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Elementary Particles: "Tangled" Electromagnetic Waves, Orbital Electromagnetic Polarization and Orbital Electromagnetic Cyclo-Synchronization

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Abstract

I propose that elementary particles are made of "tangled" electromagnetic radiation. Modification of the existing electromagnetic wave equations in such a way as to exhibit "orbital polarization" (polarization in 3 dimensions around a fixed point) gives rise to states which describe the various elementary particles/waves that we see in our universe, as well as the other non-observable particles and waves. This is proven using mathematical modeling software (MatLab) as well as through experimental research (designed but not performed as of 2/17/2017). Orbital polarization clarifies several phenomena (strong, weak, gravity, mass, spin, anti-matter, etc.) who's mechanisms have yet to be determined. The results from calculation and simulation support that elementary particles are made of electromagnetic radiation.

Keywords: Elementary particles; Electromagnetic waves; Electromagnetic polarization

Abbreviations: FTCS-NNC: Forward Time Centred Space with Nonlocal Nonlinear Conditions; DFS-NNC: Dufort-Frankel Scheme with Nonlocal Nonlinear Conditions; BTCS-NNC: Backward Time Centred Space with Nonlocal Nonlinear Conditions; CNM-NNC: Crank-Nicholson Method with Nonlocal Nonlinear Conditions

Thesis

Elementary particles are "tangled" electromagnetic waves. They exhibit traits that can be described by states of orbital polarized electromagnetic radiation (polarized in three dimensions around a fixed point). From these states, we see the development of mass, electric and magnetic fields, strong and weak forces, gravity, as well as anti-matter formation.

Background

In modern physics, elementary particles are the smallest identifiable parts of matter which are classified into fundamental fermions and fundamental bosons. The fermions include leptons and quarks (along with their generational and anti- partners) while the bosons consist of force carriers (gluons, photons, Higgs, etc).

While this is the current understanding of the building blocks of the universe, it can be simplified into one (1) piece: electromagnetic radiation.

Electromagnetic radiation follows basic principles of electrodynamics which can be described by Maxwell's equations (Gauss's Law, Gauss's law for magnetism, Faraday's induction law, Ampere's law). Orbital polarization applies to all forms of matter and energy.

Maxwell's Equations

Maxwell's equations describe all phenomena relating to electric and magnetic fields. For electrodynamics, the equations are given as follows [1]:

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \quad \text{(a)} \qquad \nabla \cdot \vec{B} = 0 \quad \text{(c)}$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \text{(b)} \qquad \nabla \times \vec{B} = \mu_o \left(\vec{J} + \varepsilon_0 \frac{\partial \vec{E}}{\partial t} \right) \quad \text{(d)}$$

Where $\vec{E}$ and $\vec{B}$ represent the electric and magnetic field vectors, ϵ_0 and μ_0 are the permeability and susceptibility of free space (constants), and $\vec{J}$ and ρ are the current density vector and charge density, respectively.

Electromagnetic Polarization

Electromagnetic polarization describes wave behavior in space and time, the most generic being elliptical polarization. The amplitude of the elliptically polarized wave traces out an ellipse in the two dimensional plane. Both the amplitudes and phases of the wave's components are arbitrary but not equal. If one component of the polarization is set to 0 (or is in phase with the other), then it is said to be linearly polarized as the amplitude traces a line in the two dimensional plane. Note that the amplitudes only effect the orientation of the wave (slope). If both components are equal in magnitude and phase is offset by pi/2 (90 degrees), then it is said that the wave is circularly polarized (Figure 1).

The forms of the various polarizations are shown as follows in rectangular coordinates with the spherical/polar conversion functions, modified from CRC Standard Mathematical Tables and Formulae [2]:

Introduction to Orbital Polarization

The concept of orbital polarization is that the axis of propagation oscillates in three (3) dimensions (possibly with varying amplitude) around a fixed point in space. To do this, the E and B fields need to oscillate in three (3) coordinates, (x, y, z) rather than the typical (x, y). What this means physically will be answered in later sections.

In (Table 1) the Z component of the various waveforms remains

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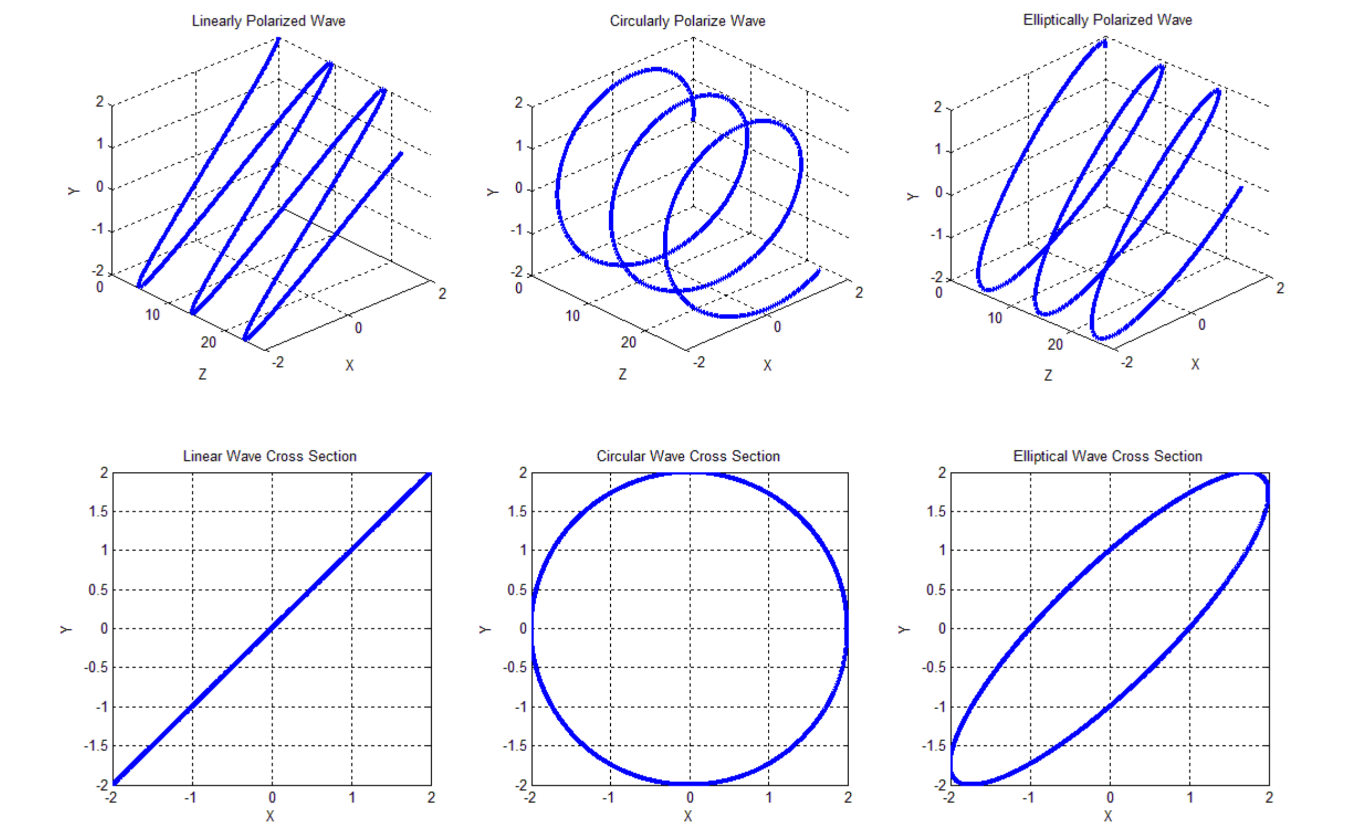

Figure 1: Polarized waves top (left to right): Linear, Circular, Elliptical Waves Bottom (left to right): Linear, Circular, Elliptical cross section.

Polarization	Rectangular	Spherical/Polar Conversion
Linear	$X(z,t)=X_0\cos(k_x z-\omega_x t)$ $Y(z,t)=Y_0\cos(k_x z-\omega_x t)$ $Z(t)=v_z t$	
Circular	$X(z,t)=X_0\cos(k_x z-\omega_x t)$ $Y(z,t)=Y_0\sin(k_x z-\omega_x t)$ $Z(t)=v_z t$	$R=\sqrt{X^2+Y^2+Z^2}$ $\theta=\tan^{-1}\left(\frac{Y}{X}\right)$ $\varphi=\tan^{-1}\left(\frac{Z}{\sqrt{X^2+Y^2}}\right)$
Elliptical	$X(z,t)=X_0\cos(k_x z-\omega_x t)$ $Y(z,t)=Y_0\cos(k_x z-\omega_x t+\delta)$ $Z(t)=v_z t$	$X(R,\theta,\varphi)=R\cos(\theta)\sin(\varphi)$ $Y(R,\theta,\varphi)=R\sin(\theta)\sin(\varphi)$ $Z(R,\theta,\varphi)=R\cos(\varphi)$

Table 1: Polarization, Rectangular and Spherical/Polar Conversion.

constant and the X and Y components are dependent on the space coordinate, z. If the Z component is allowed to vary, then the form follows as such:

$$X(x,t)=X_0\cos\left(k_x x-\omega_x t\right) \tag{1a}$$

$$Y(y,t)=Y_0\cos\left(k_y y-\omega_y t\right) \tag{1b}$$

$$Z(z,t)=Z_0\cos\left(k_z z-\omega_z t\right) \tag{1c}$$

Notice each component is linearly independent. Since it is not necessarily easy to convert directly into spherical coordinates, begin by converting the spatial components (x, y, z) and showing their dependence on time. From the conversion formulae in Table 1:

$$x(t)=r_0\cos\left(\omega_\theta t\right)\sin\left(\omega_\varphi t\right) \tag{2a}$$

$$y(t)=r_0\sin\left(\omega_\theta t\right)\sin\left(\omega_\varphi t\right) \tag{2b}$$

$$z(t)=r_0\cos\left(\omega_\varphi t\right) \tag{2c}$$

It is important to note the following frequencies in spherical coordinates are related to the rectangular counterparts by the following:

$$\omega_x=\omega_\theta\omega_\varphi \tag{3a}$$

$$\omega_y=\omega_\theta\omega_\varphi \tag{3b}$$

$$\omega_z=\omega_\varphi \tag{3c}$$

Recall the wave vector, k, is also defined as:

$$k_i=\frac{\omega_i}{v},i=x,y,z \tag{4}$$

Where ν is the propagation speed of the wave. For the case of electromagnetic radiation, this is c, the speed of light in a vacuum.

Given the above formulae (1-4), the general form of the orbital polarized electromagnetic wave is given (in rectangular coordinates) as:

$$\vec{E}=E_x\hat{x}+E_y\hat{y}+E_z\hat{z} \tag{5}$$

$$E_x(t)=E_0\cos\left(\frac{\omega_\theta\omega_\varphi}{c}\left(r_0\cos\left(\omega_\theta t\right)\sin\left(\omega_\varphi t\right)\right)-\omega_\theta\omega_\varphi t\right) \tag{6a}$$

$$E_y(t)=E_0\cos\left(\frac{\omega_\theta\omega_\varphi}{c}\left(r_0\sin\left(\omega_\theta t\right)\sin\left(\omega_\varphi t\right)\right)-\omega_\theta\omega_\varphi t\right) \tag{6b}$$

$$E\ \left(t\right)=E_0\cos\left(\frac{}{}\left(r_0\cos\left(\omega_\varphi t\right)\right)-\omega_\varphi t\right) \tag{6c}$$

This is the equation for the electric field component of the orbital polarized electromagnetic wave.

Orbital Polarization with Maxwell's Equations

Up to this point, I have been developing the basis for which I believe fundamental particles are formed. I will now see if this form holds under Maxwell's equations.

Recall, for a propagating EM wave the electric field component of the propagating wave is c times the magnetic field component: i.e. E=c * B. From this information, the magnetic field must have the form:

$$B_x\left(t\right)=\frac{E_0}{c}\cos\left(\frac{\omega_\theta\omega_\varphi}{c}\left(r_0\cos\left(\omega_\theta t\right)\sin\left(\omega_\varphi t\right)\right)-\omega_\theta\omega_\varphi t\right) \tag{7a}$$

$$B_y\left(t\right)=\frac{E_0}{c}\cos\left(\frac{\omega_\theta\omega_\varphi}{c}\left(r_0\sin\left(\omega_\theta t\right)\sin\left(\omega_\varphi t\right)\right)-\omega_\theta\omega_\varphi t\right) \tag{7b}$$

$$B_z\left(t\right)=\frac{E_0}{c}\cos\left(\frac{\omega_\varphi}{c}\left(r_0\cos\left(\omega_\varphi t\right)\right)-\omega_\varphi t\right) \tag{7c}$$

It is important to know which formulae are necessary to show that orbital polarization holds physically. For a propagating wave, these are Maxwell's equations (0b) and (0d).

$$\nabla\times\vec{E}=-\frac{\partial\vec{B}}{\partial t} \tag{0b}$$

$$\nabla\times\vec{B}=\mu_o\left(\vec{J}+\varepsilon_0\frac{\partial\vec{E}}{\partial t}\right) \tag{0d}$$

To verify, combine the above equations. First, start by taking the curl of both (0b) and (0d). It is important to note that in the case of the propagating wave, the current density and charge density are both zero. So for (0d), J=0. Recall that $\mu_o\varepsilon_0=1/c^2$.

$$\nabla\times\left(\nabla\times\vec{E}\right)=\nabla\times\left(-\frac{\partial\vec{B}}{\partial t}\right) \tag{8a}$$

$$\nabla\times\left(\nabla\times\vec{B}\right)=\nabla\times\left(\frac{1}{c^2}\frac{\partial\vec{E}}{\partial t}\right) \tag{8b}$$

Now, equate the terms and separate the electric and magnetic fields into their own equations, which gives the electromagnetic wave equations.

$$\nabla^2\vec{E}=\frac{1}{c^2}\frac{\partial^2\vec{E}}{\partial t^2} \tag{9a}$$

$$\nabla^2\vec{B}=\frac{1}{c^2}\frac{\partial^2\vec{B}}{\partial t^2} \tag{9b}$$

Solve the electromagnetic wave equations using orbital polarization. Recall the form of E from equations (7a)-(7c). The ∇^2 term:

$$\nabla^2\vec{E}=\nabla^2\left(E_0\cos\left(k_xx-\omega_xt\right)+E_0\cos\left(k_yy-\omega_yt\right)+E_0\cos\left(k_zz-\omega_zt\right)\right) \tag{10}$$

$$\nabla^2\vec{E}=-E_0k_x^2\cos\left(k_xx-\omega_xt\right)-E_0k_y^2\cos\left(k_yy-\omega_yt\right)-E_0k_z^2\cos\left(k_zz-\omega_zt\right) \tag{11}$$

The time derivative becomes:

$$\frac{1}{c^2}\frac{\partial^2\vec{E}}{\partial t^2}=\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\left(E_0\cos\left(k_xx-\omega_xt\right)+E_0\cos\left(k_yy-\omega_yt\right)+E_0\cos\left(k_zz-\omega_zt\right)\right) \tag{12}$$

$$\frac{1}{c^2}\frac{\partial^2\vec{E}}{\partial t^2}=\frac{1}{c^2}\left(-E_0\omega_x^2\cos\left(k_xx-\omega_xt\right)-E_0\omega_y^2\cos\left(k_yy-\omega_yt\right)-E_0\omega_z^2\cos\left(k_zz-\omega_zt\right)\right) \tag{13}$$

Similarly, for the magnetic field (9b):

$$\nabla^2\vec{B}=\nabla^2\left(B_0\cos\left(k_xx-\omega_xt\right)+B_0\cos\left(k_yy-\omega_yt\right)+B_0\cos\left(k_zz-\omega_zt\right)\right) \tag{14}$$

$$\nabla^2\vec{B}=-B_0k_x^2\cos\left(k_xx-\omega_xt\right)-B_0k_y^2\cos\left(k_yy-\omega_yt\right)-B_0k_z^2\cos\left(k_zz-\omega_zt\right) \tag{15}$$

$$\frac{1}{c^2}\frac{\partial^2\vec{B}}{\partial t^2}=\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\left(B_0\cos\left(k_xx-\omega_xt\right)+B_0\cos\left(k_yy-\omega_yt\right)+B_0\cos\left(k_zz-\omega_zt\right)\right) \tag{16}$$

$$\frac{1}{c^2}\frac{\partial^2\vec{B}}{\partial t^2}=\frac{1}{c^2}\left(-B_0\omega_x^2\cos\left(k_xx-\omega_xt\right)-B_0\omega_y^2\cos\left(k_yy-\omega_yt\right)-B_0\omega_z^2\cos\left(k_zz-\omega_zt\right)\right) \tag{17}$$

Note (11) and (13) are nearly equal. Recall from equation (4), k=ω/v, and since v=c in this case, then $k^2=\omega^2/c^2$. Using this, equations (11) and (13) are equal as well as equations (15) and (17).

Since these equations hold, orbital polarization is a mathematically valid wave under Maxwell's equations, which means that it could be a valid physical form.

Implications of Orbital Polarization

The implications of orbital polarization are extensive. The first of which, and probably one of the most important, is the manifestation of "mass". I believe that mass comes from the orbital behavior of the wave form.

Mass is defined as an objects resistance to change in acceleration. As defined in Newtonian mechanics (from Goldstein Classical Mechanics [3]):

$$m=\frac{F}{a} \tag{18}$$

More generally, also given in Goldstein Classical Mechanics [3], force is proportional to the change in momentum with respect to time:

$$F=\frac{dp}{dt} \tag{19}$$

Combining (18) and (19):

$$m=\frac{1}{a}\frac{dp}{dt} \tag{20}$$

Recall that

$$a=\frac{dv}{dt} \tag{21}$$

Substituting (21) into (20):

$$m=\frac{dt}{dv}\frac{dp}{dt} \tag{22}$$

This reduces to:

$$m=\frac{dp}{dv} \tag{23}$$

Before going further, verify this by looking at the classical momentum, $p=mv$.

$$\frac{dp}{dv}=\frac{d}{dv}\left(mv\right) \tag{24}$$

$$\frac{dp}{dv}=m \tag{25}$$

Thus (23) holds under classical mechanics. Now apply (23) to electromagnetic radiation.

For the electromagnetic wave, $p = \frac{h}{\lambda}$, (Hecht Optics [4]), where h is Planks constant and λ is the wavelength. The wavelength is defined as $\lambda = \frac{\omega}{c}$, where c is the speed of light in a vacuum. To perform the analysis, let c go to a variable v, since c is a specific v. Substitute into equation (23) results in the following:

$$\frac{dp}{dv} = \frac{d}{dv}\left(\frac{h\omega}{v}\right) \tag{26}$$

$$\frac{dp}{dv} = -\frac{h\omega}{v^2} \tag{27}$$

$$\therefore$$

$$m = -\frac{h\omega}{v^2} \tag{28}$$

It is interesting to note the negative sign on the mass. For now, neglect it as an artifact of the derivation. Since mass is always seen as a positive value, then modify equation (23):

$$m = \left|\frac{dp}{dv}\right| \tag{23*}$$

This does not affect the classical interpretation, so assume that this will hold for now until experimental data is confirmed. The implications of negative mass are not known at this time. It is possible that mass needs to be negative since when an external force is applied, the object in question does not have infinite acceleration. This implies that there is a negative force in the opposite direction of some magnitude (like air resistance).

Use formula (28) to calculate the frequency of oscillation of a wave that would make up an elementary particle. Plug in the rest mass of an electron, $9.11*10^{-31}$ kg, to find the frequency of the orbital wave:

$$9.11*10^{-31}kg = \frac{h\omega}{c^2} \tag{29}$$

$$9.11*10^{-31}kg*\left(2.998*10^8\frac{m}{s}\right)^2 = 6.626*10^{-34}kg\frac{m^2}{s}*\omega \tag{30}$$

$$1.235*10^{20}\ Hz = \omega \tag{31}$$

Which yields a wavelength of ~2.427×10^{-12} m. This is consistent with observed e+ e- annihilation reactions as well as calculation from Plank-Einstein Relation [5] using the energy of one of the released gamma rays (0.511 MeV) [6].

$$E=h*f \tag{31a}$$

$$0.511\ MeV=h*f \tag{31b}$$

$$\frac{0.511*10^6\ eV}{h} = f \tag{31c}$$

$$\frac{0.511*10^6\ eV}{4.1357*10^{-15}\ eV*s} = f \tag{31d}$$

$$1.235*10^{20}\ Hz = f \tag{31e}$$

Here it is shown that equation (31) and equation (31e) are equal.

Orbital Electromagnetic Cyclo-Synchronization

After verification of the orbital polarized wave, a way to classify the wave is necessary. When dealing with multiple waves, a phase marker is used. I will introduce a term for (phase) in the orbital sense. I call it orbital electromagnetic cyclo-synchronization, denoted ς (delta). It is the combination of the phase of both components of the orbital polarization in spherical coordinates (theta and phi). It is the ratio of the frequency of phi over theta. For various ς, effects on the physical form of the wave arise (See *Models*).

Implications of Orbital Electromagnetic Cyclo-Synchronization

There are many physical implications that come from the cyclo-synchronization, ς, of the system. The specific phenomena that I will focus on are charge, spin, and gravitational forces.

Looking at the electric field with respect to ς, there are specific values for which the time-average of the field is not zero (0). This is the origin of charge. While there are values from which this can occur, there are many more that do not appear to have a net electric field. Though they do have an electromagnetic field over a short time, for each full oscillation, the net field is zero (0) or very closes to it. This implies that detection of such particles would not be possible with most current observation technology or methods.

If the net electric field is allowed to precess around a given axis (axes), this generates a standing magnetic field (from equation 0b). The given orientation determines the "spin" of the particle.

The most interesting phenomena that occur are the mutual attraction of particles, i.e. gravitation. Up until now, there has been very little understanding of the origin of this force. I would like to argue that particles with similar ς would attract one another by magnetic or electric field orientation. As calculated, elementary particles oscillate with a frequency of the order 10^{20} Hz. With an observable electromagnetic wave of the order 10^{12} Hz, the particle wave makes on the order of 10^8 complete oscillations for every one oscillation of the observable wave. Another particle, however, will see almost the exact same number of oscillations (order of 10 or less). In this instance, the particles may be treated as dipoles, each with a distinct +/- field. Then it is possible that similar particles could be both attracted and repelled from one another. If they are perfectly synchronized, then they would repel, and if they were out of phase by pi (180 degrees), then they would attract. Any phase difference (or possibly different orientation) would cause a combination of both attraction and repulsion, such that the particles will come to rest at a fixed, stable distance from each other where the attractive force is balanced by the repulsive force.

Models

Here are some arbitrary models of an orbital polarized wave. This set of data would represent the structure and/or path of the wave.

Figures 2 and 3 both show the wave path for ς=10 - 1/10. Figure 2 is the various views along the x, y, and z axis. Figure 3 shows only the x, y, and z components of the wave with respect to time. Notice how the z component is only dependent on ω_φ.

Figures 4 and 5 show the electric field (red) of the wave. Figure 4 shows the electric field overlaid on the wave path. It is broken up in the same manner as Figure 2. It is important to note that the dimensions

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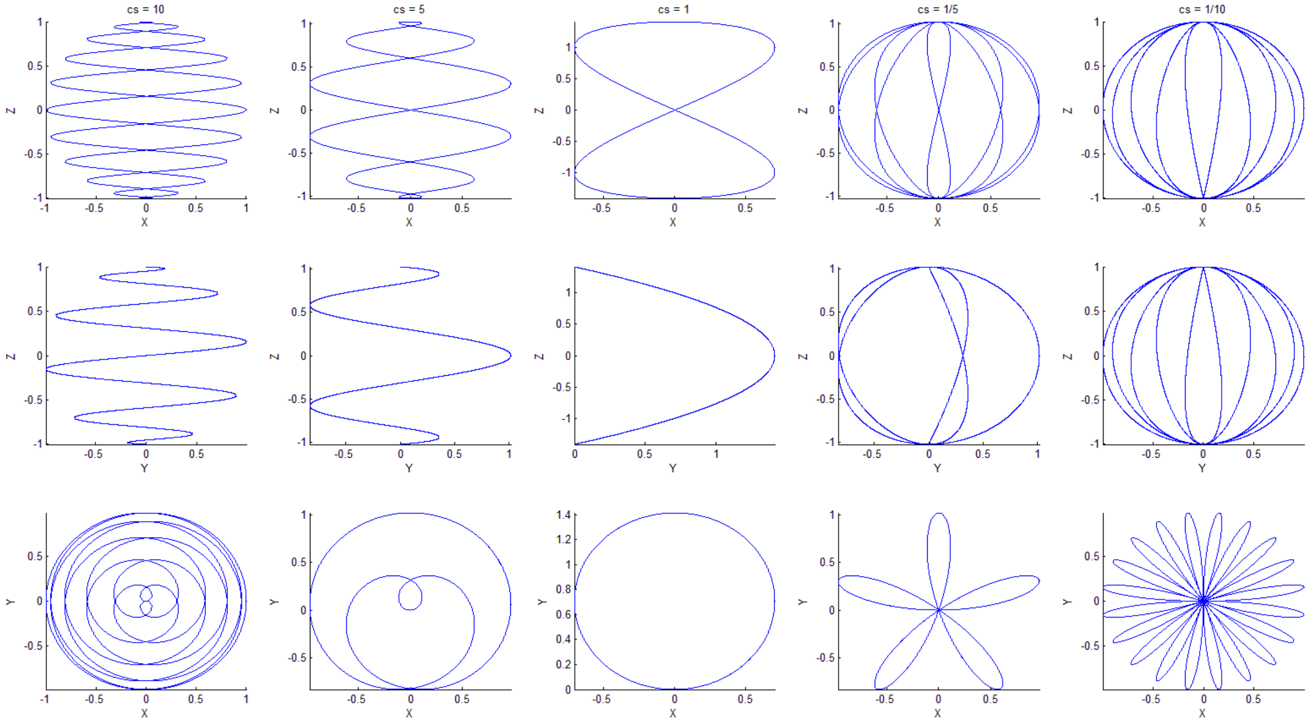

Figure 2: Wave path for ς=10-1/10 (left to right) as seen from Y, X, and Z axes (top to bottom).

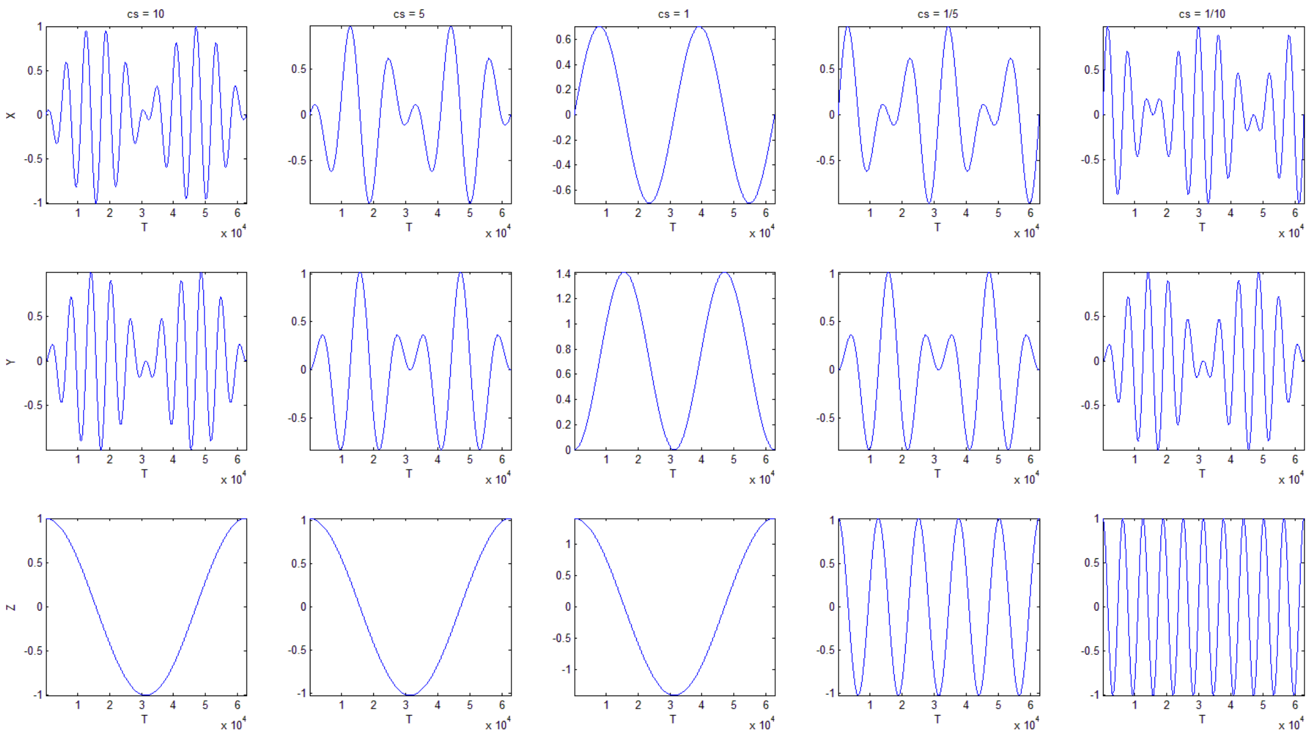

Figure 3: Wave path for ς=10-1/10 (left to right) WRT time along X, Y, and Z axes (top to bottom).

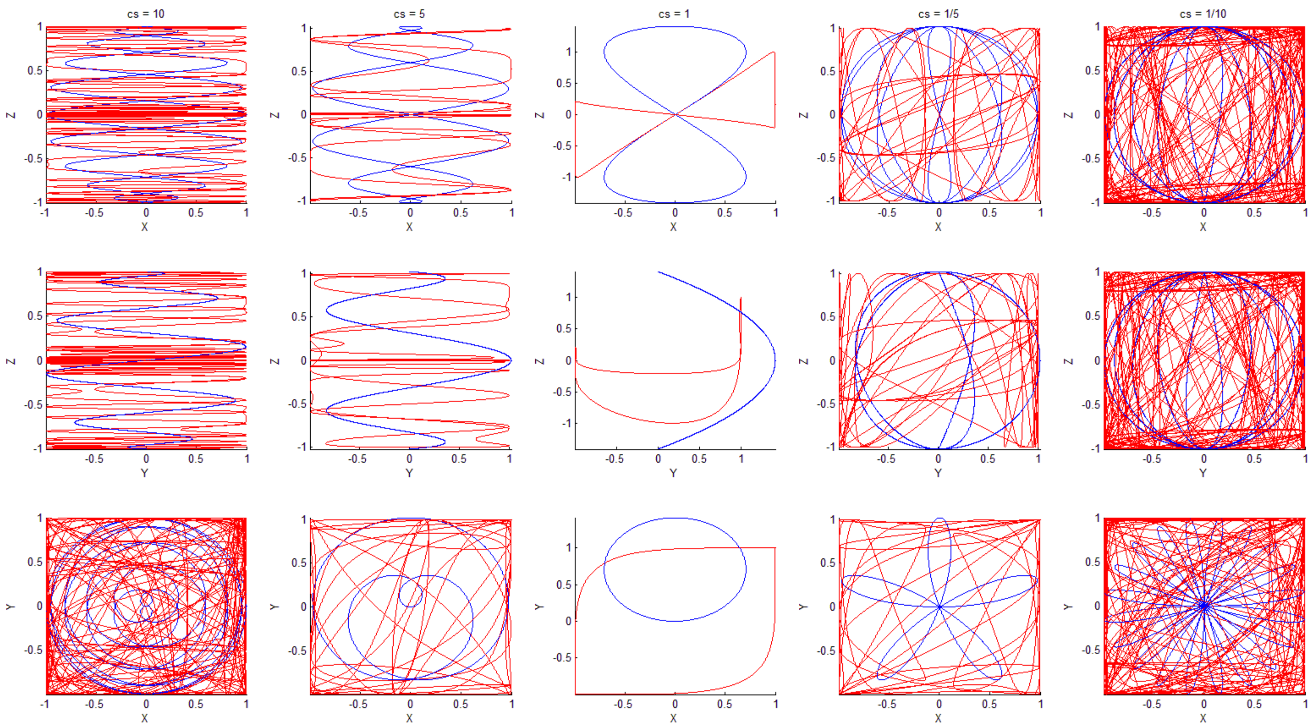

Figure 4: E-field for ς=10-1/10 (left to right) as seen from Y, X, and Z axes (top to bottom).

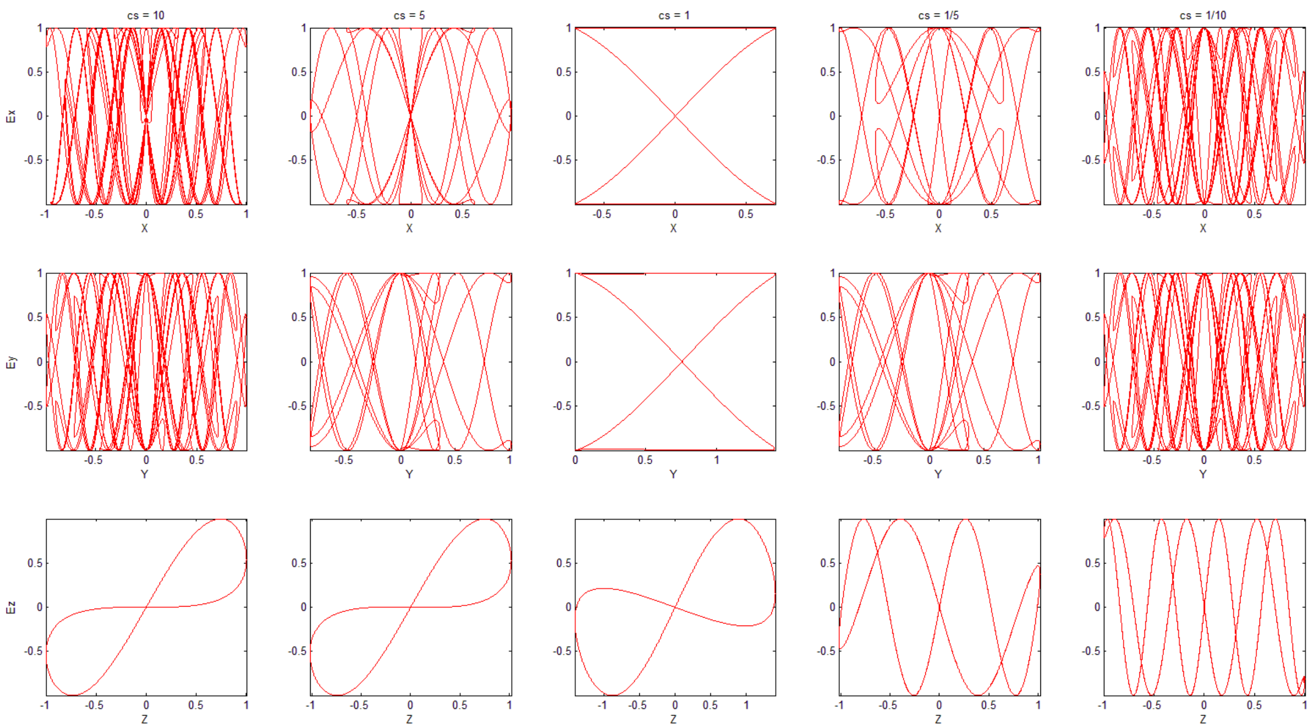

Figure 5: E-field for ς=10-1/10 (left to right) WRT space along X, Y, and Z axes (top to bottom).

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for the electric field (red) are in eV while the field path is in units of distance. Figure 5 shows the plot of the electric field versus the position.

There are many forms for ς=1. Since the electric field depends on ω_θ and ω_φ, ς will be one for all values of $\omega_{\theta=}\omega_\varphi$. Figure 6 shows various forms for ς=1. Here, $\omega_{\theta=}\omega_\varphi$=-3 to 3 (from left to right).

Figure 7 shows log plots of the time averaged electric fields. The top three (3) plots represent the x, y, and z components (respectively) of the electric field for values of ς from -100 to 100 by integer steps. The lower three (3) show data for ς=-5 to 5 with a step size of 0.01.

It is important to note from this data that there are many values for which the electric fields are near zero (0). This means that while a particle could exist at a given ς, it may be nearly impossible to detect by either electric or magnetic means.

Simulation Data

Here is a simulated electron of the orbital waveform. In the Models section, data is generated using arbitrary values for frequency and speed of light. To see how probable this form is for, say, an electron, more realistic values are needed.

Recall from equation (31) that the frequency of an electron is $1.235*10^{20}$ HZ. Assuming the frequency components are equal, then the calculated frequency could be the magnitude of ω_θ and ω_φ. Taking the speed of light to be $2.998 * 10^8$ m/s, the particle could possibly look like the following:

For Figures 8 and 9, the values used neglected the exponents of 10 in order to show detail.

Interpretation

The wave in the *Simulation Data* section shows the various effects its form and cyclo-synchronization. The net electric field has the apparent magnitude (negative) would be expected of an electron and thus supports the theory that elementary particles are orbital polarized waves.

Experimental Design

The experimental design consists of two phases. The first would show it is possible to stop an existing electric current using an external magnetic field. To simulate the electron, use a small solenoid powered by a small, constant power source (a single 9 V battery perhaps) placed within a larger solenoid attached to a variable power source. Both the inner and outer solenoids will be equipped with ammeters to measure the current through each coil.

It is possible to induce a current in a wire using a changing external magnetic field. By powering the larger solenoid with the appropriate change in current, it should be possible to stop the current flowing in the inner, smaller solenoid. The purpose of this experiment is to show that it is possible to stop the current in the small solenoid, even if only briefly.

As for the design of the main experimental system, it consists of five (5) main parts: the electron source, the energy brake, the electron selector, the spin brake, and the detector.

The electron source: The purpose is to find out what elementary particles are made of, it is not necessary to work in the high-energy regime. Working in a fairly low energy region, of the order of 0-100

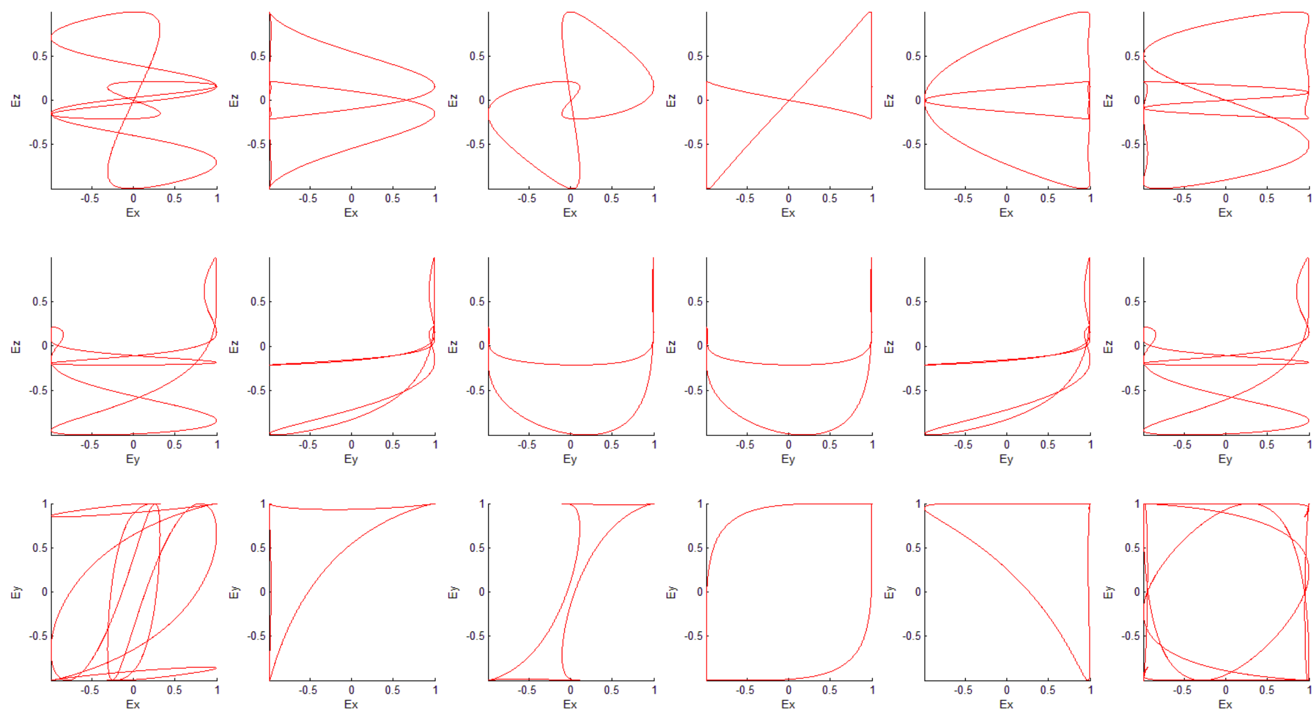

Figure 6: E-fields for ς =1 variations, left to right: (-3/-3) -> (3/3).

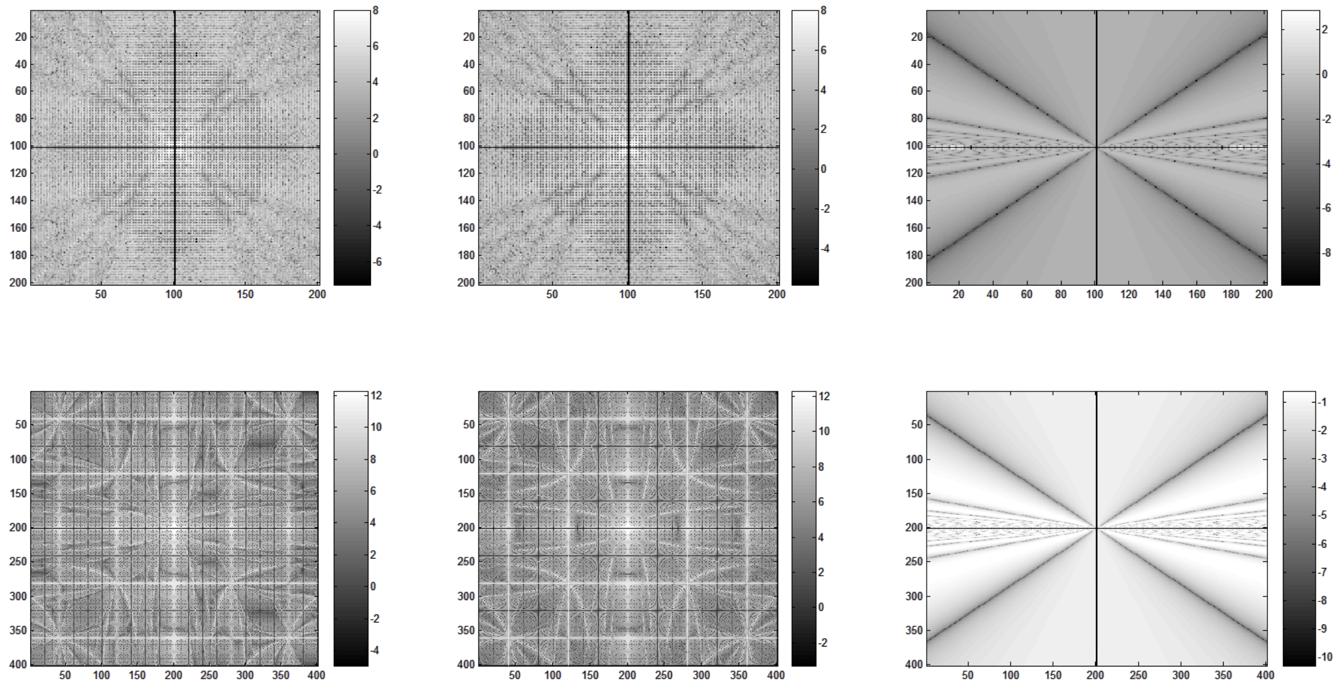

Figure 7: Time averaged E-field components X, Y, Z (top left to right) for ς=-100-100 (step size=1) Data for ς=-5-5 X, Y, Z (bottom left to right)

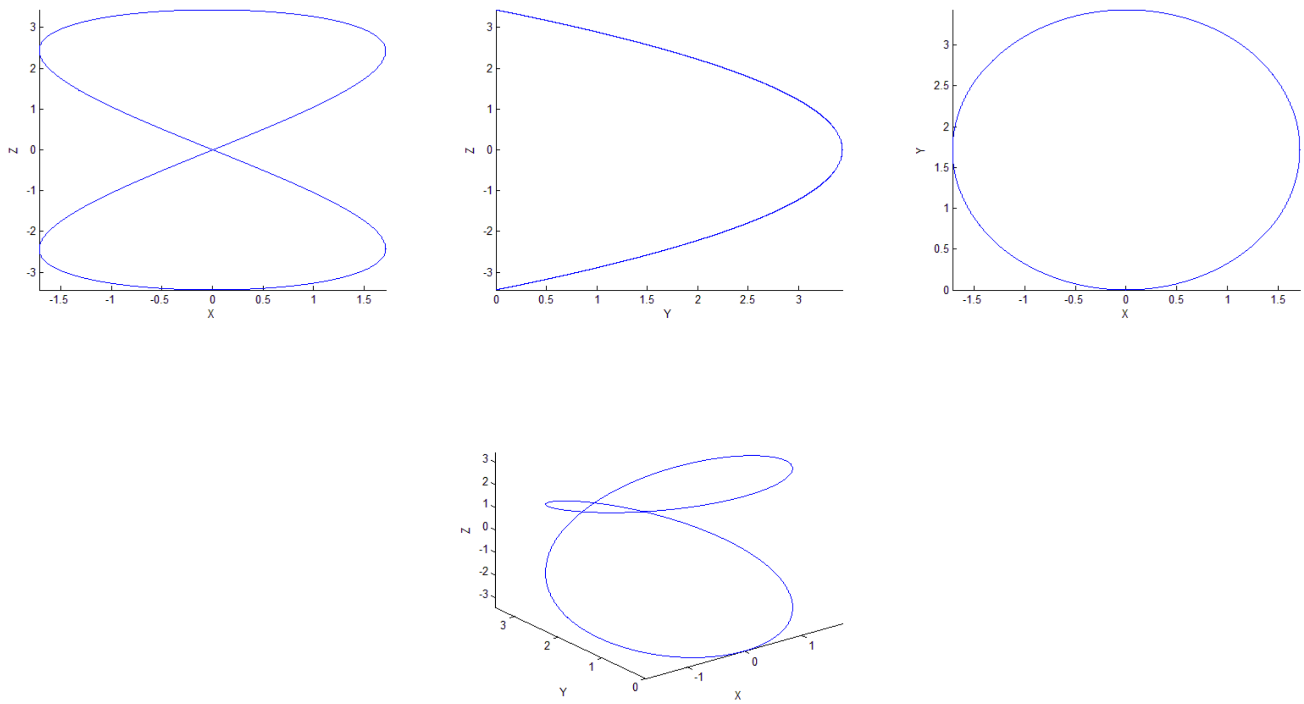

Figure 8: Electron wave path.

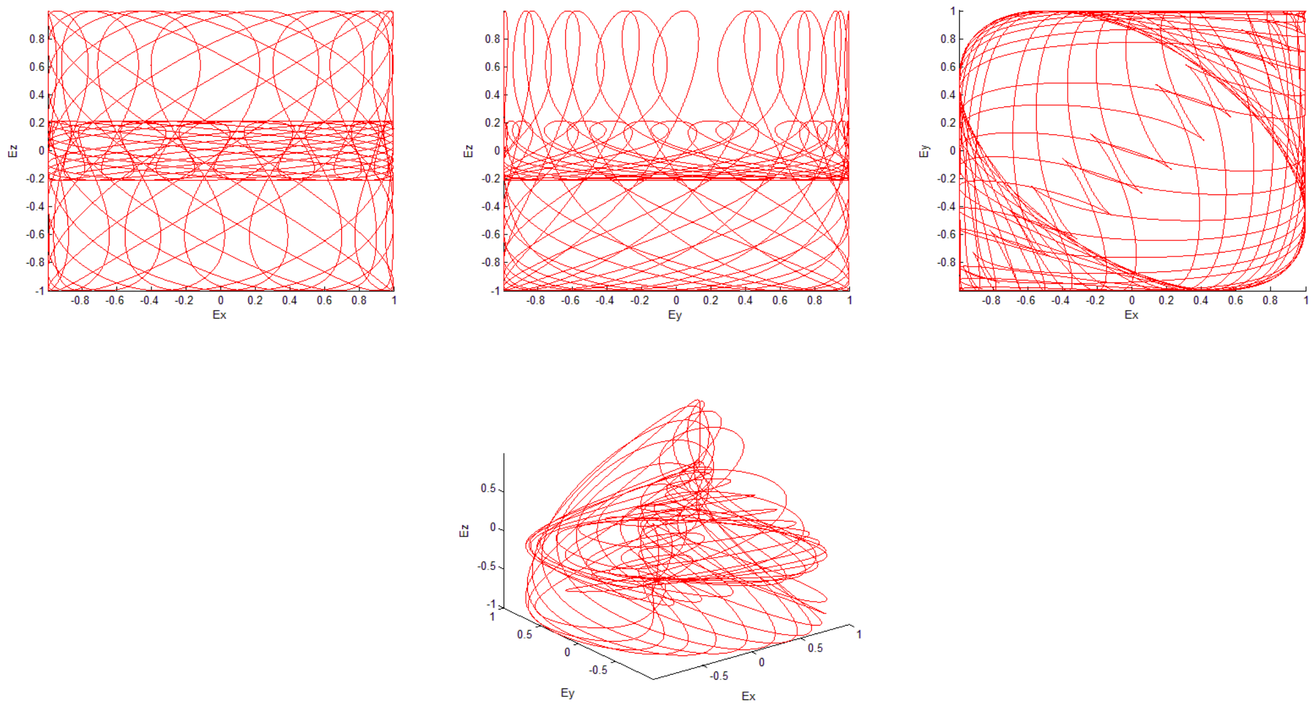

Figure 9: Electron wave electric field.

eV, is desirable. The source could be a heated cathode made to similar emission standards of an electron microscope i.e., single electron emission.

The energy brake: This is meant to slow down the electrons that are passed through it. It is a region with a standing electric field that opposes the direction of the electron's motion.

The electron selector: This portion allows us to select the electrons that have the spin characteristics that best fit the experimental region. This is a Stern-Gerlach apparatus.

The spin brake: The meat of the experiment. It is a void which has a source capable of producing the magnetic fields necessary for the disruption of the electron's magnetic field. There are two designs: one utilizes a large electromagnet while the other will use a microwave source (either magnetron or klystron) to produce a pulsed magnetic field with much higher magnitudes, which may be necessary.

The detector: The detector is a reduced version of what would be used in a normal particle physics experiment. It will consist of two (2) portions: a calorimeter to detect any rogue particles and silicon detectors for photons. The system will be calibrated to detect single photon/particle emission.

Experimental Calculations

It is necessary to calculate the magnetic field needed to make the electron stop "spinning". Since the electron has a very specific orientation, treat the electron like a very small solenoid. The approximate size of such a solenoid can be determined by using the calculated wavelength from equation (31) and assuming that that the ς of the electron is one (1). If, assuming the electron is "flat" (or circular), then the path length of the oscillation is equal to the circumference of the circular orbit:

$$\lambda = 2\pi r \tag{32}$$

$$2.427\times10^{-12} m = 2\pi r \tag{33}$$

$$r = 3.863\times10^{-13} m \tag{34}$$

Given the radius and the strength of the electron's magnetic field, ~1T (approximated by the electron's magnetic moment), the approximate current from Ampere's law for a current loop is [7]:

$$B = \frac{\mu_0 I}{2R} \tag{35}$$

$$1T = \frac{\mu_0 I}{2\times3.863\times10^{-13} m} \tag{36}$$

$$I = 6.148\times10^{-7} A \tag{37}$$

Thus the effective current in the electron "loop" is ~6.148 × 10^{-7} A. treating the electron as a loop of current; it is possible to induce a current in the opposite direction, cancelling out that of the electron. From Faraday's law for induction:

$$EMF = -N\frac{d\phi}{dt} \tag{37a}$$

For the given conditions, N=1, and $\frac{d\phi}{dt}$ is taken to be:

$$\frac{d\phi}{dt} = \frac{d}{dt}(BA) = A\frac{d}{dt}(B) \tag{38}$$

Where A is the area of the loop. Then (37) becomes:

$$EMF = -A\frac{dB}{dt} \tag{39}$$

Since EMF=IR, where R is the resistance of the circuit, then (39) becomes

$$I = -\frac{A}{R}\frac{dB}{dt} \tag{40}$$

Assuming the resistance is 1, then:

$$I = -A\frac{dB}{dt} \tag{41}$$

Given the current from (37) and area calculated from the results of (34), then the changing magnetic field can be calculated.

$$-\frac{I}{A} = \frac{dB}{dt} \tag{42}$$

$$\frac{dB}{dt} = 1.3114 \times 10^{18}\ T/s \tag{43}$$

Only using rough calculations, the magnetic field needs to change with approximately 1.3114×10^{18} T/s. This should be sufficient to cause the electron to stop "spinning" and "unravel" into a propagating electromagnetic wave.

Probable Experimental Outcomes

There are three (3) probable outcomes for this experiment, if it is performed under ideal circumstances. As for non-ideal circumstances, the electron may be thrown by the field and lost into the detector.

One outcome is simply nothing happens. This can occur for any number of reasons: poor alignment, magnet field is not strong enough or ramp is not steep enough. Alternatively, it is possible that the intrinsic spin of the electron cannot be stopped and that the electron is not an EM wave.

Another outcome could be the electron becomes another generation of the electron (muon or lower energy generation of the current). This would indicate that something much more complicated going on than just being an EM wave. However, it could also be that the magnetic field was absorbed in such a way that it caused the particle to expand.

The final outcome is the electron behaves just as predicted and completely "unravels" into a normal, propagating EM wave. In this case, the detector would signal a photon with approximately 0.511 MeV of energy. This would be direct proof that elementary particles are made of orbital polarized electromagnetic waves (Appendix).

Conclusion

The results from the calculation support that elementary particles are composed of tangled or orbital polarized electromagnetic waves. While it is yet to be observed physically, the process for showing this experimentally have been outlined and some of the experimental parameters have been calculated. Through calculation and simulation, orbital polarization explains where mass comes from as well as the formation of mutual attraction (gravity), formation of anti-matter particles, as well as strong and weak nuclear forces.

These conclusions can be used to describe the rest of the phenomena in the universe. As mentioned in the Implications of Orbital Cyclo-Synchronization section, there is mutual attraction and repulsion of similar ς particles. Particles in a collapsing star are energetic and forced into very close proximity to one another, and with such tremendous forces, two waves could overcome the repulsion of like fields and cross orbital radii. The two particles occupy the same region of space and no longer experience repulsion from their fields. Their waves interfere and the superpositioning of their amplitudes causes constructive interference (since the two particles had similar ς). This "super-particle" now has the mass and electric field of its parent particles. If two electrons were subject to this event, the result would be a "super-electron", which would have a mass of $2m_e$ and an apparent charge of $2e^-$, but would act as a single particle. With the appropriate energy, this can occur an infinite number of times and "super-particles" with masses several thousand times that of their parent particles could exist and given the number of particles in a star's core, it is likely that many of these particles will form. If the amount of "super-particles" is too low, only the core of the star will be left over and eventually cool and fade. If there are slightly more "super-particles," they will attract other normal particles, which collide and form neutrons, leading to the formation of neutron stars, but there will not be enough energy to create more "super-particles". If the amount of "super-particles" is significantly high, then they could possibly spawn more "super-particles" through their own interaction, and ultimately form a black hole. The exact numbers and limits for each of these levels is unknown and the calculations are outside of scope of this paper.

The *Models* section shows that for any given ς, a particle could exist. If this is true, then there are many particles that cannot be "seen" with electromagnetic means. All of them could exist. This would account for the rest of the "mass" of the universe that cannot be "seen". These invisible particles would still be visible by how they affect the propagation of electromagnetic radiation around them through gravitational lensing effects. As there are potentially an unlimited number of combinations for values of ς, this could account for the much theorized "dark matter".

Orbital polarization also explains the form of the electric field produced by a moving charge. If the charge is accelerated in a direction, say *x*, then the *x* component of the wave will be compressed due to the added energy to that part of the wave. This added energy is absorbed in that component, such that the frequency is increased, and the wavelength is shortened. Now the particle appears to be compressed in the direction of motion. This also explains why massed particles cannot be accelerated to the speed of light (in a vacuum) and why they rapidly radiate energy when traveling near c in a region where the speed of light is less than *c*.

In addition, the *Models* section data also shows that it is possible that antimatter is just as likely to exist in our universe as regular matter. It is not easy to prove this, since matter and antimatter both behave the same way physically. A star made of antimatter would produce the same spectra as a regular matter star. The natural interactions between matter and antimatter would be limited by the vast amounts of space and dark matter between neighboring systems.

Notes

- The orbital polarized form of the electromagnetic wave has been formed by using a fixed radius. It is possible that the orbital radius of the wave may also vary. In such a case, the form will need to be modified by allowing r to vary as well with a frequency comparable to the ω_θ and ω_φ. Here are some simulated examples of such waves with various ς:
- Figures 10 and 11 represent two sets of data formed from an orbital polarized wave with r varying in time. Each column represents different frequencies of the components of the wave. From left to right: ς=100, 10, 1, 1/10, 1/100. Figure 11 has the 3 dimensional plots for the waves represented in different views, while Figure 11 has the same waves broken down into the x, y, and z components. Note how the forms vary as the frequencies are changed.
- Another interesting calculation that may be performed is

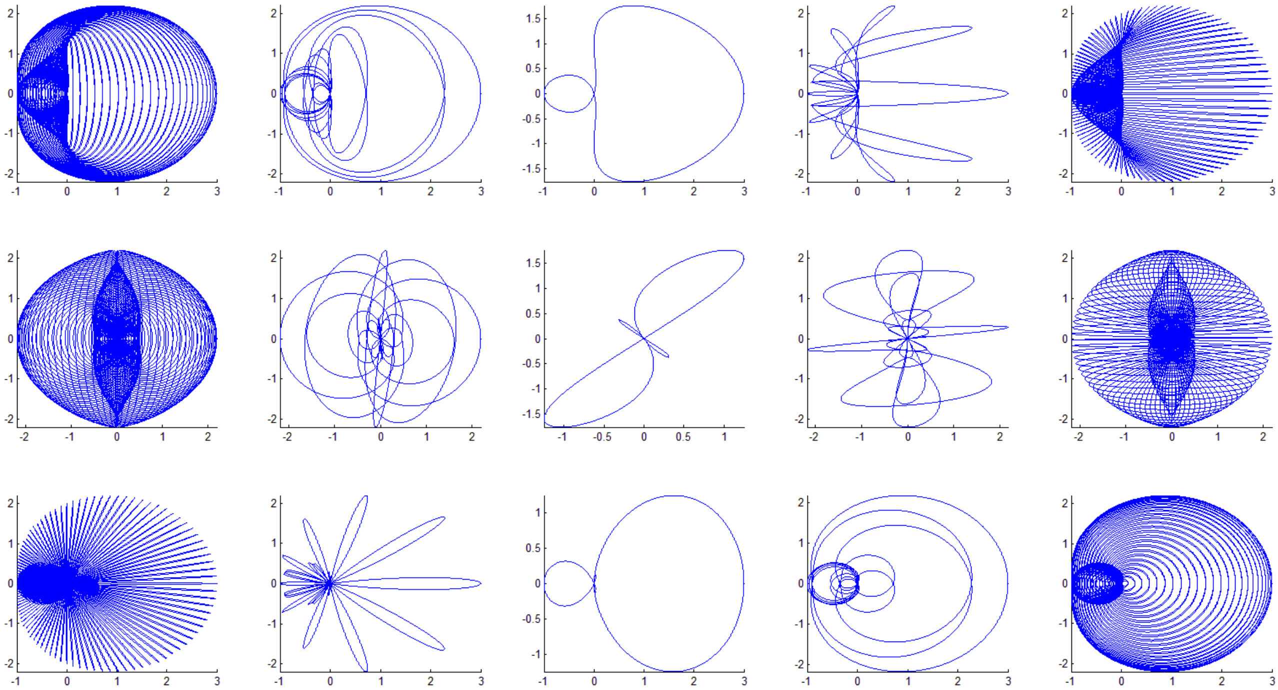

Figure 10: Wave path for ς=100-1/100 as seen from Y, X, and Z axes (top to bottom).

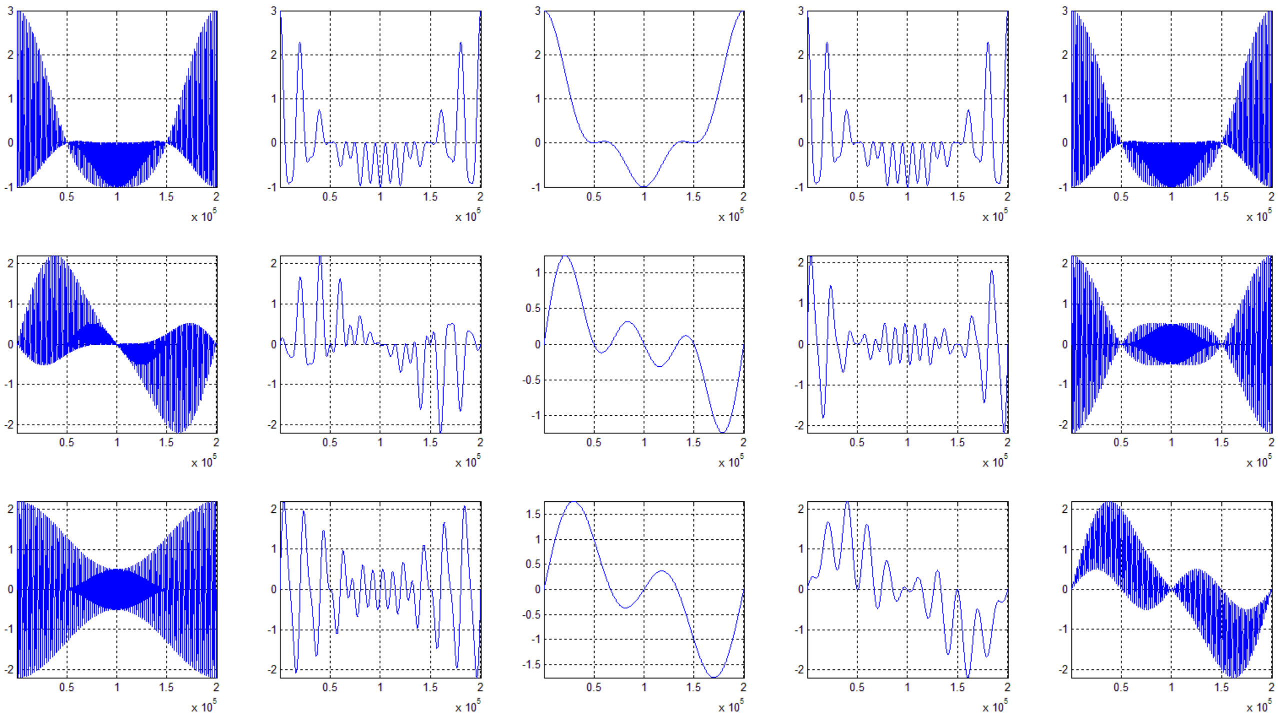

Figure 11: Wave path for ς=100-1/100 (left to right) WRT time along X, Y, and Z axes (top to bottom).

by using the above orbital forms with the other Maxwell's equations, which could be used to determine more information about the electron as well as other elementary particles.

- A note on the design of the experimental system: The calculations suggest a very fast changing magnetic field is necessary to stop the spin of an electron. To achieve this, design the experimental region in much the same way as particle accelerators. Instead of looking to maximize the electric field, focus on maximizing the magnetic field. While this may be possible to do using microwave or radio frequencies, it may be necessary to use carbon nano-tubes (CNT) or some other kind of lattice structure that could be excited with ultra-violet or x-radiation, depending on the field requirements.
- It is also important to note that orbital polarization helps clarify the apparent non-existence of magnetic monopoles. Any monopole is an artifact of time averaging the orbital wave, which means that it is possible that a magnetic monopole could exist. Recall, though, that the magnetic field is 1/c the strength of any electric field, so these would appear very weak, if at all.
- Neutron decay is a result of the cyclo-synchronization. Interaction of the wave with itself causes the apparent spontaneous decay into a proton, electron, and anti-electron neutrino (and possible photon/gamma).
- Quantum entanglement is the result of an anomaly in waveform that results in multiple nodes within the same particle allowing nodes to be separated in space, but still influence one another. Change one and the other responds almost immediately, regardless of separation distance. This is possible because the phase velocity of a wave can be greater than the speed of light.
- Expanding on quantum entanglement, this multi-node waveform to explain the creation of hadrons (protons, neutrons, etc.), as well as the movement of gluons that appear to exist outside the conservation laws through uncertainty.
- Physical orientation of particle does not affect mutual attraction or repulsion, this is only affected by temporal orientation (phase) of the waves. If it is negative in time, it will attract positive at that time and repel negative at that time.

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