Matter is Light – for the Scientist 140530

This thesis brings fundamentally new light to broad aspects of quantum mechanics. This is not a completed work, it is a beginning. It surely contains errors in both computation and understanding. The scientific method demands the assumption that it is true and unflagging efforts be made to improve the theory and experiments to prove or disprove the hypotheses presented.

There is joy ahead in the vigorous discussion and argument required for discovery of the elements of truth herein.

Outline

1 Summary

Fundamental concepts presented are:

1. While the observer at a given level of energy (e.g. approaching the speed of light according to a stationary observer, or near a strong gravitational source) will measure the speed of light as a constant herein called c_0, the speed of light is in fact a function of the local energy at its location.
2. Particles including photons exist because energy makes an energy well in the fabric of the universe.
3. De Broglie waves are light waves in a deep energy well, and the associated velocities are the speed of light at the local energy density.

4. The equation E = m c^2 implies that energy in composed of two orthogonal elements each having half the energy i.e. E = ½ m_1 c^2 + E = ½ m_2 c^2
5. The variables in E = m c^2 are E, the energy, and c, the speed of light, m is the constant

This paper takes a first cut at the mathematics involved in these concepts and develops models based on these concepts that are both plausible and bring new understanding, for example, how can a quark have 2/3 or 1/3 of a unit charge,

2 Foundation

http://en.wikipedia.org/wiki/Tests_of_general_relativity

> Henry Cavendish in 1784 (in an unpublished manuscript) and Johann Georg von Soldnerin 1801 (published in 1804) had pointed out that Newtonian gravity predicts that starlight will bend around a massive object.[10] The same value as Soldner's was calculated by Einstein in 1911 based on the equivalence principle alone. However, Einstein noted in 1915 in the process of completing general relativity, **that his (and thus Soldner's) 1911-result is only half of the correct value**. Einstein became the first to calculate the correct value for light bending.[11] The first observation of light deflection was performed by noting the change in position of stars as they passed near the Sun on the celestial sphere. The observations were performed in May 1919 by Arthur Eddington and his collaborators during a total solar eclipse,[12]

Quantum Mechanics Concepts and Application, Second Edition by Nouredine Zettili, Wiley & Sons, 2009 paragraph 1.2.6.1 (p 50) discusses "Energy levels of the Hydrogen Atom." Equating the electrostatic force with the centripetal force.

$$\frac{q^2}{4\pi\varepsilon_0 r^2} = \frac{m_{ekg} v^2}{r} \qquad \textbf{(}\text{Zettili } \textbf{1.65)}$$

Where: $\boldsymbol{q}$ is the charge of an electron 1.60217657 x 10^{-19} Coulombs

$\boldsymbol{m_{ekg}}$ is the rest mass of the electron 9.10938291 x 10^{-31} kg

$\boldsymbol{\varepsilon_0}$ is the permitivity of free space 8.854187817 × 10^{-12} F/m

$\boldsymbol{v}$ is velocity of the electron in meters per second

Defining the Bohr radii

$$\boldsymbol{r_n} = \left(\frac{4\pi\varepsilon_0\hbar^2}{m_e q^2}\right) \boldsymbol{n^{*2}} \qquad \textbf{(}\text{Zettili } \textbf{1.67)}$$

$\boldsymbol{\varepsilon_0 = 8.854187817\ x\ 10^{-12}\ F/m}$ permittivity of free space

$\boldsymbol{m_{ekg} = 9.10938291\ x\ 10^{-31}\ kg}$ kg rest mass of an Electron

$\hbar = \mathbf{1.054572\ x\ 10^{-34}}$ **J sec** **NIST-4** Planks reduced constant in Joule seconds

$\boldsymbol{q = 1.60217657\ x\ 10^{-19}}$ Coulomb charge of an electron

Using the subscript b, e.g. $r_{b,}$ as the designation for the first Bohr orbit.

$$r_b = \left(\frac{4\pi\varepsilon_0\hbar^2}{m_{ekg}q^2}\right)1^2 = \mathbf{0.053\ nm} = \mathbf{5.291772\ x\ 10^{-11}}\ \boldsymbol{meter} \quad \textbf{(Zettili 1.67)}$$

$$m_{ekg}\frac{v^2}{r_1} = \left(\frac{q^2}{4\pi\ \varepsilon_0\ r1^2}\right) \quad \textbf{(Zettili 1.69)}$$

Solving for v yields

$$v_b = \sqrt{\frac{q^2}{4\pi\varepsilon_0 m e_{kg} r_b}} = \mathbf{2.19\ x\ 10^6}\ \text{m/s}$$

Letting $\boldsymbol{c_0}$ be the notation for the speed of light in free space

$$v_b = \frac{c_0}{137} \quad \textbf{(Zettili 1.70)}$$

The electrostatic potential energy of electron in equation Zettili 1.71 and the associated discussion. Note: At infinite radius the potential energy yielded is zero

$$E_{electrostatic\_potential\_yielded} = \frac{q^2}{4\pi\varepsilon_0 r_b} \quad \textbf{(Zettili 1.71)}$$

In Zettili **1.72** and the associated discussion the value of $\boldsymbol{E_b}$ the electron energy is derived

$$E_b = \frac{1}{2}m_{ekg}{v_b}^2 = \frac{1}{2}\frac{q^2}{4\pi\varepsilon_0}\frac{1}{r_b} = \mathbf{2.17987\ x\ 10^{-18}}\ \text{Joules} \quad \textbf{(Zettili 1.72)}$$

Notation

1. $\boldsymbol{\omega}$ will be used for frequency in radians/second
2. $\hbar = \mathbf{1.054572\ x\ 10^{-34}}$ **NIST** Plank's reduced constant for energy in Joule sec.

All these foundational relationships are well accepted in the quantum mechanics world.

3 Electron Characteristics in the first Bohr orbit

Our hypothesis is that De Broglie waves are light waves adds one new relationship. It is well established that the frequency of a light wave is directly proportional to the energy of a photon.

$$E = \hbar\,\boldsymbol{\omega}$$

Where E is the energy in Joules

$\hbar$ is Plank's reduced constant

$\boldsymbol{\omega}$ is the radian frequency

Applying this relationship to the Bohr Energy $\boldsymbol{E_b}$ and solving for the Bohr radian frequency $\boldsymbol{\omega_b}$:

$$\omega_b = \frac{E_b}{\hbar} = \frac{2.1799 \text{ x } 10^{-18} \text{ joule}}{1.054572 \text{ x } 10^{-34}} = 2.067069 \text{ x } 10^{16} \; radians/sec \quad \text{(Wilson 0)}$$

Where the subscript b indicates that it is based on the energy of the first Bohr Orbit.

This allows a recalculation of the orbital radius r_b. Lets call the recalculated value r_{bcheck}.

The radius can be calculated from the velocity and the radian frequency.

$$r_{bcheck} = \frac{v_b}{\omega_b} = \frac{2.18769 \; x \; 10^6}{2.067069 \; x \; 10^{16}} = 1.058354 \; x \; 10^{-10} \quad \textbf{Wrong!} \quad \text{(Wilson 1)}$$

"Houston, we've had a problem here."

$r_{bcheck} = r_b * 2$ which will be labeled here as the Bohr energy discrepancy

The classical Bohr energy calculation does not fit

the hypothesis that De Broglie waves are light waves.

The force balance equation (Zettili 1.65) provides another way to derive the relationship between energy and velocity. This equation balances the inward electrostatic force against the centrifugal force from the electron velocity.

$$\frac{q^2}{4\pi\varepsilon_0 r^2} = \frac{m_{ekg} v^2}{r} \quad \textbf{(}\text{Zettili } \textbf{1.65)}$$

Multiplying both sides of the equation by r

$$\frac{q^2}{4\pi\varepsilon_0 r} = m_{ekg} v^2 \quad \text{(New Wilson 2)}$$

Where the left side of the equation is

$$E_{electrostatic\_potential\_yielded} = \frac{q^2}{4\pi\varepsilon_0 r_b} \textbf{ Joules} \quad \textbf{(}\text{Zettili } \textbf{1.71)}$$

And the right side of the equation is the relativistic ($like \; E = mc^2$) total kinetic energy of the electron in the same sense as the total energy in a mass in the theory of relativity

Thus the correct relativistic equation for the first orbit Bohr total energy E_{br1} is

$$E_{br1} = m_{ekg} {v_b}^2 = 9.10938291 \; x \; 10^{-31} \left(2.18769 \; x \; 10^6\right)^2 = 4.359744 \; 10^{-18} \quad \text{(Wilson 3a)}$$

$$\omega_{br} = \frac{E_{br1}}{\hbar} = \frac{4.359744 \; 10^{-18} \text{ joule}}{1.054572 \text{ x } 10^{-34}} = 4.134137 \text{ x } 10^{16} \; radians/sec \quad \text{(Wilson 3b)}$$

$$r_{bcheck} = \frac{v_b}{\omega_{br}} = \frac{2.18769 \; x \; 10^6}{4.134137 \text{ x } 10^{16}} = 5.291772 \; x \; 10^{-11} \quad \textbf{Right!} \quad \text{(Wilson 3c)}$$

Using the energy of (Wilson 3a) results in an $r_{btcheck}$ equal to the NIST radius i.e. the Bohr discrepancy is eliminated.

At this point the justification for the energy calculation is that it is a direct derivation from Zettili 1.65 which is well accepted in quantum mechanics.

That should not be enough but hold onto the thought.

4 Light Model of Electron in Free Space

Now moving on from the Bohr atom to consideration of an electron in free space.

4.1 Hypothesis

Hypothesis: A De Broglie wave is a photon of light and to a stationary observer speed of light is a variable, thus the velocities calculated in the above sections are light velocities.

Corollary: It should be noted that if you were riding on the electron orbiting the proton and measured the speed of light, you would get C_0, the speed of light in free space, BUT because of the Lorentz contraction of your space the actual speed of light to an observer at rest would be the velocities developed in the previous section. The implication is that in the equation $E=mc^2$ the mass is the rest mass and the Energy state and c are the variables. With that in mind we have

$c^2 = E/m$ where m is the fixed element of the equation.

With this hypothesis and corollary as a foundation, the conceptual model will be developed assuming that an electron is a slow moving light wave.

The entire Bohr discussion above is consistent with this hypothesis

4.2 Mathematics of an Electron in Free Space

Applying the Bohr principles to an electron in free space leads to somewhat different results.

Starting from the NIST value of the electron radius:

$$\boldsymbol{r_{eNIST} = 2.817940\ x\ 10^{-15}\ \text{meters}}$$

The equation for the kinetic energy of the photons is submitted on the basis, that reasonable values of photon velocity work through a "reasonable" re-interpretation of the energy equation to achieve an $\boldsymbol{r_{echeck}}$ equal to the $\boldsymbol{r_{eNIST}}$. The value of $\boldsymbol{v_e}$ was adjusted until the $\boldsymbol{r_{echeck}}$ was correct.

$$\boldsymbol{v_e = \ 3.450525\ x\ 10^3} \qquad \text{(Wilson 4)}$$

$$\boldsymbol{E_e = m_{ekg}\ {v_e}^4 = \ 1.291307\ x\ 10^{-16}\ \text{Joules}} \qquad \text{(Wilson 5)}$$

$$\boldsymbol{\omega_e \ = \frac{E_e}{\hbar} \ = \frac{1.291307\ x\ 10^{-16}\ \text{Joules}}{1.054572\ \text{x}\ 10^{-34}} = 1.22448510^{18}\ Joule/sec} \qquad \text{(Wilson 6)}$$

$$\boldsymbol{r_{echeck} = \frac{v_e}{\omega_e} = r_{eNIST}} \qquad \text{(Wilson 7)}$$

These mathematics are offered on the basis that the results indicate they are somehow related to reality – as the introduction stated this is a beginning, not a completed work. A possible

implication is that the velocity interaction with the magnetic field is source of the difference from the electron in the hydrogen atom.

Studies to derive these equations on fundamental principles will be the next focus of study and the reader is invited to contribute to this website.

The conceptual model argues strongly for the adaptation of this model.

5 Photon Model of the Electron in Free Space

Figure 5-1 below shows the chosen coordinate system in the middle, and a uniform monochromatic plane wave of light moving in a circle into the paper (z^ direction) on the left and out of the paper on the right. The postulated motion of the plane wave is a circular path of length Lambda i.e. one wavelength and a photon of this same length.

Setting Theta, the angular measurement to zero at the left hand, and using clockwise from the top (+y) direction for positive angular measurement yields the right hand position at Theta = 180 degrees and a reversed direction of motion.

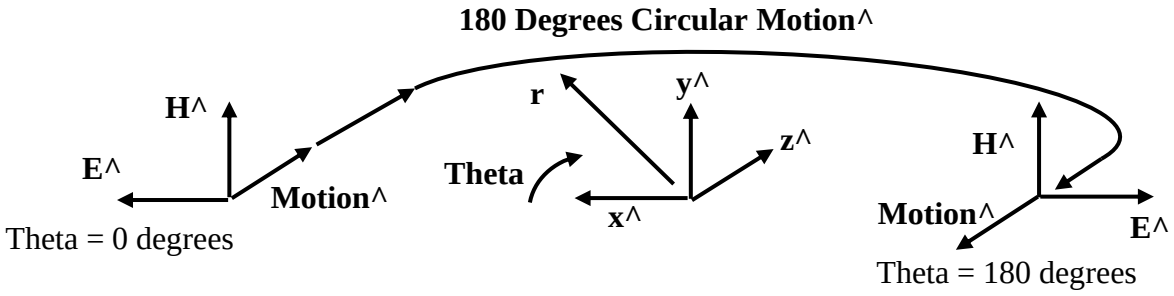

Figure 5-1 Plane Wave of Light Moving in a Circular Motion of Path Length Lambda

Note: E^ and H^ are unit vectors indicating the positive direction of the related field not the value of the field at that position.

In this case the time variation of the light wave is exactly the same as the angular variation.

Phase = Theta

As a result of the length of the photon being equal to the circular length Lambda, there is always a point on the photon at every point on the curve so despite the circular velocity, the wave is stationary in value at every point.

Letting the Phase be zero at the left hand point so that E (0) = E_0 Cos(Theta)

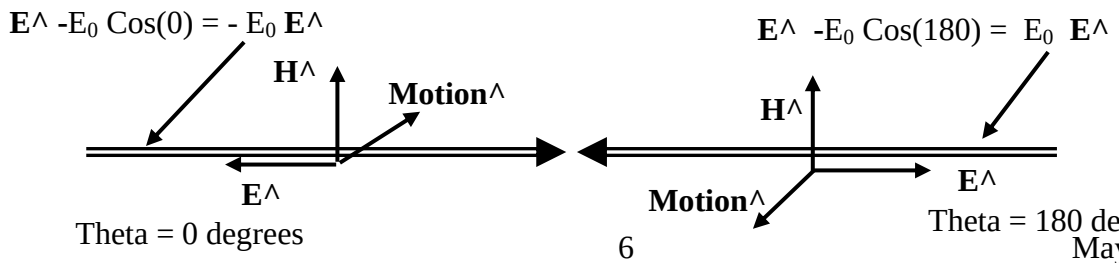

Figure 5-2 Graphical Presentation of E field at theta = 0 and 180 degrees

Notice that both E field vectors point toward the middle i.e. there is a divergence of a negative q field from the center of the electron which is the charge.

Written

$Del * E = Q$ Maxwell's differential equation for Divergence of E field from charge

On the other hand there is no inversion of the H^ field reference vector thus the H field inverts between Theta = 0 and Theta = 180 as shown in Figure 5-3 below resulting in a magnetic dipole, a well-known characteristic of an electron.

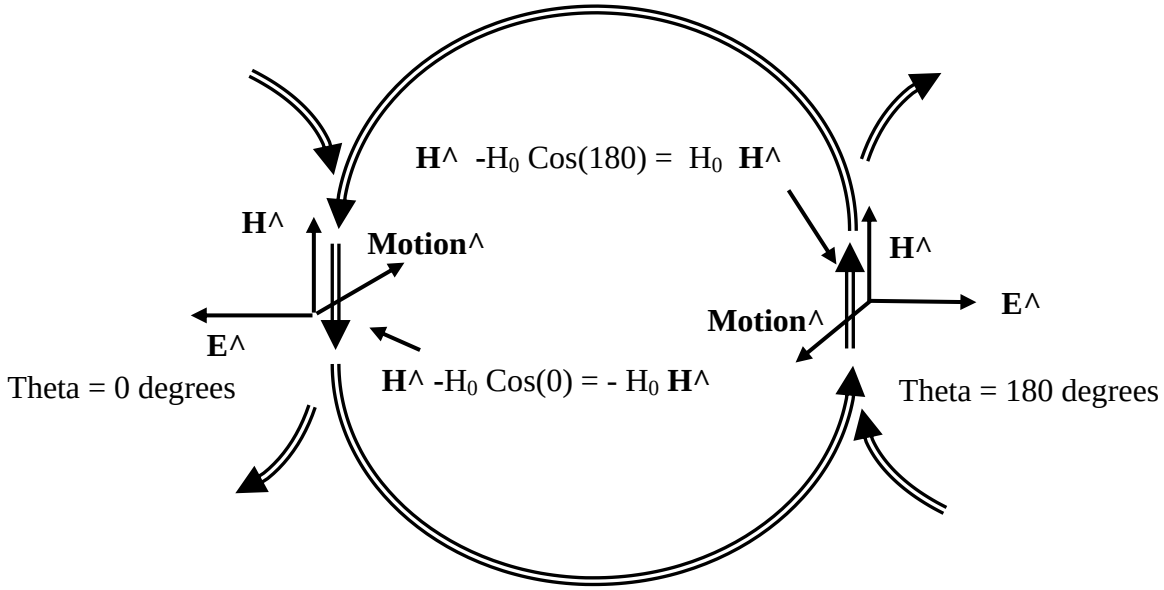

Figure 5-3 Graphical Presentation of H field Dipole at Theta = 0 and 180 degrees

5.1 Photon Model of a Positron

The light model of the positron is exactly the same as the electron except the light travels in opposite direction in the circular pattern i.e. counter clockwise as viewed from the top in this model.

5.2 In Plane Orthogonality

Those who have already correlated the discussion will recognize that there is no significant Ez field in the model as presented, and at theta = 90 degrees, the H field also goes to zero in the same manner. That problem is addressed by recognizing that two waves that are 90 degrees out of phase are orthogonal. Thus the energy can be divided equally between two photons 90 out of phase and traveling together.

Thus the E total in this plane is the sum of the contribution of both photons based on the fact that their peaks are ninety physical degrees apart.

E_1 = - x^ * E_0 Cos(Theta) Would then be the contribution from section 5.1

E2 = -z^ * E0 Sin(Theta) Would be the contribution of the orthogonal photon

E_{xz} = E1 + E2 = -E0 (- x^ * Cos(Theta) - z^ * Sin(Theta))

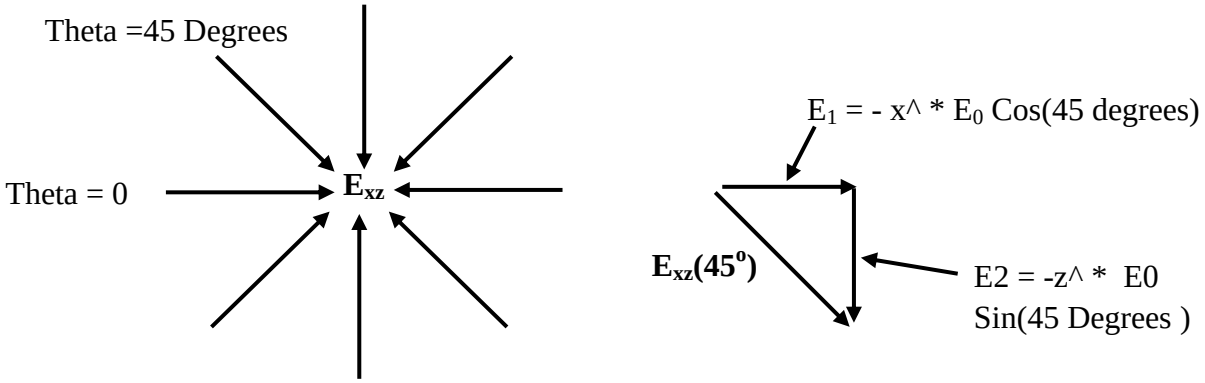

Figure 5 -4 E_{xz} is a vector spinning in the xz plane of magnitude –E0

5.3 Orthogonality in Three Planes

The above discussion deals with the uniformly radiating field in the xz plane, but an electron has a radiating field in all three planes xz, xy, and yz. Thus the more complete model of the electron includes six degrees of orthogonality, two in phase and three in planes, each of which can be described using the concepts above and inherent dispersion factor of 1/(4π) used to calculate the dispersion of the electron charge into four steradians.

Thus an electron is comprised of six individual photons each orthogonal to the others.

5.4 Quarks Parts of an Electron Included???

If you throw high energy particles or photons at larger particles you can knock off any part of an electron or all of it.

If you knock off one plane of motion the remainder has a charge of 2/3 electron

If you knock off two planes of motion, the remainder has a charge of 1/3 electron

If you knock off all of an electron you change neutron into a proton.

It is not obvious what happens when you knock off one of a pair of photons orbiting in a specific plane.

That sounds suspiciously like the characteristics of a quark!

6 Acknowledgement, Experimental Evidence and Conclusion

The questions that led to this paper were posed by my son Chris Wilson based on his reading on the general theories of the universe. Armed with a high school education and an inquisitive mind, he had concluded that the speed of light had to be a variable

Experimental evidence is given in Scientific American Volume 310, #2, February 2014, cover and page 32, where Jan C. Bernauer and Randolph Pohl pose the "Proton Radius Problem," i.e. the proton radius measured with electrons is larger than that measured with the heavier muons. This paper would predict the difference in proton radius from the increased energy density during the measurement caused by the 200 times greater mass of the muon.

Conclusion: Chris Wilson was right, the speed of light is a function of the local energy density and everything is made of light.