On Primary Physical Transformations of Elementary Particles: the Origin of Electric Charge

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Abstract

After having established a meaning relation between electric charge and spin, in this paper we prove, using concepts of the Theory of Reference Frames, a few important tranformations concerning fundamental elementary particles. In particular we examine electron annihilation, photon materialization and transformation of electrodynamic mass of electron to antimass which is characterized by the physical property of having a negative value of mass. Moreover we prove photon spin is null and not unitary as it is assumed in the standard theory.

1. Introduction

Electric charge and spin of an elementary particle are connected with an important relation which we will prove in the next paragraph. As per this relation we prove electron and positron have opposite spin and moreover elementary particles with null electric charge (like for example photons) have a null spin otherwise than claimed in the standard theory where photons have unitary spin. That statement of the standard theory is in disagreement not only with the relation that we will prove but consequently also with the conservation law of angular momentum (spin) applied to the phenomenon of electron annihilation in the collision process with positron. With regard to electron annihilation we prove it is possible also by a different process of auto-annihilation of the same electron when it is duly accelerated to the critical speed v_c=1,41c. According to considered physical conditions the result of annihilation is the generation of two, three or four energy quanta in the spectrum of gamma radiation (γ rays). When then electron is further accelerated to greater speeds than the critical speed our theory forecasts an altogether new physical phenomenon characterized by negative electrodynamic mass that in our model represents the antimass and is the main physical property of particles for greater speeds than the critical speed. Successively we analyse the phenomenon of materialization of energy quanta belonging to the γ spectrum and we prove it can happen also in the absence of an atomic nucleus otherwise than required by the standard model.
The considered transformations are called primary because they happen among particles which are stable whether before or after the physical transformation while there are other transformations, called secondary, which happen among stable particles and unstable particles or vice versa, like for example collisions with high and very high energy and decay phenomena of particles in which unstable particles decay to stable particles.

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2. Electric charge and spin

The electric charge is a characteristic physical property of elementary particles and can have two polarities: positive and negative. The spin is a characteristic physical property of elementary particles it too and coincides with intrinsic angular momentum of particles. The spin too, being a vector, can have positive and negative values according to the rotation direction around the axis of rotation (dextrorotatory spin or laevorotatory spin). We consider here the angular spin and disregard the magnetic spin. Both physical quantities (electric charge and spin) can take on only a few discrete values and cannot change in continuous way. We know the Q electric charge (positive or negative), leaving out the fractional charges of the quark model, can take on only multiple values of the module "e" of the elementary charge of electron equal to $1,6 \times 10^{-19}$ Coulombs [C]

$$Q = \pm k e \qquad k = 1, 2, \dots \qquad (1)$$

The spin can take on only values equal to integer or half-integer multiples of Plank's rationalized constant $\hbar = h/2\pi$. The spin value is[1][2]

$$q_s = \pm \frac{k\hbar}{2} \qquad k = 1, 2, \dots \qquad (2)$$

where $h = 6,625 \times 10^{-34}$ Js = $6,625 \times 10^{-27}$ erg s. Let us want to establish a mathematical relation between electric charge and spin, so we can write

$$q_s = \pm k \frac{h}{4\pi} = \frac{h}{4\pi e} Q = SQ \qquad (3)$$

The spin can take on only values proportional to the Q electric charge through the S constant of proportionality

$$S = \frac{h}{4\pi e} = 0,330 \times 10^{-15} \text{ volts} \times \text{s} \qquad (4)$$

If a particle has null electric charge (like for example photons) in that case Q=0 and therefore for (3) $q_s=0$. Besides as the electric charge can be positive or negative, also the spin can take on positive or negative values because of the bipolarity of the direction of rotation around the axis of rotation. Electric charge and spin have the same sign as per (3) and we take on the convention that a positive spin and a positive charge correspond to the dextrorotatory rotation. Inverting the equation (3) we have

$$Q = \frac{q_s}{S} = C q_s = 3,03 \times 10^{15} q_s \qquad (5)$$

The relation (5) gives very precise indications about the origin of electric charge and in particular it establishes the electric charge is generated by the angular spin of the particle and hence by the rotary motion of the same particle around its own axis through the constant of proportionality $C = 1/S = 3,03 \times 10^{15}$ Hz/Volts.

The free electron, or in the ground level when it is bound, has a negative elementary charge $-e$ (with k=1 and negative sign) and on the basis of (2) has a spin

$$q_e^- = -\frac{\hbar}{2} \qquad (6)$$

The positron has the same physical properties of electron except electric charge which is positive and equal to +e (k=1 and positive sign) and therefore has a spin

$$q_e^+ = +\frac{\hbar}{2} \qquad (7)$$

Because of the relation between electric charge and spin, the bound electron in any atom orbit has a negative spin and equal to $s\hbar = -k\hbar/2$ where $s = -k/2$. Moreover it has an orbital angular momentum equal to $\pm k\hbar$ for which the total angular momentum of orbital electron is[2]

$$q_{kt} = \pm k\,\hbar - k\,\frac{\hbar}{2} = \left(\pm k + s\right)\hbar \qquad (8)$$

The spin of orbital electrons causes the hyperfine structure of frequency spectra whose atomic levels of energy have been already previously calculated[2].

2. On the physical nature of electron

Electron is the essential constituent of electric currents and, together with protons and neutrons, the most important element of the atom structure. It may be free or bound inside atom in electronic orbits. The free or bound electron is an elementary particle characterized by following physical properties:

- electrodynamic mass at rest $m_o = 9{,}1 \times 10^{-31}$ kg
- intrinsic electrodynamic energy $E_i = m_o c^2$ equal to 0,511 MeV
- negative electric charge equal to $1{,}6 \times 10^{-19}$ C
- spin $q_s = -\hbar/2$ whether in the free state or in the fundamental level of energy at the bound state.

In the paper " Dynamics and Electrodynamics of Moving Real Systems in the Theory of Reference Frames "[3] a critical distance r_c (nuclear radius) has been calculated and it represents the transition from the electronic structure to the nuclear structure of atom. At the critical distance from the centre of atom electron has the following physical properties:

- null electrodynamic mass
- superluminous critical speed $v_c = \sqrt{2}\,c = 1{,}41c$
- negative conventional electric charge
- intrinsic potential energy $E_{pi} = -m_o c^2$
- negative electrodynamic mass for distances from the centre of nucleus smaller than the critical distance and for speeds greater than the critical speed.

The last considered property about electron is a consequence of the following relation[3][4]

$$m = m_o \left(1 - \frac{1}{2} \frac{v^2}{c^2}\right) \qquad (9)$$

where m_o is the electrodynamic mass at rest of electron which changes to negative mass when electron has greater speeds than the critical speed.
Electron inside the nucleus doesn' t have physical characteristics of the normal elementary particle but takes on those of nuclear electron. Under the action of the nuclear central force the accelerated electron changes completely electrodynamic mass to radiant energy until the annulment of its electrodynamic mass at the critical distance. In the transition then from the atomic structure to the nuclear structure its electrodynamic mass becomes negative for speeds greater than the critical speed. These considerations are valid also for free electron that is accelerated before until the critical speed and then to speeds greater than the critical speed.
Time of nuclear electron with respect to the reference frame of the still observer (reference frame of laboratory) at the critical speed is null[3][4] and therefore loses physical meaning. In fact from the (9) we deduce that at the critical speed $v=\sqrt{2}\,c$ the electrodynamic mass of moving electron is null with respect to the reference frame at rest and as per the following relation proved always in the same paper[3]

$$dt = \frac{m}{m_o}\, dt' \qquad (10)$$

we have dt=0. It means if t' is its own time of the moving particle, for coincident initial instants (t=t'=0), at the critical distance and hence at the critical speed time of the moving particle with respect to the reference frame of the still observer (reference frame of laboratory) becomes null (t=0) and so all happens as if in these conditions time stops. Inside the nucleus (for distances smaller than the critical distance and for speeds greater than the critical speed) the concept of relativistic time, given by (10), implies a time reversal (dt<0) because also electrodynamic mass is negative (m<0). Inside the nucleus therefore time loses the conventional physical meaning for the observer of the laboratory (at rest reference frame) while with respect to the reference frame of the particle time goes by ordinarily as inertial time. It means time isn't a physical quantity that we can use in order to study and analyse physical phenomena inside the nucleus. And because also space coordinates lose a precise physical meaning because of inability to measure them we can claim, as per our present knowledges, inside the nucleus kinematics loses any conventional physical consistency.
Atoms, molecules, agglomerates of atoms and molecules represent the "inertial matter" which is characterized by a "inertial mass" sensible to mechanical and gravitational forces. Elementary particles, that emit radiant energy when they are accelerated, represent the "electrodynamic matter" characterized by an "electrodynamic mass" sensible to electromagnetic forces. Electrons, whether orbital or free, and free protons represent the electrodynamic matter. Nucleus instead is made up of bound protons and bound neutrons which represent the "nuclear matter" sensible to nuclear forces which hold the nucleus together.

It is useful here to remind that mass of microphysical systems (elementary particles and not elementary particles) is expressed in conventional way by means of u.f.m. (physical unities of mass) where 1 u.f.m. = 931 MeV and 1 MeV = 0,001074 u.f.m.

3. High energy radiation and physical transformations

High energy radiation is made up of electromagnetic nanowaves[5][6] belonging to the frequency spectrum of X rays, γ rays and δ rays[7]. X radiation is emitted by orbital electrons, γ radiation has nuclear origin and it is emitted generally together with α particles or β particles by numerous natural and artificial nuclei. δ radiation is at very high energy, it is placed in the most high zone of the frequency spectrum and is connected with decay phenomena of particles. The low band of γ frequencies is partially superimposable with the high band of X frequencies which nevertheless have roots in energy jumps of orbital electrons. Emission of γ rays is generally explained with the existence in the radioactive nucleus of energy states excited with respect to the energy fundamental state: γ radiation is emitted when the nucleus, after having expelled a α or β particle, is in an excited state of energy and in passing to energy fundamental state emits one γ electromagnetic energy quantum which has so nuclear origin. γ radiation intervenes in two very important physical processes:

a. The electron annihilation
b. The photon materialization

4. Electron annihilation

Electron annihilation[1] [8][9] is the phenomenon that consists in the collision of electrons with positrons. The two particles disappear and generally two energy quanta appear in their place. In Thibaud' s experiment free positrons were launched against a metal lamina (tungsten) which is rich in conductive electrons (fig.1). Whether the positron or the electron have in that case low energy and the generation of two energy quanta was observed for every positron. Each quantum has an energy of about 0,51MeV, with frequency and wavelength placed in the spectrum of gamma radiation (γ rays): $f=1,2\times10^{20}$Hz ; $\lambda=2,5\times10^{-2}$Angstroms.

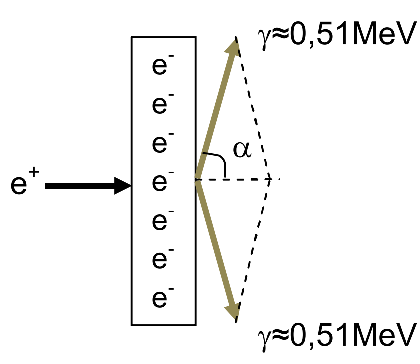

Fig.1 Production of a pair of γ quanta by the collision of a positron with an electron in the Thibaud experiment and confirmed by subsequent experiments in synchrotrons.

As per the conservation law of energy, because the intrinsic total energy of both, electron and positron, is 1,02MeV, each quantum has about 0,51MeV. As per the conservation law of momentum the two quanta have by practise opposite directions with an angle $\alpha \approx 90°$. The same phenomenon happens if free electrons and free positrons collide with low speed (fig.2). In both the considered processes electric charge of the two particles dissolves in the collision.

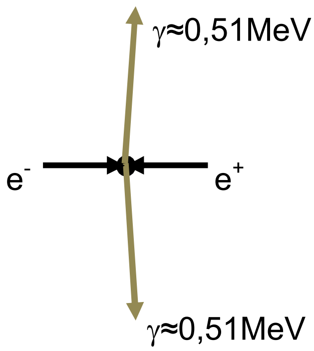

Fig. 2 Feynman diagram of the electron-positron collision at low energy

In the standard model photons and generally energy quanta have a spin equal to 1 for which, in respect of the considered process of annihilation, the consevation law of spin is respected only if electron and positron have the same positive value of spin equal to 1/2 : it is in contrast to the equation (3).
In our theory the conservation law of spin is compatible with (3) only if photons and energy quanta have a spin equal to 0, because the sum of spin of electron and positron is null.
Only within the Theory of Reference Frames[3] we are able to explain an altogether new physical phenomenon, in which the annihilation happens with the contribution of only one accelerated particle: we have in that case a sort of auto-annihilation.
In fact in the Theory we have proved accelerated electron, under the action of a linear force, at the speed of light generates a quantum with energy $hf = m_o c^2/2 =$ $= 0,255$ MeV which is in the frequency spectrum of gamma radiation (γ): $f = 0,6 \times 10^{20}$Hz , $\lambda = 5 \times 10^{-2}$ Angstroms.
The remaining mass $m_o/2$, if further accelerated, at the critical speed $v_c = \sqrt{2}\, c$ generates a γ second quantum with the same characteristics of frequency and wavelength than the first. In fig.3 the Feynman diagram of the auto-annihilation of accelerated electron is represented.
In reality in that case it is more suitable to talk about auto-transformation of electron than annihilation which consists in the real disappearance of the particle.
In that case in fact, increasing the speed of electron under the action of an applied force, the electrodynamic mass of electron, at rest positive and equal to m_o, decreases gradually according to the relation[3][4]

$$m = m_o \left(1 - \frac{1}{2}\frac{v^2}{c^2}\right) \qquad (11)$$

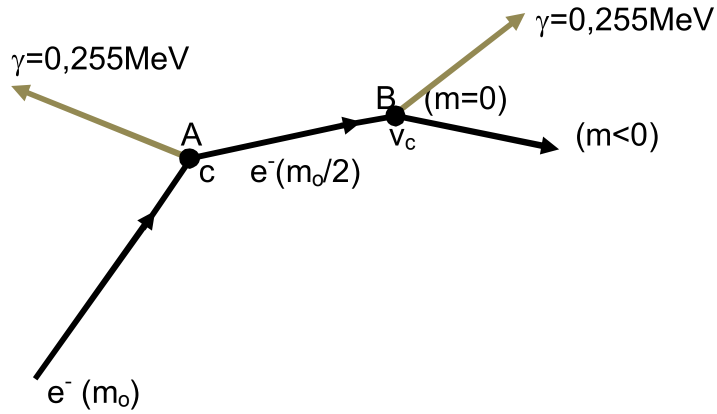

Fig.3 Feynman diagram of the auto-transformation of accelerated electron with the production of a pair of quanta γ=0,255MeV.

At the speed v=c (A point) electrodynamic mass halves while the other half generates a first gamma quantum (γ=0,255 MeV). The remaining half, further accelerated, annihilates at the critical speed $v_c = \sqrt{2}\, c = 1{,}41c$ generating the second γ quantum (B point). At the current state electrodynamic mass of electron is null but the particle is still existing because whether its electric charge or its spin remain: in fact the electric charge of electron disappears with the particle only in the annihilation with positron.
If the emerging particle in the B point is further accelerated its electrodynamic mass becomes negative. This negative electrodynamic mass represents the "antimass" of the electron. For further accelerations the antimass becomes always more negative and at the speed v=2c it is equal to $-m_o$.
Returning now to the annihilation between two particles, if one of the two particles is first accelerated to high speed, greater than that of light, it is possible to predict the simultaneous generation of three γ quanta, the first with energy equal to 0,255 MeV, and the other two quanta with energy equal to 0,383 MeV (fig.4).

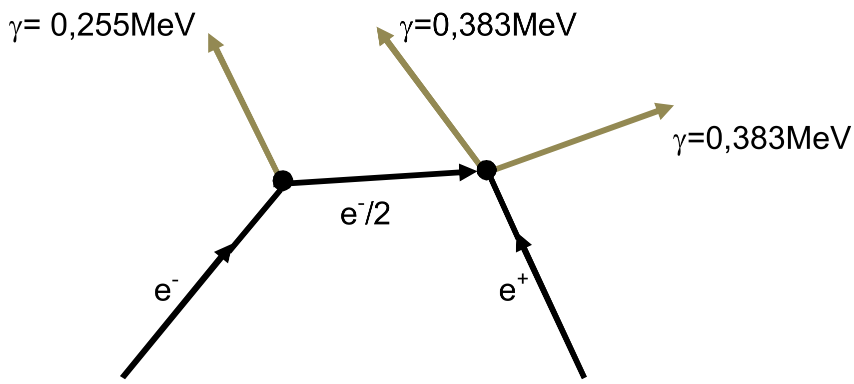

Fig. 4 Feynman diagram on the electron-positron collision at high energy with the production of three quanta, in which the electron is first accelerated at greater speed than the speed of light and then is made to collide with a positron at low energy.

Suppose that both the particles have high energy, are accelerated to greater speeds than the speed of light and smaller than the critical speed, and then are made to come into collision, they generate four γ quanta, everyone with 0.255 MeV energy (fig.5).

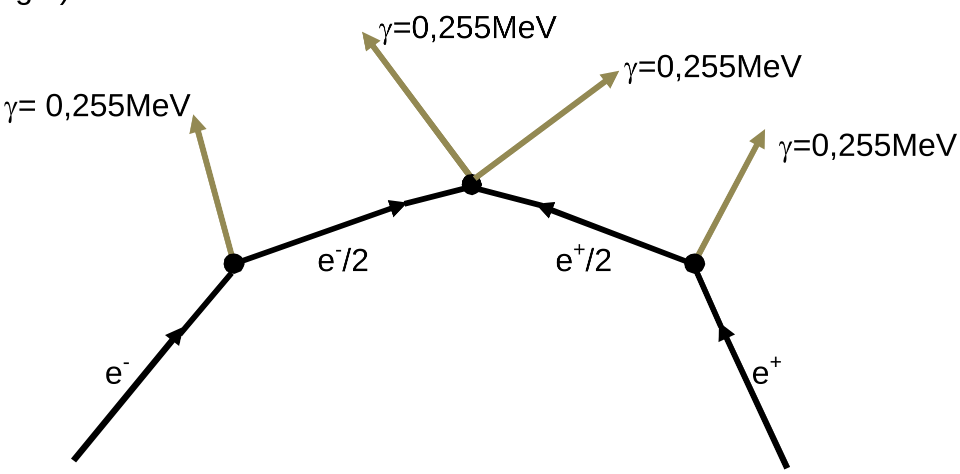

Fig. 5 Feynman diagram on the electron-positron collision in high energy with the production of four quanta, in which whether the electron or the positron are accelerated to greater speeds than the speed of light and then made to collide.

If the two particles before colliding are accelerated to greater speeds than the critical speed electrodynamic masses become negative and they are not more able to emit energy. In that case they can take on in absolute value largest numbers and the more large the more the speed is great and this possibility opens interesting prospects for the study of particles in high and very high energy.
Let us want now to search for giving a physical meaning to the antimass of the particle. We have proved the positive electrodynamic mass, when is accelerated, emits radiant energy and decreases; when it is decelerated absorbs energy and increases. The antimass has negative electrodynamic mass: when it is accelerated absorbs radiant energy and increases in absolute value; when it is decelerated emits energy and decreases in absolute value. We see that the antimass has a completely antisymmetric behavior with respect to the positive electrodynamic mass of the particle. The critical speed, in which the electrodynamic mass is null, represents the transition speed between mass and antimass.

5. Photon materialization

The standard theory asserts that the materialization of a γ energy quantum to a electron and to a positron happens only with γ quanta which have greater energy than 1,02 MeV and in front of a nucleus with high atomic number (fig.4).

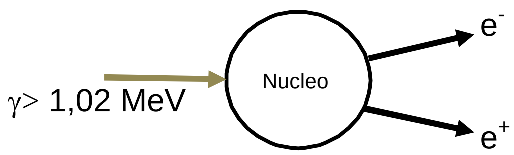

Fig. 4 Representation of the materialization of γ photon in an electron-positron pair in the standard theory.

Let me see how the Theory of Reference Frames examines the photon materialization. Let us consider to that end a γ quantum with hf energy and suppose that it produces an electron-positron pair, everyone with m_o electrodynamic mass moving with the same speed v_o. According to the experimental results obtained in the Wilson chamber, for symmetry physical reasons with respect to the quantum direction and for the conservation law of momentum the situation is represented in fig.5

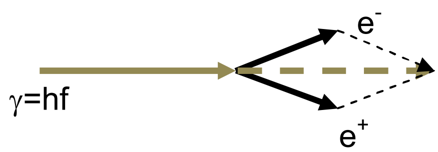

Fig.5 Feynmam diagram of the γ photon materialization.

Because the phenomenon can happen the total energy E_t of two particles has to be equal to the hf energy of the quantum.
The energy E of each particle in the act of the materialization, leaving out at the moment the kinetic energy of the two particles, is given by the intrinsic energy m_oc^2 and so

$$E_t = 2\, m_oc^2 \leq hf \qquad (12)$$

Being m_oc^2=0,51 MeV, it must be

$$hf \geq 1{,}02 \text{ MeV} \qquad (13)$$

The necessary energy of the γ quantum for the materialization must be greater or equal to 1,02 MeV which represents a minimum threshold so that the process of materialization can happen. If the quantum energy is greater than 1,02 MeV the more energy subdivides in the shape of kinetic energy between the two particles. Extra the conservation law of momentum has to be respected. If $\mathbf{p=m_ov_o}$ is the momentum of every electron (negative and positive) and if $\mathbf{p_\gamma=hf/c}$ is the quantum momentum, as per the conservation law of momentum has to be (fig.6)

$$\mathbf{p^+ + p^- = p_\gamma}$$

$$\mathbf{m_ov_o + m_ov_o = p_\gamma}$$

$$2m_ov_o\cos\alpha = \frac{hf}{c} \qquad (14)$$

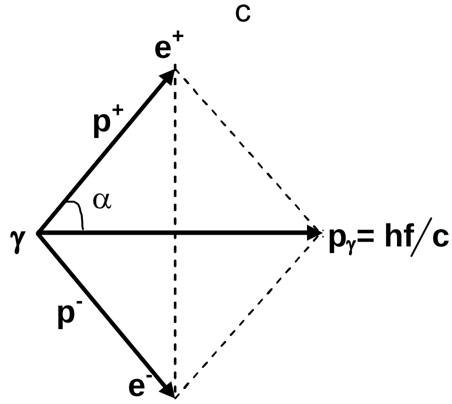

Fig. 6 Graphic representation of the conservation law of momentum

From (12) we deduce $hf/c \geq 2m_o c$ and so

$$v_o \geq \frac{c}{\cos\alpha} \qquad (15)$$

From (15) we infer that the two electrons with opposite charge, produced by the materialization of the γ energy quantum have necessarily a greater speed than c; the speed of the two particles has the minimum speed v=c only when α=0°.
Let us remind that in the Theory of Reference Frames greater speeds than the speed of light are possible and so this result is altogether legitimate. Besides for greater speeds than the speed of light and smaller than the critical speed masses electrodynamic of the two particles of the electron-positron pair are positive while for greater speeds than the critical speed electrodynamic masses are negative.
This result induces to think that large improvements and notable progresses are possible for a better understanding of the physical behavior of elementary particles which have very high energy.

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