the form of up/down quarks) constituting the proton, during rotation, each falls into the cone of influence of the adjacent lepton (quark), which does not happen in the case of the 3 charges of the electron since they rotate around their charge center. Therefore, when an external observer makes measurements, as in the case of galaxies, they will obtain values that are biased by the effects related to singularities, effects that are always maximized. Considering this, we can proceed to calculate the ratio between the mass of the proton and that of the electron. We need to consider (as in the case of galaxies) the conversion factor for the force and apply it to the three quarks constituting the proton. The ratio (m_P/m_e) can be calculated in at least two ways. The presented method takes into account that only one quark of the proton interacts at a time. The ratio (m_P/m_e) can be calculated using the following formula:

$$\frac{m_P}{m_e} = R \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = R \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^N \approx 1.1466 \cdot (11.7)^3 \approx 1836 \tag{9.4}$$

By inserting the mass of the electron into the equation, it is possible to calculate the mass of the proton (and vice versa). The same applies to the neutron. The neutron consists of 2 down quarks and 1 up quark. The average charge number of the quarks constituting the neutron is calculated by averaging the charge numbers of the quarks:

$$\bar{n}_c = \left(\frac{3.3\bar{3} + 3.6\bar{6} + 3.6\bar{6}}{3}\right) \approx 3.55 \tag{9.5}$$

The ratio between the charge number of one of the quasi-particles constituting the neutron (also considered an elementary molecule) and that of the electron is:

$$R = \frac{\bar{n}_c}{n_c} \approx \frac{3.55}{3} \approx 1.185 \tag{9.6}$$

This means that each quasi-particle constituting the neutron, in terms of elementary charges, is worth 1.185 times the electron. Since the ratio between the number of constituents of the two particles is also $N = 3$ in this case, applying the conversion factor for the force to each of the three quarks constituting the neutron, we obtain:

$$\frac{m_N}{m_e} = R \cdot \left(\frac{1}{f[\boldsymbol{F}]}\right)^N = R \cdot \left(\frac{1}{\sqrt{\alpha}}\right)^N \approx 1.185 \cdot (11.7)^3 \approx 1898 \tag{9.7}$$

Finally, we can calculate the mass ratio between the neutron and the proton:

$$\frac{m_N}{m_P} \approx \frac{1898}{1836} \approx 1.034 \tag{9.8}$$

This does not correspond to what is observed experimentally [53]. In nature, the mass of the neutron differs by only 0.1% from that of the proton, while according to calculations, it should be 3.4%. This discrepancy could be attributed to the presence of additional delocalized charge in the neutron, which generates greater attraction between the quarks, bringing them closer to the central (delocalized) singularity.

9.2 Hydrogen atom

The difference between what is expected to be measured and what is actually observed [30] can be explained in this way. The charges constituting the electron orbit around their own charge center. Additionally, when the electron is bound to the proton (in the hydrogen atom), it also rotates around the singularity of the proton. Therefore, the electron will have a lower velocity than theoretically predicted (≈ 3.42 for each component). It will also be closer to the nucleus. In fact, the orbit of the electron will be smaller by a factor of ≈ 3.42 for each component, a situation opposite to what occurs in the universe, where R_{uI} is larger than the theor. radius R_{uT}.

10. The forces

10.1 THE MEANING OF FORCES

From a quantum perspective, force is nothing more than the effect that occurs as a result of the exchange of particles called mediators [52]. This process is analogous to monetary exchange. Since all particles (coins) can be exchanged, all are carriers of force. Particles interact with each other in two ways: electrically and gravitationally, although each in a different manner. At the elementary level, depending on the particle carrying it, forces can be divided into bosonic forces (mediated by bosons) and leptonic forces (mediated by leptons). These can then be further subdivided, based on the particle involved in the exchange, into strong force or singularity force $q^{-/+}$, electrogravitational force $g\gamma^{0}$, weak force $W^{-/+}$, Z^{0}, leptonic forces $e^{-/+}$, $\mu^{-/+}$, $\tau^{-/+}$, and neutrino forces ν_e, ν_μ, ν_τ. The ***strong force or singularity force*** (free elementary elect. charge $q^{-/+}$) is the force that holds together the constituents of subatomic particles and operates whenever there is a singularity. It is mediated by free electric charge (spacetime itself). Contrary to popular belief, it also operates on a large scale, as in the case of galaxies and the entire universe, where it causes all those effects attributed to dark energy and dark matter. This force increases with distance from the singularity, as predicted by conversion factors. Its coupling constant is approximately 137 times greater than that of the electromagnetic force. This is easily explainable, as in the case of mutual interaction between *elementary particles, the force conversion factor is $f^{-2}[\boldsymbol{F}] \approx 11.7^{2}$. The ***electrogravitational force*** (*graviphoton* $g\gamma^{0}$) represents the force responsible for the manifestation of electrical, magnetic, and some gravitational phenomena. The ***weak force*** (*bosons* $W^{-/+}$, Z^{0}) is responsible for beta decay processes in atomic nuclei. The ***leptonic forces*** (*electron* $e^{-/+}$, *muon* $\mu^{-/+}$, *tauon* $\tau^{-/+}$). The binding force (*electron* $e^{-/+}$) is the force that binds atoms in molecules and modulates chemical reactions. At a higher level (molecular), this constitutes the analogue of the strong force. Regarding the other leptonic forces (*muon* $\mu^{-/+}$, *tauon* $\tau^{-/+}$), muons and tauons, due to their high mass, have a shorter average lifespan compared to electrons. In ordinary contexts, these particles are not involved; however, at very high energies such as in colliders, they can replace electrons in some electronuclear reactions. The ***Neutrino forces*** (neutrinos ν_e, ν_μ, ν_τ). Due to the directional nature of p orbitals, these particles can pass through large amounts of matter without interacting. This characteristic makes them particularly interesting for the study of astrophysical phenomena and for experiments requiring the detection of particles from very distant sources. The ***Gravitational force*** (*all particles*). Because all particles (elementary and non-elementary) and all masses are composed of elementary electric charges (quantum singularities), which are themselves deformations of spacetime, this force acts on all particles both through spacetime deformation and through the exchange of graviphotons, other particles (elementary and non el.), and macroscopic masses.

11. The Multiverse

11.1 The black-hole universe

We have identified four impassable limits (horizons). These separate the observable universe (each observer has their own observable universe) from those regions of spacetime unreachable by light, and therefore impenetrable (singularities): our observable universe, black holes, and quantum singularities (elementary electric charges) are entities of the same kind. Consequently, there must be some connection between them. In fact, our universe is the progenitor of all the black holes present within it. Quantum singularities (elementary electric charges), on the other hand, represent the "embryos" from which, under certain conditions (critical mass/energy sufficient to break the bond between the two elementary electric charges of the graviphoton), new black holes (and thus new universes) can form. This thesis is supported by some interesting analogies. The first we have already seen: in a black hole, the event horizon represents the point beyond which there is no causal relationship with the interior. The same situation occurs with quantum singularities and, conversely, with the cosmic horizon. The second observation is this: the gravitational attraction force generated by the mass of the entire universe (at a distance equal to R_{uI} if we take into account dark matter, or R_{uT} if we consider only ordinary matter) is of the same order of magnitude as the Planck force c^4/G, which is the force required to create a black hole and the force that holds together, in flat spacetime, the two charges of the graviphoton: when the bond between the electric charges is "broken," the negative charge will form a black hole, while the positive one (white hole) being unstable when isolated, decays (?). This explains both the positional asymmetry of elementary particles in atoms (positrons at the center) and partly the energy of the vacuum. Therefore, our universe is part of a giant black hole formed about 13.6 billion years ago in a higher universe through the gravitational collapse of a sufficient concentration of mass/energy. In this perspective, the cosmic microwave background radiation represents what remains of the formation of our universe-black hole. The redshift of the cosmic microwave background radiation is related to the contraction (still ongoing) of matter and, therefore, of the ruler with which measurements are made. Furthermore, what is commonly referred to as primordial expansion is actually a phase of violent contraction, resulting from the gravitational collapse of the mass from which our black hole-universe originated.

11.2 The repeated gravitational collapses multiverse

There has always been debate about what the ultimate fate of the universe could be [26]. Eternal inflation, proposed by Alan Guth, represents a cosmological model derived from extending the Big Bang theory. This contrasts with other cosmological theories, particularly the cyclic model, which predicts a repeated series of expansions and contractions. The theory of eternal inflation includes the multiverse variant proposed by Andrei Linde (bubble theory). In Linde's multiverse, universes expand within each other. Each universe is confined within its bubble in eternal inflation. In this scenario, our observable universe represents nothing more than a tiny region of existence, which may have had a beginning, or perhaps not. In Linde's theory, each of these universes has different parameters and constants, and only a few have values that have allowed for the development of life. However, the fine-tuning of the physical laws of our universe (fine-tuned universe) could also be the result of intelligent design (designed universe; this represents one of the main paradigms of digitalist physics), and therefore life might be expected in each of the bubbles. The concept of a bubble universe involves the formation of universes derived from a "parent universe". The "child" universes would be generated from nuclei, "embryos" or "cosmic eggs", pre-existing at the Planck scale (which, as we have seen, are the quantum singularities/elementary electric charges q_e^-). Our idea of the multiverse differs from Linde's bubble theory, as instead of being based on an infinite series of expansions, it is based on a repeated series of gravitational collapses (Matryoshka Multiverse). Moreover, the complexity of life cannot be something random, but designed, and therefore expected in every universe. We know that in a star, when the nuclear fusion process exhausts its fuel and the mass is sufficiently high, it collapses upon itself, giving rise to a black hole, and thus to a new universe [54], which is nothing but a naked elementary electric charge q_e^- (unshielded). From this, it follows that all black hole-universes, to form, must reach a minimum mass limit (in this view, white dwarfs represent failed universes). Our universe exists within a larger universe and contains, in turn, other universes: it is very likely that some of the most massive black holes in our universe harbor other black holes inside them, and thus other universes, hence the name Matryoshka Multiverse. In this perspective, our universe represents only one of the many levels (realms) that make up the multiverse, all separated by horizons (limits), which are simultaneously event horizons (for an external observer) and cosmological horizons (for an internal observer).

11.3 THE ETERNAL RETURN

The view of the multiverse as a series of repeated gravitational collapses (Matrioshka) connects to the concept of "eternal return". This concept states that all events recur in time after a certain period (return period), in a cyclical manner, like seasons. The Stoics believed that the universe was periodically destroyed and rebuilt, and that each universe was a similar version of the previous one. If the universe (multiverse) is infinite in duration but not in material content, then all matter must pass through a finite number of combinations, and every series of combinations, especially the most probable ones, must eventually repeat (Ouroboros). This can be related (?) to Poincaré's recurrence theorem, which states that dynamical systems can return infinitely close to their original state, and if these systems are discrete, there is a possibility that they return exactly to their starting state. The theorem, first proposed by Henri Poincaré in 1890, forms the basis of ergodic theory today. This theorem also applies to large systems, such as the universe and the entire multiverse.

12. Matrix (and Simulation?)

12.1 Introduction

During the Industrial Revolution, Joseph Marie Jacquard developed a device in Lyon capable of significantly accelerating the silk weaving process. This device, known as the Jacquard loom, demonstrated that information could be manipulated and managed mechanically. The secret of this invention lay in a simple punched card, which controlled the lifting and lowering of the loom to recreate the desired pattern in the fabric. This invention showed that it was possible to capture the essence of something and represent it in a different form, much like writing captures spoken language and transforms it into symbols. Jacquard had demonstrated that with just two symbols, a hole or an empty space, it was possible to capture the information of any image. Translating information into symbols represented an idea of extraordinary power, yet their methods of transmission and communication were still constrained by the speed at which physical objects could be transported. This limitation was overcome when electricity was utilized for information transfer. In this regard, in 1840, Samuel Morse developed the telegraph, a device capable of sending a sequence of short and long pulses of electric current, which when combined appropriately, could represent all the letters of the alphabet. Since Morse's time, it was realized that information was not just about communicating a message but was a concept of broader scope. This all began to emerge thanks to a problem posed by the Scottish physicist James Clerk Maxwell, who was among the first to understand that heat was linked to the movement of molecules. Maxwell imagined a tiny demon perched on a box with such acute vision that it could precisely observe the movement of all the molecules inside. The demon controls a door that divides the box in half. Every time it sees a fast-moving molecule approaching the door from the right, it opens it to allow passage to the left. Likewise, when it sees a slow-moving molecule approaching the door from the left, it opens it to allow passage to the right. Over time, all the fast-moving molecules will accumulate on the left side of the box, while all the slow-moving molecules will be on the right. Maxwell's demon seemed to suggest that simply by knowing what happens inside the box, it would be possible to make one half hotter and the other colder without using any energy, creating order from disorder. Scientists intuitively felt that something was amiss, but it took more than a century to resolve this puzzle. It required the development of what we now know as "information theory". One of its pioneers was Claude Shannon. In his publications, Shannon demonstrated that information is closely tied to the surprise element of a message. Information becomes news when it is unexpected. If today's news were to replicate yesterday's news, there would be nothing new, and its informational content would be zero. Shannon also developed a method to quantify the information contained in a message. He realized that the binary digit (bit), zero or one, could be used as a fundamental unit since any message could be translated into a sequence of zeros and ones. The binary digit (bit) thus represents the atom of information, the smallest unit sufficient to communicate anything. Everything, whether sounds, images, or texts, can be digitized and transmitted in the form of bits using a system capable of assuming at least two states. In fact, any system with two states, such as a coin, contains a bit of information. Through Shannon's discoveries, it was finally possible to provide an answer to Maxwell's puzzle. When the demon identifies a molecule, it must store its information. However, since its memory is finite, there will come a time when it must erase them (to make room for new ones), thus increasing, in an irreversible process, the entropy of the universe. This erasure consumes energy. What was discovered is that there is a minimum amount of energy, known as Landauer's limit, required to erase one bit of information. This demonstrates that energy and information are two physically connected concepts. Indeed, it has always been apparent that the creation of physical order, such as the construction of architectural or invisible digital structures, incurs an energy cost. Thus information obeys physical laws, like any other thing present in the universe [*].

12.2 The informational universe

Despite the abstract nature of information, for it to exist, it must be embodied in a physical system. Information must be "contained" by something, whether it's a stone slab, a book, a CD, or any other medium. This raises the question of whether there exists a fundamental level at which information can be encoded, the level of the fundamental "0s" and "1s". This can only be the spacetime itself (electrogravitational field). We have seen how the smallest fluctuation of spacetime corresponds to the elementary electric charge, which therefore represents the "quantum of curvature", with the charge sign corresponding to the sign of the disturbance (if we consider spacetime as a vast ocean, elementary electric charges can be seen as springs/wells that emerge and dissolve within it; elementary and non-elementary particles are therefore clusters of multiple springs/wells). The electrogravitational field can be assigned the value "0" where it is undisturbed, and the value "1" where there is an elementary electric charge present. The entire reality is thus an enormous dynamic matrix (binary or ternary, depending on whether the sign of the charges is considered or not). The points of the field are akin to the “pixels” of a screen, with the ability to be either on or off. The total curvature of the field (mass) is determined by the sum of elementary electric charges, regardless of their sign, hence by all the “on” points.

12.3 Law of conservation of information

We know that electric charge is a conserved quantity, which implies that whenever there is a positive-sign fluctuation in the spacetime fabric, there must simultaneously be an equivalent fluctuation with opposite sign. Therefore, information, like any other physical quantity, is conserved. We can thus formulate the following equation:

$$n(1) + n(-1) = 0 \qquad (12.1)$$

For $(n \in \mathbb{N}) = 1$, this reduces to the constitutive relation of the graviphoton, represented by the string (-1;1). Moreover, since the bit "1" corresponds to the elementary electric charge, which is related to mass and energy, we can formulate a general law of conservation. Remembering that $1 = -e^{i\pi}$ and substituting $\pi = \alpha h_P c/2Kq_e^2$, we can define the "1" bit through the complex exponential; a similar relation holds for the negative bit "-1". We obtain the general relationship, which involves the fine-structure constant α, Planck's constant h_P, the speed of light c, the fact.2 (equipartition of action), Coulomb's constant K, and the elementary charge q_e.

$$n\, e^{i\frac{\alpha h_P c}{2Kq_e^2}} + n - e^{i\frac{\alpha h_P c}{2Kq_e^2}} = 0 \tag{12.2}$$

When $n = 1$, this reduces to Euler's identity $e^{i\frac{\alpha h_P c}{2Kq_e^2}} + 1 = e^{i\pi} + 1 = 0$. The dependence on the conversion factors of the terms in the equation is implicit.

12.4 Particles as numerical strings

Within particles, elementary electric charges are distributed so that within the same orbital there are at most two charges (Pauli-like exclusion principle), with opposite signs (-1;1). Since each elementary electric charge corresponds to a bit (positive or negative), this implies that every particle, particularly the elementary ones, can be represented by a numerical string. Therefore, everything that exists can be reduced to atoms, atoms to subatomic particles, and subatomic particles in turn to elementary electric charges, which ultimately are reducible to bits. Reality is thus described by equations involving numerical strings, which can be solved algorithmically (?).

12.5 The universe as a mathematical structure

That the reality around us is governed by mathematical principles is a well-known fact. Galileo Galilei asserted [55] that the universe is written in the language of mathematics. However, we may ask why mathematics is so effective in describing reality. According to Tegmark [56], this happens because the universe is essentially a mathematical structure, a set of elements in relation to each other. We can identify these elements as elementary electric charges, the bits "1" of the program. In this sense, everything that is mathematically provable also exists physically. Mathematical existence equates to physical existence. In fact, many mathematical theories have been developed which have only later found their application in the real world. For example, 60 years after it was formulated, Einstein [6] used Riemannian geometry to describe gravity. According to this paradigm, all mathematics developed will sooner or later find its place in the physical world. A first step in this direction can be taken by substituting the identities $1 = -e^{i\frac{\alpha h_P c}{2Kq_e^2}}$ and $\pi = \alpha h_P c/2Kq_e^2$ inside various mathematical equations. This allows us to transform theorems developed in mathematical contexts into physical laws. Furthermore, since the universe is a mathematical structure, it means that it is possible to construct an axiomatic system (which, by describing a set consisting of a finite number of elements, the elementary electric charges, on a continuous background, spacetime, is not necessarily subject to Gödel's incompleteness theorems?) very similar to those developed for arithmetic or computer science, to describe the physical world. This is because it is possible to reduce the entire universe to a sequence of "0" and "1".

12.6 ARE WE PART OF A SIMULATION?

In the film "The Matrix", when Neo meets Morpheus, he asks him: "What is the Matrix?" He tells him that the answer is all around him. The Matrix possesses him, surrounds him. The truth is that he was born into a prison for his mind. Today we know that phenomenal perception occurs in the brain and if the brain is deceived, false sensations can be created, just like in dreams. Thus, the pain of a wound, the sight of an object, or taste, do not exist, except in our mind. In this sense, everything we perceive is essentially illusory. In fact, as we have demonstrated, the universe is nothing more than a vast program, an enormous video game, an illusion interpreted as real by our brain. The world, matter, energy, and spacetime, are essentially computational: everything is made of rules, laws, bits. According to digital physics [57], this inevitably implies the existence of an external programmer who has developed the program, the simulation in which we live. In this sense, human consciousness is not part of spacetime, it interacts with the world through a system of input and output, similar to what happens with computer programs, experiencing the world through the senses. Human consciousness is thus "causality" originating outside spacetime. This is the source of free will, which could not exist within a closed system because, at a macroscopic level, every action would correspond to a perfectly or statistically predictable reaction and therefore a deterministic outcome. Free will is possible only if there is something external that acts upon the system. The starting point of the chain of events. Everything begins with a choice, which then activates the domino chain of cause and effect. The more people know, the more they are able to see alternative paths. Choices represent the independent variables, and each choice will have a different effect on reality. Knowledge makes a person free, not just a piece of the domino, but an active player, while ignorance reduces them to part of the causal chain, susceptible to the influence of the superstructure created by others. Moreover, considering that a choice represents an option between two states, it follows that the universe is fundamentally dual. Duality is at the basis of the dynamics of physical systems. Without opposites there is no differentiation, forces would not exist, and everything would be inert. Duality is a law of symmetry that applies to every entity and at every level of existence. Everything that exists has formed and forms through consecutive ramifications (divisions or symmetries), like the branches of a tree. Hence arises the parallel with the tree of life. All existence can be traced back to a single root, the electrogravitational field. In this sense, the elementary electric charge represents the cell (unit) of our reality [*].

13. Implications and Predictions

13.1 Majorana Neutrinos

One of the most important predictions of electogravitational theory is that neutrinos are Majorana particles (their own antiparticles), rather than Dirac particles. The property of being one's own antiparticle has profound implications. A Majorana neutrino implies lepton number violation ($\Delta L \neq 0$), allowing rare processes such as neutrinoless double beta decay (experimentally observable?). Lepton number violation is a phenomenon that cannot be explained by the Standard Model in its current form, and confirming it would greatly strengthen the validity of the theory.

13.2 Properties of all Elementary Particles

The electrogravitational theory is able to explain the properties of all elementary particles (e.g. electron radius $\boldsymbol{r_e} \approx 1.73 \cdot 10^{-36}\ m$) and to predict their masses: zero in the case of the photon; small but still positive for neutrinos, with an expected value of $\boldsymbol{m_{\nu e}} \approx 1.13 \cdot 10^{-40}\ kg$, $\boldsymbol{m_{\nu\mu}} \approx 1.55 \cdot 10^{-38}\ kg$, and $\boldsymbol{m_{\nu\tau}} \approx 8.93 \cdot 10^{-38}\ kg$.

13.3 Possible existence of other Elementary Particles

The definition of elementary orbitals technically allows us (?) to describe particles that go beyond the $2s$ elementary orbital. Consequently, it is possible to determine the structures, properties, and masses (by applying equations 8.10 and 8.11) of previously unknown particles. Thus, having their theoretical masses available, it becomes possible to search for their existence using particle accelerators.

13.4 Spin of Elementary Particles

The spin of elementary particles is generally considered to be an intrinsic property. However, as we have seen, J can be attributed entirely to the angular momentum of quantum singularities. Since the graviphoton possesses both an electric dipole and a mass quadrupole, the rotation of its charged singularities generates a magnetic **B** field and a cogravitational **K** field, both of which have zero divergence (Eqs. 4.9–4.9b). Therefore, magnetic monopoles do not exist, even at the fundamental level.

13.5 Higgs boson and Hyerarchy Problem

That the Higgs boson is *derived from the Z^0 is justified by the fact that at high energies, the Z^0 loses its vector nature and interacts like a scalar (Goldstone Equivalence Theorem). The Higgs boson, being rotationally invariant, has Spin 0. His energy* can, at most, be converted into another Z^* boson. Finally, the fact that H^0 is a particle composed of charged quantum singularities, each having a mass equal to half the Stoney/Planck mass, with their proper mass being partially cancelled out due to the electrical interactions between them, solves the hierarchy problem.

13.6 Bits and Quantum Bits

Elementary electric charges are simple bits of the electrogravitational scalar field. By coupling at least two of them, the system can function as a qubit. Therefore, graviphotons can be used as qubits by exploiting their polarization states. The addition of further charged quantum singularities introduces additional degrees of freedom, causing the dimension of the computational space to grow exponentially.

13.7 Electrogravitational Waves

The electrogravitational theory tells us that electromagnetic and gravitational waves represent the same physical phenomenon. Therefore, every gravitational wave must possess an electromagnetic component. This component can be measured by coupling a highly sensitive electromagnetic antenna to a gravitational wave interferometer. The antenna should be designed to detect weak electromagnetic signals in frequency bands corresponding to those of the gravitational waves. Real-time synchronization of data acquisition between the interferometer and the electromagnetic antenna will enable correlation analyses to identify coincident events. The detection of an electromagnetic component coupled to gravitational waves would represent a significant confirmation of the electrogravitational theory.

13.8 Black hole Depression Cones

We have seen that black holes produce a depression in the fabric of spacetime. To simplify the analysis, we have assumed that this cone converges linearly. *In the case of the entire observable universe, this is an excellent approximation even across enormous distances. This cone, converging toward the black hole, manifests as a modification of all physical laws, constants, and parameters (conversion factors). If we consider an observer located on the event horizon, this effect increases with distance from it (strong force). For an external observer, the situation is the opposite.

13.9 Galaxy Rotation Curves

We can calculate the rotation curve of a galaxy as follows: I) Determine the boundaries of the black hole's cone of influence. The more massive the black hole, the larger its cone of influence. II) Divide the cone of influence into concentric shells. The number of shells depends on the desired level of accuracy. The finer the subdivision, the more accurate the calculations will be. III) Convert the physical parameters associated with each shell individually. IV) Reconstruct the galactic rotation curve. If we wish to perform the inverse calculation, we begin with the observed galactic rotation curve and apply the conversion factors in reverse. This yields a rotation curve corrected for singularity-related effects. To achieve the highest possible level of accuracy, we should take into account the effects produced by the stellar-mass black holes distributed throughout the galaxy. These objects affect their immediate surroundings and consequently modify the parameters of the celestial bodies located within their respective local cones (spheres) of influence.

13.10 CPT-Symmetric Universe

In the CPT-Symmetric Universe Theory, it is proposed that the fundamental laws of the universe respect CPT symmetry. This also implies that our observable universe must have a dual, an anti-universe, both emerging from the Big Bang. As we have seen, electrogravitational theory predicts the existence of pairs formed by quantum black and white holes (combined to form graviphotons), from whose splitting massive black holes, and consequently new universes, emerge. Therefore, our universe did have a dual, but this CPT-Symmetric anti-universe no longer exists (?).

13.11 Black-Hole Universe

Now, if we adopt the perspective that our universe is inside a black hole of a larger universe (Popławski) [58], this does not change anything we observe internally. From the outside, we would see matter falling towards the infinitely small. Instead, from the point of view of an "internal" observer, everything behaves exactly as predicted by the standard cosmological model (or more precisely, as with the extended model discussed in the first chapters): the universe appears to be expanding*, the CMB has the observed distribution, galactic filaments and large-scale structure are consistent, and the laws of physics work as we know them. In other words, the theory of a universe inside a black hole does not contradict what we observe from inside.

13.12 Angular Momentum of the Universe $\neq 0$

The idea that the total angular momentum of the universe is zero is consistent with some theoretical and observational considerations. Modern cosmology, based on the FLRW model, assumes that the universe is isotropic and homogeneous on large scales. However, it is important to note that some recent research suggests the possibility of a non-zero total angular momentum for the universe. In particular, a recent study by Lior Shamir [59] revealed a surprising result: there are more galaxies rotating in a clockwise direction. This asymmetry in the rotation of galaxies suggests the existence of a preferred rotational direction for the universe. One possible explanation is that this reflects the interior of a rotating black hole. In this scenario, the universe would have inherited the angular momentum of the parent black hole.

13.13 Magnetic Moment of the Universe $\neq 0$

If a preference in the rotation of galaxies were confirmed, it would necessarily imply the existence of a net magnetic moment for the universe. Galaxies contain ionized gas and charged particles that, rotating predominantly in the same direction, would generate electric currents. On a galactic scale, these currents produce local magnetic fields, while on a cosmic scale, a global asymmetry would give rise to an overall magnetic moment. The cosmological implications would be profound: it would influence the formation of cosmic structures like superclusters and galaxy filaments, and provide further evidence that our universe could be the interior of a black hole.

13.14 Electric and Gravitational Fields

Every elementary electric charge is a quantum singularity. Negative electric charges correspond to quantum black holes, which absorb spacetime, while positive charges correspond to quantum white holes, which emit spacetime. Electric fields arise from the flows of spacetime toward or away from these singularities. A predominance of negative singularities generates negative flux of spacetime (negative electric fields), while a predominance of positive singularities generates positive flux (positive electric fields). The interaction between charges of the same sign leads to their repulsion, whereas the interaction between charges of opposite signs leads to their attraction. When there is a significant number of charges, both positive and negative, electromagnetic effects cancel out, allowing the gravitational ones (gravitational and cogravitational fields) to emerge, which are related to the deformation of spacetime. In addition, dark matter (dark gravity), is due to the slope of spacetime falling toward black holes, whereas dark energy, as in the case of the universe, is due to a negative slope. This offers a possible explanation for the $ER = EPR$, as incoming/outgoing flows of spacetime between correlated singularities connected through a wormhole in a fifth dimension (still four-dimensional) similar to that of Kaluza-Klein [60] theory.

13.15 Cogravitational/Gravitomagnetic Effects

The main gravitomagnetic effects include the Lense-Thirring precession, in which a rotating massive body drags the surrounding space-time, affecting the orbits of satellites and nearby bodies; the frame-dragging effect, which alters the orientation of rotation axes or gyroscopes; the small forces acting on masses moving within a gravitomagnetic field; and the generation of gravitomagnetic waves by accelerated masses. These effects, although very weak, have been experimentally confirmed through missions such as *Gravity Probe B* and the analysis of the *LAGEOS satellites*.

13.16 Antigravitational Effects

In electrogravitational theory, moving or rotating masses generate a cogravitational field. This field can exert forces on other moving masses, and in certain configurations, these forces can have a component that is repulsive relative to normal gravity. In other words, an effect resembling a local antigravitational phenomenon can be observed: some masses tend to separate rather than fully attract each other. However, it should be emphasized that this effect is extremely weak, much smaller than normal gravitational attraction, and requires particularly specific conditions, such as masses moving in a parallel direction at ultra-high speeds. So far, no direct experiment has detected significant antigravitational effects, and therefore, although theoretically possible, it remains practically negligible under observable conditions. It should be noted, however, that since gravitational and electric fields are both spacetime phenomena, arising respectively from curvature and spacetime flows, electric and/or magnetic repulsions can be regarded as an antigravitational effect.

13.17 BLACK-HOLE PARADOX?

If light cannot escape from a black hole, but gravity can, does that mean they are carried by different particles? We know that a black hole has such intense gravity that once a certain region called the event horizon is crossed, not even light can escape. However, we also know that when light approaches the event horizon, for an external observer it does not actually fall into the black hole, but undergoes an infinite redshift. Consequently, when an electrogravitational wave "falls" toward a black hole, it does not vanish. As we have seen, a dilution of the wave only dilutes the electromagnetic fields and allows the gravitational ones to emerge. Therefore, there is no paradox related to black holes. Furthermore, a black hole, like any other mass, curves the spacetime around it, so gravity can propagate without any impediment.

13.18 STRING THEORY AND LOOP QUANTUM GRAVITY

Each elementary electric charge can be interpreted in the context of string theory [61] as half an oscillation over a period (Fig.6), with the positive (crest) or negative (trough) polarity corresponding to the sign of the singularity's electric charge. In this way, instead of using elementary orbitals, we can describe particles in terms of strings, where the charge number corresponds to the number of lobes composing the strings. Although it is fairly difficult to represent particles with non-integer charge numbers or hybrid states, this does not negate the fact that the string formalism is appropriate for particle representation. Regarding loop quantum gravity, in LQG space is discrete, made up of units of volume and area, organized in a network called a spin network. Obviously, even though in electrogravitational theory spacetime is continuous (the discretization is related to the particles and their observables), this does not preclude the possibility that space itself could be quantized in reality.

13.19 CONSCIOUSNESS (SPECULATIVE)

From common experience, it appears that consciousness does not "strictly" follow the principle of cause and effect. This is because consciousness, through imagination, is capable of fabricating "psychological" causes that do not need to be triggered by real external events, which then manifest in the physical world as effects. This can only happen if consciousness truly "exists" outside of spacetime. From what we have seen, the only way to "exit" spacetime is through quantum singularities (quantum black and white holes); therefore, consciousness, through mechanisms we do not yet understand, must somehow emerge via flows involving elementary electric charges, much like electric fields. It is likely that the duality present at the level of elementary electric charges manifests at the macroscopic level as a duality (symmetry) not only of physical entities but also of conceptual opposites (good/evil, love/hate, etc.). Consequently, consciousness requires matter to exist, but not all matter is conscious, since not all matter can access quantum singularities in the same manner. This could explain the difference between inert matter and living matter.

** Additional implications and predictions will be included in forthcoming updates.*

14. Theoretical Consistency

14.1 Introduction

In this chapter, the main no-go theorems and other known theoretical constraints are analyzed, evaluating how the electrogravitational theory relates to them. The goal is to demonstrate how the proposed construction is consistent with the limitations imposed by the theorems. We will divide the no-go theorems into four groups. ***Group A*** includes no-go theorems fundamental to QFT + gravity consistency: Weinberg–Witten (WW), Aragone–Deser (AD), Spin–Statistics, CPT theorem, Positive Energy Theorems (Schoen–Yau, Witten), Penrose–Hawking theorem. ***Group B*** includes no-go theorems for unification and symmetries: Coleman–Mandula (CM), Haag–Łopuszański–Sohnius (HLS). ***Group C*** includes no-go theorems for QFT/scalar for malism: Higgs / Triviality / Landau pole, Triviality of QED / Scalar theories. ***Group D*** includes no-go theorems for field formalism and consistency: Haag theorem, Osterwalder–Schrader theorem, Lieb–Thirring & Cluster Decomposition.

14.2 Group "A" theorems

Weinberg–Witten theorem [62] states that, in a local and Lorentz-invariant QFT with asymptotic states of well-defined momentum, there cannot exist massless particles with spin > 1 that serve as sources of conserved currents or of the energy–momentum tensor. The electrogravitational theory avoids the no-go because the graviton (*graviphoton*) turns out to be a composite particle (made of two spin-0 particles) of finite size (non-pointlike). Since the graviphoton is not pointlike, there are no states with exactly defined momentum at scales of the order of the Stoney/Planck length $\approx l_S/l_P$, so the WW assumptions are not satisfied. Therefore the tensor $T_{\mu\nu}$ is nonlocal at small scales. Nevertheless, it is possible to define a tensor $T_{\mu\nu}$ which approximates the behavior of the graviphoton and reproduces the continuum limit of GR, treating it as a pointlike particle. ***Aragone–Deser theorem*** [63] (a no-go for spin-2 interactions) states that the local and consistent coupling of a massless spin-2 field with other gauge fields is strongly constrained. As in the case of the Weinberg–Witten theorem, the electrogravitational theory avoids the no-go result because the graviton is a composite state. ***Spin–Statistics theorem*** [64,65] states that, under the assumptions of locality and Lorentz invariance, integer-spin particles are bosons, while half-integer-spin particles are fermions. The electrogravitational theory avoids the no-go constraint imposed by this theorem because the graviphoton has spin 2 (composed of two spin-0 bosons). Therefore, there is no contradiction, and the theorem is not violated. ***CPT theorem*** [66,67] states that a local, Lorentz-invariant quantum field theory with positive energy is invariant under the combined CPT operation. The electrogravitational theory is compatible with this theorem both at the macroscopic level and at the Stoney/Planck scale.

Positive Energy Theorem (Schoen–Yau, Witten) [68,69] states that, in classical General Relativity, under suitable energy conditions, the ADM energy is non-negative. The electrogravitational theory avoids this no-go because the local stress-energy tensor can have both positive and negative contributions that cancel globally. In summary, the global balance ensures physical stability. ***Penrose–Hawking Singularity Theorems*** [70,71] state that, in classical General Relativity, under certain energies and causal conditions, the formation of singularities is inevitable. The electrogravitational theory aligns perfectly with these theorems, since elementary electric charges, the building blocks that combine to form all particles and, consequently, all matter, are themselves singularities (quantum black and white holes) formed at the time of the Big Bang. Moreover, quantum singularities, together with black holes, constitute the lower limit of observability in our universe, while the cosmological horizon constitutes the upper limit. In conclusion, the Penrose–Hawking theorems are respected at all scales, since the entire theory is based on General Relativity, which holds from cosmological to the Stoney–Planck scale.

14.3 GROUP "B" THEOREMS

Coleman–Mandula theorem [72] states that in a relativistic QFT with an analytic S-matrix and non-trivial scattering, the only admissible combination of spacetime and internal symmetries is the direct product. Spacetime symmetries and internal symmetries must almost always remain separate; they cannot be mixed in a non-trivial way. The electrogravitational theory avoids the no-go because gravity is an emergent phenomenon and is not obtained by imposing a new symmetry. ***Haag–Łopuszański–Sohnius theorem*** [73] states that the only non-trivial extension of the Coleman–Mandula symmetries is supersymmetry. The electrogravitational theory avoids the no-go because unification does not arise from a superalgebra.

14.4 GROUP "C" THEOREMS

Higgs no-go (triviality/Landau) theorem [74] states that a scalar field ϕ in 4D can become "trivial" or exhibit consistency problems (non-renormalizable) without new physics or a cutoff being introduced. Key assumptions: elementary Higgs, fundamental QFT valid at all scales or up to very high scales without a new cutoff. The electrogravitational theory avoids the no-go because the Higgs is not a fundamental field (it is a hybridization of Z^0). Therefore, triviality arguments do not apply, and it has a natural physical cutoff (scale l_s/l_p). ***Landau pole*** *and* ***triviality in QED and scalar theories*** [75] state that certain gauge and scalar theories (such as QED and the Higgs sector) exhibit a divergence of the coupling constant at ultra-high energy scales (Landau pole) or become "trivial" (vanishing interactions) if extended to arbitrarily high energies. The electrogravitational theory avoids the no-go because it has a natural physical cutoff at Stoney/Planck scale, so the QFT is not valid arbitrarily. The Landau pole is a problem only if the theory is extended to arbitrary scales; here, the natural cutoff (elementary charges) prevents such problem.

14.5 Group "D" theorems

Haag's theorem [76] states that the Hilbert space constructed for a free QFT is not isomorphic to that of an interacting theory, implying that the canonical formalism is formal and requires care (which motivates the use of renormalization, perturbation theory, etc.). Haag's result challenges the concept of a "pure" interacting point-like field. Since the electrogravitational theory works with extended objects (quantum singularities), and operates within a closed universe, the no-go theorem is avoided. ***Osterwalder–Schrader theorem*** [77] states that, under certain assumptions (such as reflection positivity), a properly defined Euclidean theory can be reconstructed as a Lorentzian QFT. The electrogravitational theory respects this theorem because, as discussed, it is a Lorentzian theory constructed from a Euclidean one. ***Lieb–Thirring** and **Cluster Decomposition theorems*** [78,79] state that, under conditions of quantum matter stability and for a given type of interactions, correlations at large distances must factorize. The electrogravitational theory is consistent with these theorems because the decomposition into electric charges prevents unbounded energy decay. Moreover, interactions at the Stoney/Planck scale ensure that the energy is bounded from below. In conclusion, non-locality is suppressed at the Planck scale, and matter stability along with cluster decomposition naturally emerge at macroscopic scales.

14.6 Conclusions

In summary, the electrogravitational theory is fully consistent with the main no-go theorems and known theoretical constraints. The graviphoton, being a composite particle formed from two spin-0 bosons and having finite size, evades the restrictions imposed by the Weinberg–Witten and Aragone–Deser theorems on the local coupling of a spin-2 particle with other fields, while its bosonic nature ensures compliance with the spin-statistics relation. Moreover, the theory is compatible with the CPT theorem at both macroscopic and Stoney/Planck scales. The global energy stability, achieved by balancing positive and negative local contributions, satisfies the requirements of the Schoen–Yau and Witten positive energy theorems. Elementary electric charges (quantum singularities), which constitute the fundamental building blocks of all matter, allow the theory to respect the Penrose–Hawking theorems (on the inevitable formation of singularities), from Stoney/Planck to cosmological scales. Similarly, emergent gravity and the absence of a superalgebra for unification avoid the constraints of the Coleman–Mandula and Haag–Łopuszański–Sohnius theorems. Regarding scalar fields and high-energy QFT, the Higgs, being a Z^0 hybrid state rather than a fundamental field, is not subject to triviality or the Landau pole, while the natural Stoney/Planck-scale cutoff prevents analogous issues in QED and scalar theories. Finally, since the theory employs elementary electric charges as extended objects rather than point-like fields, the constraints of Haag's theorem and the requirements of the Osterwalder–Schrader theorem are satisfied: Planck-scale interactions suppress non-locality, ensuring that matter stability and cluster decomposition naturally emerge at macroscopic scales.

Appendix

CONVERSION FACTORS

TIME	$T_{uI} = 1 \cdot T_{uT}$
LENGTH	$R_{uI} = 1/\sqrt[4]{\alpha} \cdot R_{uT} \approx 3.42 \cdot R_{uT}$
VELOCITY	$\boldsymbol{v}_{uI} = 1/\sqrt[4]{\alpha} \cdot \boldsymbol{v}_{uT} \approx 3.42 \cdot \boldsymbol{v}_{uT}$
ACCELERATION	$\boldsymbol{a}_{uI} = 1/\sqrt[4]{\alpha} \cdot \boldsymbol{a}_{uT} \approx 3.42 \cdot \boldsymbol{a}_{uT}$
CURVATURE	$S_{uI} = \sqrt{\alpha} \cdot S_{uT} \approx 1/11.7 \cdot S_{uT}$
ENERGY	$E_{uI} = \sqrt[4]{\alpha} \cdot E_{uT} \approx 1/3.42 \cdot E_{uT}$
MASS	$m_{uI} = \sqrt[4]{\alpha^3}\, m_{uT} \approx 1/40 \cdot m_{uT}$
GRAVITATIONAL ATTRACTION FORCE	$\boldsymbol{F}_{g\,uI} = \sqrt{\alpha}\, \boldsymbol{F}_{g\,uT} \approx 1/11.7 \cdot \boldsymbol{F}_{g\,uT}$
UNIVERSAL GRAVITATIONAL CONSTANT	$G_{uI} = 1/\alpha\sqrt{\alpha}\, G_{uT} \approx\ 1600 \cdot G_{uT}$
GRAVITATIONAL PERMETTIVITY	$\varepsilon_{g\,uI} = \alpha\sqrt{\alpha}\, \varepsilon_{g\,uT} \approx 1/1600 \cdot \varepsilon_{g\,uT}$
COGRAVITATIONAL PERMEABILITY	$\mu_{g\,uI} = 1/\alpha\, \mu_{g\,uT} \approx 137 \cdot \mu_{g\,uT}$
ELECTRIC CHARGE	$q_{uI} = \sqrt{\alpha}\, q_{uT} \approx 1/11.7 \cdot q_{uT}$
COULOMB FORCE	$\boldsymbol{F}_{e\,uI} = \sqrt{\alpha}\, \boldsymbol{F}_{e\,uT} \approx 1/11.7 \cdot \boldsymbol{F}_{e\,uT}$
COULOMB CONSTANT	$K_{uI} = 1/\alpha\, K_{uT} \approx 137 \cdot K_{uT}$
ELECTRIC PERMETTIVITY	$\varepsilon_{e\,uI} = \alpha\, \varepsilon_{e\,uT} \approx 1/137 \cdot \varepsilon_{e\,uT}$
MAGNETIC PERMEABILITY	$\mu_{e\,uI} = 1/\sqrt{\alpha}\, \mu_{e\,uT} \approx 11.7 \cdot \mu_{e\,uT}$

UNITARY CONVERSION FACTORS

LENGTH	$l_d \approx (7.8 \cdot 10^{-27} m^{-1}) \cdot d \cdot l_0$
VELOCITY	$\boldsymbol{v}_d \approx (7.8 \cdot 10^{-27} m^{-1}) \cdot d \cdot \boldsymbol{v}_0$
ACCELERATION	$\boldsymbol{a}_d \approx (7.8 \cdot 10^{-27} m^{-1}) \cdot d \cdot \boldsymbol{a}_0$
CURVATURE	$S_d \approx -(1.95 \cdot 10^{-28} m^{-1}) \cdot d \cdot S_0$

ENERGY	$E_d \approx -(6.65 \cdot 10^{-28} m^{-1}) \cdot d \cdot E_0$
MASS	$m_d \approx -(5.69 \cdot 10^{-29} m^{-1}) \cdot d \cdot m_0$
GRAVITATIONAL ATTRACTION FORCE	$\boldsymbol{F}_{g\,d} \approx -(1.9 \cdot 10^{-28} m^{-1}) \cdot d \cdot \boldsymbol{F}_{g0}$
UNIVERSAL GRAVITATIONAL CONSTANT	$G_d \approx (3.64 \cdot 10^{-24} m^{-1}) \cdot d \cdot G_0$
GRAVITATIONAL PERMETTIVITY	$\varepsilon_{g\,d} \approx -(1.42 \cdot 10^{-30} m^{-1}) \cdot d \cdot \varepsilon_{g\,0}$
COGRAVITATIONAL PERMEABILITY	$\mu_{g\,d} \approx (3.11 \cdot 10^{-25} m^{-1}) \cdot d \cdot \mu_{g\,0}$
ELECTRIC CHARGE	$q_d \approx -(1.95 \cdot 10^{-28} m^{-1}) \cdot d \cdot q_0$
COULOMB FORCE	$\boldsymbol{F}_{e\,d} \approx -(1.95 \cdot 10^{-28} m^{-1}) \cdot d \cdot \boldsymbol{F}_{e0}$
COULOMB CONSTANT	$K_d \approx (3.11 \cdot 10^{-25} m^{-1}) \cdot d \cdot K_0$
ELECTRIC PERMETTIVITY	$\varepsilon_{e\,d} \approx -(5.69 \cdot 10^{-29} m^{-1}) \cdot d \cdot \varepsilon_{e\,0}$
MAGNETIC PERMEABILITY	$\mu_{e\,d} \approx (2.66 \cdot 10^{-26} m^{-1}) \cdot d \cdot \mu_{e\,0}$

INVARIANTS

THE PRODUCT	Gmm
THE PRODUCT	Kqq
THE RATIO	K/μ_g
THE RATIO	S/q
THE RATIO	$\boldsymbol{F}_g/\boldsymbol{F}_e$
ELECTRIC FIELD	$\boldsymbol{E}$
FINE-STRUCTURE CONSTANT (see Eq.1.21)	α

NOTE: The subscripts uT and uI are often used generically to indicate whether the system is experiencing the expansion (contraction) of the universe. Additionally, instead of the speed of light c, sometimes the generic velocity $\boldsymbol{v}$ is used, which also includes the component due to spacetime. Then, equation (1.18) can be formulated either in the current way or as a variation of energy in the 4 components. In Chapter 8, the Schrödinger equation was used to derive the structure of elementary particles. In equation (9.4), it was considered that only one quark of the proton interacts at a time; the same reasoning applies when we calculate the neutron-electron mass ratio. Finally, both in the Abstract and in Chapter 12, the term “matrix” was used instead of “tensor”, due to the cinematic representation of reality given by the movie ”The Matrix”.

LEGEND

THEORET. AND MEAS. VALUES OF THE UNIV.	uT, uI
CONVERSION FACTORS	$f[\,]$
PLANCK CONSTANT	$h_P \approx 6.626 \cdot 10^{-34}\, J \cdot s$
STONEY CONSTANT	$h_S \approx 4.836 \cdot 10^{-36}\, J \cdot s$
PLANCK LENGTH	$l_P \approx 1.616 \cdot 10^{-35}\, m$
STONEY LENGTH	$l_S \approx 1.381 \cdot 10^{-36}\, m$
PLANCK TIME	$t_P \approx 5.391 \cdot 10^{-44}\, s$
STONEY TIME	$t_S \approx 4.605 \cdot 10^{-45}\, s$
PLANCK CHARGE	$q_P \approx 1.876 \cdot 10^{-18}\, C$
ELEMENTARY OR STONEY CHARGE	$q_S = q_e \approx 1.601 \cdot 10^{-19}\, C$
PLANCK MASS	$m_P \approx 2.176 \cdot 10^{-8}\, kg$
STONEY MASS	$m_S \approx 1.859 \cdot 10^{-9}\, kg$
FINE-STRUCTURE CONSTANT	$\alpha \approx 1/137$
IMPEDANCE OF FREE SPACE	$Z_0 \approx 376.7\, \Omega$
DENSITY OF DIPOLES (OR GRAVIPHOTONS)	$\rho_n = n/V$
CURRENT DENSITY VECTOR	$\boldsymbol{J}_n = \rho_n \boldsymbol{v}$
ELECTRIC AND MAGNETIC FIELD	**E**, **B**
GRAVITATIONAL AND COGRAVITAT. FIELD	**g**, **K**
STRESS TENSOR	σ_{ij}
EINSTEIN TENSOR	$G_{\mu\nu}$
RIEMANN TENSOR	$R_{\mu\nu}$
SCALAR CURVATURE	R
METRIC TENSOR	$g_{\mu\nu}$
STRESS-ENERGY TENSOR	$T_{\mu\nu}$

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[*] The Seal of the Rebis on the cover was taken from the Azoth of Basil Valentine (1613). The introduction has been adapted from "La Discontinuità della Natura" by Marco Capogni, published on INFN, Scienza per Tutti. The citations have been added subsequently and are not integral parts of the original article. Additionally, for the writing of this text, numerous sources from Wikipedia have been used, both in Italian and English (Paragraphs 1.1, 1.2, 4.8, 6.1, 7.1, 8.1, 8.2, 8.3, 11.1, 11.2, 11.3). For Chapter 12, excerpts were used from the documentary "Harnessing The Power Of Information, Order and Disorder" by Jim Al-Khalili, Spark (Paragraph 12.1), and from the series "Matrix," accessible on the YouTube channel "Mortebianca" (Paragraph 12.6).

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FINAL NOTES

This text is only an introduction to the electrogravitational theory. By expanding these concepts, we will see how this theory can be applied to all physical phenomena. Among the various issues addressed, we will be able to demonstrate the equivalence principle, provide a solid explanation of the holographic principle, clarify the ER=EPR conjecture, and so on... Moreover, not less significantly, since the quantum of action can be represented in relation to other physical constants, we will be able to reformulate the entire quantum physics and physics in general.