

# Tachyons And Modern Physics

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**ABSTRACT:** We have carried out an exhaustive analysis of the scope of Relativity, showing that it is possible to couple it with Quantum Theory, but not with Classical Mechanics. In order to do that, we have introduced the concept of electromagnetic and virtual mass to all particles subjected to Quantum Field Theory, radically different from the real or inertial mass included in Newtonian Dynamics, which turns out the adequate status to understand quantum phenomena without resorting to explanations difficult to admit. In that line we have considered the particles so-called Tachyon, for which we made a reformulation of the relativistic equation avoiding the space-like or negative interval (non-causal); thus, it has been demonstrated its identification with antiparticles, on account of the peculiar behavior of energy and momentum regarding the particles and photons.

## INTRODUCTION

It is easy to notice that Modern Physics (since early 20<sup>th</sup> century) has become a kind of ceremony of confusion, specially for two reasons:

- By making the real or inertial mass as an essential parameter that should even govern the evolution of the Universe through Gravitation.
- Establishing a Quantum Mechanics that, although paradoxically does not use any mass has assumed the inertial mass, especially since the so-called Relativistic Quantum Mechanis or Quantum Field Theory counterpart.

On the other hand, it turns out amazing the argument used about stellar evolution, according to which the production of a "gravitational collapse" is possible due to the force of gravity, overcoming strong, weak and electromagnetic forces, despite the extremely small value of the constant, G, relative to that of other interactions. We believe there are well-founded theoretical reasons to question the hitherto accepted Cosmological Model. (our paper: "Cosmological Model: a new approach"). Moreover, the approach to quantum description of physical phenomena has been held from Classical Mechanics in a very special way, since it needs no mass; but by introducing it with the Relativistic Quantum Theory has managed to establish a Standard Model for the behaviour of Elementary Particles full of fissures and cracks, as evidenced by the fact the same had to be modified in a very short time to accomodate Supersymmetry, Superparticles, String Theory, etc. Our point of departure is Relativity Theory, whose real impact is on Quantum Theory, which forces us to introduce the complicated mathematical world, with which we will try to give meaning to the concepts emerging in line with its development. The relativistic construction is carried out setting the hypothesis of an interval whose only condition is to be constant and in the case that was negative the corresponding physical event is called "non-causal" according to the Minkowski diagram.

In the latter situation it is found the peculiar or rather singular case of Tachyons, appearing as a result of contemplating the existence of particles with mass whose square would be negative, ie. imaginary mass; this implies that these particles must have greater speed of light in vacuum, c, which does not contradict the famous Michelson-Morley experiment that only claimed c had to be an absolute constant. In trying to understand the seemingly prohibited particle capable of travelling faster than light, we will find it can be explained unexpectedly.

## RELATIVITY: ANOTHER APPROACH

### Kinematics

As it is well known, the origin of the theory is found in the result of the Michelson-Morley's experiment, which eliminates the existence of ether in vacuum and converted the speed of light or electromagnetic radiation, c, in an absolute value or universal constant, for being independent of both the relative velocity of the source and the observer. With this fact and before proceeding, we wish to clarify that according to the above, the mathematical expressions, c-v or c+v have no physical meaning, as it is not possible to add or subtract scalar (c) with vector (v) for not being homogeneous magnitudes; but we can perform arithmetic on numeric value, c<sup>2</sup> and v<sup>2</sup>. Relativistic equations are difficult to understand, not to say incomprehensible, because the relationship of the coordinates of physical quantities between reference systems are not properly raised. Thus, it has been considered times, t, t' and x, x' attached to references system fixed (O) and moving (O'), respectively, where observers are placed, without realizing that we can only perform any experiment from one of them, fixed or moving, since both are interchangeable on account of the "relative" character of velocity. So, the issue of the "twin paradox" and the composition of velocities are discarded, though philosophically they may be of concern, but not an experimental science. The proper approach is made by a geometric construction, in which instead of time coordinates, t, t', are considered elapsed times, dt and dτ, that use light waves to travel the space, cdt and cdτ from the fixed (O) and moving (O') systems, respectively. Naturally, on entering the characteristic parameter of the latter, ie, its velocity, v, we may get the **time\_dilation** equation:

$$c^2 dt^2 - v^2 dt^2 = c^2 d\tau^2 \implies$$

$$dt = d\tau / \sqrt{1 - v^2/c^2} \quad (1)$$

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We think that it should be noted that the expression presupposes the existence of a right triangle in which we simply have applied the Pythagorean theorem and where the velocity,  $v$  is always perpendicular to the leading waves emitted from the moving system and according to (1) may be positive or negative. But what is really important (as prescribed by the theory) is the definition of **interval**:  $ds \equiv cdt = \text{const.}$ , which provides guidance for obtaining other equations. It is not possible to demonstrate experimentally the equation (1), although some authors (Panofsky) propose “thought experiments”, something surprising in an experimental science. In fact, the only “event” that occurs is the transmission of the electromagnetic wave, since the velocity,  $v$ , is given beforehand and is considered constant; in a more formal way, it is said the  $v$  represents a “boost” in the Lorentz Transformation (Group). Indeed, if we consider the four-dimensional space,  $(ct, \mathbf{r})$ , we could obtain from the equation of motion,  $dr = cdt + d\mathbf{r}$ , (2) the four-velocity,  $V$ :

$$V = dr/d\tau = cdt/d\tau + d\mathbf{r}/d\tau = cdt/d\tau + (d\mathbf{r}/dt)(dt/d\tau) = dt/d\tau(c + \mathbf{v}).$$

But  $V$ , as any four-vector it must comply with the quadratic condition and in that case we'll have:

$$V^2 = (c^2 - \mathbf{v}^2)/(1 - v^2/c^2) = c^2 \quad (3)$$

So, the numerical value of four-velocity is just the own speed of light!

Given this result and going to the parameters that define any wave, that is, the frequency,  $w = 2\pi/T$ , and wave number,  $k = 2\pi/\lambda$ , which in the case of light are related by  $c = w/k$  (4), the time dilation (1) will result in less frequency detected in  $(O)$ , ie, “redshift” radiation (Doppler Effect). Also, due to the constancy of  $c$ , to a smaller value of wave number ( $k$ ) corresponds a greater value from the moving frame  $(O')$ , which implies a shorter wavelength; this constitutes the so-called Lorentz “contraction”, which will affect the particles situated in  $(O')$  in the direction of movement thereof, ie, perpendicular to the wave direction. The so-called “proper time”,  $d\tau$ , is only applicable to the radiation emitted by the particle placed in  $(O')$ ; accordingly, the **kinematic** of the said particle **does not exist**, since velocity,  $v$ , relative to the fixed system  $(O)$  is constant and given a priori, and its only purpose is to influence the wave parameters. Actually, relativistic construction may be regarded as that of an observer, who placed in the fixed frame  $(O)$ , detects the emitted light wave from the moving one  $(O')$  as a projective image and vice versa.

### Dynamics

The reason for calling inertial to the moving frames  $(O')$  is for trying to justify the inertial or real mass,  $m_0$ , to particles placed there. In this sense, from  $m_0$  we could define the momentum,  $\mathbf{p} = m_0\mathbf{v}$ , as it is usual in Classical Mechanics; but in Relativity, we should take the four-velocity,  $V$ , according to (3), in which case we find the four-momentum,  $p$ :

$$p \equiv m_0 V = m_0 c^2 / \sqrt{(1 - v^2/c^2)} + m_0 \mathbf{v} / \sqrt{(1 - v^2/c^2)} \quad (5), \text{ where “time” term}$$

is energy:  $E = m_0 c^2 / \sqrt{(1 - v^2/c^2)} = mc^2$  (6), while the “space” term is momentum:  $\mathbf{cp} = m_0 \mathbf{v} / \sqrt{(1 - v^2/c^2)} = c\mathbf{mv}$  (7).

Following the relativistic prescription, four-momentum,  $p$ , is the new physical quantity that becomes the “interval” (dynamic) and therefore its square value should be constant. Apparently everything is correct, because if we apply the quadratic condition to the above expression and simplify:

$$p^2 = (m_0 c^2)^2 / (1 - v^2/c^2) - (c m_0 \mathbf{v})^2 / (1 - v^2/c^2) = [(c^2 m_0)^2 c^2 - (c^2 m_0)^2 v^2] / (c^2 - v^2) =$$

$$= (m_0 c^2)^2 \implies p^2 = E^2 - \mathbf{cp}^2 \equiv (m_0 c^2)^2 \quad (8).$$

But, surprisingly is an **identity!**, since the terms (6) and (7) disappear, so that the use of the use of the very repeated Energy formula:

$E = \sqrt{[c^2 \mathbf{p}^2 + (m_0 c^2)^2]}$  (9) as an **equation** is totally **inadequate**, because you can not use  $m_0 c^2$  at the same time that  $E = mc^2$  and  $\mathbf{p} = m\mathbf{v}$ .

Also, we can see that velocity,  $v$  once again disappears as happened with the four-velocity,  $V$ , so it is meaningless the claim that  $E = m_0 c^2$  happens when velocity or momentum are zero; therefore,  $m_0$  cannot be the rest or proper mass.

Moreover, an identity allowed to use of the terms, so the true formulas are for energy  $E = mc^2$ , while for momentum,  $\mathbf{p} = m\mathbf{v}$  and both, though related, can be applied to different situations, as we will see later.

The consequence is clear: it is **not possible a Relativistic Dynamic** and the “unifying” attempt between Electromagnetism and Classical Mechanics **fails**; thus, among other things, we solve the inconvenience of having to support two kind of masses: transverse and longitudinal.

Why the error persists?. Here are some reasons:

- 1) We believe that it is, because (8) has been used as  $E^2 - c^2 \mathbf{p}^2 = E'^2 - c^2 \mathbf{p}'^2$ , but in that case is overlooked that the constant  $(m_0 c^2)^2$  is known, so  $E'$  and  $\mathbf{p}'$  are redundant.
- 2) It also contributes the special case corresponding to the so-called “light cone” or “light-like” interval ( $v = c$ ), which is being considered as purely electromagnetic, where  $E = c\mathbf{p}$ , forcing to  $m_0 = 0$ , something impossible, since in that case  $E$  and  $\mathbf{p}$  also disappear.
- 3) We can also see some authors (Panofski, Möller, etc.) have worked to extract the dynamic properties from the Energy variation:  $dE/dt = \mathbf{v} \cdot d\mathbf{p}/dt = \mathbf{v} \cdot \mathbf{F}$  (work/time) =  $mc^2 + \text{cont.}$  and to justify this result it is defined the energy,  $mc^2$ , as a measure of “work content”; but such work would be “virtual”.
- 4) The series expansion being obtained:  $E = m_0 c^2 + 1/2 m_0 v^2 - \dots$  from energy formula (6), is a purely mathematical result without physical meaning, as there is an obvious contradiction (it is ascribed a speed,  $v$ , to  $m_0$ ) and the argument that Classical Mechanics is presented as special case of Relativity is not justified.

Besides, it is usually considered the energy change  $\Delta E = \Delta mc^2 = (m_2 - m_1)c^2$  (10).

Apart from the above, it arises by itself the question: how can any corporeal thing being endowed with "real or inertial" mass if that can not reach the speed of light?. The concept of "energy content" only may be understood with a **electromagnetic mass**, since the parameter  $c$  is not merely a constant, but acts as a speed, without any force; logically, this reasoning have to apply to the mass,  $m$ , but under the formula (6) is usually transferred to  $v$ , without realizing that it behaves as a parameter which dimensionally means nothing. In other words, referring to the expression  $m = m_0/\sqrt{(1-v^2/c^2)}$  we can only say that the relativistic mass,  $m$ , is variable and may increase or decrease depending on the value of  $v$ . For all these reasons, the only way to take these masses ( $m, m_0$ ) without incurring contradictions it is regarding it as an **electromagnetic** and **virtual** nature (not real or inertial). This "virtuality" is compatible with the **reality of energy**, as we are used to nowadays with stored images and sounds because of the powerful tools of internet; otherwise, how are we going to consider the so-called "cloud" provided with a inertial (weighted) mass?

## QUANTUM THEORY: A NEW VIEW

Quantum theory is based on clear ambiguity, since both the status of "particle" as "wave" overlap; hence, it arises the uncertainty principle, the wave function or Hilbert vector space, measurement problem, etc. Relativity is also installed on ambiguity, since the formulation of the same through the concept of "interval" actually involves the interaction between "radiation" (wave) and "particle" (charged) as it will be seen with Compton effect (scattering). Consequently, after having shown that Classical Mechanics was rule out, it appears as something natural the intended unification is achieved between Relativity and Electromagnetism; in other words, Relativity becomes relevant in Quantum Theory and thanks to the concept of "virtual" mass many results may be clarified avoiding many difficulties in understanding thereof.

### Photons:

Quantum Theory makes its appearance by the well-known equation of Planck:  $E = hv$  (11), as action quanta, to explain the energy curve of blackbody radiation, introducing the particles called **photons**; they are originated in the electromagnetic interaction through an indefinite exchange (like any "boson") and indistinguishable from each other like any quantum particle ("boson" or "fermion"). Could these particles have the same kind of mass required by Classical Mechanics?. As we explained above, we have solved this with the concept of "virtual" mass, which may be assigned as well to **photons**, specially after having shown that the "light-like" or "light cone" in the Minkowski diagram was unfeasible, because relativistic's construction can not accept situations as  $v = c$  and  $v = 0$ , in which cases everything (energy and momentum) disappears. We may associate mass  $m_0$  and therefore  $m$  to "photons", so it will be correct to put  $mc^2 = hv$  (12), giving consistency to the action quanta as a "particle". On the other hand, in accordance to (8),  $m_0c^2$  should be considered as a minimum energy, which may be linked to vacuum as it is done in Bose-Einstein equation on "bosons"; this situation

will also be adequate for radiation, ie. "photons". Besides, the virtual mass,  $m_0$ , is consistent with the existence of "virtual" photons that sometimes appears in Quantum Theory. But, it is important to note that the working of photons in the interactive process with charged particles such as electrons is through the energy,  $mc^2$  (not  $m_0c^2$ ).

### Electrons

The importance of "virtual" mass is consistent with electromagnetic phenomena, whose sources require only electric charge,  $q$ , as the fundamental parameter or physical magnitude, making the mass to "derive" from such charge. In that sense, electrons, like all subatomic particles have mass that usually comes expressed in electron-Volt (eV); this unit is based on  $eV \equiv mc^2$  (13), in which case the particle becomes a relativistic quantum particle being its charge,  $e$ , the essential parameter, while mass,  $m$  must be considered secondary, so that when we use eV units, mass has "no entity", ie, it is "virtual".

Why mass appears more relevant than charge?;

This is, because it is been used as rest mass,  $m_0$ , incorrectly, as it would be based on the alleged "equation" (9), which is nothing more than an identity and the velocity  $v = 0$  is forbidden; otherwise the whole relativistic construction will be vanished. For this reason we take the relativistic mass,  $m_e$ , as the measured value for the electron mass,  $m_e = 9.1 \times 10^{-31}$  kg that being variable it should not be considered as the essential magnitude; that value allows us to calculate 0.5 MeV and from there, thanks to expression (13), the electromagnetic magnitudes charge,  $e$ , and potential,  $V$ , turns out to be the quantities for determining the energy of electron at any moment. Thus, the concepts of "energy content" and "mass-energy equivalence" are both redundant; the only equivalence is represented by the expression (13), according to which the charge is constituted as the main physical quantity. In this regard two renowned authors (P.Roman and A. Messiah) referred to Dirac equation of the electron as of a charge,  $e$ ; this particle can not be displayed and remains as an abstract entity, having some problematic aspects. Actually, the discovery of the antielectron or positron was the most marked contribution of this equation, since it introduced the so-called "antimatter" in Modern Physics. On the other hand, the expression (13) acquires a true meaning when is attached to (12) and establishing the expression:  $eV = mc^2 = hv$  (14), where mass appears as "money change" (whose intrinsic value is zero) in the energy exchange that allows the electronic structure of the atom: the emission or absorption of photons occurs when any electron change its energy level ( $\Delta mc^2$ ), represented by the quantum numbers ( $n, l, l_x, s$ ). Besides, "virtual" mass is the only way to understand the existence of orbitals (not orbit) for electronic distribution of atoms, as well as for free electrons in the processes:

- Compton scattering:  $e_1^-$  (electron) +  $\gamma$  (photon)  $\rightarrow$   $e_2^-$  +  $\gamma'$
- Pair annihilation:  $e^- + e^+$  (positron)  $\rightarrow$   $\gamma + \gamma$
- Pair creation:  $\gamma + \gamma \rightarrow e^- + e^+$

These are represented by Feynman diagrams, which in fact are "didactic" resources; in those conservation of

momentum is applied, but from a relativistic point of view in the end it comes down to that of energies. Actually, in the first case (a), the radiation (photon) experienced a decrease in its energy, whereas the particle (electron) increased its momentum,  $\mathbf{p}$ , which corresponds an increase of energy as follows from the "identity" (8). But if we consider the De Broglie formula,  $p = \hbar k = h/\lambda$  (15), which includes "duality wave-corpuscule" through wave number,  $k$ , so that a decrease in frequency,  $-\hbar\Delta w$ , for **radiation** requires an increase of energy for **electron**, which as a "particle" set to  $\Delta mc^2 = e\Delta V$  and as a "wave",  $\hbar\Delta k = \hbar\Delta w$ .

Finally, to apply the expression (14) we get:

$$m_1c^2 \text{ (or } \hbar k_1) + \hbar v_1 \text{ ---} \rightarrow m_2c^2(\hbar k_2) + \hbar v_2 \text{ ===} \Rightarrow e\Delta V = (m_2 - m_1)c^2 = -h(v_2 - v_1).$$

### Protons

Proton turns out to be the most stable of compound particles or hadrons and as such may be considered the starting point to form the "matter"; in other words, it turns out to be the cornerstone on which lifts the material world, whose consistency must be supported in its **real** or **inertial mass**. This **mass** is produced by **strong interaction**; without going into details, it is known that quarks  $u$ ,  $u$ ,  $d$ , are the components of the proton,  $p$ , supplying its charge:  $q_p = +2/3 + 2/3 - 1/3 = +1$ , but the masses associated with quarks (elementary particles) are "virtual", so the proton mass,  $q_p = 839.2$  MeV is due to the "interactive network" that causes the strong force through the gluons, which together with the so-called confinement does not allow to quarks of going outside. Thus, it is achieved the compactness any massive body demands, since inertial needs structure; otherwise, how could be produced the internal forces, without which that can not exist?. (E. Mach, obsessed for overcoming the absolute concepts of space and time in newtonian physics attributed to centrifugal force of the rotation of the Earth a "true" existence, when it is nothing more than a fictitious force introduced didactically). (Our paper: "Stars: a new approach"). On the other hand, as a particle, proton becomes the turning point between the actual or inertial mass subject to Classical Mechanics and virtual mass requiring by Quantum Theory; hence, it can be considered from two point of view:

- Given that the measurement of the proton mass is similar to the electron, ie. being derived from electromagnetic quantities, may be considered as "virtual" when is expressed in eV units and as such, subject to relativistic energy,  $E = mc^2$ ; thanks to the "variability" of  $m$  it is possible to explain the enormous energies involved in nuclear reactions, as well as in strong and weak interactions.
- As the cornerstone to build atomic nuclei and its value,  $m_p = 1.67 \times 10^{-24}$  g corresponds to the atomic mass unit (amu), in which case it should be constant in consonance with the mass conservation law (Lavoisier) in Chemical reactions and with the requirement of Classical Mechanics.

### Atomic nuclei

Atomic mass unit (amu) is defined as 1/12 of the carbon-12 ( $C^{12}$ ) mass, so that protons and neutrons mass must be equal; therefore, it turns out confusing the indiscriminate

use of amu and eV units as it is usually given in Nuclear Physics literature. The fact that the neutron mass,  $m_n = 939.5$  MeV, in Particles Physics is higher than the proton is not against our interpretation of being electromagnetic and virtual as we have arguing; in this way, we can explain that the "beta decay" is produced thanks to the electromagnetic mass difference between neutrons and protons:  $n \text{ ---} \rightarrow p + e^-$  ( $\beta^-$ ), occurring spontaneously, since the neutron has a higher energy level than the proton, while the reverse process:

$p \text{ ---} \rightarrow n + e^+$  ( $\beta^+$ ), requires an energy input to proton.

Moreover, "baryons" (protons, neutrons) are firmly united in the atomic nucleus through **weak interaction**, which is described by the so-called Gauge Symmetry that takes place around the charge and not the mass, confirming our point of view. The forces involved are produced as an exchange of "bosons", called Gauge Particles ( $W^-$ ,  $W^+$ ,  $Z^0$ ); they have high energy (80-90 GeV) originated by potentials and charges (weak), so the associated masses are "virtual". Higgs Mechanism, introduced in order to give relevance to mass, becomes unnecessary, although may be consistent with our interpretation. (Our article: Charge in Quantum Theory") Due to such highly energies, the said particles should not leave the nucleus, so this may be configured as an inner space, where also may contain "neutrinos" and "antineutrinos", without going to the exterior or ordinary space. For this reason, we have deliberately omitted such particles in "beta decay". (Our article: "Elementary Particles: a new approach").

### Tachyons and positrons.

Without getting into Dirac equation and his ingenious solution over the existence of **positrons**, we can do it directly through the Energy quadratic expression,  $E^2 - c^2\mathbf{p}^2 \equiv (m_0c^2)^2$  and admitting the possibility of a negative energy. ie,  $E = -m_0c^2$ , which corresponds to those particles. This situation corresponds to a negative interval, ie,  $ds < 0$ , which imply a negative time or "absolute past". The existence of the positron as an experimental fact, forced to admit this negative energy with the condition that the "charge" was positive, apparently a set of quantum "engineering", but for us is a further proof of the relevance of the charge over the mass. The special interpretation of Feynman on **antiparticles**, according to which they are moving to the past, ie, time reversal (T) is in line with the acceptance of the "absolute past", which together with the so-called charge conjugation (C), it shows the the parity (P) should not change, that is, positron spin is the same that of the electron, 1/2, since swinging each other ( $e^+ \text{ ---} \rightarrow e^-$ ) change C and T, according to CPT Symmetry to which are subjected quantum particles. Thus, it follows the spin of photon is 1, as can be obtained in the process, Pair Annihilation:  $e^+ + e^- \text{ ---} \rightarrow \gamma + \gamma$ . Here is another aspect we think has gone unnoticed: it is the so-called **tachyon** particles that move at a speed greater that of light,  $v > c$ . If this is possible, it happens a situation similar to that of antiparticles in the energy expression (9), but now we will have  $-(m_0c^2)^2 = m_0c^2i$  that is, an imaginary result, since the term momentum,  $c\mathbf{p}$  must be superior to that of Energy,  $E$ . But, it possible to avoid that, if we go back to the starting point of relativistic formulation, that is, to the equation (1),

but assuming that  $v' > c$ , with which the interval  $ds = cd\tau$  will be now:

$$v'^2 dt^2 - c^2 d\tau^2 = (v'^2 - c^2) dt^2 = c^2 d\tau^2 \implies dt = d\tau / \sqrt{(v'^2/c^2 - 1)} \quad (17)$$

which clearly differs from equation (1), since in this case it turns out a "contraction" instead of "dilation" time; we can see that initially  $dt = \infty$  for  $v' = c$ , but decreases as  $v'$  increases to reach the maximum velocity,  $v' = \sqrt{2}c$ , in which case you can get

$dt = d\tau = \text{const.}$  as prescribed by relativistic theory.

When the above approach is transferred to energy and momentum, these should be

$E = m_0 c^2 / \sqrt{(v'^2/c^2 - 1)}$  (18) and  $\mathbf{p} = m_0 \mathbf{v}' / \sqrt{(v'^2/c^2 - 1)}$  (19) and then, we can get the "identity" equivalent to (8):

$$c^2 \mathbf{p}^2 - E^2 = c^2 (m_0 v')^2 / (v'^2/c^2 - 1) - (m_0 c^2)^2 / (v'^2/c^2 - 1) \equiv (m_0 c^2)^2 \quad (20).$$

It turns out curious the evolution of energy, since initially has a very high, near infinity value and it will be decreasing until reaching a constant minimum,

$$E = m_0 c^2, \text{ when } v' = \sqrt{2} c.$$

But the surprise comes when we perform the sum of energy-momentum of tachyon with that of electron:

$$(c^2 \mathbf{p}^2 - E^2)_{\text{tachyon}} + (E^2 - c^2 \mathbf{p}^2)_{\text{electron}} =$$

$$= c^2 (m_0 v')^2 / (v'^2/c^2 - 1) - (m_0 c^2)^2 / (v'^2/c^2 - 1) + (m_0 c^2)^2 / (1 - v^2/c^2) - c^2 m_0^2 v^2 / (1 - v^2/c^2) =$$

$$= (m_0 c^2)^2 + (m_0 c^2)^2 = 2(m_0 c^2)^2 \quad (21).$$

The equivalence to the process Pair annihilation:  $e^+ + e^- \rightarrow \gamma + \gamma$ , it would appear as evident if (21) were just satisfying CPT symmetry. Certainly, after parity conservation (P), ie, spin (s), charge conjugation (C) may be explained with the changes made at (20) in relation to (8), which allows to consider  $\mathbf{p} \rightarrow -\mathbf{p}$ , ie. a negative velocity ( $v' < 0$ ), compatible with relativistic formulation, either (1) or (17). Such speed,  $v'$ , should correspond to the positively charged Positron, according to Lorentz force,  $\mathbf{F} = q(-\mathbf{v}') \wedge \mathbf{B} = (-q)\mathbf{v}' \wedge \mathbf{B}$ ; finally, the time reversal (T) is contemplated by the change of velocity sign. So, **positrons** are behaving as **tachyons** and more generally:

### **Tachyons and Antiparticles are identical!**

Assuming positrons the characteristic of tachyons, it is possible to clear the issue with "super-luminal" electrons, ie.  $v' > c$ , appearing in some recent studies. Besides, equal masses of positrons mass and electrons should correspond to that of the energy, E, of tachyons and electrons:  $m_0 c^2 / \sqrt{(v'^2 - 1)} = m_0 c^2 / \sqrt{(1 - v^2/c^2)} \implies v'^2 + v^2 = 2c^2$ , which is the condition for producing positrons and electrons under the equivalence with the process: Pair creation:  $\gamma + \gamma \rightarrow e^+ + e^-$ . Finally, such condition requires a high energy for the occurrence of those particles and also if we consider the variation of energy with respect to  $v$  and  $v'$  for electrons and tachyons (positrons) respectively, is of a much more

limited sequence for positrons; therefore, their existence is just casual.

## CONCLUSION

It was carried out a detailed analysis of Relativity and although it has been demonstrated the impossibility of the Unification of Electromagnetic Theory with Classical Mechanics, is viable its insertion into Quantum Theory, on account of the concept of virtual mass, which is perfectly consistent and appropriate for particles and radiation subject to this theory, radically different from the real or inertial masses of Classical Mechanics and Gravitation. In this line, we have performed a complete dissection of the conjunction of baryons or nucleons (protons, neutrons) provided with real or inertial masses as compound particles, with the virtual mass thereof, which also possess electrons, positrons and photons in its condition of being elementary particles (without structure). After including Tachyons around the previous game and submit them to their special behaviour from the relativistic point of view, we have found the unexpected: these particles may be identified with antiparticles. In this way, we can overcome something that our mind refuses to admit: the existence of negative energy and consequently of antimatter in a real Universe. Also, we show that antiparticles can not follow the same physical behaviour of particles; otherwise, those should appear as frequent as these.

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