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The Positronium and Mass-energy Equivalence

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Abstract
The positronium consists of two oppositely charged particles of the same mass m and intrinsic energy 'E'. A positron of charge +e and an electron of charge -e, revolve diametrically, under mutual attraction, at equal radius, round their center of mass. The revolution is in unclosed elliptic paths with radiation or a closed circular orbit without radiation. The positron or electron is considered to be an impregnable spherical shell of radius a and mass m as a constant equal to the rest mass 'M'. with electrostatic field Eo and energy density (ε/2)Eo^2, in space. The particles may combine, with centers 2a apart, without annihilating, emitting radiation of energy 'E', equivalent to m, to form a dipole, a neutral particle called 'unitron' of intrinsic energy 'E' and mass m. The 'unitron' has negative potential energy -'E', according to a mass-energy equivalence law. The positron, electron and 'unitron' are the basic building blocks of matter.

Keywords: Electric Charge, Dipole, Electron, Energy, Field, Mass, Positron, Radiation, Radius, Revolution, Velocity

Introduction

Stjepan Mohorovičić, the Croatian physicist, predicted the existence of positronium in a 1934. The positronium was experimentally discovered by Martin Deutsch at MIT in 1951 [1]. Many subsequent experiments have precisely measured the properties of the positronium. It was found to be an unstable system consisting of an electron and positron revolving diametrically, under mutual attraction, round their common centre of mass, like the hydrogen (protium) atom [2].

In 1838, British natural philosopher Richard Laming introduced the concept of an indivisible quantity of electric charge. Irish physicist George Johnstone Stoney named this charge 'electron' in 1891. The great physicist J. J. Thomson and his team of British physicists identified the electron as a fundamental particle, in 1897 during the cathode-ray tube experiment [3].

The antiparticle of the electron is the positron. The positron has the same mass as the electron, but carries an equal positive charge. Discovery of the positron was credited to Carl David Anderson, during an experiment with Wilson Cloud chamber, on 2nd August 1932, for which he was awarded the Nobel prize in 1936 [4].

In "A Dynamical Theory of the Electromagnetic Field" in 1865, the famous Scottish mathematician and physicist, James C. Maxwell gave the speed of electromagnetic wave, same as the speed of light in a vacuum, as:

$$c = \sqrt{\frac{1}{\mu_o \varepsilon_o}} \tag{1}$$

where μ_o is magnetic permeability and ε_o electric permittivity of space. This speed is maximum for a charged particle losing potential energy in acceleration by an electric field.

This paper proposes that the electron and positron of the positronium revolve round their centre of mass, with emission of radiation, at slightly increasing frequency of revolution, exhibiting *fine structure* before settling in a stable circular orbit [5]. It is shown that the positronium does not annihilate on collapsing, but becomes a dipole, a neutral particle of rest mass mo, in accordance a mass-energy equivalence law [6, 7].

Mass-energy Equivalence Law

The author derived a "mass-energy equivalence law", for mass m of a particle, equal to the rest mass 'm_o', a constant independent of speed v, as [7]:

$$E_n = \frac{1}{2} m_o c^2 \tag{2}$$

This differs from the relativistic equation, $E_n = mc^2$, where m depends on speed v, said to have been derived by H. Poincarè, but claimed by A. Einstein [3]. Actually, equation (2) is easily derived for a particle of rest mass mo moving with speed v, relative to an observer. Total energy E of a particle, intrinsic E_n and kinetic ½ $m_o v^2$, is:

$$E = E_n + \frac{1}{2} m_0 v^2 \tag{3}$$

The energy En cannot be zero, neither can it be infinitely large. The only reasonable and natural value, E_n can assume in equation (3), without the speed of light c being exceeded, is E_n = ½ $m_o c^2$. In this case, equation (3) becomes:

$$E = E_n + \frac{1}{2} m_0 v^2 = \frac{1}{2} m_0 c^2 + \frac{1}{2} m_0 v^2 = \frac{1}{2} mc^2$$

$$m = m_0 \left(1 + \frac{v^2}{c^2} \right) \tag{4}$$

where m is the equivalent mass, dependent on speed v, relative to an observer.

Configuration of Positron and Electron

If a positron of charge $+e$ or electron of charge -e is to assume any configuration, it is likely to be an impregnable spherical shell of radius a with electrostatic field $\mathbf{E}_o$ extending from a, reducing to zero at infinitely long distance from the charge. The intrinsic or electrostatic energy En, is given by volume integral:

$$E_n = \frac{\varepsilon_o}{2} \int_V E_o^2 (dV) = \frac{\varepsilon_o}{2} \int_a^\infty \left(\frac{e}{4\pi\varepsilon_o r^2} \right)^2$$

$$\left(4\pi r^2\right)(dr) = \frac{1}{2\varepsilon_o} \int_a^\infty \left(\frac{e^2}{4\pi r^2} \right)(dr) = \frac{e^2}{8\pi\varepsilon_o a} \tag{5}$$

Equations (2) and (5) give mass m in terms of electric charge e, as:

$$E_n = \frac{1}{2} m_o c^2 = \frac{\mu_o e^2}{8\pi a} \tag{6}$$

Equations (1) and (6) give the rest mass mo, of the electron or positron, a fundamental particle of matter, as:

$$m_o = \frac{\mu_o e^2}{4\pi a} \tag{7}$$

The intrinsic energy E_n is contained in the electrostatic field $\mathbf{E}_o$, but it can be expressed in terms of the charge e (equation 5) or the rest mass mo (equation 2).

Potential Energy of Two Electric Charges

Figure 1 shows a stationary (relative to an observer) isolated electric charge Q with radial electric fields $\mathbf{E}_o$ and straight lines of force. In Figure 2, for two stationary unlike-electric charges, distance r apart, under a pulling force **F** of attraction, the lines of force, particularly the lateral ones, are curled. The arrows indicate the direction of force on a positive charge, a negative charge is pulled in opposite direction of the arrows.

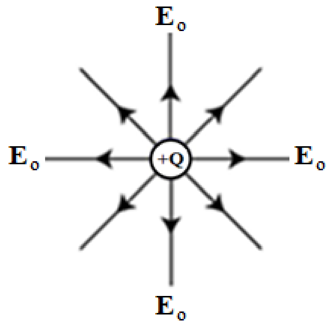

Figure 1: An isolated charge with radial electrostatic field $\mathbf{E}_o$, equivalent mass m_o and intrinsic energy E_n = ½ $m_o c^2$

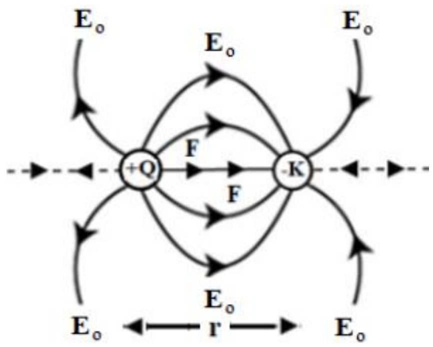

Figure 2: Two unlike-charges Q and $-K$, distance r apart, under force of attraction **F**, with total energy $2E_o - QK/4\pi\varepsilon_o r = m_o c^2 - QK/4\pi\varepsilon_o r$

In Figure 1, energy of the electric charge is contained in its electrostatic field E_o, as expressed in equation (5). In Figure 2, energy W of two unlike-charges, Q and K, distance r apart, as contained in the curled fields, is:

$$W = m_o c^2 - \frac{QK}{4\pi\varepsilon_o r} \tag{8}$$

Figure 2 may be a positronium, where $+Q = +e$ *and* $-K = -e$, with the two particles, as impregnable shells of radius a, revolving in a circle of radius $r/2$, where e is the magnitude of electronic charge.

Combination of Positron and Electron

A positronium collapses, with emission of radiation, to form a dipole, a neutral body of two particles with the centers $2a$ apart as shown in Figure 3. Energy of the combination is given by equations (7), with $r = 2a$, thus:

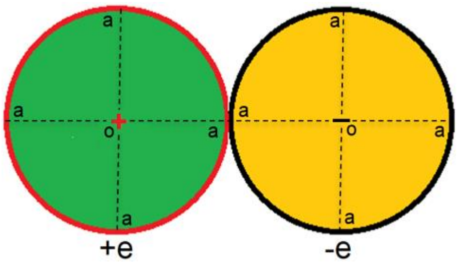

Figure 3: Positron of charge +*e*, mass *m* and electron of charge -*e*, mass *m*, combining with centers 2*a* apart to form a neutral particle of mass *m*

$$W = m_o c^2 - \frac{QK}{4\pi\varepsilon_o r} = m_o c^2 - \frac{e^2}{8\pi\varepsilon_o a} \qquad (9)$$

Equation (6) and (7) give:

$$W = m_o c^2 - \frac{e^2}{8\pi\varepsilon_o a} = m_o c^2 - E_n = E_n \qquad (10)$$

Results and Discussions

- Equation (7), with e as a constant, makes mass m also a constant, equal to the rest mass mo, independent of speed of a particle, relative to an observer.
- A positronium of mass 2m does not annihilate but collapses to a neutral particle, 'unitron', of mass m.
- The energy of an electric charge e, of mass m, is contained in its electrostatic field Eo and may be expressed in terms of the charge or mass , in accordance with a mass-energy equivalence law.
- The positron of charge +e and the electron of charge -e are the fundamental particles of matter.
- The positron of charge +e and mass m, the electron of charge -e and mass m and the 'unitron' of zero charge and mass m, are the basic building blocks of matter.
- Atomic particles are of charge +*e* (mass *m*) or -*e* (mass *m*) and total mass as sum $2m\sum_{n=1}^{N} n = Nm(N+1)$, where m is the electronic mass and n = 1, 2, 3…..*N*. For the positronium n = 1 and mass = 2*m*. For the protium, mass is *Nm*(*N* + 1) = 1836*m*, making *N* = 42.35, as the number of orbits in the protium isotope of the hydrogen atom. This number, which should be an integer, 42 or 43, is reasonable.

Conclusions

- The paper has shown that the positronium of mass 2m does not annihilate on collapsing but turns into a neutral particle of mass m, with emission of radiation of energy equivalent to mass m, where m is the electronic mass, equal to the rest mass mo.
- If the positronium annihilated to nothing, there would have been no creation of matter in the Universe.

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