How Electrons consist of Electromagnetic Waves

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In this paper we investigate the connection between electrons and electromagnetic waves. We then propose how electrons could consist of electromagnetic waves. From this proposal we explain why electron-positron annihilation results in only gamma rays being formed, as well as how gamma rays can form electron-positron pairs.

1 Introduction

Both electrons (or positrons) and electromagnetic waves have always been thought of as separate entities, i.e. as particles and waves respectively. However we know that these two entities can display both particle and wave like behaviours [3, 19], implying there is some sort of connection between them. Moreover, electron-positron annihilations produce only electromagnetic waves [5, 2] and conversely electromagnetic waves can produce electron-positron pairs [11]. This further enhances the possibility that there is a connection between electromagnetic waves and electrons. Thus in this paper we will investigate this connection between the two and propose how one can consist of the other.

2 Electrons and Electromagnetic Waves

We know that an electron has wave like properties, which was first proposed by de Broglie in 1924 [3]. Also an electron at rest is unable to move without an external force being applied to it [1]. This is the opposite of an electromagnetic wave, which is able to travel without any external forces acting upon it [17]. Hence we propose that an electron consists of half an electromagnetic wave, in particular the electric negative half, with its associated magnetic pole. This comes from the assumption that electromagnetic waves with integer or half integer values of their wavelength, greater than one, (i.e. 1, 3/2, 2, 5/2, ...) are able to travel. As a result the electron is unable to travel, as it has insufficient "information" in which to propagate like a wave, i.e. it is not a complete wave. From this definition of an electron, it naturally follows that a positron would be the positive half of an electromagnetic wave. Hence the electron and positron would have all the same properties, e.g. mass, but have equal and opposite charges, which would correlate with the definition of matter and anti-matter [5, 2]. Also when an electron and positron touched each other, then by our definitions, they would have all the "information" required for each to convert back into an electromagnetic wave. Hence two waves would be produced each with the energy of either the electron or positron. These waves would travel in opposite directions since the waves would be initially formed by each particle, before passing through their counterpart, i.e. one goes in the direction of electron to positron, whilst the other from positron to electron. This creation of two equal waves travelling in opposite directions correlates with the experimental evidence [20]. Additionally, it would follow from our definition of an electron and a positron, that they could be produced by breaking sufficiently high energy electromagnetic waves in two. We note that multiple waves would be required to produce an electron-positron pair and then separate them from each other. Since although it would first appear that a single wave could produce a pair, conservation of momentum dictates that the electron and positron would still travel together nose to tail. Hence, by our definition of an electron and positron we would still have a full single gamma wave, not a pair of particles. Also from our definition it would explain why the production of electrons and positrons occur in pairs, all of which correlate with experimental evidence [11].

If electrons and positrons do consist of half an electromagnetic wave, then we should be able to calculate the wave's properties, e.g. frequency. Now we know from relativity [4, 8] that mass and energy are equivalent, such that, for a stationary particle we have

$$E = mc^2, \tag{1}$$

where E is the energy, m is mass and c is the speed of light (in a vacuum). We also have Planck's relation [21], which states that the energy of an electromagnetic wave is proportional to its frequency, given by

$$E = hf, \tag{2}$$

where h is Planck's constant. Thus equating these two equations and rearranging for frequency, we obtain

$$f = \frac{mc^2}{h}. \tag{3}$$

This equation states what the frequency of an electromagnetic wave would be, if all the mass of a particle was converted into a single wave. Moreover, equation (3) is the same as de Broglie's equation [3], i.e.

$$\lambda = \frac{h}{mc}, \tag{4}$$

if we convert the latter from a description about wavelength (λ) to a frequency, using $c = f\lambda$ [10]. However, we proposed that an electron is only half a wave and thus we must double its mass to obtain the correct frequency of it constituting electromagnetic wave. Hence, the wave's frequency is

$$f = \frac{2mc^2}{h} \tag{5}$$

$$= 2.4 \times 10^{20} Hz, \tag{6}$$

based upon the mass of an electron being $9.1093826 \times 10^{-31}$ [12]. Moreover, equation (5) correlates with the (linear) Zitterbewegung frequency found in Dirac's equation [7], when it is applied to an electron.

Furthermore, the classical equation for the magnetic moment (m_m) of an electron is [18, 9]

$$m_m = -\frac{\mu_B S}{\hbar}, \tag{7}$$

where S is the spin value of the electron ($=\frac{1}{2}\hbar$) [6], $\hbar$ is the reduced Planck's constant and μ_b is the Bohr magneton. The Bohr magneton is given by [18, 9]

$$\mu_B = \frac{e\hbar}{2m}, \tag{8}$$

where e is the charge of an electron and m is the mass of an electron. Thus substituting all this information into equation (7) we obtain

$$m_m = -\frac{e\hbar}{4m}. \tag{9}$$

However this value for the magnetic moment of an electron is only half the experimentally determined value [18, 9] and hence a g-factor is added into equation (7), to correct the theoretical value. Thus in the case of an electron this g-factor equals 2 when only a single, lone electron is taken into account, i.e. the electron is not absorbing or radiating an electromagnetic wave (otherwise it is slightly larger at 2.002...) [18]. Since equation (7) is classical, then it assumes that the electron is a particle or conversely from a wave prospective, a full wave. From our definition of an electron though, being half a wave, it follows that the classical equation would equal only half the experimental value, as shown. This is similar to a one dimensional density calculation (i.e. $\frac{\text{mass}}{\text{volume}}$) where the correct mass has been obtained, but twice the correct distance is used. Thus the resulting answer is half the correct value.

Also since an electron and positron have mass and consist of electromagnetic waves, then this would correlate with our previous proposal that electromagnetic waves can have mass [14, 15]. In particular this proposal stated that the mass of a wave was inversely proportional to its speed. This was such that when the wave was travelling at the speed of light it had zero mass, but as the wave slowed down its mass monotonically increased to its maximum value when the wave stopped (i.e. impacted something). Our proposals in this paper would also correlate with our proposal that mass is "generated" when energy is localised to a point [16]. This follows since the half wave still has energy but is unable to move without any external force. However as the energy and particle (in this case the electron or positron) are the same thing, if the energy moves so does the particle and its mass.

3 Conclusions

In this paper we investigated the connection between electrons and electromagnetic waves. In particular we proposed that an electron consists of the negative half, and its associated magnetic pole, of an electromagnetic wave. Hence this explained why electrons at rest cannot move without an external force being applied [1], since they consist of half a wave, which have insufficient "information" to propagate. Conversely an electromagnetic wave consists of at least a single full wave and thus has all the "information" to freely propagate through space [17]. This definition of an electron also explains why they have wave like properties [3]. Furthermore, from the definition it followed that a positron would be the positive half of an electromagnetic wave. Therefore this explains why an electron and positron have all the same properties, but equal and opposite charges [5, 2].

These definitions of the electron and positron, then explained why their annihilations produce only electromagnetic waves as well as why in the majority of cases, two of them are produced. It also explained why gamma rays can produce electron-positron pairs, plus why this production method always produces one of each. These various explanations correlate with the experimental evidence regarding electron-positron annihilation and production [20, 11]. Since we proposed that electrons and positrons consist of electromagnetic waves, we investigated what the frequency of these constituting waves would be. By equating the equivalence of energy and mass from relativity [4, 8], and energy and frequency from Planck's relation [21], we were able to produce de Broglie's formula [3]. However, as each particle consists of only half a wave, the correct frequency of the wave is obtain by doubling the mass, giving a value of 2.4×10^{20} Hz. Moreover this value is the (linear) Zitterbewegung frequency found in Dirac's equation [7], when it is applied to an electron.

We then used these definitions to explain why the classical equation for the magnetic momentum of an electron only gives half the experimental value. This followed since the classical equation assumes that the electron is a particle, or in wave terms a full wave. Thus the value it obtains is only half the correct answer. This is similar to a one dimensional density calculation (i.e. $\frac{\text{mass}}{\text{volume}}$) where the correct mass has been obtained, but twice the correct distance is used. Thus the resulting answer is half the correct value. Lastly we showed how this connection between electrons (and positrons) and electromagnetic waves correlated with our previous proposals that electromagnetic waves can have mass when not travelling at the speed of light [14, 15]. Also that mass is "generated" when sufficient amounts of energy are localised [16], which follows in this case since half an electromagnetic wave has insufficient "information" to travel.

Overall therefore this paper not only defines what constitutes an electron and a positron, but also explains why they have wave like properties.

4 Further Work

Although this paper shows how electrons and positrons consist of electromagnetic waves, we have made no mention of any other subatomic particles. Thus work is required to explain how these other particles can consist of electromagnetic waves, which has already been done in "The Atom Uncovered" [13].

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