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The Conservation of Energy and Momentum in the Positron-Electron Annihilation According to Complete Relativity

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ABSTRACT

According to Complete Relativity (an improvement of Special Relativity where a new postulate was introduced: an electron cannot move at average speeds less than $u_0 = \alpha c / \pi$ where α is the constant of fine structure and c is the speed of light), and with the hypothesis that the electron and positron are two three-dimensional electromagnetic spherical standing waves, the electromagnetic standing waves of an electron-positron pair can overlap in the low energy conditions and generate a single γ ray of $E = 1.022$ MeV. Instead the actual physical theories consider a model of positron-electron pair annihilation, where conservation of momentum requires the creation of two 511 keV photons moving toward opposite directions. But in the paper we do not consider any photons: there is only a progressive electromagnetic wave compound by two electromagnetic standing waves. Only a thorough test will be able to decide the right model.

Indexing terms/Keywords

Complete relativity; Electron model in three-dimension; Positron model in three-dimension; Positron-electron annihilation; Conservation of momentum; Conservation of energy

Academic Discipline And Sub-Disciplines

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SUBJECT CLASSIFICATION

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INTRODUCTION

In 1981 I studied computer hard disc vibrations using the mathematic bi-Laplacian operator. The mathematical solution of this activity was published on TI Journals in the paper: *Vibrational Modes of Thin Flat Circular Plates Calculated Using the Dynamic bi-Laplacian Equation* [1]. During my research I asked myself: *Can I simulate the atomic nucleus with a solid sphere and study it with the bi-Laplacian operator in polar coordinates?* Hence, a new idea in Fundamental Physics, where particles are considered as electromagnetic spherical standing waves, was developed in five articles.

The first considers the Dynamic bi-Laplacian Equation, in order to calculate the Magic Numbers of atomic nucleus [1]. On July 2009 the paper entitled: *The dynamic bi-Laplacian Equation in polar coordinates and the magic numbers of atomic nucleus* [2] was published online on the Physics Essays website. The focal point of considering electrons, atoms and atomic nuclei as a superimposition of e.m. standing waves, is a modification of Einstein's Special Relativity. In accordance with Appendix B of [2], I introduced a new postulate: an electron cannot move at average speeds less than $u_0 = \alpha c / \pi$ where α is the constant of fine structure and c is the speed of light. The postulate characterizes the Complete Relativity Theory.

The hydrogen atomic model founded on the electromagnetic standing waves [3]. This paper proposes a new three-dimensional electron model. The electron model [$\psi(r,t)=(\sin(kr)/r)\cos(\omega t)$] criticizes the electric charge notion. In reality the innermost spherical nodal surface of the electron (that corresponds to the first root of $\sin(kr)/r$) is surrounded by other concentric nodal surfaces (that correspond to the other roots of $\sin(kr)/r$). According to Einstein's formula $E = mc^2$, the energy of the e.m. standing wave (averaged over time) in the innermost sphere, has an equivalent in mass. Moreover, the averaged energy of the e.m. standing wave of the electron outside this sphere can be considered to be generated by an equivalent electric charge stored on the innermost spherical nodal surface. So the innermost sphere can be considered as a spherical particle: the electrically charged electron. Then the electric charge would only be an ideal concept (averaged over the time period of the e.m. wave). The best physical result in [3] is the calculation of the fundamental spectral frequency of the molecular Hydrogen. Another important result can be achieved by considering the energy function of the electron:

$$E_0(r) = m_e c^2 \left[1 - \frac{\sin\left(\frac{2\alpha^2}{\pi r_e} r\right)}{\frac{2\alpha^2}{\pi r_e} r} \right] \qquad (1)$$

We can interpret $E_0(r)$ as the total energy of the e.m. standing wave of the electron inside a sphere of radius r concentric with the electron. Then $E_0(r)$ can represent the potential energy of the electron at a distance r from the centre. So then its derivative represents the field of forces in accordance with the value of the vector radius r. Instead deriving the function $E_0(r)$ of the positron, we can conclude that at the centre of the positron there is an impulse function of force. Then between the electron and the positron, both their structures are completely asymmetric. Nevertheless at great distance they appear symmetric.

The Hydrogen Atomic Model Based on the Electromagnetic Standing Waves and the Periodic Classification of the Elements [4]. This paper shows a new Periodic Classification of the Elements which differs from the current Classification for the heavy elements of VI and VII Period (see Table 1). His organization is according to the fractal form of the atoms. In the new Classification, Ytterbium can be seen as a useful element for the cold fusion tests. Furthermore, a new phenomenon appears: a new set of e.m. theoretical (albeit unsteady) wavelengths of Hydrogen spectrum. Should this phenomenon be revealed, then it would confirm the proposed Fundamental Physics Theory that was named Electromagnetic Atomic Theory (EAT).

Table 1. New periodic classification of the elements.

Adapted from Table 4 of [4]

H																															He
Li	Be																									B	C	N	O	F	Ne
Na	Mg																									Al	Si	P	S	Cl	Ar
K	Ca							Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn									Ga	Ge	As	Se	Br	Kr
Rb	Sr							Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd									In	Sn	Sb	Tc	I	Xe
Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lw	Ku	Ha													

[1] The Magic Numbers are the atomic numbers of the nuclei with special properties of stability. They are: Helium (2), Oxygen (8), Calcium (20), Tin (50) and Lead (82 protons , 126 neutrons) .

The Doppler Effect according to complete relativity [5]. This paper highlights the zone of the e.m. spectrum (from the γ-rays to X-rays) covered by the Doppler effect applied to the γ-ray of 1.022 MeV produced by a positron-electron superimposition. We analyze the Doppler effect in Complete Relativity when the wave front moves away from the observer. When the p/e pair moves in relation to the relativistic observer with a ratio $\beta > 0.5774$ we observe an inversion of the normal behaviour: instead of an increase in the wavelength of the e.m. radiation, we can observe a decrease in the wavelength. In addition, when the p/e pair moves away at round the speed of light, we can observe a blue shift due to the relativistic addition of the speeds. Furthermore, the paper shows a new way of considering the photoelectric effect.

Finally in *The ideas behind the Electromagnetic Atomic Theory* [6] some ideas are indicated in order to develop the Electromagnetic Atomic Theory. In the paper a new vision of the Cosmos is discussed.

THE POSITRON – ELECTRON ANNIHILATION

We consider the electromagnetic (e.m.) spherical standing wave of a positron [$\psi(r,t)=(\cos(kr)/r)\sin(\omega t)$]. Into a sphere of radius r (the origin O of r is the centre of positron) total energy $E_0^+(r)$ of positron is worthy:

$$E_0^+(r) = m_e c^2 \left[1 + \frac{\sin\left(\frac{2\alpha^2}{\pi r_e} r\right)}{\frac{2\alpha^2}{\pi r_e} r}\right] \quad (2)$$

where: α = constant of fine structure , r_e = electron radius ;

r_e is a value obtained by the following Eq. (3) (see Appendix B of [2]):

$$\frac{1}{2}\left[\frac{e^2}{4\pi\varepsilon_0 r_e}\right] = m_e c^2 \quad (3)$$

where: e = electron charge ε_0 = vacuum permittivity m_e = electron mass c = speed of light

On the other hand, total energy $E_0^-(r)$ of the e.m. spherical standing wave of electron into a sphere of radius r (the origin O' of r is the electron centre) is worthy:

$$E_0^-(r) = m_e c^2 \left[1 - \frac{\sin\left(\frac{2\alpha^2}{\pi r_e} r\right)}{\frac{2\alpha^2}{\pi r_e} r}\right] \quad (4)$$

Eq.(2) and Eq.(4) are gained in [3] (p. 366) .

We can consider a gap ($a + b$) = (|O'P| + |PO|) between the electron and positron (see Figure 1). A new orientated r axis joins the electron centre O' to the positron centre O ; its origin is in the point P . Electron is moving with the speed $u^- = \beta_2 c$ toward the positron and in accordance with the new r axis. Positron is moving in the opposite direction with the speed $u^+ = \beta_1 c$.

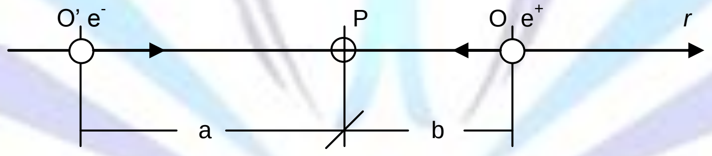

Figure 1 - Sketch of the electron (e^-) positron (e^+) pair annihilation with a creation of a γ ray.

According to Complete Relativity, Eq. (2) becomes:

$$E_0^+(r-b) = \gamma_1 m_e c^2 \left[1 + \frac{\sin\left(\frac{2\alpha^2}{\pi r_e}(r-b)\right)}{\frac{2\alpha^2}{\pi r_e}(r-b)}\right] \quad (5)$$

where:

$$\gamma_1 = \frac{1}{\sqrt{1+\left(\frac{\alpha}{\pi}\right)^2 - \beta_1^2}} \quad (6)$$

whereas Eq. (4) becomes:

$$E_0^-(r+a) = \gamma_2 m_e c^2 \left[1 - \frac{\sin\left(\frac{2\alpha^2}{\pi r_e}(r+a)\right)}{\frac{2\alpha^2}{\pi r_e}(r+a)}\right] \quad (7)$$

where: $$\gamma_2 = \frac{1}{\sqrt{1+\left(\frac{\alpha}{\pi}\right)^2 - \beta_2^2}} \qquad (8)$$

Immediately before the perfect superposition of the two e.m. spherical standing waves of electron and positron, total energy $E_{T0}(r)$ of the e.m. standing wave formed by them is worthy:

$$E_{T0}(r,a,b) = E_0^+(r-b) + E_0^-(r+a) = m_e c^2 \left\{ \gamma_1 \left[1 + \frac{\sin\left(\frac{2\alpha^2}{\pi r_e}(r-b)\right)}{\frac{2\alpha^2}{\pi r_e}(r-b)} \right] + \gamma_2 \left[1 - \frac{\sin\left(\frac{2\alpha^2}{\pi r_e}(r+a)\right)}{\frac{2\alpha^2}{\pi r_e}(r+a)} \right] \right\} \qquad (9)$$

We study the case whose conditions are: $\gamma_1 = \gamma_2 = 1$ and $(a, b) \rightarrow 0$. Then Eq. (9) is converted into:

$$E_{T0}(r,a,b) = 2m_e c^2 \qquad (10)$$

In the same conditions of the energy calculation [$\gamma_1 = \gamma_2 = 1$ and $(a, b) \rightarrow 0$], we can write the differential of momentum dQ as:

$$dQ = u_1(dm^+ + dm^-) = \beta_1 c(dm^+ + dm^-) = \frac{\alpha}{\pi} c(dm^+ + dm^-) \qquad (^2) \qquad (11)$$

where:

$$dm^+ = \frac{\frac{d[E_0^+(r-b)]}{dr}dr}{c^2} = \frac{m_e}{(r-b)} \left\{ \cos\left(\frac{2\alpha^2}{\pi r_e}(r-b)\right) - \frac{\sin\left(\frac{2\alpha^2}{\pi r_e}(r-b)\right)}{\frac{2\alpha^2}{\pi r_e}(r-b)} + 2(r-b)\delta(r-b) \right\} dr \qquad (12)$$

being $\delta(r-b)$ the impulse function of Dirac. It is important to have $\delta(r-b)$ into Eq. (12), in order to obtain Eq. (5) with $\gamma_1 = 1$ if we integrate Eq. (12) from b to r.

$$dm^- = \frac{\frac{d[E_0^-(r+a)]}{dr}dr}{c^2} = -\frac{m_e}{(r+a)} \left\{ \cos\left(\frac{2\alpha^2}{\pi r_e}(r+a)\right) - \frac{\sin\left(\frac{2\alpha^2}{\pi r_e}(r+a)\right)}{\frac{2\alpha^2}{\pi r_e}(r+a)} \right\} dr \qquad (13)$$

Into Eq. (12) and Eq. (13) the functions $\frac{d[E_0^+(r-b)]}{dr}$ and $\frac{d[E_0^-(r+a)]}{dr}$ are the energy densities of the e.m. standing waves of positron and electron that move with the minimum speed $u_1 = \alpha c / \pi$.

Using Eq. (12) and Eq. (13) then Eq. (11) becomes:

$$dQ = \beta_1 c 2 m_e \delta(r-b) dr = F dt \qquad (14)$$

When the p/e pair tends to overlap, then $b \rightarrow 0$ and $\delta(r-b) \rightarrow \delta(r)$

$$Q = \int_0^{\varepsilon_t} F dt = F\varepsilon_t = \beta_1 c 2 m_e \int_{-\infty}^{+\infty} \delta(r) dr \qquad (15)$$

Since $\varepsilon_t \rightarrow 0$ and the last member of Eq. (15) is a finite real number, then the force F tends to infinity. But this is the condition for a collision between the positron and the electron. Since the force F tends to infinity, also the acceleration of the positron-electron pair tends to infinity when $\varepsilon_t \rightarrow 0$; then the speed u_1 tends to the maximum value possible: the speed of light c. Then $\beta_1 \rightarrow 1$, and during the collision of the e/p pair, Eq. (15) becomes:

$$Q = 2m_e c \qquad (16)$$

being: $\int_{-\infty}^{+\infty} \delta(r) dr = 1$

Then the two e.m. standing waves of the electron and positron modify suddenly their status and transform themselves in a γ ray of 1.022 MeV. Energy and momentum of the e.m. progressive wave created by the annihilation of the p/e pair are worthy:

$$E = h\nu = 2m_e c^2 \qquad Q = \frac{h\nu}{c} = 2m_e c \qquad (17)$$

On the other hand, since:

$$\lim_{\substack{r\to 0 \\ b\to 0}} E_0^+(r-b) = 2m_e c^2 \qquad \lim_{\substack{r\to 0 \\ a\to 0}} E_0^-(r+a) = 0 \qquad (18)$$

the γ ray direction is in agreement with positron velocity.

[2] In accordance with Classic Mechanics and with Figure 1, during an elastic collision between two bodies, momentum is espressed by the equation: $Q = m_1 v_1 - m_2 v_2$ where: m_1, $m_2 > 0$. In our case, in accordance with Einstein formula $E = mc^2$ the following Eq.(12) and Eq.(13) show two opposite mass densities equivalent to the correspondent energy densities: where Eq.(13) is negative (positive), the analogous part in Eq.(12) is positive (negative). This reflection gives explanation for the plus sign in Eq.(11).

CONCLUSIONS

The paper is a study of the annihilation of an electron-positron pair according to the electron and positron models based on the e.m. standing waves and to Complete Relativity. We achieved that in the low energy conditions the electron-positron overlap generates only a γ-ray of 1.022 MeV. Yet nowadays Physicists think that the positron-electron annihilation creates two photons of 511 keV moving toward opposite directions. They obtain this result considering the e/p pair two physical points with opposite electric charge. But the atomic model based on the e.m. standing waves considers the electric charge only an equivalent concept (see [3] p. 365) . Moreover, in order to simulate the electron and positron, the paper makes use of two different three-dimensional models. So, in the low energy conditions, conservation of momentum in the positron-electron annihilation allows (unconventionally) to calculate a single γ-ray of 1.022 MeV. If by a thorough test we will be able to verify this result, we will have made a worthy experimental contribution in order to validate the electron and positron three-dimensional models of EAT.

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Author' biography

Giuseppe Bellotti graduated from Politecnico of Turin as Nuclear Engineer (102/110 , 1980) and worked in the Research and Development Department of Olivetti. He earned a Baccellierato in Philosophy from Facoltà Teologica of Lugano (CH) (Summa cum Laude, 2001). His research interests are Fundamental Physics, Mathematics and Structural Analysis. He published eight articles in International Journals: on PHYSICS ESSAYS (*An International journal dedicated to fundamental questions in Physics*): Set. 2009, **22** , (268) *The dynamic bi-Laplacian Equation in polar coordinates and the magic numbers of atomic nucleus*; Set. 2011, **24**, (364) *The hydrogen atomic model founded on the electromagnetic standing waves*; Set. 2012, **25**, (315) *The Doppler Effect according to complete relativity*; on APPLIED PHYSICS RESEARCH (*Published by Canadian Center of Science and Education*): Aug. 2012, Vol 4, No. 3, (141) *The Hydrogen Atomic Model Based on the Electromagnetic Standing Waves and the Periodic Classification of the Elements*; on CSCANADA (Canadian Research & Development Center of Science and Cultures): Dic. 2012 Advances in Natural Science Vol. 5 No. 4 (7-11) *The ideas behind the Electromagnetic Atomic Theory*; Dic. 2012 Management Science and Engineering Vol. 6 No. 4 (149-159) *Stress Analysis Non Standard of Curved Beams*; on TI JOURNALS: Jun. 2013 International Journal of Engineering Sciences Vol. 2 No 6, (250-258) *Vibrational Modes of Thin Flat Circular Plates Calculated Using the Dynamic bi-Laplacian Equation*; Jul. 2013 World Applied Programming, Vol 3, No 7, (287-292) *Fermat's Demonstration of His Last Theorem.*