On the Stability of Electrodynamic Particles: the Delta Radiation

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Abstract

Electrodynamic particles have an exclusive physical property that distinguishes them from all other physical systems. This property is the electrodynamic mass that allows accelerated particles to emit or to absorb energy quanta. Stable particles have a lower speed than the critical speed, when they are accelerated they lose electrodynamic mass and emit energy in the shape of quanta while when are decelerated they absorb energy quanta and electrodynamic mass. Unstable particles on the contrary have higher speeds than the critical speed; they absorb energy and negative electrodynamic mass when they are accelerated and lose energy and electrodynamic mass when they are decelerated. Muon and tauon are the main unstable electrodynamic particles and they have the physical property to emit the delta radiation on the decay.

1. Introduction

Electron is the parent of electrodynamic particles. It is a stable particle and only if accelerated to highest speeds it is subject to autotransformation with emission of energy quanta. In particular the accelerated electron emits a first gamma quantum at the speed of light and a second gamma quantum at the critical speed v_c=1,41c. This emission of energy is accompanied by a simultaneous decrease of the electrodynamic mass that becomes zero at the critical speed. In this primary transformation[1] the electron doesn't disappear but it changes and at greater speeds than the critical speed it assumes a negative electrodynamic mass preserving the negative unitary conventional electric charge.
Physical properties of the negative electrodynamic mass have been considered in previous works[1][2], we would want here to remind the negative electrodynamic mass behaves in dual way with respect to the positive electrodynamic mass.
In fact an accelerated electron with positive electrodynamic mass (it is stable and has lower speed than the critical speed) emits radiant energy in the shape of gamma quanta, while an electron with negative electrodynamic mass (it is unstable and has higher speeds than the critical speed) emits radiant energy in the shape of delta quanta in the deceleration stage which coincides with the decay stage of the unstable particle. Anyway the energy emission is always a quantum process that doesn't happen time after time.

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This complex process of electron transformation can be represented by a diagram as in fig.1

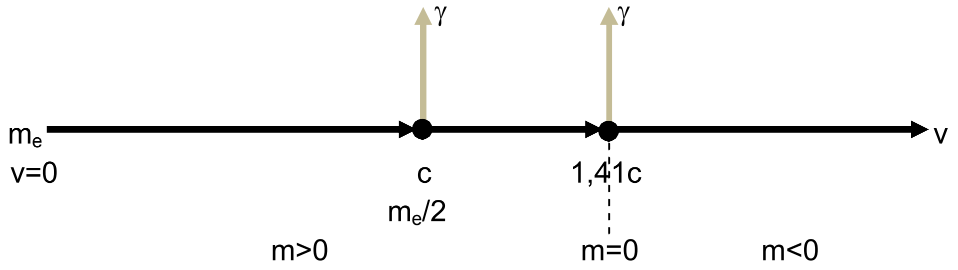

Fig.1 Feynman diagram of the accelerated electron that emits two quanta of gamma radiation respectively at the speed of light and at the critical speed. For greater speeds than the critical speed the accelerated electron absorbs energy in the shape of negative electrodynamic mass. m_e is the electron resting mass.

2. Wave equation of electrodynamic particles

An electrodynamic particle (in particular electron), endowed with v speed, as per De Broglie's hypothesis has an equivalent wavelength $\lambda=h/p$, where $p=m_e v$ is the particle momentum. Making use of this equivalence we are able to describe the particle motion by the following wave equation[3] derived from d'Alembert's equation[4], valid at any t time,

$$\Delta u + k\,(E - E_p)\,u = 0 \qquad (1)$$

where $\Delta = \delta^2/\delta x^2 + \delta^2/\delta y^2 + \delta^2/\delta z^2$ is Laplace's operator, u(x,y,z) is a wave function valid at any time during the motion, k is a quantity to calculate, E is the electron total energy, E_p is its potential energy and $E_c=E-E_p$ is the kinetic energy. Suppose that the motion happens along the x axis, in the considered model the u(x,y,z) is function only of the x variable (fig.2) and at any t time the particle and its equivalent wave function are in a different position with respect to x.

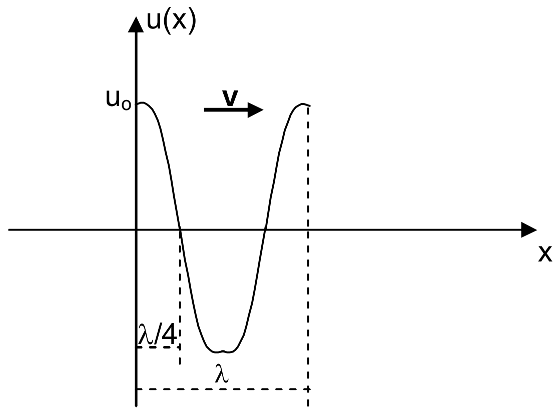

Fig.2 Mathematical representation of De Broglie's wave function in the shape of cosine.

Therefore the wave equation of motion is a linear differential equation of second order

$$\frac{d^2u}{dx^2} + kE_c\, u = 0 \qquad (2)$$

The (2) has to respect the initial conditions $u(0)=u_o$ and $[du/dx]_0=0$. Let' s assume $W=kE_c$, the equation (2) has two solutions: $p_1= -\sqrt{-W}$ and $p_2= +\sqrt{-W}$ and therefore the wave function u(x) has the expression

$$u(x) = A_1e^{-x\sqrt{-W}} + A_2e^{+x\sqrt{-W}} \qquad (3)$$

$p_1= -\sqrt{-W}$ and $p_2= +\sqrt{-W}$ are in the Theory of Systems[5] the poles of the physical system that represents the moving electron.
According to the initial conditions we have

$$A_1 = A_2 = \frac{u_o}{2} \qquad (4)$$

Let us reminder that in Standard Quantum Mechanics the kinetic energy can be negative as per the probabilistic meaning of the wave function while in Deterministic Quantum Physics[4] the negative kinetic energy involves that the wave function is unstable. The kinetic energy is $E_c=m_ev^2/2$ and it can be negative only if the mass is negative. In the Theory of Reference Frames the electrodynamic particle has positive electrodynamic mass when its speed is smaller than the critical speed and has negative electrodynamic mass when its speed is greater than the critical speed. If particle motion happens outside a force field then $E_p=0$ and $E=E_c$.

3. Stability of electrodynamic particles

Let us consider two possible situations depending on W is negative or positive and assume the quantity k is positive.

3.a $W > 0$ and $E_c > 0$.

The two algebraic solutions p_1 and p_2 are conjugate imaginary and assuming $W=Z^2$ the wave function has the expression

$$u(x) = A_1\, e^{-iZx} + A_2\, e^{iZx} \qquad (5)$$

Applying Eulero' s formulas we have

$$u(x) = (A_1+A_2) \cos Zx - i\,(A_1- A_2) \text{ sen } Zx \qquad (6)$$

Because $A_1=A_2=u_o/2$ it is

$$u(x) = u_o \cos Zx \qquad (7)$$

Imaginary solutions deriving from positive kinetic energy assure the stability[5] of the wave function during the motion and consequently the stability of the particle. The relation (7) is concordant with the representation in fig.2 for every time t. Moreover in concordance with the condition $u(\lambda/4)=0$ we have

$$\cos Z \frac{\lambda}{4} = 0 \qquad (8)$$

The preceding relation is respected only if

$$Z \frac{\lambda}{4} = (2l - 1) \frac{\pi}{2} \qquad \text{with } l=1, 2, 3, ... \qquad (9)$$

for wich being $W=kE_c= Z^2$ we have

$$W = \frac{4(2l - 1)^2\pi^2}{\lambda^2} \qquad (10)$$

Because for electrodynamic particles with mass m_e

$$E_c = \frac{1}{2} m_e v^2 = \Delta m\, c^2 = \frac{h\, c}{\lambda} \qquad (11)$$

and being $k = W/E_c$, we have

$$k = \frac{4(2l - 1)^2\pi^2}{\lambda^2\, \Delta m\, c^2} \qquad (12)$$

or

$$k = \frac{4(2l - 1)^2\pi^2}{h\lambda c} \qquad (13)$$

3.b $W<0$ and $E_c<0$.

In that case the two solutions are real: $p_1 = -\sqrt{-W}$ is certainly negative while $p_2 = +\sqrt{-W}$ is certainly positive and the wave function is

$$u(x) = A_1\, e^{p1\, x} + A_2\, e^{p2x} \qquad (14)$$

In concordance with the theory of stability of linear systems[5] a positive real solution produces instability during the motion because the u(x) amplitude of the wave function tends to increase in exponential way (Fig.3).

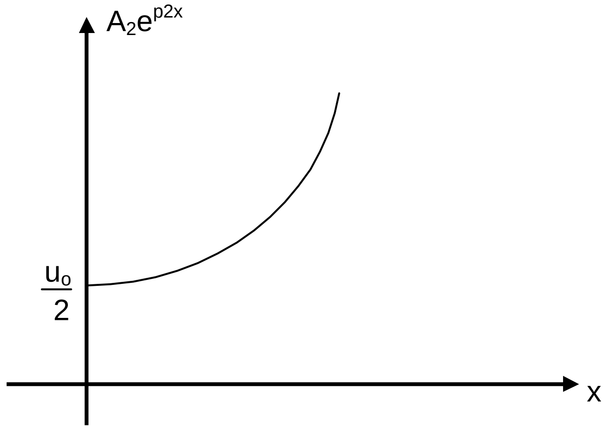

Fig.3 A positive real solution produces a degeneracy of the wave function to a function with increasing amplitude and therefore causes instability of the particle

A negative solution instead produces an exponential decrease of the u(x) amplitude (Fig.4) and it causes again instability of the wave function during the motion .

Fig.4 A negative real solution produces a function with decreasing amplitude and degeneracy of the wave function with instability of the particle

In our wave model the E_c positive kinetic energy involves stability of the wave function during the motion and consequently stability of the electrodynamic particle. On the contrary the E_c negative kinetic energy involves necessarily instability of the wave function during the motion and consequently instability of the electrodynamic particle. At the same time the negative kinetic energy involves necessarily a negative electrodynamic mass and therefore electrodynamic particles with negative electrodynamic mass are unstable and have a shortest average life. We observe further the instability is as greater as the negative kinetic energy and the negative electrodynamic mass are greater in absolute value. Similarly the instability is as greater as the speed of particle is greater with respect to the critical speed.

The physical situation at the critical speed, where the kinetic energy is zero because of zero electrodynamic mass, implies the wave function is a constant function with $\lambda=\infty$. It doesn' t imply instability but only a singularity for the considered particle which at this speed undergoes an important change. In this physical situation the electrodynamic particle is on the verge of stability.

4. Unstable electrodynamic particles and delta radiation

We said before electrodynamic particles have an exclusive and essential physical property: the electrodynamic mass changes with the particle speed and the emission or the absorption of radiant energy in the shape of energy quantum is associated with that variation.
Electron is a stable electrodynamic particle for lower speeds than the critical speed, when it is accelerated the electrodynamic mass decreases. At the speed of light the electron emits a first gamma quantum of energy losing half of its mass and at the critical speed v_c=1,41c emits a second gamma quantum[1] setting to zero its electrodynamic mass. At greater speeds than the critical speed the process of autotransformation intensifies, the electron assumes a negative electrodynamic mass and a negative kinetic energy: it involves the electron becomes unstable.
In relation to some particular values of the superluminous speed the unstable electron assumes typical values of negative electrodynamic mass generating characteristic unstable particles. In fact at the speed $v = 14{,}41v_c = 20{,}38c$ the accelerated electron assumes a negative electrodynamic mass $m_\mu = -206{,}65m_e = -105{,}6$ MeV/c^2 changing into the muon (μ^-) that is an unstable electrodynamic particle with an average life $\tau_\mu = 2{,}2\times10^{-6}$ s. The free muon, i.e. not accelerated, tends spontaneously to decay into a stable electron and into a muon neutrino (ν_μ).
If instead the unstable electron (muon) is accelerated further to greater speeds, it changes into the tauon (τ^- particle) at the speed $v = 59{,}98v_c = 83{,}41c$.
The tauon is a strongly unstable electrodynamic particle with an average life $\tau_\tau = 290{,}6\times10^{-15}$ s and a greatest negative electrodynamic mass $m_\tau = -3477{,}50m_e = -1777$MeV/$c^2$. The τ particle has been observed in the 1975.
When the acceleration stops working all unstable electrodynamic particles tend spontaneously to decay into a stable electron and into a neutrino. In the event of muon the decay process is

$$\mu^- = e^- + \nu_\mu \qquad (15)$$

The frequency of the muon neutrino is given by

$$f = \frac{\Delta m\, c^2}{h} = 2{,}6\times10^{22}\ \text{Hz} \qquad (16)$$

and it is into the frequency band of the delta radiation.

Also tauon respects this general process decaying into an electron and into a tauon neutrino (ν_τ)

$$\tau^- = e^- + \nu_\tau \qquad (17)$$

The tauon neutrino is, like all neutrinos, an energy quantum whose characteristic frequency can be calculated similarly

$$f = \frac{\Delta m\, c^2}{h} = 4{,}3\times10^{23}\ \text{Hz} \qquad (18)$$

Also frequency of the tauon neutrino is into the frequency band of the delta radiation.
Both muon and tauon have the same negative electric charge ($q=-1$) and the same spin ($q_s=-\hbar/2$) than the electron. It is possible to verify that the decay processes (15) and (17) respect both the conservation laws: the electric charge and the spin.
Besides like the electron has an antiparticle (positron) that has the same physical properties than the electron except those connected with the electric charge, similarly the muon and the tauon have an antiparticle: the positive muon and the positive tauon.
The behaviour of the electron with the speed can be represented in brief by a graph (fig.5) in which the electron is initially still.
Under the action of a force field the electron is accelerated, its electrodynamic mass decreases and at the speed of light (c) it emits a first γ_1 quantum of energy ($E_{\gamma1}=m_e/2c^2$) and at the critical speed $v_c=1{,}41c$ a second γ_2 quantum ($E_{\gamma2}=m_e/2c^2$).
In this physical situation (lower speed than the critical speed) the electron is stable because its kinetic energy is positive. If in this situation the electron is decelerated, starting from the critical speed, it absorbs energy and electrodynamic mass in the shape of gamma quanta of energy represented by yellow vectors in figure.
If instead the electron is further accelerated to greater speeds than the critical speed the electrodynamic mass and the kinetic energy become negative and the electron is unstable: it means that if the force field stops working, the unstable electron tends to return to the state of stability decreasing both the speed and the negative electrodynamic mass as far as to assume again a positive electrodynamic mass. Generally this process of evolution towards the stability would be gradual to the critical speed but for some values of negative electrodynamic mass (in particular for muon and tauon masses) this process isn' t gradual and happens by the decay phenomenon with emission of δ energy quanta as described in the relations (15) and (17) (these decays are represented by azure vectors in figure).

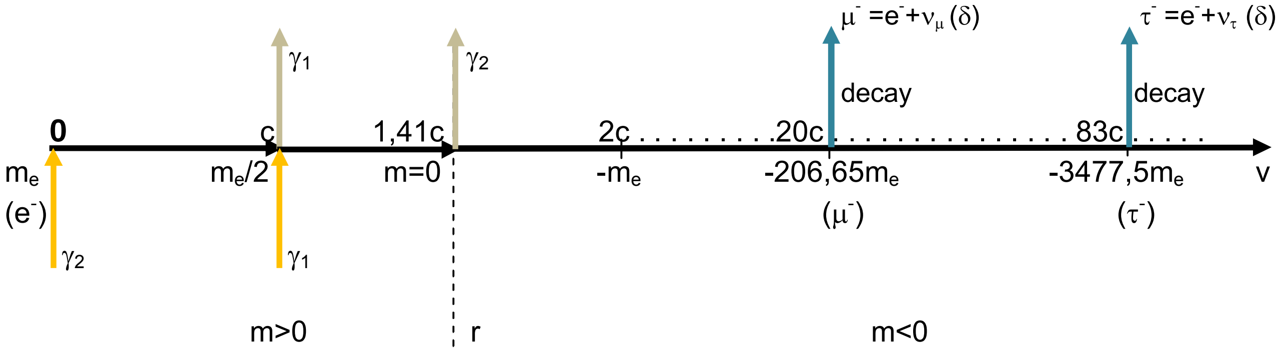

Fig.5 Graph relating to the behaviour of the accelerated electron. The r dotted line separates the stable behaviour of the electron (left) from the unstable behaviour (right).

All neutrinos are energy quanta but they have different frequencies according to their origin. The electron neutrino (ν_e) arises from the decay of neutron which is a not elementary composed particle and has wavelengths and frequencies which are inside the gamma radiation[2][6]. The muon neutrino (ν_μ) and the tauon neutrino (ν_τ) instead arise from decay of unstable elementary particles and have different wavelengths and frequencies that are over the gamma band in the band which we called " delta radiation".

Unlike X rays which have atomic nature and arise from energy quantum jumps of bound electrons in atomic electronic orbits, γ rays arise from the autotransformation of accelerated stable electron or from the decay of free or bound neutron while δ rays arise from a decay process of an unstable elementary particle.

The gamma radiation has a wavelength spectrum ($1 \div 10^{-3}$) Angstroms and a frequency spectrum ($3 \times 10^{18} \div 3 \times 10^{21}$) Hz. The low part of the gamma radiation (soft γ) coincides with the high part of the X radiation (hard X). The delta radiation (δ rays) has a lower wavelength than 10^{-3} Angstroms and consequently a greater frequency than 3×10^{21}Hz.

References

[1] D. Sasso, On Primary Physical Transformations of Elementary Particles: the Origin of Electric Charge, viXra.org, 2012, id:1202.0053

[2] D. Sasso; Beta Radiation, Gamma Radiation and Electron Neutrino in the Process of Neutron Decay, viXra.org, 2012, id:1205.0052

[3] E. Persico, Foundations of Atomic Mechanics (Zanichelli Editor - Bologna - 1968)

[4] D. Sasso, Basic Principles of Deterministic Quantum Physics, 2011, viXra.org: 1104.0014

[5] D. Sasso, On the stability of linear systems, 2011, viXra.org: 1102.0009

[6] D. Sasso, If the Speed of Light is Not an Universal Constant According to the Theory of Reference Frames: on the Physical Nature of Neutrino, 2011, viXra.org: 1110.0007