Structures of electron, neutron, and proton and the unification of fundamental forces

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Abstract

While the Standard Model of physics is largely successful in explaining a wide variety of experimental results, it leaves some phenomena unexplained and falls short of being a complete theory of fundamental interactions. For example, it does not incorporate the full theory of general relativity, neither does it fully reconcile general relativity and quantum mechanics. In this context, here I present the fundamental particles of matter as geometrical forms of electromagnetic waves, whose size is directly linked to the wavelength. Thus, hadrons and leptons are considered as being composed of three and one intersecting waves, respectively. The particles' spatiotemporal structures appear to explain their magnetic moments and spin. This model suggests that the weak force arises from electric and magnetic interactions between the substructures of neutron, the strong force from the close contact among the charges of nucleons, and the gravitational force from the curvature of space created by matter.

Keywords: structure of subatomic particles, magnetic moment, particle size, spin, unification of fundamental forces

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1 Introduction

The Standard Model has found remarkable success in describing a wide variety of experimental results, to the extent that it has been dubbed "the theory of almost everything". However, certain fundamental physical phenomena such as gravity, dark matter, spin and the origin of mass are not adequately explained by the model. In this study, we attempt to provide an alternative to the Standard Model. First, we present an overview of the Standard Model, its associated discoveries and anomalies, and then we propose the new model.

The Standard Model of physics describes elementary particles (electrons and quarks) and the strengths of their interactions. These particles are described as point-like, and their properties (spin, charge, and magnetic moment) are considered intrinsic. The birth of the Standard Model is basically linked to the development of quantum physics. The discovery of the spin of particles by Stern and Gerlach [1,2] in 1922 gave rise to the idea that certain properties of the matter are intrinsic. With further theoretical development, interpretations of the fundamental aspects of matter have become increasingly more mathematical than physical.

The neutron was discovered by Chadwick in 1932, [3] and several teams measured the moments of the proton and deuteron in 1933. [4-6] These discoveries led to the understanding that a neutron is not an elementary particle but has a substructure. However, in 1935, Yukawa suggested a new kind of interaction based on the concept of particle-mediated strength (meson), considering that the interaction between proton and neutron cannot be electromagnetic. [7] One of his arguments was that the binding energy between nucleons (from 2 to 8 MeV) appears incompatible with electromagnetic interactions. However, these assumptions were wrong, because the neutron has a substructure with opposite charges, and the distance between charges within the neutron and proton is considerably smaller than the distance predicted (about 10^{-15} m).

After World War II, the discovery of several new particles appeared to support Yukawa's theory. However, these discoveries only confirmed the ability of space to create particles from large amounts of energy. The first high-precision measurement of the magnetic moment of the proton was reported by Felix Bloch in 1950. [8] In 1962, Gell-Mann proposed to describe matter based on particles called quarks. [9] Further, in 1968, Jerome Friedman, Henry Kendall, and Richard Taylor obtained evidence that nucleons have inner structures with point-like scattering centers, thus identifying the quarks. However, there remains the question of whether these point-like scattering centers are particles.

Today, the experimental reality is that the Standard Model cannot predict the values of the magnetic moments or spins of the proton and neutron. Further, after "newer" quarks have been suggested and "discovered", the Standard Model has become a chaotic model, as a "sea of quarks and gluons". Meanwhile, these new developments still failed to predict the magnetic moments. A second issue is the incompatibility between general relativity and quantum physics. The theory of relativity postulates that space is curved due to the presence of matter, an aspect that is ignored by the Standard Model. Instead, the model utilizes a Euclidean space in which particles (including photons) attract each other. In this regard, physics is in a crisis, and it is necessary to reconsider certain previously accepted concepts. [10,11]

The model presented in this paper posits that all properties of matter arise from its spatiotemporal representation, not from the intrinsic qualities of the particles. Furthermore, the strong and weak nuclear forces and gravitational forces are described as derivatives of the electromagnetic force. Finally, the curvature of space is included in a general theory of matter, allowing compatibility with quantum physics.

Louis de Broglie's discovery [12,13] of the wave/particle duality of matter is considered the first step towards the notion of wave-particles. However, it does not account for the structure of stable particles and the consequences of these structures on their properties. While we know that matter is associated with a wave, we now have to understand how matter *is* a wave. Such a theory drastically challenges the Standard Model.

2 Preliminary notions about the concept of electric charge

We posit that charge is an electromagnetic entity that allows us to consider that a particle has electric field lines flowing outward from its center of gravity**.** According to convention, the charge is positive if the field lines flow away from it, and negative if the fields are directed toward it.

Charges are often wrongly considered as point-like objects. This cannot be the case, however, since the strengths of electrostatic repulsion for distances within the charged particle would be considerable (or infinite) according to Poincare. Moreover, were the charges point-like, the electric field would be perfectly homogeneous in all directions. Then, the particle's rotation would not lead to any variation in the electric field, and hence there would be no corresponding magnetic field. Further, with a null radius, the magnetic field of a charged particle would be null.

On the other hand, if the electrical charges are not point-like, they must have a spherical geometrical structure. The concept of charge as a three-dimensional particle necessarily involves the impossibility of a photon to penetrate the particle. The charge is inevitably linked to another entity responsible for the curvature of space.

Electric charges are quantified as spheres whose totality of fields on the surface has the same orientation (divergent or convergent) with elementary values (+1, -1). Partial charges do not exist in a whole particle. Since the energy of a photon only depends on its frequency, the charge of a particle will only depend on the orientation of the fields. The quark model is incorrect, because it is based on the existence of point-like particles having partial charges (2/3 and -1/3).

3 Electron

3.1 Experimental data

The electron can be considered an unknown object similar to a wave or a particle. We know its energy and hence its Compton wavelength, charge, spin, and magnetic moment. However, doubt persists concerning its size and speed of rotation. [14-18] Compared to the proton, the magnetic moment of the electron is very large, and shows an anomaly that has long been studied theoretically in the field of quantum electrodynamics. [19-25]

3.2 Electron mass and its reduced Compton wavelength $\lambda\!\!\!^{-}$

The electron has a rest mass of 0.510998 MeV/c^2 or 9.109 × 10^{-31} kg, i.e., a reduced Compton wavelength $\lambda\!\!\!^{-}$ = 386.5926799 × 10^{-15} m.

3.3 Electron magnetic moment

The magnetic moment of the electron is -928.476462 A·m^2 or -1.001160μ_B, where μ_B represents the Bohr magneton. While the current unit for the magnetic moment is J/T, the old unit of

$A \cdot m^2$ is more understandable in this context.

The magnetic moment μ of a spinning spherical shell of charge is: [26]

$$\mu = e\,\omega\,r^2 / 3 \tag{1}$$

where e is the charge, ω is the angular speed and r is the radius of the sphere. *If*

$$\omega = c / r \tag{2}$$

then

$$\mu = e\,c\,r / 3 \tag{3}$$

Hence, we can calculate the radius r of the charge that produces the experimentally measured magnetic moment as:

$$r = 3\mu / e\,c \tag{4}$$

where $\mu = -928.476462 \times 10^{-26}$ $A \cdot m^2$, $e = -1.602176 \times 10^{-19}$ C, and $c = 2.997924 \times 10^{8}$ m/s, according to the Committee on Data for Science and Technology (CODATA). For the electron, the value of r is calculated to be 579.91×10^{-15} m. This radius is precisely equal to 1.5 $\bar{\lambda}$ where $\bar{\lambda}$ is the reduced wavelength of Compton of electron.

Quantum electrodynamics considers the electron as a point-like particle. Therefore, the anomalous magnetic moment requires interactions with virtual objects to be subject to renormalization, which some scientists find unsubstantiated. This concept needs to be revised. Specifically, both radii suggest a spatiotemporal representation of the wave.

3.4 Spatiotemporal representation of electron

In 1962, Paul Dirac [27] represented the electron as an object with spherical symmetry. He suggested that it cannot be a point-like particle, since the muon is an activated form of the electron. J. J. Hudson subsequently demonstrated that the electron must be a quasi-perfect sphere. [28]

In this study, we posit the electron's spatiotemporal structure as a sphere, with an electromagnetic wave existing on its surface with a predefined wavelength. Suppose that the radius of the sphere equals 1.5$\bar{\lambda}$, and that the circular wave stretches from one pole to the other, we can represent this structure as in Figure 1.

Fig. 1 Artistic 3D view of the electron model. The charge causes the elementary wave to diphase, and creates a system of interference fringes (shown ad bands). The structure is no longer an electric dipole, but it retains the bipolar geometry. Note that in reality, one cannot “see” within the electron because of the curvature of space, which creates the charge in the first place.

The presence of charge on the particle’s skeleton can be interpreted within two modalities. Either the charge is like a “glove on a hand” (i.e. r slightly greater than $\bar{\lambda}$), or like a “tattoo on a hand” (i.e., the skeleton expands to adapt to the radius of charge). In this study, we prefer the second hypothesis.

As shown in Figure 1, a small dilation of the bubble-shaped wave causes it to dephase. Such dephasing produces a series of interference fringes leading to the disappearance of the electrical dipole. However, the electron retains its bipolar structure**.** The thickness of the fringes varies with time, which represents a corresponding electric field variation and entails the formation of a magnetic field during the rotation of the particle (on the condition that the axis of rotation does not pass through both poles). It is the surface current that creates the magnetic field. The strongest magnetic field is produced when the particle turns around the axis. This privileged orientation of the rotation is the origin of the spin properties.

3.5 Size of electron

Up to now, no experiments have irrefutably proven that the electron is point-like. In this regard, the Dehmelt value [29] is an extrapolation instead of a direct measurement (Figures 2,3). Dehmelt considers the equation:

$$|G-2| = R/\bar{\lambda} \qquad (5)$$

Here G = Landé factor and R = radius of the electron. From Eq. (5), he obtained $R = 10^{-20}$ m, but this equation is incorrect because $R = 1.5\bar{\lambda}$ in the case of the electron.

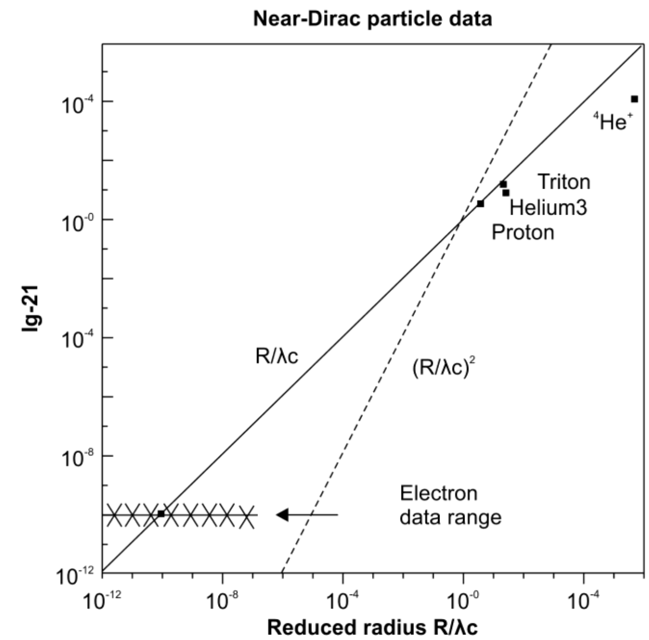

Fig. 2 Original hypothesis of Dehmelt regarding the size of the electron. [29]

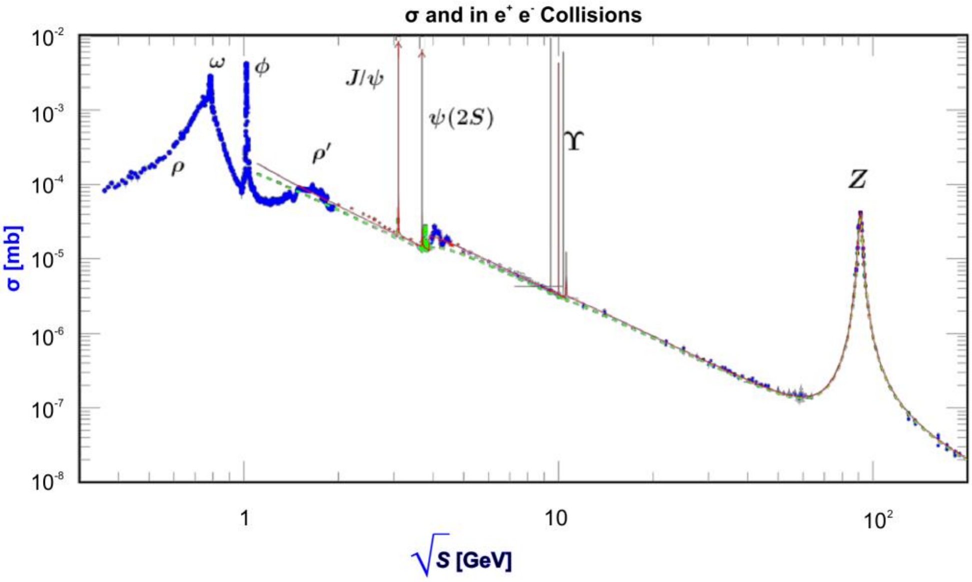

Fig. 3 Measured cross section σ of the electron, which decreases with increasing particle energy.

The best indicator of the electron radius is the study of cross section in the Bhabha diffusion experiment, [30] as shown in Figure 4. In this experiment, the particles collide with very high energy. It appears that when the energy is 10 times higher, the cross section σ is reduced by a factor of 100. The reason is that the radius of the particle decreases with growing energy. Therefore, the electron's size, as well as the wavelength of the associated wave, decreases with higher impulsion. This observation appropriately illustrates the law of de Broglie. Using de Broglie's well-established classical equations

$$\lambda = h/p = hc/E \tag{6}$$

and

$$r = \lambda/2\pi = \hbar c/E, \tag{7}$$

we obtain

$$\sigma = \pi r^2 = \pi(\hbar c/E)^2 = K/E^2 \tag{8}$$

with

$$K = \pi\hbar^2 c^2 \tag{9}$$

Here, λ = wavelength associated with the particle, h = Planck's constant, $\hbar$ = reduced Planck's constant, and p = impulsion = E/c. In the case of Bhabha diffusion, [30] we observe:

$$4\ \text{GeV} \rightarrow \sigma = 2\times10^{-5}\ \text{mb}$$

$$40\ \text{GeV} \rightarrow \sigma = 2\times10^{-7}\ \text{mb}$$

However, the experiment does not provide the cross section of these particles at low energies or at rest. If we extrapolate the line of elastic collision towards very low energies, we obtain the theoretical value of the electron's cross section as

$$\sigma = \pi(579.91)^2 \approx 10^6\ \text{mb} \tag{10}$$

This approximate value is obtained with an extrapolated energy of 0.017 MeV, which is 30 times lower than the rest mass energy of the electron (0.511 MeV) (Figure 5).

$$0.017\ \text{MeV} \Rightarrow \sigma \approx 10^6\ \text{mb} \tag{11}$$

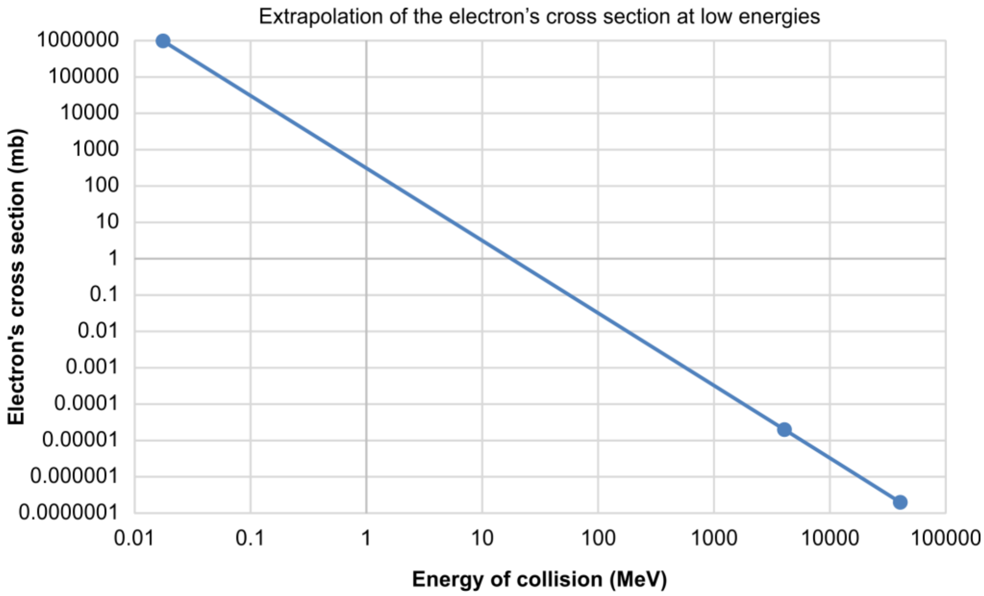

Fig. 4 Extrapolation of the electron's cross section at low energy. The theoretical value (10^6 mb) is very near the value obtained with an extrapolated energy of 0.017 MeV.

3.6 Spin of the electron

Stern and Gerlach [1,2] discovered in 1922 that the electron can only have two spin states. This canonical experiment contributed to reinforce certain aspects of the quantum theory. Today, the spin is considered an intrinsic property of the particle, and the Standard Model considers this property as unrelated to the rotation of the particle.

The question arises as to whether our proposed model can cast a new light on the origin of spin. As mentioned previously, the electron is considered a spherical wave that turns by itself with the tangential speed of light. The axis of rotation is oriented along the spatial direction that allows the highest rotation speed. If this axis is also the axis of movement, the spin of the electron can have only two values (+ or -).

If the displacement speed of the electron were null in the absolute sense, both values of spin would disappear. The speed of an observer around the earth, around the sun, and in the direction of the Great Attractor is about 600 km/s. If a Stern–Gerlach device generates jets of electrons in the reverse direction with an equal speed, the electrons would have an absolute speed of zero. The particles would consequently spin in all directions. In this state, it would be possible to observe the fusion of two beams into one in the Stern–Gerlach experiment.

Einstein and Ehrenfest speculated [31] that the time of alignment of particles in the magnetic field was longer than the time of this experiment. This concept is incorrect because the alignment occurs with the speed of the light.

4 Proton

As in the case of the muon, above a certain energy level the wave of the proton cannot be organized as the electron. Another anatomy must be adopted to ensure stability.

4.1 Experimental data

Several studies have focused on the properties of the proton. Its rest mass is 938.27 MeV·c^{-2}, corresponding to a Compton wavelength of 1.32140985 × 10^{-15} m. Its radius of charge is 0.8751(61) × 10^{-15} m when associated with an electron, and 0.84184 × 10^{-15} m when associated with a muon (CODATA). [32-35] Nevertheless, this last value is obtained by considering electron and muon as point-like objects. It would be interesting to recalculate this value, upon considering that the electron and muon are much larger than the proton. We also know whether its magnetic moment is shielded or not. It is also known to break into three jets, and contains certain very small zones of scattering. [36-38]

4.2 Magnetic moment of the proton

The unshielded magnetic moment of the proton is 1.410606 × 10^{-26} A·m^2 or 2.792847μ_B. The shielded value is 1.4105705 × 10^{-26} A·m^2 or 2.92775μ_B. We take the former value as reference in the following section. We use Eq. (4) to calculate *r*, the radius of the charge producing this magnetic moment:

$$r = 3\mu/ec \qquad (12)$$

with μ = 1.410606 × 10^{-26} A·m^2, *e* = 1.602176 × 10^{-19} C, and *c* = 2.997924 × 10^8 m/s (CODATA). For the proton, we have *r* = 0.881129 × 10^{-15} m. This value is perfectly compatible with the radius of charge of the proton (0.8751(61) × 10^{-15} m). This result *falsifies* the Standard Model, because all the charge producing the magnetic moment is on the surface of the particle (i.e., the proton is an empty shell).

5 Neutron

5.1 Experimental data

The neutron has a rest mass of 1.67493 × 10^{-27} kg, equivalent to an energy of 939.5654 MeV·c^{-2}. Its Compton wavelength is 1.31959 × 10^{-15} m. Experiments of neutron collisions with electrons have shown that the neutron is composed of a positive nucleus and a negative shell. The presence of a magnetic moment suggests the existence of substructures of charges with different rotation speeds. [39-43]

5.2 Magnetic moment of the neutron

The magnetic moment of the proton is -0.96623647 × 10^{-26} A·m^2 or -1.913042μ_B. We saw in the previous section that the proton could be considered as a +1 (positively) charged sphere. According to this model, the neutron is a +1 (positively) charged sphere within a -1 (negatively) charged shell. The sum of the charges is zero, but the magnetic moment cannot be zero.

Suppose that the radius of the particle is equal to the Compton wavelength of 1.3195 × 10^{-15} m. Thus, we can calculate the contribution of the magnetic moment of the negatively charged external shell using Eq. (1). Using *e* = -1.602176 × 10^{-19} C, *c* = 2.997924 × 10^8 m/s, and *r* = 1.3195 × 10^{-15} m (CODATA), we have

$$\mu = ecr/3 = -2.11247 \times 10^{-26}\ \text{A·m}^2 \qquad (13)$$

By subtraction, the contribution of the positively charged internal sphere to the magnetic moment is

$$\mu_{internal} = \mu_{total} - \mu_{external}, \qquad (14)$$

which means

$$\mu_{internal} = (-0.96623 \times 10^{-26}) - (-2.11247 \times 10^{-26}) = 1.14623 \times 10^{-26}\ \text{A}\cdot\text{m}^2 \qquad (15)$$

We still have to calculate the equatorial speed of the positive internal core, considering that the equatorial speed of the shell is equal to the speed of light. The equatorial speed is related to the radius of the internal core, which is calculated from Eq. (4) as follows

$$\text{core radius} = 3\mu/ev \qquad (16)$$

where

$$v = (\text{core radius/shell radius}) \times c \qquad (17)$$

Hence, the core radius is $(3\mu \times \text{shell radius}/ec)^{0.5} = (3(1.14623 \times 10^{-26})(1.31959 \times 10^{-15})/(1.602176 \times 10^{-19})(2.997924 \times 10^{8}))^{0.5} = 0.97 \times 10^{-15}$ m, where $\mu = 2.2025 \times 10^{-26}$ A·m^2, $e = -1.602176 \times 10^{-19}$ C, $c = 2.997924 \times 10^8$ m/s, and $r = 1.31959 \times 10^{-15}$ m (CODATA). It appears that the core radius of the neutron is larger (0.97 fm) than that of the proton (0.88 fm).

A consequence of the spatiotemporal organization of the neutron is its instability. Indeed, the neutron is destabilized by two forces, which explain beta radioactivity as due to 1) the electrostatic repulsion between the positive charge of the core and the positive charge on the inner side of the shell, and 2) the magnetic repulsion between the opposite magnetic moments of the core and shell.

Now we understand why the neutron is stabilized by direct interaction with the proton. The direct interaction of the negative shell with the proton stabilizes the shell, and prevents the transformation of the neutron into the proton by the expulsion of an electron and antineutrino.

Attempts to explain the magnetic moments of the proton and neutron in the Standard Model have failed, a situation referred to as the “spin crisis”. It appears that the contribution of the quarks to the magnetic moment is very weak. This observation has led to the postulated existence of other quarks and particles. However, these values still have no underlying explanation.

6 Spatiotemporal representation of neutron and proton

In the standard model, the proton and neutron are considered to be composed of a sea of quarks closely linked together by gluons, forming a chaotic set of particles. In our model, “quarks” and “gluons” belong to the same wave. The geometry of these waves is very accurate, and there is no chaos in our model.

As shown in Figure 5, the forms of the waves are no longer spherical but ellipsoidal (i.e. shaped like a rugby ball). Each ellipsoid is characterized by a short and a long radius (semi-minor and semi-major axes, respectively). The long radius corresponds to the wavelength of the hadron (~1.32 fm) and the short radius to the positive internal core (0.97 fm for the neutron).

Fig. 5 3D view of the neutron's ellipsoid. The equatorial surface (in yellow) is positively charged, and the polar areas (in black) are negatively charged.

The ellipsoid form originates primarily from the vibrational modes. With neutrons, the wave spans the particle over two wavelengths. There is a repulsion between the poles of the neutrons (Figure 6). At the poles, we observe an electromagnetic "spike effect", since the surface is minimal at the origin of the circular wave (Figure 7). This area is very important, because it is precisely at this spot that the electrons collide with the hadrons. This area is about 10^{-30} cm^2/sr. It corresponds to a disk with a diameter of 10^{-17} m, which accounts for 1% the size of the particle. This area corresponds to the quark of the standard model. However, we note that it is an area, not a particle (Figure 7).

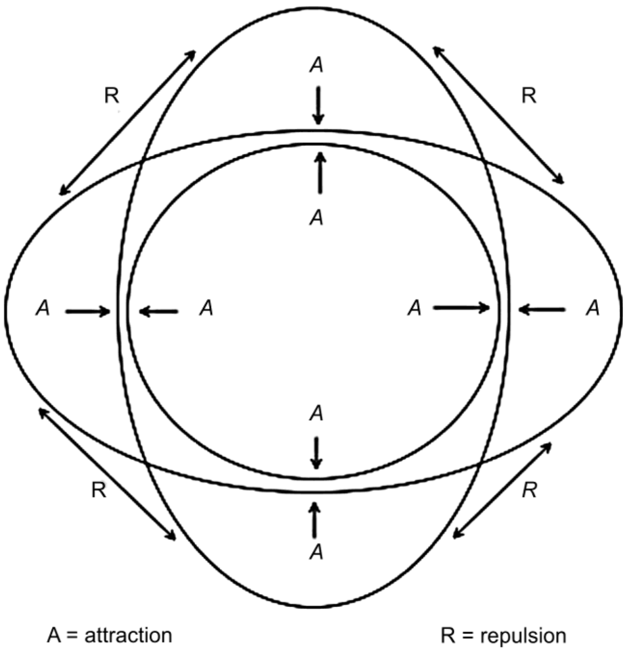

Fig. 6 2D schematic of the interaction of different parts of the particle. The core is very stable because of the electrostatic attraction between the walls of the equatorial band of each ellipsoid. The poles exist because of electrostatic repulsion. The ellipsoids can undergo some deformation. The electrostatic repulsion within the core leads to the formation of a perfectly spherical structure.

Fig. 7 Representation of the spike effect at the origin of the circular wave.

The ellipsoid waves intersect with themselves to form a complex object (Figure 8). This structure contains a core and 6 polar areas. In the neutron (Figure 9), the core is positively charged and the tops are negatively charged. In the proton (Figure 10), the structure of the neutron is lost because of the added positive charge and the proton becoming a simple sphere. The three ellipsoid waves become spherical waves. The stability of the neutron arises from the strong interaction of the equatorial areas and the repulsion of the tops of different ellipsoidal waves (Figure 9). The stability of the proton arises from the added charge and the repulsion of the tops of different ellipsoidal waves (Figure 10).

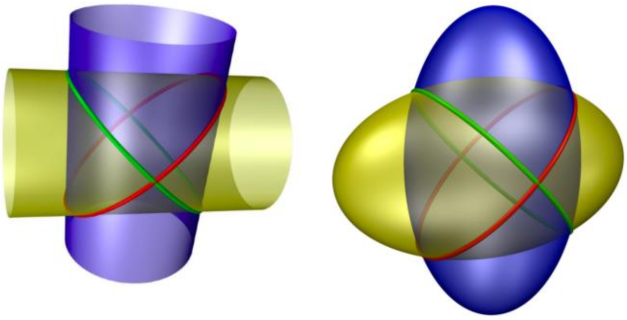

Fig. 8 Intersection of two cylinders [44] or two ellipsoids, generating a complex surface. [45] Using three ellipsoids (along the X-, Y-, and Z-axes) instead of two along the X- and Y-axes, we obtain a quasi-spherical core

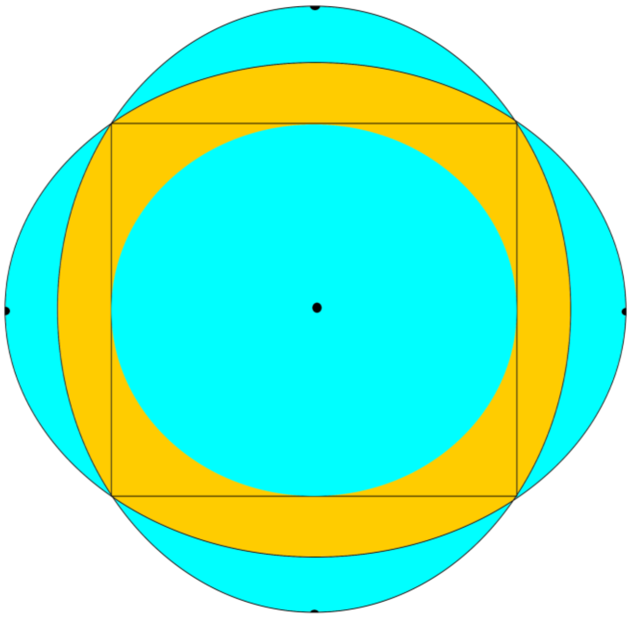

Fig. 9 2D schematic of the anatomy of the neutron. The three ellipsoids intersect to form a positive core (in yellow). The six tops form a negative shell (in blue). The six poles (black) are the point-like scattering centers.

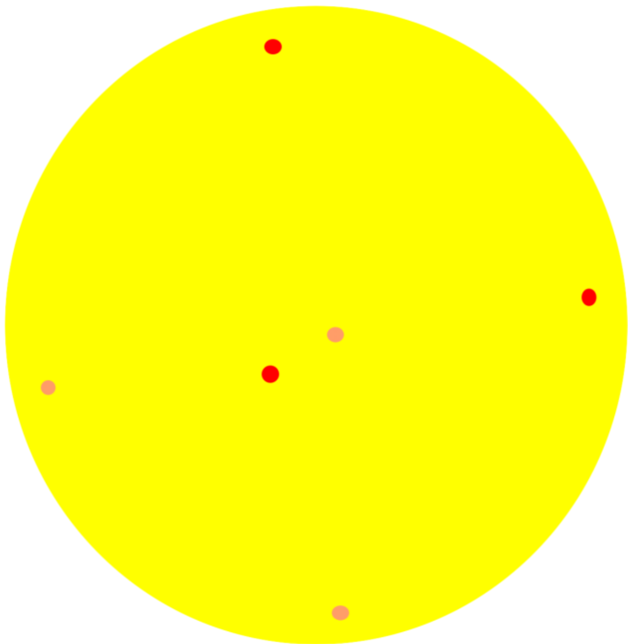

Fig. 10 2D schematic of the anatomy of proton. In this case, the three ellipsoids (x, y, z) become circular waves on account of the positive charge. The six poles (front: red, back: pink) are the point-like scattering centers.

7 Discussion

7.1 Electromagnetic force

In our model, the electromagnetic force is the only fundamental force, from which all the other forces are derived. This force originates from rotating electric charges, which produce a magnetic field. There are two kinds of charges:

1) The anatomic charges, resulting from the geometry of the intersection of ellipsoid waves in the neutron core (+1) and shell (-1).
2) The "built-up" charges, resulting from the association of an external charge with a wave forming the skeleton of the particle. For example:

   charge -1 with a circular wave of $\lambda = 2426$ fm forming the electron

   charge +1 with a circular wave of $\lambda = 2426$ fm forming the positron

   charge +1 with three circular waves of $\lambda = 3.96$ fm forming the proton

7.2 Strong interaction between quarks

Quarks are considered as not particles, but very small areas of larger objects (Figures 9 and 10). These "quarks" are linked together because they belong to larger structures (ellipsoid waves), which prevent their dispersion. As shown in Figure 8, the strong linkage originates from the intersection of the three waves to form the positive core of the neutron**.** There is repulsion between the poles and a very strong attraction at the equatorial area. The geometry of the intersecting ellipsoids explains the strong stabilization of the particle (Figure 8). It is not possible to separate these three intersecting waves. Our model implies that the model of quarks and gluons must be modified.

7.3 Strong interaction between nucleons

This model is based only on the effects of the electromagnetic force between charged particles (positive core and negative pole) *in direct contact* with each other, thereby explaining the very high magnitude of the strong force, as shown in Figure 11.

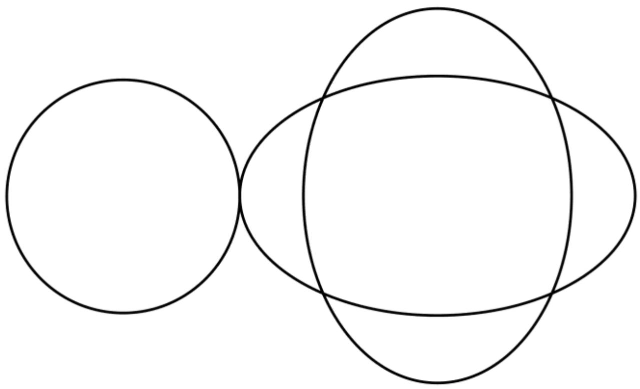

Fig. 11 2D schematic of the strong interaction. The proton is *in direct contact* with the negative charge of the pole of the neutron.

We remark here that there is no need to postulate the existence of bosons to explain this interaction. The total potential energy is the sum of the electrostatic and magnetic potential energies: [46,47]

Electrostatic potential energies between two opposite charges q_1 and q_2: $-|q_1 \cdot q_2|/4\pi\varepsilon_0 a$

Magnetic potential energy between two charges: $+ 2\mu_0 |\mu_n \cdot \mu_p| /4\pi b^3$

Here, q_1 and q_2 represent the charges of the proton and neutron in direct contact, respectively. The values of q_1 and q_2 are considered unknown. μ_0 denotes the magnetic constant, μ_n the magnetic moment of the neutron, μ_p the magnetic moment of the proton, ε_0 the electric constant, a the distance between two opposite charges, and b the distance between the centers of both nucleons with $a << b$.

The electrostatic potential energy is attractive, while the magnetic potential energy is repulsive. The electrostatic potential energy between two particles of opposite charges and distance of 10^{-15} m is 1.44 MeV. In comparison, the energy levels of the strong interaction range between 2 and 8 MeV. Based on this difference, Yukawa suggested that this interaction was not electrostatic. However, this argument is incorrect, since the distances of interaction are predicted to be significantly less than 10^{-15} m.

7.4 Weak interactions and radioactivity

The weak interaction is not really a force. However, it is considered so because it is the force that splits neutrons into the proton/electron-antineutrino pair. In the earlier section on the neutron, we discussed its instability when it is not linked to a proton by a strong interaction (Figure 12).

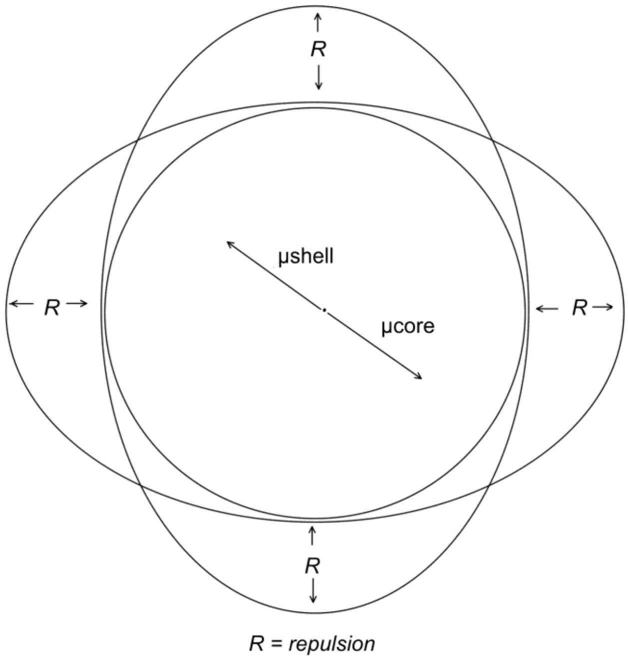

Fig. 12 The magnetic and electrostatic interaction between the positive internal side of the shell and the positive side of the core (μ_{shell} vs. μ_{core}) creates a tension, which the neutron can resolve by neutralizing and expelling the negative external charge of the shell.

The neutron is relatively stable, but its energy is not at a minimum. Beta radioactivity leads to the formation of a proton, a electron, and an antineutrino. The system of proton/electron is definitely stable. However, with energy release it is possible to "rebuild" a neutron from the proton (p-p fusion) and form deuterium from proton and neutron. This model does not require the existence of bosons.

7.5 Gravitational force

The gravitational force is an indirect electromagnetic force similar to the Van der Waals interaction, H-bonding, or hydrophobic interactions. In the case of gravitational force, an analogy can be made with hydrophobic interaction that attracts fat molecules. Specifically, hydrophobic molecules agglomerate not because they are subject to a force attracting them, but because water attempts to "escape" from their interaction. The hydrophobic strength is very weak, but it is extremely important for the structure of proteins and nucleic acids. In this sense, space is similar to water: "Spacetime tells matter how to move; matter tells spacetime how to curve" said Wheeler.[48]

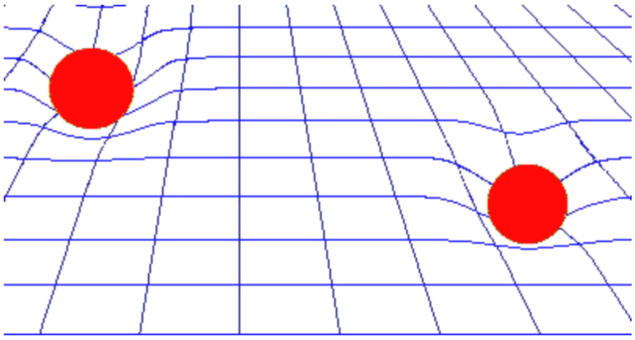

Fig. 13 Curvature induces the “pressure of space” on particles. When two particles approach each other, this pressure decreases. Matter does not attract matter. Instead, space imposes upon matter its movement.

In this model, our particle creates curvature in space by expelling the photons (Faraday cage effect). This effect on curvature is proportional to the energy of the particle, not its size. This curvature subsequently induces a “pressure of space” on the particles. When two particles approach each other, the “pressure of space” decreases (Figure 13). This effect is very small but it acts in the long term regardless of the charges of the particles. The recent discovery of gravitational waves is a major step towards understanding this mysterious force.[49]

To summarize, our proposed model does not require the existence of bosons. Only the electromagnetic strength is considered the fundamental force, from which all other forces are derived. More importantly, our model makes general relativity compatible with quantum physics. The curvature of the space and the size of the particle are linked by a common factor: the energy of the particle.

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