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Space, Time and Energy

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Abstract: The hypothesis that both the Universe and particles possess four spatial dimensions, together with the quantification of space, allows us to apply the equations of classical macroscopic physics to elementary particles and obtain a four-dimensional spatial particle or atoms of space and time, from which they derive all other particles: electrons, photons, quarks, etc. and their corresponding antiparticles. Energy is the curvature of space, mass is due to rotation of the particle in four-dimensional space, while the charge is the time or period it takes to go around the fourth dimension. Two rotations, one in space and the other in the fourth dimension, suffice to obtain four different particles, two electrons and two positrons with spins $\pm 1/2$. The photon is an atom of space-time, turning only in three-dimensional space.

1. Introduction.

General relativity supposes that space-time is continuum. However there is no experimental evidence of this. Are continuous space and time? Or just are we convinced that continuity as a result of conditioning of education? In recent years physical and mathematical have questioned whether it is possible that space and time are discrete.

> *"The familiar concept of a "space-time continuum" implies that it should be possible to measure always smaller and smaller distances without any finite limit. Heisenberg, who insisted on expressing quantum mechanical laws in terms of measurable observables, questioned already the validity of this postulate [1]. We should thus treat the ultimate limit a for the smallest measurable length as a yet unknown quantity. Actually, we learned already from the development of relativity and quantum mechanics that Nature can impose restrictions on our measurements because of two universal constants: the velocity c and the quantum of action h. Could Nature impose a third restriction, resulting from the existence of a universally constant quantum of length a and a universally constant quantum of time a/c?" [2]*

Theories related to quantum gravity such as string theory and doubly special relativity and black hole physics predict the existence of a minimal length [3-7]. In 1947 Snyder used a technique that has a minimal lenght quantification in the physics of space-time [8, 9].

In 1962, Wheeler [10] was one of the first physicist to introduce the discrete space-time to approach the problem of quantum gravity. Ponzano and Regge later [11] propose discrete space-time based on adjacent triangles network, thus achieving an arbitrary curved surfaces.

Also, G. Jaroszkiewicz and K. Norton, in a series of papers replace the continuum space-time by a discrete space-time. [12-16]. Another modern approach to quantized space-time is provided by Prugovecki [17, 18].

Heisenberg himself noted that physics must have a fundamental length scale which, together with Planck's constant and the speed of light, permit the derivation of particle masses [19, 20].

The combination of the speed of light c, the quantum of action h and the gravitational constant G, gives the Planck length $\lambda_P = \sqrt{G\hbar / c^3}$, which is considered a limit to the extent the space-time distance [21,24]. It is also assumed that the Planck length is the limit of application of the Newton's nonrelativistic law of gravitation. However, the gravitational interaction has only been tested for distances greater than 1 cm with good accuracy [25-30].

"Considering that the general purpose of physics is to build theories that account for numerical experimental data, the construction of a theory of space-time is a necessity" [31].

In this paper we put forward such a model of discrete space-time curvature in which part of a minimal length and that both the particles and the space itself has four spatial dimensions. It follows natural way:

- time, due to the expansion of the universe.
- energy, due to the curvature of space.
- mass, due rotation of the elementary particle.
- electric charge, which is the time it takes for the particle in a spin in the fourth dimension.

"The idea of using extra spatial dimension to unify different forces started in 1914 with Nordstöm. In 1919 Kaluza noticed that the 5-dimensional generalization of Einstein theory can simultaneously describe gravitational and electromagnetic interaction [32]".

Currently to resolve the hierarchy problem of particle physics, theories are also used extra dimensions [33-41]. Pauli declared "the concept of space and time in a very small scales requires a fundamental change".

2. The fundamental constants in physics.

Among the fundamental and universal constants in nature are the gravitational constant G, Planck's constant h, the speed of light c, the permittivity of vacuum or electric constant ε_0 and the permeability of vacuum or magnetic constant μ_0.

Unlike other physical constants, the value of the gravitational constant *G* is determined with few accuracy due to gravity is the weakest of the four fundamental interactions.

In the International System of Units (SI) [42], the definition of the meter fixes the speed of light in vacuum *c* and the definition of the ampere fixes the magnetic constant. Since the electric constant is related to μ_0 by $\varepsilon_0 = 1/\mu_0 c^2$, it too is known exactly.

Table I. Some constants relevant to the 2010 adjustment

Quantity	Symbol	Value	Uncertainty (ppb)
spee of light in vacuum	*c*	299 792 468 m s^{-1}	exact
permittivity of free space	ε_0	8.854 187 871 x 10^{-12} F s^{-1}	exact
permeability of free space	μ_0	4π x 10^{-12} N A^{-2}	exact
gravitational constant	*G*	6.674 28(67) x 10^{-11} m^3 kg^{-1} s^{-2}	1.0 x 10^5
Planck constant	*h*	6626 068 96(33) x 10^{-34} J s	50
Planck constant, reduced	$\hbar$ =h/2π	1.054 571 628(53) x 10^{-34} J s	50
electron mass	m_e	0.510 998 910(13) MeV/c2	25
		9.109 382 15(45) x 10^{-31} kg	50
electron charge magnitude	q_e	1.602 176 487(40) x 10-19 C	25
fine structure constant	α	7.297 2 5376(50) +* 10-3	0.68

In the Standard Model, the interactions depend on 28 fundamental constant, of which highlight the following:

- the gravity constant G,
- the fine-structure constant α,
- the masses of the three charged leptons m_e, m_μ, and m_τ,
- the masses of the six quarks m_u, m_d, m_c m_s, m_t and m_b.
- etc

The fine structure constant is given by: $\alpha = Kq^2 / \hbar c$, were K the constant of Coulomb's law $K = 1/4\pi\varepsilon_0$, q the electron charge, $\hbar$ the reduced Planck constant and c is the speed of light.

The values accepted by the Committee on Information Science and Technology (CODATA) are shown in Table I [43].

3. Restricted relativity.

The Hubble observations showed that distant galaxies are moving away at a rate proportional to their distances, these observations lead to an expanding universe model. [44]

Let us suppose that we have a single spatial dimension. If we expand it (by stretching the ends) an observer situated at the end on the left (right), (Fig.1(a)) will see that the others move away to the right (left). For everybody to see that the others are moving away, space must be curved (Fig.1(b)), by which a second dimension is enclosed.

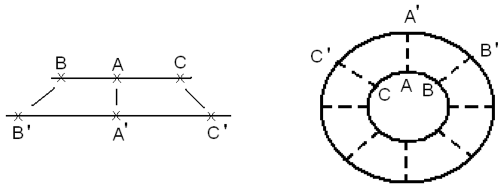

Figure 1. A one-dimensional expanding universe.

If we are in a flat two-dimensional space in expansion, we will have to curve this space for everybody to be able to see that the others are moving away, i.e. we will be on the curved two-dimensional surface of an expanding balloon. In the same way, a curved three-dimensional universe encloses a fourth dimension that we do not see as such. The equation for a four-dimensional sphere that expands at the speed of light c is:

$$x^2 + y^2 + z^2 + u^2 = r^2 = c^2 t^2 \tag{1}$$

In which x,y,z are the three spatial dimensions, u the fourth spatial dimension, r the radius of the expanding universe and t the age of the universe.

Let us consider an observer at rest at the origin of coordinates_3D (Fig. 2) ($x=y=z=0$), then: $u=ct$ y $v_u=c$, therefore, at rest and in the absence of external forces, we are moving in the fourth dimension at the speed of light. Einstein stated: "Any object in the universe are always traveling through space-time at a fixed speed, speed of light."

If any the observer moves at a constant speed v in the 3D space, the second derivative with respect to time of Eq.(1), in the absence of external forces, is:

$$v_x^2 + v_u^2 = c^2 \;\; ==> \;\; \overline{\mathrm{c}} = \overline{\mathrm{v}} + \overline{v}_u \tag{2}$$

Multiplying by time at rest (t_0) and dividing by the speed of light (c), we obtain:

$$t_m = \frac{v_u}{c} t_0 = t_0 \sqrt{1 - v^2 / c^2} \tag{3}$$

Therefore, the movement through space causes a decrease of the speed in the fourth dimension, so that the speed in four-dimensional space is always constant and equal to the speed *c* of the expanding universe. [45]

Accordingly, the fourth dimension we can consider as space or time.

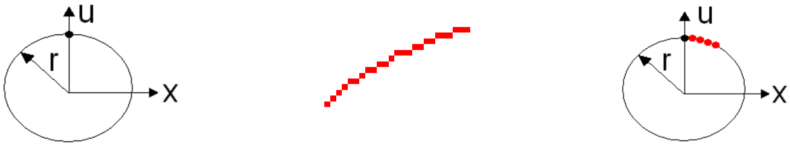

Figure 2. Two-dimensional Universe: a) Continuum. b) Amplification c) Quantified.

If we observe the circumference (Fig.2(a)) we get the impression that it is continuous, but if we expand it (Fig.2(b)) we see it is formed by a set of points (pixels) whose size is determined by the program or printer.

An expanding universe continuously increases its volume. Physically the expansion of the universe means the creation of space. The creation of space can be visualized by 2D analogy with the expansion of the sphere in 3D space, and for 2D beings, their universe grows with time.

> *"Our observable 1+3-dimensional universe could be a surface, the brane, embedded in a dimensionally richer 1+3+ d-dimensional spacetime (d being the number of extra dimension)."[46]*

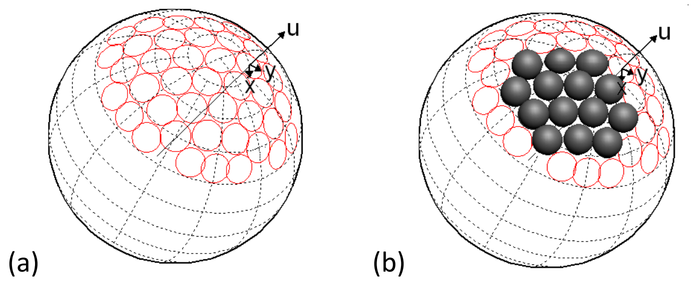

Figure 3. 3D quantized universe. a) with 2D particles. b) with 3D particles .

Hypothesis:

Both the universe and the particles have 4-dimensional and they have a minimum 4D volume (observable 3-spatial dimensions plus time).

Under these conditions, the expansion of the universe means that in any direction are creating new particles or atoms of space-time [47] at a constant speed.

4. Quantum Universe

Let us suppose there is a quantum fluctuation of energy equal to Planck energy, the duration of this process must be equal to or less than the Δt allowed by Heisenberg's Uncertainty Principle, i.e.:

$$E_p \cdot \Delta t = \frac{1}{2}\hbar = \frac{1}{2}E_p \cdot t_p \quad \rightarrow \quad \Delta t = \frac{1}{2}t_p \tag{4}$$

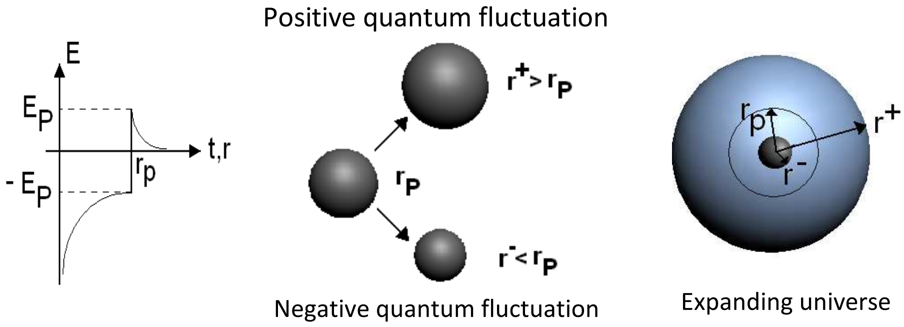

Figure 4. Quantum fluctuations.

If we remember that Planck's time $t_P = \sqrt{G\hbar / c^5}$ can be positive or negative due to the double sign of the square root, the quantum fluctuation can also be negative. A positive quantum fluctuation is a curvature of space with a larger radius than the Planck radius, whereas a negative quantum fluctuation is a curvature of space with a smaller radius than the radius of Planck.

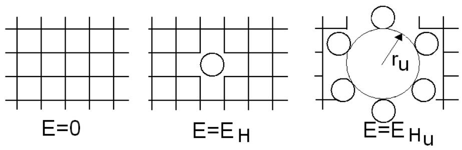

Figure 5. Two-dimensional representation of a 4D quantum fluctuation.

In a flat universe energy is null since it is of infinite length. Let us suppose that there is a continuous series of positive and negative fluctuations, each of which disappears before the next one appears. However, if before the fluctuation disappears another one appears with the opposite sign, there will be mutual repulsion, so that the positive radius increases its length (Fig. 4(c)), while decreasing the negative one, mathematically:

$$E_i = \frac{1}{2}\frac{\hbar}{t^+} + \frac{1}{2}\frac{\hbar}{t^-} = 0 \tag{5}$$

E_i, being the initial energy. Multiplying by the speed of light, we obtain:

$$\frac{1}{2}\frac{\hbar c}{r^+} + \frac{1}{2}\frac{\hbar c}{r^-} = 0 \tag{6}$$

Initially, $r^+ = r^- = r_p$ (Planck´s radius) but due to repulsion r^+ will tend to infinity and r^- to zero, causing an imbalance of energy that will give rise to a quantum universe to compensate for the imbalance, in such a way that at all times the following equation is verified:

$$E_U + \frac{1}{2}\frac{\hbar c}{r^+} + \frac{1}{2}\frac{\hbar c}{r^-} = 0 \tag{7}$$

The term in r^+ is reduced ($\rightarrow$0) as the radius of the universe (r^+) increases, so that it can be ignored, while the term in r^- increases negatively ($\rightarrow -\infty$) , producing increased energy in the universe, so the total energy of the universe is zero at all times.

$$E_U + \frac{1}{2}\frac{\hbar c}{r^-} = 0 \tag{8}$$

The universe created from nothing, was treated for Tryon some time ago [46]. Planck's particle will expand until reaching the unitary radius (r_u), which will induce the curvature of new Planck particles. These will expand in turn, triggering a kind of chain reaction and giving rise to a quantified space so that each and every space particle that constitutes space-time has the same radius.

5. Definition of time

What relates time to speed? The answer is obvious: SPACE, in which space is not the distance between two points but the space that fills the universe. We can thus define time as:

The variation of the space-universe with speed.

Planck's particle expands in four spatial dimensions at the speed of light, giving rise to the appearance of time as a result of the variation of space with the speed of expansion *c*.

Let us now consider the gravitational force between the sun and the Earth. To simplify matters, let us suppose that the earth describes a flat circular orbit. To calculate this path we use the coordinated *x-y* axes. But from the solar perspective, the only important thing for the sun to exert a force on the Earth is the distance *r.* It does not matter whether the earth is on the right, left, behind or in front, as this force does not vary with position. The same happens with the expansion of the Universe; only one of the three spatial dimensions is important: the direction between the two points or objects of reference considered. This direction is at all times perpendicular to the fourth dimension (radial direction). The increase of space is two-dimensional and for an observer at rest time will be given by:

$$t_0^2 = \frac{\Delta S}{c^2} = \frac{\Delta \mathrm{r(x,y,z)} \Delta \mathrm{u}}{c^2} \quad \rightarrow \quad \mathrm{t}_0 = \sqrt{\frac{\Delta S}{c^2}} \tag{9}$$

At rest v=0, y $v_u=c$ (Ec. (2)), so that $t_u=t_0$ (Ec. (3)) so, $\Delta r(x,y,z)=\Delta u=ct_0$, and in the observable universe, the expansion in 3D is the same as in the fourth dimensión.

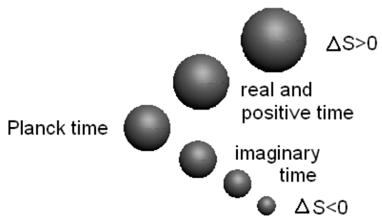

Figure 6. Time and the expansion of the Universe.

If the surface increase is positive, time will be real and positive. This is proper time, pertaining to relativity and to the time we observe and measure. However, if the surface increase is negative, the time is imaginary. This is the time that must be considered, for example, when we measure particles with energy whose wavelength is less than that of the particle or when we apply Schrödinger's equation.

This is a two-dimensional effect of the expansion of the Universe, one three-dimensional time (t_0) and one fourth dimensional time (t_u).

6. Unitary Element of Energy

If space and time are quantified, it seems reasonable to suppose the existence of a unitary element from which all other elements are derived. In other words, any element of energy (mass, charge, space or frequency) can be expressed according of the unitary element.

If we make the energy corresponding to Heisenberg's uncertainty equal to unity, we obtain:

$$E_{Hu} = \frac{1}{2}\frac{\hbar\ c}{l_u} = \frac{\hbar\ c}{4\ \pi\ r_u} = 1 \text{ J} \tag{10}$$

l_u being the length of the circumference of radius **r_u**, of the unitary element, $\hbar = 1{,}05457163\ 10^{-34}\ \text{m}^2\ \text{Kg s}^{-1}$, the Planck constant and c=2,99792458 10^8 m s^{-1}, the speed of light. From which:

$$r_u = \frac{\hbar\ c}{4\ \pi}\frac{1}{E_{Hu}} = 2{,}515863\ 10^{-27} \text{ m} \tag{11}$$

Energy is therefore due to the curvature of space (*1/r*), so that space is simply another manifestation of energy.

Since we do not find it easy to imagine a fourth dimension, not to mention representing it in two dimensions, let us eliminate one spatial dimension in order to make it more understandable and easier to represent.

The unitary element will be able to turn in both three-dimensional space and in the fourth dimension (radial direction), which gives rise to the following combinations:

- 0 rotations
- 1 spatial rotation ω_e.
- 1 rotation in the fourth dimension ω_u.
- 2 rotations, one spatial ω_e and another in the fourth dimension ω_u.

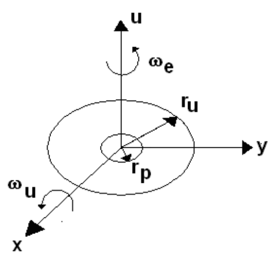

Figure 7. Rotations of the unitary element.

To calculate the mass, charge, rotation or frequency of the unitary element of energy, let us apply the potential of the gravitational field to the element of energy.

$$\frac{Gm}{r} = v^2 \tag{12}$$

In which, let us suppose that the escape velocity *v* is the linear speed of rotation of the unitary element. This equation has two solutions:

Wave. In Eq.(14) we carry out:

$$v = \omega_e \lambda_p = \omega_e \sqrt{\frac{G\hbar}{c^3}} \quad \text{y} \quad r = \lambda_u = \frac{c}{\omega_e} \tag{13}$$

G=6,67428 10^{-11} N m^2 kg^{-2} being the gravitational constant, λ_p the Planck wavelength and λ_u the wavelength of the elementary unit. This gives:

$$E = m_u c^2 = \hbar\omega_e = \frac{\hbar c}{\lambda_u} \tag{14}$$

This indicates that the rotation of the space particle 4D (**particle**) makes the adjoining space 3D rotate up to a distance equal to its wavelength **(wave**). At this distance, space particles move at a linear rotation speed equal to *c.*

In 3D observable space, due to ω_e, the particle is inverted because it has both a 180 degree turn in the fourth dimension. In 3D space the electron is like a flat disk of radius equal to its wavelength and thickness equal to $2r_u$. This disk will consist of approximately 10^{30} atoms of space and time.

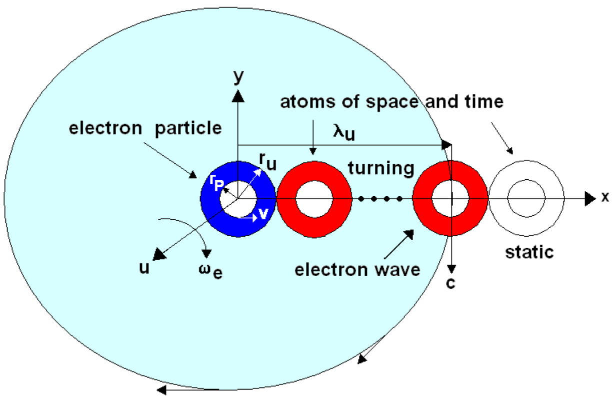

Figure 8. Two-dimensional representation of the electron.

Particle*:* $v=\omega_e r_u/4\pi$ and considering Eq.(11) we obtain:

$$m_u = (4\pi)^5 \frac{G}{\hbar\ c^7} E_{Hu}^3 = 9{,}111\ 10^{-31}\ \text{Kg} \tag{15}$$

The charge will be due to the rotation (one of three rotations possible) or period (T_u) in the fourth dimension, known as *time at rest* or *proper time* in spatial relativity:

$$q_u = \frac{1}{cr^2}\frac{\partial V_{4D}}{\partial r} = 2\pi^2 T_u \tag{16}$$

and the energy will be:

$$E = \frac{h}{T_u} = 2\pi^2 \frac{h}{q_u} \tag{17}$$

and considering Eq.(14) we obtain:

$$q_u = 2\pi^2 \frac{h}{m_u c^2} = 1{,}597\ 10^{-19}\ \mathrm{s} \tag{18}$$

Which, expressed in the form of energy, is:

$$E_u = m_u c^2 = 2\pi^2 \frac{h}{q_u}\ \ J \tag{19}$$

We now have the values of the physical magnitudes at rest (*m,q,r,t*), belonging to any energy element, as a function of the constants G, *h* and *c*, thus reinforces the idea of Heisenberg of existence of a fundamental length (r_u), from which they derive the masses of all particles.

The value accepted by the Committee on Information Science and Technology (CODATA) for mass and electric charge of the electron is shown in Table I.

As the energy element has two rotations, one in three-dimensional space and the other in the fourth dimension, and these can be either on the right or the left, we actually have four elements that are all, in principle, different.

In the fourth dimension, or time axis, the spatial rotation ω_e can be to the right or left, which gives rise to two energy elements. For each rotation ω_e around any diameter, e.g. that of the *x* axis, rotation ω_e may also be clockwise or anticlockwise, giving rise to a total of four unitary elements of energy.

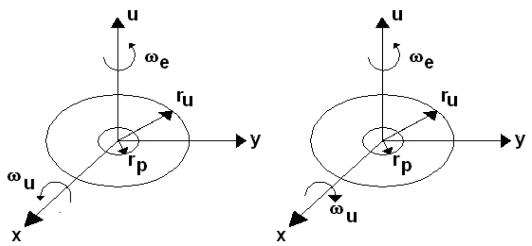

Figure 9. Anticlockwise spatial rotation. Electron.

As three-dimensional beings, rotation in the fourth dimension will not be perceived but its effects (charge) will. Let us take the example of clockwise rotation ω_e as positive charge, and negative in the anticlockwise direction. We now have two new particles with the same properties as the electron but with a positive charge, i.e. the positron.

The masses of the particles, such as neutron, proton, muon, pion and so on. can be calculated from the electron mass and the fine structure constant (Appendix**).**

7. Electron spin.

Spin is a physical property of subatomic particles, defined as the intrinsic angular momentum. Like mass or electrical charge, this is an intrinsic property of the particle.

The rotation of the charge will give rise to a magnetic field whose direction will be determined by:

$$\vec{u}_B = \vec{u}_v \wedge \vec{u}_r \tag{20}$$

i.e. a magnetic field is generated in the radial direction due to the rotation ω_{ux} of the charge.

On completing the circle, due to ω, the particle is inverted, which causes a 180º turn in the fourth direction, which corresponds to a time semiperiod.

The spin will be given by:

$$n_0 J = \frac{1}{2\pi^2} E_u \frac{T_t}{2} = \frac{1}{2\pi^2} mc^2 \frac{2\pi\lambda}{2c} = \frac{\lambda}{2\pi} mc = \hbar \tag{21}$$

n_o=2 being the number of orientations of the magnetic field in a period. Therefore:

$$J = \pm \frac{\hbar}{2} \tag{22}$$

Since we have three degrees of liberty (*x,y,z*), the fourth dimension may rotate around any of the *x*, *y* or *z* axes, which will give rise to three different electrons. Each of these will have a magnetic field, or up or down-oriented spin, giving a total of six electrons and six positrons (***quark colour charge?).***

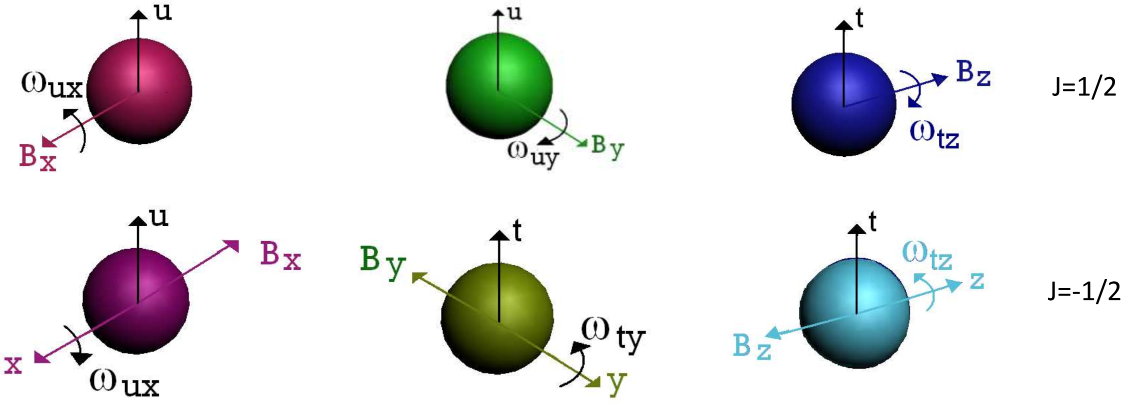

Figure 10. Orientation of the magnetic field of the energy element.

8. Elementary quarks

From Eq. (21) we obtain:

$$4\pi^3\hbar = m_u c^2 q_u \tag{23}$$

The preceding equation is no other than Heisenberg's Uncertainty Principle, which we must not modify. Therefore in order to maintain this equation we have to multiply both terms, which can be expressed by:

$$2\pi^2 nh = n^2 m_u c^2 \frac{q_u}{n} \tag{24}$$

n being the number of particles,

$$m_p = n^2 m_u \tag{25}$$

m_p the particle mass and

$$q_p = \frac{q_u}{n} \tag{26}$$

q_p its corresponding electric charge.

For *n=1* we obtain the unitary particles (electrons and positrons), as we have seen.

For *n*>1 we will obtain a set of elementary particles as a result of the collision between particles of identical electric charge and mass, so that energy is kept constant in a period.

- **Down quark and antiquark**

Under the hypothesis that energy stays constant during a period (Eq. (23)), for n=3 we will obtain the corresponding quark and its antiquark with 1/3 of the unitary electric charge, whose mass (Eq.(25)) has the value

$$m_d = 9m_u = 4{,}59 \text{ MeV}. \quad (27)$$

A value within the estimated limits of 3 to 7 MeV. [47]

The electric charge (Eq. (26)) will be

$$q_d = -\frac{q_u}{3} \quad (28)$$

for the down quark, and

$$\overline{q}_d = +\frac{q_u}{3} \quad (29)$$

for the antidown quark.

- **Up quark-antiquark**

The electric charge of up quark-antiquark is twice that of the down quark-antiquark, so in Eq (23) the mass is half of the down quark, thus keeping the quantum of action *h.*

So that:

$$m_{up} = \frac{9}{2}m_u = 2{,}30 \text{ MeV}. \quad (30)$$

A value within the estimated limits of 1.5 to 3 MeV. [47]

The up quark (antiquark) can also be obtained by the collision between a down quark (antiquark) and a positron (electron). In this case an electronic antineutrino (neutrino) will be produced.

$$d + e^{+} \leftrightarrow u + \overline{\upsilon}_e \qquad \overline{d} + e^{-} \leftrightarrow \overline{u} + \upsilon_e \quad (31)$$

If we consider the spin (between brackets in Eq.(36)), we have:

$$d(+1/2) + e^{+}(-1/2) \rightarrow u(+1/2) + \overline{\upsilon}_e(-1/2) \quad (32)$$

Quark *d* with spin +1/2 collides with a positron (*J*=-1/2) producing an electronic antineutrino with a negative charge and spin -1/2 plus quark *u* (*J*=1/2). A second transformation is also possible, quark anti_*d* with spin -1/2 collides with electron (*J*=+1/2), producing antiquark *u* (*J*=-1/2) plus an electronic neutrino with spin +1/2.

9. Real and imaginary time.

We have seen that the electron is a particle of four-dimensional space whose rotation drags space particles up to a linear rotation speed equals the speed of light. This occurs at a distance equal to its wavelength λ.

When we measure electron mass precisely, we need a lot of time, or, which is the same, little energy, this is equivalent to being at a distance greater than its wavelength. However, when we want to measure its position accurately, we use a lot of energy or short wavelength, which is equivalent to being at distances smaller than the electron's wavelength. According to the given definition of time, the spherical surface will be formed by the fourth dimension (radial direction) and the direction of the observation, so that:

$$t_0^2 = \frac{\Delta S}{c^2} = \frac{S_e - S_0}{c^2} \quad (33)$$

will be real and positive for distances greater than the wavelength.

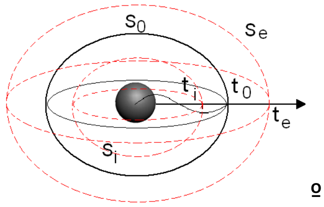

Figure 11. Real and imaginary time.

When we get closer to the particle (a distance shorter than its wavelength) it turns out that the surface variation in the interior of the surface of radius $\lambda_0 = ct_0$ is negative, so that:

$$t_i^2 = \frac{\Delta S}{c^2} = \frac{S_o - S_i}{c^2} = -t_e^2 \qquad t_i = it_e \tag{34}$$

In which t_i, is the time in the interior of the surface of radius λ_0, t_e is the time on the exterior of the surface and t_0 is the time on the surface, or time at rest of the relativity, or ct_0, the wavelength of the quantum mechanics.

Therefore, as the charge is due to the rotation of the fourth dimension (interior of the particle) it will be imaginary. Consequently, the total energy of the electric charged particles will be real part, due to the mass, and imaginary part, so that:

$$E = mc^2 + iE_q \tag{35}$$

being Eq the module of the energy due to the electric charge, which will be calculated below.

10. Newton and Coulomb.

Planck energy can be expressed as:

$$E_p = \frac{Kq_p^2}{\lambda_p} = \frac{Gm_p^2}{\lambda_p} \rightarrow m_p = \sqrt{\frac{K}{G}} q_p \tag{36}$$

And the energy of the electric charge in Planck conditions will be:

$$E_p = m_p c^2 = \sqrt{\frac{K}{G}} q_p c^2 = \sqrt{\frac{K}{Gc^2}} q_p c^3 = \sqrt{\frac{\mu_0}{4\pi G}} q_p c^3 = \frac{1}{\sqrt{4\pi\alpha}} q_p c^3 \tag{37}$$

With:

$$\frac{1}{\alpha} = \sqrt{\frac{\mu_0}{G}} = 137{,}21 \quad \text{kg}^{-1}\ \text{m s}^{-1}\ \text{C} \tag{38}$$

Ihe constant that links the gravitational and magnetic fields, compared to the fine structure constant (1/α=137.036), gives an error of 0.1%.

$$E = mc^2 + i\frac{1}{\sqrt{4\pi\alpha}} qc^3 \tag{39}$$

Therefore the energy of the electron (q^-=-q) is:

$$E_{e^-} = mc^2 - i\frac{1}{\sqrt{4\pi\alpha}} q^- c^3 \tag{40}$$

and of the positron (q^+=+q) is:

$$E_{e^+} = mc^2 + i\frac{1}{\sqrt{4\pi\alpha}} q^+ c^3 \tag{41}$$

The force between the two energy elements (electron and positron) will be given by:

$$F\,F_P = F_{e^-} F_{e^+} \rightarrow F = \frac{1}{F_P} F_{e^-} F_{e^+} \tag{42}$$

Since we start from Planck conditions and two particles must be formed with opposite charges (inverse rotations in the fourth dimension), total imaginary energy is null. Therefore, the force between electron and positron at distance r will be:

$$F=\frac{1}{F_P}\frac{E_{e^-}}{r}\frac{E_{e^+}}{r}=\frac{1}{r^2F_P}\left(\left(mc^2\right)^2+\frac{1}{4\pi\alpha^2}q^+q^-c^6\right) \tag{43}$$

Considering that the Planck force is given by:

$$F_P=\frac{c^4}{G} \tag{44}$$

Substituting in the above equation and considering Eq.(38), we obtain:

$$F=G\frac{mm}{r^2}+K\frac{q^+q^-}{r^2} \tag{45}$$

Evidently, Eq.(45) is only valid when both particles are at rest (*v=0*). For *v*≠0 the total force produced will be:

$$F=\left(G\frac{mm}{r^2}+K\frac{q^+q^-}{r^2}\right)\left(1+\frac{v^2}{c^2}\right) \tag{46}$$

It explains the perihelium shift of Mercury.[50-52]

11. Conclusions

From the hypothesis by which both particles and space have four spatial dimensions we can deduce the equations of restricted relativity as well as the charge, mass and frequency of the unitary particle, which coincides with the electron and from which all the others are derived.

The mass of the unitary particle or electron (Eq.15) is obtained from the potential of the gravitational field due to the rotation of the Planck bubble, which expands until it reaches the unitary radius (Eq.11). It can also be obtained by keeping constant energy per volume, so that:

Planck energy can be expressed as:

$$E_P=\frac{\hbar c}{r_P} \tag{47}$$

Multiplying by the Planck radius cubed, so that:

$$E_P\,V_P=\frac{\hbar c}{r_P}r_p^3=\frac{G\hbar^2}{c^2} \tag{48}$$

If the Planck particle expands until reaching the unitary radius (r_u), keeping the initial conditions constant (*E V* = constant), we obtain:

$$mc^2r_u^3=\frac{G\hbar^2}{c_u^2}=\frac{G\hbar^2}{\left(c/4\pi\right)^2} \tag{49}$$

While the wavelength and the electric charge are obtained from the conservation of initial momentum principle.

$$h=m_Pcr_p=mc\lambda\rightarrow m\lambda_u=\frac{h}{c}=cte. \tag{50}$$

$$h=m_Pc^2t_p=mc^2t_u\rightarrow mt_u=\frac{h}{c^2}=cte. \tag{51}$$

Mass, charge, space and time are quantified and are different manifestations of energy.

The energy of the electron can be expressed in terms of its mass, charge (in module), proper time, or wavelength (radius of the flat disk) or distance at which the space and time atoms reach a lineal speed of rotation equal at the speed of light or universe expansion in the fourth dimension or time dimension.

$$E = m_u c^2 = 2\pi^2 \frac{h}{q_u} = \frac{h}{t_u} = \frac{hc}{\lambda_u} \qquad (52)$$

The up quark and down quark masses and their respective electric charges are obtained in terms of unit mass. The mass and electric charge of the proton and neutron can also be obtained in terms of unit mass. The mass difference between proton and neutron is due to the different energies of the constituents (quarks).

The masses of up and down quarks and their respective electric charges are obtained in terms of the unitary mass. The proton and neutron's mass and charge can also be obtained in terms of the unitary mass. The mass difference between proton and neutron is due to the different energy in the constituent elements (quarks).

a) Electron: We can suppose the electron (particle) to be a unitary spherical volume of space can rotate about x, y, z of the fourth dimension. The mass is then the energy enclosed within this volume 3D, while the electric charge is its spherical surface.

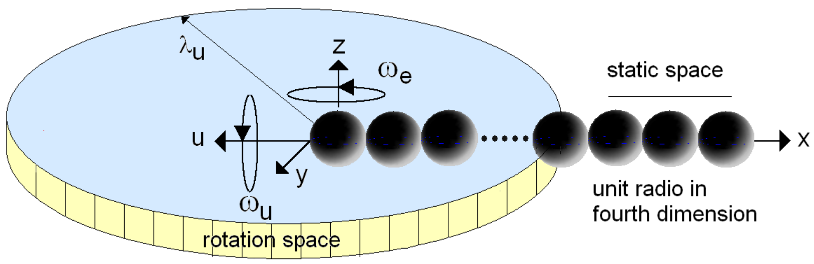

Figure 12. Representation of the electron.

Since the 3D space particles are united (Newton's law of gravitation), the rotation will also make the surrounding space rotate until the linear rotation speed reaches $c=\omega_e\lambda_u$, which occurs at a distance of $r=\lambda_u$.

Because of the 3D particles are linked (Newton's law of gravitation), the rotation will rotate the atoms of space and time of the 3D space adjacent to the linear speed of rotation is equal to $\boldsymbol{c=\omega_e\lambda_u}$, and this occurs at a distance $\boldsymbol{r=\lambda_u}$.

Rotation in the fourth dimension will change the atoms of space and time in observable three-dimensional space, which generates the wave and giving rise to charge and time at rest.

While one rotation is made in three-dimensional space, half a rotation is made in the fourth dimension, which means we see the particle in reverse, with spin ½.

Einstein assumed that the electron is the most important particle in the Universe.

b) Photon: In the photon, the spherical volume of space surrounded by a space-time ring that turns in three-dimensional space ($\omega_e=2\pi\nu$) gives rise to the observable frequency. As the rotation may have opposite senses **,** clocwise or anticlockwise, we can have a photon with positive or negative spin. The rotation will rotate the space adjacent to a distance equal to its wavelength, which generates the wave.

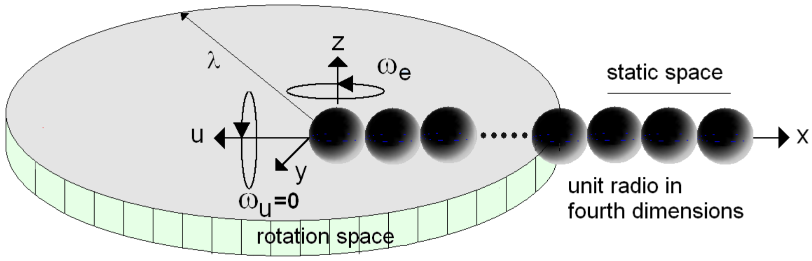

Figure 13. Representation of the photon.

c) Space: When both rotations are null we obtain empty space. Therefore space is formed by a series of four-dimensional space bubbles or space-time particles spreading in all directions, which causes the curvature and expansion of the Universe. If we attribute spatial rotation ω_e to empty space it becomes a photon.

When both rotations are zero, we get empty space, so space will consist of a series of 4D space particles or atoms of space-time of four dimensions that extend in all directions, causing the curvature and expansion of the Universe. . If we equip the empty space of the spatial rotation ω_e, becomes a photon. If in addition to the spatial rotation, it takes a second rotation in the fourth dimension, we get the different particles, electrons and quarks of first generation and their corresponding antiparticles. Therefore, the particles are excitation of the medium, this being formed from particles or atoms of four dimensions of space and time.

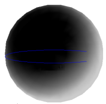

Figure 14. Atom of space and time.

The old intuition that something has to be in "absolute rest" (the atom of space and time) was correct.

A. Messer also part of a minimum length that calls a, and a four-dimensional space. It allows to characterize different types of particles with quantum numbers

"Although the idea of a minimal length is now more easily acceptable, it is still used in various ways [53]". "Different types of elementary particles are now characterized by their (u_x, u_y, u_z, u_{ct}), quantum numbers, specifying how the associated Ψ functions vary in space and time at the scale of a/2. In this sense, we can say that particle states correspond to different patterns of excitations of space and time[2]".

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Appendix

The mass of the particles (Table A.1) can be calculated by equating the electromagnetic energy (at a distance equal to the wavelength) to the electron energy. For example, for the pion:

A quark "up" and other "anti-down" form the π +, while a quark "down" and other "anti-up" constitute the π- (the antiparticle of π +) the energy can be expressed as:

$$\frac{K}{\lambda_\mu}\left(\frac{q_d q + q_u q}{2}\right) + \frac{1}{\alpha}E_c = \frac{1}{2}\frac{Kq^2}{\hbar c}m_\pi c^2 + \frac{1}{\alpha}E_c = m_e c^2$$

Where q_d and q_u are the load down and up quark, respectively, q the electron charge, m_μ the pion mass, m_e the electron mass and E_c kinetic energy of the quarks that make up the particle. The kinetic energy is :

$$E_c = \frac{1}{2}\left(m_d\frac{\alpha^2}{81} + m_u\frac{4\alpha^2}{81}\right)c^2 = \frac{1}{2}\left(3m_d\frac{1}{81}\alpha^2\right)c^2 = \frac{1}{6}m_e\alpha^2 c^2$$

Here, m_d y m_u are the quark mass down and up, respectively.

Table A.1. Mass of some particles				
Mass	Proton	Neutron	Muon	Pion
Measured value	1.672621637 10^-27	1.674927211 10^-27	105.658367	139.5718
Units	kg	kg	MeV/c²	MeV/c²
Error	5 10^-8	5 10^-8	3.79 10^-8	2.51 10^-06
Expression	$m = \frac{27}{2}\left(\frac{1}{\alpha} - \frac{17}{18}\right)m_e$	$m = \frac{27}{2}\left(\frac{1}{\alpha} - \frac{5}{9}\right)m_e$	$m = \left(1 + \frac{3}{2\alpha}\right)m_e$	$m = \left(\frac{2}{\alpha} - \frac{1}{3}\right)m_e$
Calculated value	1.67361 10^-27	1.67839 10^-27	105.55	139,88
Error	5.91 10^-04	2.07 10^-03	1.03 10^-03	2.01 10^-03

Also has been calculated (Table A.2) the gravitational constant G, the constant of the Coulomb law, K and α, fine structure constant.

Table A.2. Constants calculated			
Constant	G	K	α
Measured value	6,67428 10^-11	8,987551788 10^+9	7,297352510^-3
Units	N · m² · Kg^-2	N · m² · C^-2	
Error	1,0 10^-4	Exact	6,8 10^-10
Expression	$G = \frac{3}{128}\hbar c^3\left(\frac{c_{tu}}{E_{HU}}\right)^2$	$K(t_{qu} = 1) = \frac{Gm_e^2}{\sqrt{2}\ \pi\ t_P q_e^2}(t_{qu})$	$\alpha = \frac{1}{8\pi^2\sqrt{3}}$
Calculated value	6.660 10^-11	8.973 10^+9	7.312 10^-03
Error	2.20 10^-3	1.66 10^-3	2.04 10^-03

Where $\hbar$ is the reduced Planck constant, t_p the Planck time and the boundary conditions are: t_{qu} = 1 s, is unit time in the elementary charge (electron), speed is c_{tu}=1m s^{-1} and power unit seen before E_{HU}=1 J.

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