Helical Electromagnetic Waves

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Abstract

Our objective is to look at the electromagnetic wave in a way in which we can see the continuous conservation of energy using theoretical physics. The magnetic field energy M is at maximum when the electric field energy E is at minimum and vice versa. They are perpendicular sine and cosine waves. Light is a sequential machine. E-M-E-M-E-M. The total energy is continuous and conserved as the one is transformed into the other. We will also look at the underlying ring structure and mechanism of the "light wave" using Euler's equations of torque-free precession. We will see that the speed of light is caused by the rate at which the electric and magnetic fields sequentially advance and transform into each other. This paradigm also allows us to see that loops of light waves may be the basis of elementary particles.

Key Words

The electric and magnetic phases are 90 degrees apart in light or EM radiation, electromagnetic waves, Ampere's law, Faraday's law, Maxwell's displacement current, the speed of light is caused by the rate of transformation of the electric or magnetic fields into each other, light as a sequential machine, light as flux tubes, photons or light as rings, particles as rings of light, Euler's equations

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Authors Note

This document was written with Latex `http://latex-project.org/ftp.html` and TexStudio `http://texstudio.sourceforge.net/`, both of which are excellent, open-source and free. The PDF pages it produces can be read in two page view and printed two pages at a time in landscape to save paper or make a book.

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1 Introduction

We take a theoretical look at the electromagnetic wave in terms of the conservation of energy. This requires that the magnetic field energy, M, is at maximum when the electric field energy, E, is at minimum and vice versa. They are perpendicular sine and cosine waves. Light is a sequential machine. E-M-E-M-E-M. The total energy is continuous and conserved as the one is transformed into the other. We will also look at the underlying ring structure and mechanism of the "light wave" using Euler's equations of torque-free precession. We will see that the speed of light is caused by the rate at which the electric and magnetic fields sequentially advance and transform into each other. This paradigm also allows us to see that loops of light waves may be the basis of all elementary particles. We will look first at the

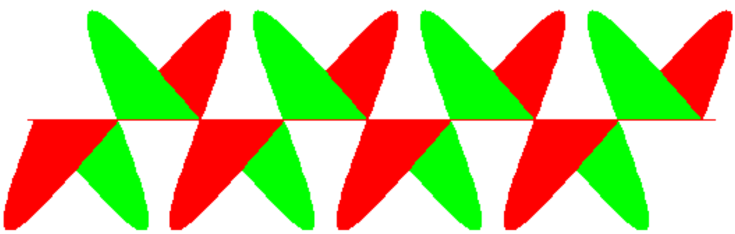


Figure 1: Maxwell and Hertz

electromagnetic wave of Maxwell and Hertz where the aether is the medium of propogation for the wave [1]. The perpendicular electric and magnetic waves are in phase as shown on figure (1). The energy of the wave which is required for the next alternation of the wave is considered stored in the elastic spring-like quality of the aether. The wave is at zero amplitude along the line where the energy of the wave is discontinuous. It is the energy previously stored in the aether which produces the opposite alternation of the wave.

They only look like bird wings. The red and green waves are perpendicular and in phase sine waves. They come to a zero point on the line at the same place and time. The energy at this time is discontinuous.

J.C. Maxwell used the elastic medium of the luminiferous aether to store the energy of the waves like a compressed spring for the next cycle.

Hertz concurred [2]. Three problems: no aether, no spring, no obvious mechanism to possess or transfer energy or angular momentum. This is the oddly usual view of electromagnetic waves.

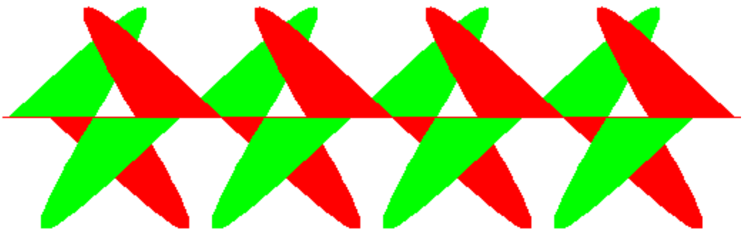


Figure 2: An alternative view

With figure (2) we choose a slightly different path See the animation [3]. The vacuum of space is a vacuum. Without the aether we must modify the wave form and postulate that the magnetic field energy is at maximum when the electric field energy is at minimum and vise versa. The red and green waves are perpendicular but they are out of phase by 90 degrees. They are sine and cosine waves. The one is transformed into the other. When one wave has maximum energy the other wave has minimum energy so the total energy is continuous and conserved. We will see them as sequential machines. Maxwell called it, "Using mechanical illustrations to assist the imagination, but not to account for the phenomena." Pendulums, Hook's law oscillators, current and voltage in LC oscillators, MRI and transmitter antennas all share this relationship. Light has the same behavior. All share the same math.

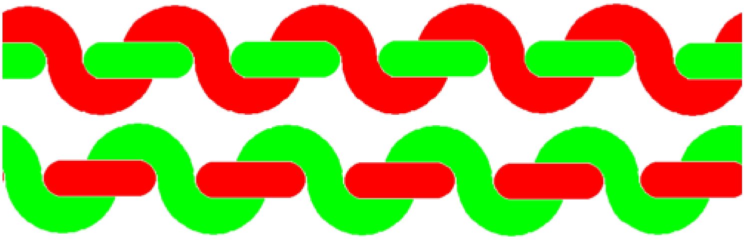


Figure 3: Top and Side Views of Braided Wires

At the top of figure (3) we are looking at the red plane of figure (2) where red loops around the green. At the bottom of the figure (3) we are looking at the green plane of figure (2) where the green loops around the red.

These red and green wires are not the right shape for electromagnetic waves since the the wires do not go to zero diameter at a change in direction, but they are close. They are fun to make out of colored wires, see (10.5). The red and green are correctly, 90 degrees out of phase. The red and green oscillate in perpendicular planes. They rotate 90 degrees four times per wavelength or 360 degrees per wavelength. They demonstrate the torque around a perpendicular axis.
How does this work?

A torque around one of three perpendicular axes produces a torque perpendicular to the other two axes in a gyroscope. Here the axes of the torque is moving with the waves. This is gyroscopic precession and movement in the direction of travel of the wave. This is a very odd gyroscope indeed. We will explore this later using Euler's equations.

On the left in figure (4) we see Faraday's law. The green flux of B times the area of the loop equals red -E times the cir-

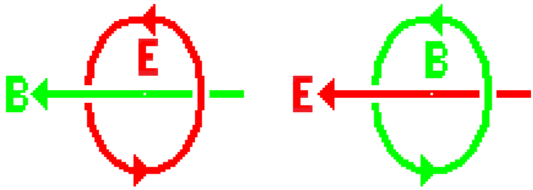


Figure 4: Faraday's and Ampere's Laws

cumference. A flux causes a looping around or a looping around causes a flux. A looping or rotating E causes a flux of B. A flux of B causes a looping or rotating E.

On the right in figure (4) we see Ampere's law plus Maxwell. The red flux of E times the area of the loop equals green B times the circumference. A flux causes a looping around or a looping around causes a flux. A looping or rotating B causes a flux of E. A flux of E causes a looping or rotating B.

Galaxies and solar systems may form around currents in space as in the plasma universe [6]. This is a flux causing a looping around. The disks around proto-stars [7] frequently have jets as do galaxies. This is a looping around causes a flux (jet). Faraday's and Ampere's laws at a huge scale.

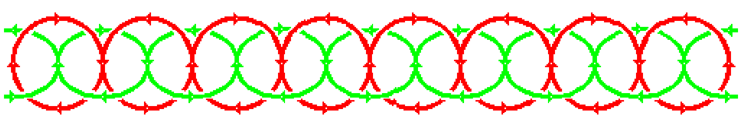


Figure 5: A Chain of Faraday's and Ampere's Laws

In figure (5) we see a chain using the laws of Faraday and Ampere from figure (4). If these are standing waves they might be self sustaining if the chain were looped into a ring.

In figure (6) we see the four strands from figure (5) which

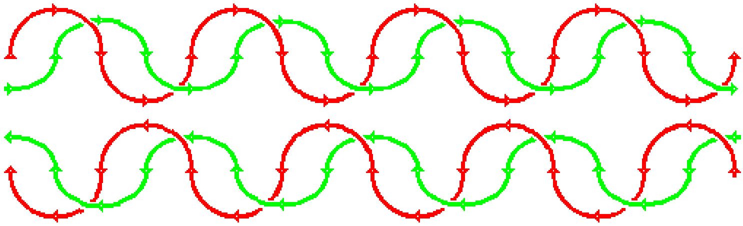


Figure 6: Two Halves and Four Strands from the Chain

have now been divided into two sets which now follow the sine and cosine waves of figure (7). Each half is identical but they travel in opposite directions. Figure (5) can also be looped. These rings could be related to Bostick's plasmoid [8] or these rings flipping end over end might look like a sphere and could be related to ball lightning, articles by Louis [9] or Wiki [10].

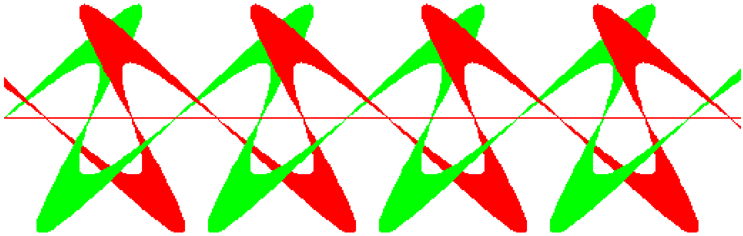


Figure 7: Flux Tubes

In figure (7) we see stylized sine and cosine waves. See the animation [4].This is similar to figure (2) but we see them now as flux tubes with their thickness proportional to their energy content. Their zero crossings are along the line. Each plasticine element of the flux tube begins and ends at a point. We see a continuous cycle of

$$red\ up \rightarrow green\ right \rightarrow red\ down \rightarrow green\ left \rightarrow red\ up$$

This is something like a Halbach array [5]. Energy alternates between the red and green waves as each wave induces the other through its own collapse. The one is transformed into the other. The maximum of energy moves forward and rotates. Light has spin and can transfer angular momentum.

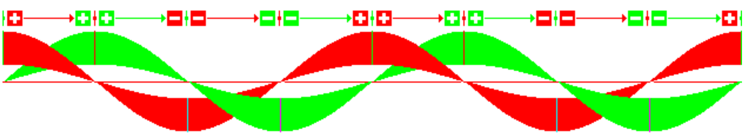
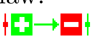
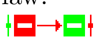


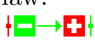
Figure 8: Transformation and an Induction Indicator

Figure (8) is another view of figure (7). The red and green flux tubes are still perpendicular but they are drawn flat so they can be scaled. Above the waves is an induction indicator showing how the waves are transformed. Red is transformed into green. Green is transformed into red. Working sequentially left to right showing cause and effect for the four steps of one wavelength of figure (8) while using figure (4):

 The red in is transformed into the green out. Ampere's law.

 The green in is transformed into the red out. Faraday's law.

 The red in is transformed into the green out. Ampere's law.

 The green in is transformed into the red out. Faraday's law.

1.1 The speed of light

is the speed that the green B magnetic field or the red E electric field, loops around and augers to the right. The index of refraction, of the medium, reduces the velocity. The quarter

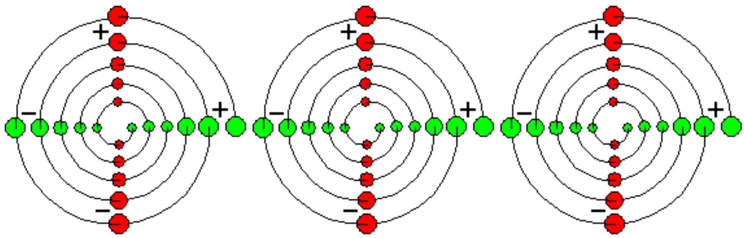


Figure 9: Helical Electromagnetic Waves

wavelength pulse of flux, through the quarter circle of area, produces a quarter wavelength looping around the circumference, a quarter wavelength advance of the electromagnetic wave, in $wavelength/(4 \cdot c)$ *seconds*.

Figure (9) is an end view of three parallel approaching light beams of figure (8). We seem to be looking down an approaching rotating cylinder with flux tubes on its perimeter. The peaks of the cross sections through the flux tubes are shown as colored circles. The peaks of the flux tubes are also shown on figure (8) where they are marked by the vertical lines through the flux tubes.

It is easy to follow a clockwise path around figure (9) starting at the top,

$$+E \to +B \to \neg E \to \neg B \to +E \text{ or with figure (8)}$$
$$red\ sine \to green\ cosine \to red\ \neg sine \to green\ \neg cosine$$

Light and all electromagnetic radiation can be seen as a sequential machine advancing on a helical path with four fluid transitions per wavelength.

The helical structure and the transition delay between the peaks accounts for the velocity and refraction [11] of light.

The transition delays are proportional to the wavelength of the light and the medium. Each transition advances the light like a screw by a quarter wavelength.

The beam having opposite polarity on opposite sides would be rotated in a magnetic or electrical field.

A vertical slit would show only red and a horizontal slit would show only green. This is polarization. Light can go through a hole smaller than its wavelength.

Thomas Young's double slit experiment [12] and diffraction [13] at an edge are explained by this structure.

Use your pencil to hide the green of figure (9), the beam is a double source with electric field interference. Use your pencil to hide the red, the beam is a double source with magnetic field interference. If you use your pencil is it still a Gedankenexperiment? This view of nature has some utility. What kinds of devices does it make possible?

This question was answered. By adjusting the phase of parallel beams of light, rotating the polarization, the beams may be made to attract or repell each other. This is demonstrated in this Nature [14] article or this Discover [15] article.

1.2 Pump analogy

The flux of E or B through an area makes a 90 degree turn and then B or E rotates around the circumference. In a centrifugal pump, the liquid enters the eye of the pump, the center of the impeller and makes a 90 degree turn in one plane and then a perpendicular 90 degree turn in another plane and is slung outward by the motor along a path that is parallel to the circumference.

1.3 Do we pretty much know everything?

We have no deep knowledge of the underlying reality. Our ignorance is more profound than just the missing link between quantum mechanics and relativity. Perhaps both are flawed and the pieces that each contributes to the puzzle of reality need to be rearranged by cherry-picking the best pieces of each. Science is a puzzle. When you close your eyes or walk in the dark to another room, you still know where you are because of your internal world model. Consciousness is seeing oneself mirror-like in ones internal world model. Our knowledge of reality is as riddled with voids as is swiss cheese. Our consciousness papers over these voids so our world model is perceived as smooth and uncomplicated for quick actions necessary for survival. We evolved to quickly see the face of a predator or prey in the shadows. We also see faces in the clouds. Some see the face of God. Apparently, we only see the shiny bits not the voids. We assemble these bits to quickly paint a shallow picture of reality and proceed to live our lives by rules-of-thumb based on these perceptions.

1.4 What are forces?

We see the puppets move but we don't see the strings. How are forces propagated? What is their velocity of propagation? What is inertia? These are big unanswered questions which are close to home. Do you see the absurdity of trying to answer deep question about reality, like these, with sentences which include words like "virtual"? Do you see virtual photons in the clouds? Are you seduced by these shiny bits? Do our perceptions and behaviors seem so ape like?

1.5 Perpendicular Transformations

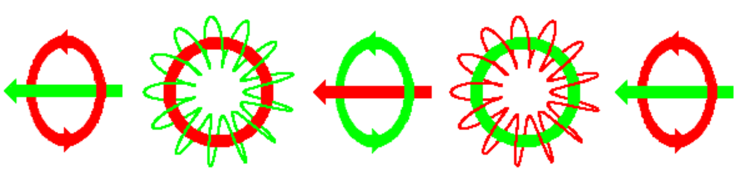


Figure 10: Perpendicular Transformations

First from the left on figure (10): The poloidal green flux of

B/($c\cdot\,\mu_0$) times the area of the ring equals or is transformed into the toroidal red E/($c\cdot\,\mu_0$) times the circumference of the ring.

$$\frac{Faraday's\ law}{c\cdot\,\mu_0} = \frac{d(B\pi r^2)}{dt}\frac{1}{c\cdot\,\mu_0} = \frac{2\pi r\cdot\,E}{c\cdot\,\mu_0} = Amps \quad (1.1)$$

Red exerts a torque around green. B, E and the area of their loops may be constant but there is looping. A change in direction is also a change over time in the flux, a dB/dt or dE/dt.

Second from the left on figure (10): The poloidal green flux which was shown as a green arrow is now shown as a green poloidal looping around the red torroidal current. The green flux is still out of the ring like the north pole of a magnet.

Third from the left of figure (10): Maxwell's changing red poloidal displacement current times the area of the tube equals or is transformed into the toroidal green current times the circumference of the tube. Green exerts a torque around red.

$$Ampere's\ law = \epsilon_0\frac{d(E\pi r^2)}{dt} = \frac{2\pi r\cdot\,B}{\mu_0} = Amps \qquad (1.2)$$

This is a cross section through the second figure. It shows a single green loop of the poloidal flux around the tube and a piece of the red ring is now shown as a red arrow. In this cross section, the former red toroidal is now red poroidal and the former green poroidal is now green toroidal. This perpendicular transformation changes our viewpoint from Faraday to Ampere.

Forth from the left of figure (10): The poloidal red flux which was shown as a red arrow is now shown as a red poloidal looping around a green torroidal current. The red flux is still out of the ring.

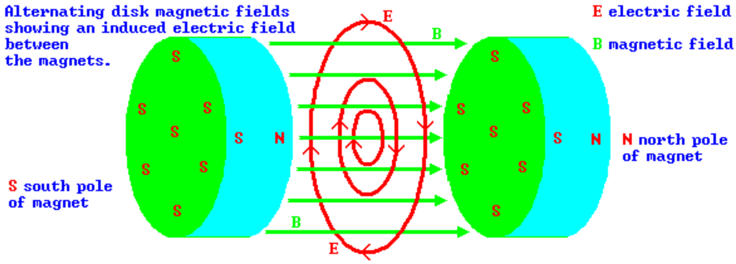
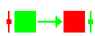


Figure 11: Faraday's law and the electromagnetic wave

2 Faraday's law

A changing magnetic flux through a circular area generates a loop electric field which accelerates the electrons in a Betatron seen on figure (11). Green is transformed into red.

 $+B \to \neg E \quad or \quad \neg B \to +E$

E and B are sine and cosine waves because they are ninety degrees out of phase. B is the cosine since it has a sign change in its derivative.
Lenz's law [31] comes from the sign change in the derivative.

$$\frac{d(cos)}{dt} = \neg sin \; or \; \frac{d(\neg cos)}{dt} = sin$$

Faraday's law is applied twice per wavelength so there is no net sign change per wavelength since, $\neg 1 \cdot \neg 1 = 1$. This sign change does not occur in Ampere's law, noting

$$\frac{d(sin)}{dt} = cos \; or \; \frac{d(\neg sin)}{dt} = \neg cos, \tag{2.1}$$

does not have a sign change.

2.1 Our derivation of Faraday's law

starts with the idea that the rate of change of B is 4πB times the frequency of the wave.

$$\frac{d(B)}{dt} = 4\pi B\cdot frequency = \frac{kg}{A\cdot s^3} = \frac{Teslas}{second} \tag{2.2}$$

$$4\pi B\frac{c}{2\pi r} = \neg\frac{d(B)}{dt} \tag{2.3}$$

frequency = c/wavelength = c/(2πr)
wavelength = 2πr
Frequency measures how many loops something, moving at c, does in the ring = 2πr, per second.
$B\cdot c = E$ in an electromagnetic wave.

$$2\cdot E = \neg r\frac{d(B)}{dt} =$$

$$E = \frac{volts}{meter} = \frac{kg\cdot m}{A\cdot s^3} = \frac{kg\cdot m}{s^2}\frac{1}{A\cdot s} = \frac{force}{charge} \tag{2.4}$$

group terms and multipy by πr

$$Faraday's\ Law = 2\pi r\cdot E = \neg\frac{d(\pi r^2 B)}{dt}\ or\ \oint E\cdot ds = \neg\frac{d(\Phi_B)}{dt} =$$

$$volts = \frac{kg\cdot m^2}{A\cdot s^3} = \frac{energy}{charge} = \frac{watts}{amps} = amps\cdot resistance \tag{2.5}$$

Toroidal red E times the circumference of the loop equals the rate of change of the poloidal magnetic flux of green B times the area of the loop. Faraday's law.
When we divide the voltage on both sides of Faraday's law by the resistance of a loop or coil of wire then we get Ohm's law: volts/resistance = amps.

$$\frac{2\pi r\cdot E}{resistance} = \neg\frac{d(B\cdot\pi\cdot r^2)}{dt}\frac{1}{resistance} = amps\ or \tag{2.6}$$

$$\oint E\cdot ds \frac{1}{resistance} = \neg\frac{d(\Phi_B)}{dt}\frac{1}{resistance} = amps \qquad (2.7)$$

The toroidal amps in the loop equals the poloidal flux of amps through the area of the loop.
This is the reversing current seen on a galvanometer, when hooked to a coil of wire, while a magnet is inserted and removed from the coil of wire. This classic experiment is strong direct evidence for Faraday's law.

2.2 Integrals of Faraday's Law

$$Faraday's\ law = \oint E\cdot ds = \neg\frac{d(\Phi_B)}{dt} \qquad (2.8)$$

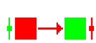
Integral form of Faraday's law from Hyperphysics [32] or Wiki [33].

$$\oint E\cdot ds = 2\pi r E = \frac{d(\Phi_B)}{dt} = \neg\frac{d(\pi r^2 B)}{dt} \qquad (2.9)$$

The line integral of the electric field equals the circumference of the loop times E.
The rate of change of the magnetic flux equals the rate of change of the area of the loop times B.

3 Ampere's law

A changing electric flux through the circular area of a plate capacitor generates a loop magnetic field as seen on figure (12). Red is transformed into green.

 $E \rightarrow B$

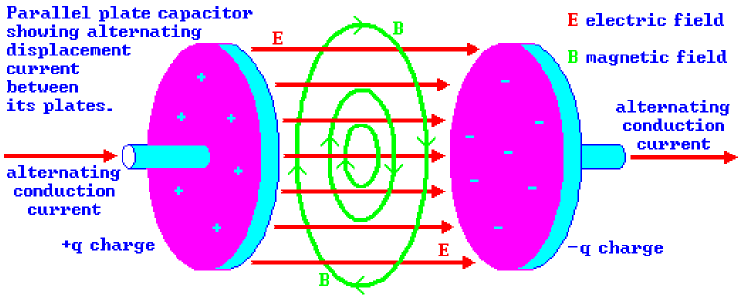


Figure 12: Ampere's law and the electromagnetic wave

3.1 Our derivation of Ampere's law

is very similar to Faraday's law. The rate of change of E is $4\pi E$ times the frequency of the wave.

$$\frac{d(E)}{dt} = 4\pi E\cdot frequency = \frac{kg\cdot m}{A\cdot s^4} = \frac{volts}{meter\cdot seconds} \tag{3.1}$$

$$\frac{d(E)}{dt} = 4\pi B\cdot c\cdot frequency \tag{3.2}$$

$E = B\cdot c$, in an electromagnetic wave.

$$\frac{d(E)}{dt} = 4\pi B\frac{c^2}{2\pi r} \tag{3.3}$$

$$frequency = \frac{c}{wavelength} = \frac{c}{2\pi r} \tag{3.4}$$

Frequency measures how many loops something, moving at c, does in the ring $2\pi r$ per second.

$$2\cdot B = \frac{r}{c^2}\frac{d(E)}{dt} = \frac{kg}{A\cdot s^2} = Teslas \tag{3.5}$$

collected terms and multiply by πr

$$2\pi r B = \frac{\pi r^2}{c^2}\frac{d(E)}{dt} \tag{3.6}$$

$$2\pi r\cdot B = \frac{1}{c^2}\frac{d(\pi r^2 E)}{dt} \quad or \quad \oint B\cdot ds = \frac{1}{c^2}\frac{d(\Phi_E)}{dt} \tag{3.7}$$

Toroidal green B times the circumference of the loop equals one over c squared times the rate of change of the poloidal electrical flux of red E times the area of the loop. Ampere's law.

$$B = \frac{kg}{A\cdot s^2} = \frac{kg\cdot m}{s^2}\frac{1}{A}\frac{1}{m} = \frac{force}{amps\cdot meters} \tag{3.8}$$

$$Force = B\cdot q\cdot v = B\cdot A\cdot s\frac{m}{s} = B\cdot A\cdot m \tag{3.9}$$

v is velocity.

$$2\pi r\cdot B = \epsilon_0\cdot \mu_0 \frac{d(E\cdot \pi r^2)}{dt} \quad or \quad \oint B\cdot ds = \epsilon_0\cdot \mu_0 \frac{d(E)}{dt} \tag{3.10}$$

Ampere's law. $1/c^2 = \epsilon_0\cdot \mu_0$.

$$2\pi r\cdot B\frac{1}{\mu_0} = \epsilon_0 \frac{d(\pi r^2 E)}{dt} \quad or \quad \frac{1}{\mu_0}\oint B\cdot ds = \epsilon_0 \frac{d(E)}{dt} = amps \tag{3.11}$$

The left hand side of the equation, the toroidal amps, due to B, in the loop equals the right hand side of the equation, the poloidal flux of amps, due to E, through the area of the loop. The right hand side of the equations are Maxwell's displacement current. We will use this, amps equals amps form, along the wavefront of the light wave.
This is the form of Ampere's law used in the ring electron [34]

3.2 Integrals of Ampere's law

$$Ampere's\ law = \oint B\cdot ds = \frac{1}{c^2}\frac{d(\Phi_E)}{dt} \tag{3.12}$$

$$\oint B\cdot ds = 2\pi r\cdot B \tag{3.13}$$

The line integral around the curve equals the circumference of the loop times B.

$$\oint B\cdot ds = 2\pi r\cdot B = \frac{1}{c^2}\frac{d(\Phi_E)}{dt} = \frac{1}{c^2}\frac{d(E\cdot \pi r^2)}{dt} \tag{3.14}$$

The rate of change of the electric flux equals the rate of change of E times the area of the loop.

$$\oint B\cdot ds = I\cdot \mu_0 + \frac{1}{c^2}\frac{d(E\cdot da)}{dt} \tag{3.15}$$

I is amps. Maxwell's modification of Ampere's law per Hyperphysics [35] or per Wiki [36].

$$\oint B\cdot ds = I\cdot \mu_0 + \epsilon_0\cdot \mu_0\frac{d(E)}{dt} \tag{3.16}$$

Substituted $\epsilon_0\cdot \mu_0 = 1/c^2$.
The above is written more clearly.

$$\frac{1}{\mu_0}\oint B\cdot ds = I + \epsilon_0\frac{d(\Phi_E)}{dt} \tag{3.17}$$

Divided by μ_0.

$$\frac{2\pi r\cdot B}{\mu_0} = I + \epsilon_0\frac{d(\pi r^2\cdot E)}{dt} = amps \tag{3.18}$$

These equations are written more clearly without the integral and flux symbols if we remember that the circumference and area both vary with time. This makes them more accessible to a larger audience but the witch doctor rarely wants to share his tricks. Wiki is especially subject to experts writing in the code of their trade with no thought to a larger audience. I could not find these these simpler equations on the Internet. They are shown in the textbooks I reference [25]. The right hand side of the equations is Maxwell's displacement current. The amps in the loop equals the flux of amps through the area of the loop.

4 Loops, tubes and rings

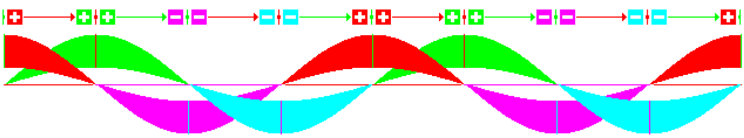


Figure 13: Flux tubes with polarity color

This looks like a double helix in figure (13) but it is the oscillating perpendicular electric and magnetic fields which are confined to their planes. We stretch these planes into three dimensions on figure (14) where we see top and side views of figure (13). These now three dimensional double helix structures are drawn to scale according to the (wavelength to fatness ratio) which are invariant features of all wavelengths. They all have the same shape. The wavelength on figure (14) was 314 pixels

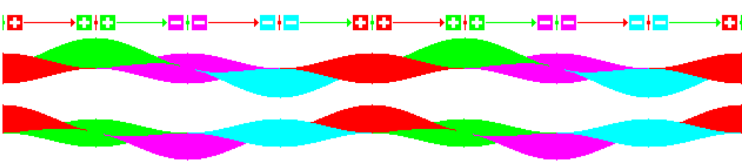


Figure 14: Flux tubes in three dimensions

and the maximum diameter of the flux tubes was 25 pixels. The flux tubes are pointy jelly beans strung together like sausages. The loops which were visible, above and below the center line on figure (13), are now hard to see on figure (14) but they are clearly shown on figure (15) as the sines and cosines of the triangles. The half wavelength flux tube segments still start and end on a point in the center. They make continuous rolling contact with a neighbor flux tube. Each wavelength may be considered another series photon.

The electric field E is a +red and -pink sine wave flux tube. E is transformed into B. E exerts a torque around B. The magnetic field B is a +green and -cyan cosine wave flux tube. B is transformed into E. B exerts a torque around E.

The cross sectional radius and ring of circumference of the flux tubes is proportional to $sine^2$ *or* $cosine^2$ as is their energy. The energy is located along the rotating circular rings of circumference of the flux tubes. E and B rotate in opposite directions. Where the E and B flux tubes touch there is a rolling contact and transfer of energy, current and circumference as the flux tubes change size. This is a three dimensional view of an action which occurs over time on the two dimensional surface of the expanding spherical wavefront. The action and flux tubes are created by expanding and shrinking ring pairs on the wavefront. We have an alternating electric field flux tube which spirals along an alternating magnetic field flux tube.
We have an alternating magnetic field flux tube which spirals along an alternating electric field flux tube.

The flux tubes on figure (14) are braided. A line between the centers of the E and B flux tubes traces out the icon of life, a double helix. Life preceeded by light. Nature shows us this shape in a stream of water or the chop on a lake. There is a circular circulation in a cross section of a wave of water or a wave of light. Here the waves only appear bean like or volume like when seen over time. The waves exist only as swirling rings of energy on an expanding two dimensional spherical wave front, only in the here and now, rain drops making rings on still water. Working left to right on figure (14) or (15) for the four steps of one wavelength.

Red in green out = red is transformed into green = +E $\rightarrow +B = d(sine)/dt \rightarrow cosine = Row\ 1\ on\ figure$ (15).

$$Ampere's\ law = \epsilon_0 \frac{d(E\cdot \pi r^2)}{dt} = \frac{2\pi r\cdot B}{\mu_0} = Amps \qquad (4.1)$$

Maxwell's red changing poloidal displacement current times the area of the loop equals the green toroidal current times the circumference of the loop.

Green in ¬pink out = green is transformed into ¬pink = $+B \rightarrow \neg E = d(cosine)/dt \rightarrow \neg sine =$ Row 2 on figure (15).

$$\frac{Faraday's\ law}{c\cdot \mu_0} = \frac{d(B\cdot \pi r^2)}{dt}\frac{1}{c\cdot \mu_0} = \frac{2\pi r\cdot E}{c\cdot \mu_0} = Amps \quad (4.2)$$

The changing green poloidal current times the area of the loop equals the toroidal pink current times the circumference of the loop.

¬Pink in ¬cyan out = ¬pink is transformed into ¬cyan = -E → -B = d(-sine)/dt → -cosine = Row 3 on figure (15).

$$Ampere's\ law = \epsilon_0 \frac{d(E\pi r^2)}{dt} = \frac{2\pi r\cdot B}{\mu_0} = Amps \qquad (4.3)$$

Maxwell's changing pink poloidal displacement current times the area of the loop equals the toroidal cyan current times the circumference of the loop.

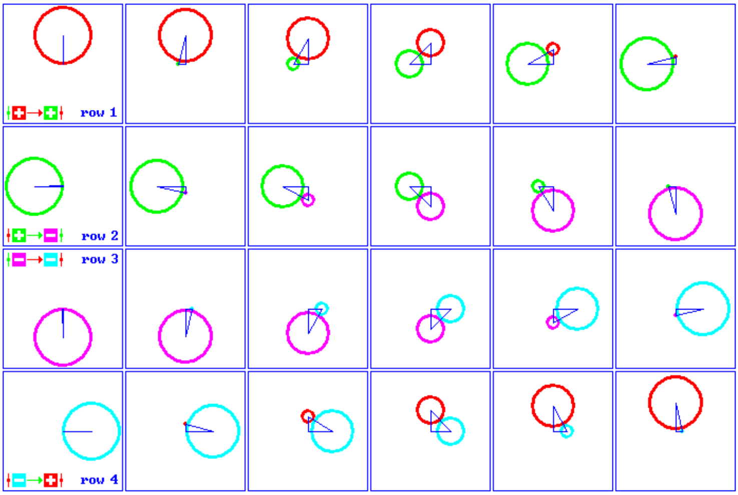
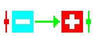


Figure 15: Cross sections through flux tubes

 $\neg Cyan\ in\ red\ out = \neg cyan\ is\ transformed\ into\ red = \neg B \to +E = d(-cosine)/dt \to sine =$ Row 4 on figure (15).

$$\frac{Faraday's\ law}{c\cdot\mu_0} = \frac{d(B\cdot\pi r^2)}{dt}\frac{1}{c\cdot\mu_0} = \frac{2\pi r\cdot E}{c\cdot\mu_0} = Amps \quad (4.4)$$

The changing poloidal cyan current times the area of the loop equals the toroidal red current times the circumference of the loop. On the flux tubes of figure (14) we saw top and side views of sine and cosine flux tubes waves.

Here on figure (15) we see an animation array showing 24 cross sections through those flux tubes per wavelength. See the animation [27].

We have end views of the cross sections of figure (14). The cross sections through the flux tubes are loops or rings which travel on the two dimensional surface of the expanding spherical wavefront. The sequence is

$$+red \rightarrow +green \rightarrow \neg pink \rightarrow \neg cyan \rightarrow +red$$

The plane of the paper is the wavefront on figure (15). The rings are on the wavefront. Light is rings of current. These rings are the substance and hold the energy of electromagnetic waves.

Rings preceed flux tubes. Any cross section through the hollow flux tubes show their origin in the rings. Flux tubes are the integration of these rings over time. The central axis of the wave is at the right angle of the triangle.

The electric field rings move up and down.

E is a $+red$ *or* $\neg pink$ *ring.*

Its radius is proportional to the $sine^2$. Vertical movement of E exerts a torque around the B horizontal axis.

We have a current in the rings and also a flux emanating from the shrinking ring and terminating in the expanding ring. The flux loops along the hypotenuse through the E and B ring pairs.

The magnetic field rings move left and right.

B is a $+green$ *or* $\neg cyan$ *ring*. Its radius is proportional to the $cosine^2$. Horizontal movement of B exerts a torque around the E vertical axis.

The energy is located on the rotating circular rings of current along the circumference of the flux tubes. The energy is proportional to the radius or circumference of the rings.

E and B rotate in opposite directions.

Where the E and B rings touch there is a rolling contact and transfer of energy, current and circumference as the rings change size. This is an action which occurs over time on the two dimensional surface of the expanding spherical wavefront.

The action and flux tubes are created by expanding and shrinking ring pairs on the wavefront.

We have an alternating electric field ring which spirals along an alternating magnetic field ring.

We have an alternating magnetic field ring which spirals along an alternating electric field ring.

Energy or frequency changes in electromagnetic waves result in tensile or compressive forces. Electromagnetic waves can be viewed as a coiled spring. When the wavelength increases the distance between the coils increases. This is a tensile force on the medium. When the wavelength decreases the distance between the coils decreases. This is a compressive force on the medium. There can be huge forces, at high currents anywhere the wavelength or frequency varies.

Exploding wires which look like fragmented spaghetti and compression damage in rail guns have been noted. See Graneau and Graneau in, "Newton versus Einstein" [26] for these and other details of the ongoing conflict between conventional theory and experiment.

The vertical or horizontal straight line motions of the rings in and out of the right angle on figure (15) are sine or cosine flux tube waves when seen over time from the perpendicular point of view of figure (14).

The circles in the animation are vaguely reminiscent of accretion disks, like those found in binary star systems, where one star streams material onto the other star. Here we expect a current to stream from one ring to the other at their point of rolling contact.

The expanding spherical shell of any electromagnetic wavefront would have polka-dots of this pattern. These rings are the only substance an electromagnetic wave has. They only exist on a wavefront. We only see the sine and cosine waves or flux tubes of figure (14) through the persistence of vision of an oscilloscope.

On the left of figure (16), a capacitor ring is shown in two stages as it shrinks. A string of charges making a ring has a uniform charge per unit length. The charge Q along the rings per unit length is uniform but the circumference and area is changing. The ring looses charge as it shrinks. A shrinking or

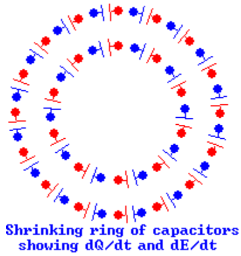


Figure 16: Shrinking and Expanding Rings

expanding ring with a charge per unit length would show dQ/dt which is Amps. A charge has an electric field E . The electric field along the ring is uniform but the length and area is changing so it shows dE/dt. This is Ampere's law.

On the right of figure (16), a magnetic ring is shown in two stages as it shrinks.

A string of magnetic beads making a ring has a uniform magnetic charge per unit length. The magnetic field B along the ring per unit length is uniform but the circumference and area is changing so it shows dB/dt. This is Faraday's law.

4.1 Transition math

$frequency \cdot wavelength = c$
$wavelength = 4 \cdot transition$
we have four ring-to-ring transitions per wavelength on figure (15)
$frequency \cdot transition = c/4$, Short wavelengths and higher frequencies have shorter transitions.
$energy = h_p \cdot frequency$, h_p is Plank's constant.
$energy \cdot transition = c \cdot h_p/4$, At higher energies the transition is shorter.

4.2 Hypotenuse, Wavelength and Ring Radius

The rings rotate in opposite directions where they touch on figure (15). The charge content of the rings rotates at the speed of light as the rings transfer charge and energy to their partner.
The ring to ring transfers occur along the line between their centers, the hypotenuse. The ring to ring transfers can be said to be a flux from the area of one ring which decreases the size of the donor to the circumference of the recipient which increases in size.
hypotenuse = wavelength/(8π), is constant.
The hypotenuse of the triangles in figure (15) and the distance between the rings are constant.
The hypotenuse rotates tracing out a double helix.
The sum of the circumferences of the ring pairs =
$2\pi\cdot hypotenuse = wavelength/4$.
It is the length of the string or ribbon of charge, in a ring orbit, making four ring to ring transfers per wavelength while traveling a distance of one wavelength at the speed of light.
$h\cdot cos^2 = wavelength\cdot cos^2/(8\pi)$, the radius of the x ring.
$h\cdot sin^2 = wavelength\cdot sin^2/(8\pi)$, the radius of the y ring.
$2\pi\cdot cos^2 + 2\pi h\cdot sin^2 = 2\pi h = wavelength/4$, the sum of the circumferences of the ring pair.
The hypotenuse in figure (15) was about 7 mm so this could be a cross sectional diagram of a
$7\ mm\cdot 8\pi = 176\ mm\ wavelength$, 1.7 Ghz electromagnetic wave.
In the waveforms of figure (14), the wavelength is 314 pixels and h the maximum radius is 12.5 pixels, so the waveform is drawn to scale.

4.3 Sharing between the rings

The end views of figure (15) are useful. We have rings, charges, fluxes, currents and energy which flow in loops in the x and y directions.

A vertical current is a $current_y$.
A horizontal current is a $current_x$.
The energy, charge, radius and circumference in the rings are transfered ring to ring and are proportional to the $sine^2$ or $cosine^2$ of the wave. We have rings, masses, charges, fluxes, currents and energy which flow in loops which move in the x and y directions.

4.4 Ring radius or energy or mass

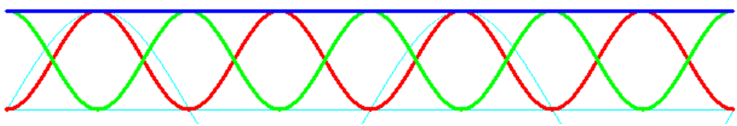


Figure 17: Ring radius or energy

In figure (17):
$Red = E\ ring =\ sin^2$.
$Green = B\ ring =\ cos^2$.
$Blue = E + B\ rings = sin^2 + cos^2$.
$Cyan$ = frequency reference sine wave.
$h{\cdot}\,cos^2\ or\ h{\cdot}\,sin^2$, are the radius of the rings. Their graphs are symmetrical. One ring grows and the other shrinks. The sum of the radii, circumferences, charge, current, magnetic charge, magnetic flux or energy of the two rings are constant. These are twice the frequency of the electromagnetic wave. The height of the graph on figure (17) indicates that the total energy from the sum of E and B is constant while oscillating between E and B. This is consistent with all the charge or energy of the wave being uniformly distributed over the sum of the circumference of the ring pairs which is $2\pi h = wavelength/4$. Any vertical line on figure (17) shows the division of the radius, circumference, charge or energy between the colors so we can write,

$$\frac{B^2}{\mu_0} = energy\ density$$

$$\frac{B^2}{\mu_0} = \left(\frac{\sqrt{c \cdot h_p \cdot \mu_0}}{wavelength^2}\right)^2 \frac{1}{\mu_0}$$

$$\frac{B^2}{\mu_0} = \frac{c \cdot h_p \cdot \mu_0}{wavelength^4} \frac{1}{\mu_0}$$

$$\frac{B^2}{\mu_0} = \frac{c \cdot h_p}{wavelength^4}$$

$$\frac{B^2}{\mu_0} \cdot wavelength^3 = \frac{c \cdot h_p}{wavelength} = total\ energy \tag{4.5}$$

This is energy density times wavelength cube equals energy.
h_p *is Plank's constant.*

$$\frac{B^2}{\mu_0} \cdot wavelength^3 \cdot (sine^2 + cosine^2) = \frac{c \cdot h_p}{wavelength}$$

using $(sine^2 + cosine^2) = 1$,

$$\frac{B^2}{\mu_0} \cdot wavelength^3 \cdot sine^2 + \frac{B^2}{\mu_0} \cdot wavelength^3 \cdot cosine^2 = \frac{c \cdot h_p}{wavelength}$$

and $B^2 = E^2/c^2$ so,

$$\frac{B^2}{\mu_0} wavelength^3 \cdot sine^2 + \frac{E^2}{c^2 \cdot \mu_0} wavelength^3 \cdot cosine^2 = \frac{c \cdot h_p}{wavelength}$$

and $1/c^2 = (\epsilon_0 \cdot \mu_0)$ so,

$$\frac{B^2}{\mu_0} wavelength^3 \cdot sine^2 + \epsilon_0 \cdot E^2 \cdot wavelength^3 \cdot cosine^2$$

$$= \frac{c \cdot h_p}{wavelength} = total\ energy \tag{4.6}$$

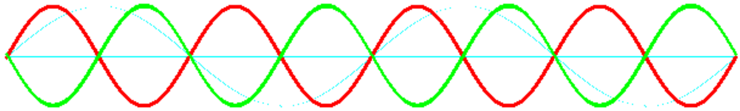


Figure 18: The rate of change of the rings

4.5 The rate of change of the rings

$Red = E\ ring = 2 \cdot sin \cdot cos.$
$Green = B\ ring = \neg 2 \cdot sin \cdot cos.$
$Cyan = frequency\ reference\ sine\ wave.$

In figure (18) we see the rate of change of the radius, circumference, charge or energy of the rings. The rates of change are maximum when the rings have the same size. The rates of change are minimum when the rings have their maximum or minimum radius. In figure (15) we expect a current to stream from one ring to the other at their point of contact. In figure (18), above the center line the current flows in and below the line the current flows out. The current flowing out of one ring equals the current flowing into the other ring just like the flow through a junction in hydraulic calculations. A shrinking or expanding ring with a charge per unit length would show a dq/dt = Amps ring to ring current.

4.6 Rate of change of ring circumference

$$\frac{d(2\pi r \cdot frequency)}{dt} \tag{4.7}$$

The rate of change of the length of the circumference,

$$\frac{d(2\pi r)}{dt},\ has\ units\ of\ velocity = \frac{meters}{second}$$

$$\frac{d(2\pi r)}{dt} = \frac{d(2\pi h \cdot sin^2)}{dt} = \frac{2\pi \cdot wavelength}{8\pi} \frac{d(sin^2)}{dt} \tag{4.8}$$

$$\frac{d(2\pi r)}{dt} \cdot frequency = \frac{wavelength}{4} \frac{d(sin^2)}{dt} \frac{c}{wavelength}$$

$$\frac{d(2\pi r)}{dt} \cdot frequency = \frac{c}{4} \frac{d(sin^2)}{dt} = \frac{c \cdot sin \cdot cos}{2} \tag{4.9}$$

5 Current in the rings

Current is the rate of change of the ($Amps \cdot seconds$) charge.

$$\frac{d(Amps \cdot seconds)}{dt} = \frac{d(charge}{dt}) = Amps \tag{5.1}$$

q_w is the total charge.
q_w is spread over the sum of the circumference of the rings.

$$q_w = \frac{Ce}{\sqrt{2\alpha}} = \sqrt{\frac{h_p}{c \cdot \mu_0}} = Amps \cdot seconds \tag{5.2}$$

$$\frac{q_w}{total\ length\ of\ loops} = \frac{4 \cdot q_w}{wavelength} \tag{5.3}$$

This is the charge per unit length.
The sum of the circumference of both loops is the wavelength/4.

$$\frac{dq}{dt} = \frac{4 \cdot q_w}{wavelength} \frac{d(2\pi r \cdot frequency)}{dt} =$$

$$\frac{dq}{dt} = \frac{q_w \cdot c \cdot 2 \cdot sin \cdot cos}{wavelength} = q_w \cdot frequency \cdot 2 \cdot sin \cdot cos = Amps$$

$$q_w \cdot frequency \cdot \frac{d(sin^2)}{dt} = Amps \tag{5.4}$$

which flow from ring to ring
This is in the form, the charge per unit length times the velocity of the charge,

$$\frac{charge}{meter} \cdot \frac{meter}{second} = \frac{charge}{second} = \frac{Amps \cdot seconds}{seconds} = Amps \tag{5.5}$$

How could we know anything without units?

5.1 E in the rings and dE/dt

Anything that has a charge has an electric field. The electric field may point charge to charge, or be generated in a loop like Faraday's law. We will see a loop as a bipolar unit, like a long bar magnet, length of spherical magnets or magnetic beads, whose oppositely charged ends have looped around and stuck together thereby loosing its bipolar character. The charge of the wave is quite small and is spread over the length of the rings. The static electric field due to this small charge is also very small. A shrinking or expanding ring with a charge per unit length would have a dE/dt. The dynamic rate of change of the electric field, which is a product of multiplication of the small charge by the rate of change of the circumference times the frequency, can be very large.

We postulate a bipolar electric field for the flux units where opposite polarity may hold the flux units into rings. This constitutes a tensile strength associated with the electrical flux, an electrical pinch force. When the units in the rings from figure (19) are held together by this bipolar electric field the electric field is confined within the ring but the perpendicular bipolar magnetic field is exposed.

$$\frac{E_{total}}{total\ length\ of\ loops} = \frac{4\cdot E_{total}}{wavelength} \tag{5.6}$$

This is the E charge per unit length. E_{total} is the total E spread over the circumference of the rings.
The sum of the circumference of both loops is the wavelength/4.

$$\frac{dE}{dt} = \frac{4\cdot E_{total}}{wavelength}\frac{d(2\pi r\cdot frequency)}{dt} = \frac{4\cdot E_{total}\cdot c\cdot 2\cdot sin\cdot cos}{wavelength} \tag{5.7}$$

This is in the form,

$$\frac{E}{meter}\cdot\frac{meter}{second} = \frac{E}{second} = \frac{dE}{dt} \tag{5.8}$$

$$\frac{E_{total}\cdot c}{wavelength}\cdot 2\cdot sin\cdot cos =$$

$$E_{total}\cdot frequency\cdot 2\cdot sin\cdot cos = 4\pi E\cdot frequency \tag{5.9}$$

This is Ampere's law if

$$E_{total}\cdot 2\cdot sin\cdot cos = 4\pi E\cdot 2\cdot sin\cdot cos = \frac{d(sin^2)}{dt} \tag{5.10}$$

5.2 B in the rings and dB/dt

A string of magnetic beads has a magnetic charge per unit length. A shrinking or expanding ring with a magnetic charge per unit length would show a dB/dt.

$$\frac{B_{total}}{total\ length\ of\ loops} = \frac{4 \cdot B_{total}}{wavelength} \tag{5.11}$$

This is the B charge per unit length.
B_{total} is the total B spread over the circumference of the rings. The sum of the circumference of both loops is the wavelength/4.

$$\frac{dB}{dt} = \frac{4 \cdot B_{total}}{wavelength} \frac{d(2\pi r)}{dt} = \frac{4 \cdot c \cdot B_{total}}{wavelength} \cdot 2 \cdot sin \cdot cos \tag{5.12}$$

This is in the form,

$$\frac{B}{meter} \frac{meter}{second} = \frac{B}{second} = \frac{dB}{dt} =$$
$$\frac{B_{total} \cdot 2 \cdot sin \cdot cos \cdot c}{wavelength} = B_{total} \cdot 2 \cdot sin \cdot cos \cdot frequency \tag{5.13}$$

$dB/dt = 4\pi B \cdot frequency.$
This is Faraday's law if
$B_{total} \cdot 2 \cdot sin \cdot cos = 4\pi B\ or\ \neg 2 \cdot sin \cdot cos = d(cos^2)/dt.$

5.3 New currents

The rate of change of the charge on each ring as the rings change size constitutes a current which flows from ring to ring across the plane of the wavefront. The extremes of the waves, on figure (18), are the maximum currents flowing ring to ring.

5.4 The link between rings on the wave front and their perpendicular waves

We have seen toroidal currents which flow ring to ring on the wavefront. We must also describe these same currents flowing forward at the speed of light with the wavefront through the flux tubes according to Faraday's and Ampere's law.

A poloidal flux through an area produces a toroidal voltage or current in a circumference.

When Ampere's law was written to show Maxwell's displacement current we noticed: "The toroidal Amps in the loop equals the poloidal flux of Amps through the area of the loop."

This is the link between the toroidal current flowing ring to ring on the wavefront and the poloidal current flowing through the area perpendicular to the wavefront.

Ampere and Faraday are about perpendicular relationships. The toroidal current flowing ring to ring on the wavefront equals the perpendicular polodial current flowing through the flux tubes.

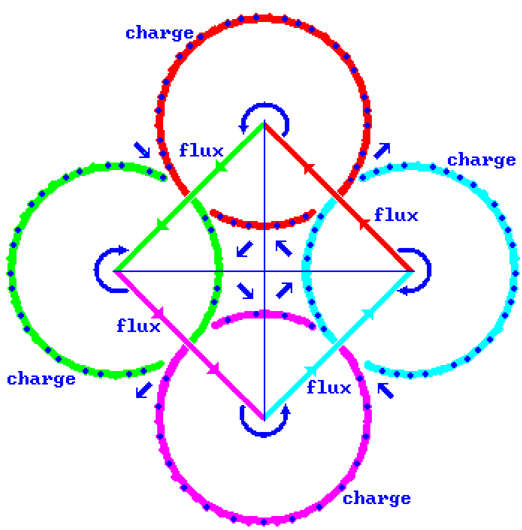


Figure 19: Cross section through flux tubes

We see a face view in figure (19). The cross sections through the flux tubes in the animation are rings. Only two rings can exist at a time but here we have shown all four rings so you can see their rotations and transformations. The center arrows show the counter-clockwise direction of the transformations. These rings evolved from earlier work on spirals [28]. See the spiral animation [29].

The rings, at this scale, are charged colored ribbons. They unroll from one ring and roll onto the next ring. They transform where the ribbon changes colors, E becomes B or B becomes E.

$$+red \rightarrow +green \rightarrow \neg pink \rightarrow \neg cyan \rightarrow +red$$

The color changes where the rings touch. Visualize a uniform charge distributed over the variable circumference of both rings. The rate of change of the charge is a current transfered ring to ring.

If the hypotenuse in figure (19) is about 37 mm this could be a cross sectional diagram of a $37mm \cdot 8\pi = 930$ mm wavelength, 322 Mhz electromagnetic wave. This detailed mechanistic view of electromagnetic waves makes falsifiable predictions. Standing waves of figure (14) have a fixed spacing of E and B fields. The E fields may be measured and located and the B fields inferred. Properly spaced B fields of a certain strength would apply a predictable polarizing torsion.

The electric field flux tube, in cross section, rotates counterclockwise. The magnetic field flux tube, in cross section, rotates clockwise. This suggest a simple root for their differences. Inertia can be understood as the acceleration dependent gravitational influence of the background Cosmos. We might understand the differences between the E an B fields in terms of the fields and rotation of the background Cosmos.

Figure 20: The rings and ribbons are shown face on

on figure (15), (19) and here in (20). These ring transitions are shown at a larger scale and are unrolled flat. The face and bottom have opposite charges as we see in figure (21) below by a vertical 90 degree rotation.

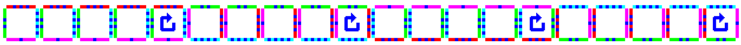


Figure 21: The rings and ribbons are shown edge on

here on figure (21). The sides where the rotation arrows are shown have little or no E or B charge. This shows the hypothetical units of charge and flux. The ribbons and rings are made from a long string of these units of flux. They each have a bipolar magnetic B field and a perpendicular bipolar electrical E field. Each unit is a flat square having a fractional $A \cdot s$ charge per unit and four E or B charged edges: As we rotate, the top is,

$$\neg E \rightarrow \neg B \rightarrow +E \rightarrow +B \rightarrow \neg E$$

These are series and parallel magnets and charges. We have series magnets which stick together while sporting parallel charges. We have series charges which stick together while sporting parallel magnets. They interact like square magnets, opposites attract, likes repell, B and E ignore each other. The ring shaped stack of units which is unrolling radiates units.

The units transform when each unit rotates and restacks. E becomes B or B becomes E by showing a different pair of edges. The edge pairs, which stick together, B and ¬B magnets or E and ¬E charges, merge into a ring.

The strong bipolar fields of the merged units are concealed within the rings. What remains is a ring, which still shows a charged top and bottom from the other perpendicular bipolar field, E and ¬E or B and ¬B.

When the rings are stuck together with magnets then the rings hide their magnetic fields internally and show their charges and vis versa.

Stacks of the units have opposite charges on their ends. The ends attract each other to loop around to make rings which hides their end charge internally.

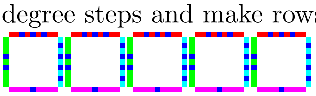
See the Beatty video [30] for this unusual and largely unnoticed characteristic of series magnets.

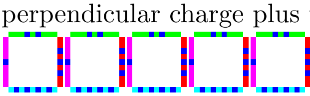
5.5 Pinch and repulsion

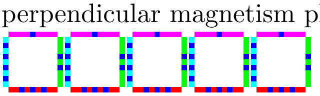
A row of parallel magnets, with their bi-poles pointing in the same direction, repell each other. If the parallel magnets are each rotated ninety degrees, they are in series, their poles now attract each other. They form rows or rings of magnets with a tensile strength. Call this opposite pair magnetic pinch and magnetic repulsion.

A row of parallel bipolar charges, with their bi-poles pointing in the same direction, repel each other. If the parallel bipolar charges are each rotated ninety degrees, they are in series, their poles now attract each other. They form rows or rings of bipolar charges with a tensile strength. Call this opposite pair electrostatic pinch and electrostatic repulsion.

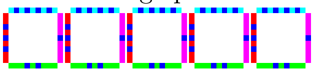
Units may have both bipolar magnetism and bipolar charge arranged in a cross or square which are assembled into rows or chains which assemble into rings. The units may rotate in ninety degree steps and make rows and rings as follows:

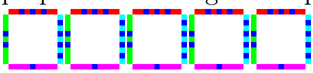

We have magnetic pinch force holding the row together, which is concealed, except for the ends which are also concealed when this loops into a ring. This has a perpendicular charge plus up.


We have electrostatic pinch force holding the row together, which is concealed, except for the ends which are also concealed when this loops into a ring. This has a perpendicular magnetism plus up.


We have magnetic pinch holding the

row together, which is concealed, except for the ends which are also concealed when this loops into a ring. This has a perpendicular charge plus down.


We have electrostatic pinch force holding the row together, which is concealed, except for the ends which are also concealed when this loops into a ring. This has a perpendicular magnetism plus down.


We have magnetic force holding the row together, which is concealed, except for the ends which are also concealed when this loops into a ring. This has a perpendicular charge plus up.

Can you see the the rings of figure (15) and (19) and the flux tubes of figure (14) in terms of series and parallel bipolar charges?

6 Magnets

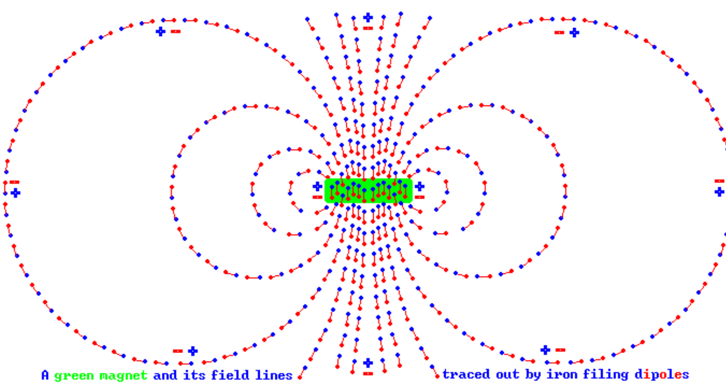


Figure 22: Iron filings and bar magnets

When you look at the pattern of iron filings on a glass or plastic over a short bar magnet you see loops or lines of magnetized iron filings stuck together by magnetism. The iron filings have become loops of tiny series magnets, loops of tiny series dipoles, curving around to the opposite poles of the bar magnet. Energy is stored in each dipole. We have to add the binding energy of the dipoles to pull them apart. We have serial tensile forces. The loops of tiny series magnets repel each other which accounts for their distance apart. The loops repel each other because their poles point in the same direction and like poles repel. The loops may stick together and clump when they are close to each other and their centers are offset. K and J [37] has an interesting magnetic field calculator which shows a pattern similar to the above for thin disk magnets. Helmholtz coils are similar. See Hyperphysics [38] for a loop or ring current.

We might say that magnetic field lines originate at the top of a magnet and return at the bottom of a magnet as they do in the figure (22) above. A much longer magnet would have its field lines stretched into a solenoid, loosing its circular symmetry, but the lines still leave the top and return to the bottom of the magnet.

When a much longer magnet is bent and closed into a loop, its top and bottom and the source and destination of the lines merge and the lines disappear so the magnetic field in a ring is concealed. If the green magnet above is stretched into a long bar magnet and bent and closed into a loop then the external field of the magnet disappears.

The huge ring currents in the electron and proton if seen would have huge magnetic fields which would disrupt the orbits of the ring electron and proton in the atom but since the ring current is closed into a loop the external fields disappears. The ring currents still cause the magnetic moment so we are left with the peculiar situation of a magnetic moment without an obvious source magnetic field.

In the ring electron [34], q moves at the speed of light, c, so we have:

$q \cdot E = q \cdot c \cdot B$, which can be written
$E = c \cdot B$,
$E^2 = c^2 \cdot B^2$, square
$E^2 = B^2/(\epsilon_0 \cdot \mu_0)$, $c^2 = 1/(\epsilon_0 \cdot \mu_0)$
$E^2 \cdot \epsilon_0 = B^2/\mu_0$, energy/volume = force/area
Coulomb repulsion pressure = magnetic pinch pressure.

Is this something which suppresses the huge magnetic field of the electron which is due to its magnetic moment?

6.1 Rings of magnetic beads or spherical magnets

have a lot of tensile strength and are hard to pull apart. They are series magnetic dipoles. Rings hide the bipolar glue of their dipolar units which holds them together in rings. Their hidden flux is confined to the ring.

Toroidal transformers are used in radio work because of their low noise or signal leakage. Rings of very strong spherical magnets have a very strong internal magnetic field and a very weak external magnetic field but they still maintain their strong tensile forces. See the Beatty video [30]. Magnets have other interesting structural assembly properties [40].

Interesting sources are K&J [37] and Neocube [39].

Warning! Magnets can be addictive. One might be subject to spousal abuse for spending too much money on too many magnets.

In a similar way, the field lines from a charge dipole or polarized atom might leave from one end and return to the other end of the dipole so we might expect a series of charge dipoles to act like the series of magnetic dipoles and hide the majority of their lines in a ring with only minor leakage and still maintain their strong tensile forces.

6.2 Magnetic beads

Bipolar atoms stick together like magnetized iron filings or strings of magnetic beads. This is like the magnetic beads in the figure below. The ends of the rows of polarized atoms have a strong

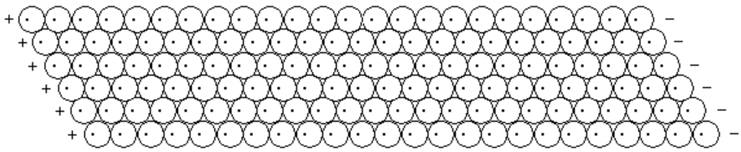


Figure 23: Neodymium magnets

polarity and strong attractive and repulsive forces. Magnets are a fun way to experiment with bipolar ideas. The ends of rows of magnetic beads have a strong polarity. These rows of magnets stick together because they are offset, close together and their poles point in the same direction.

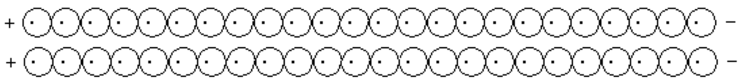


Figure 24: Like poles repel

These rows of magnets repel each other because like poles repell.

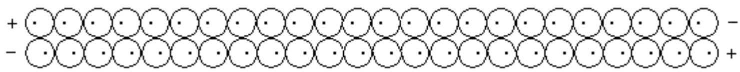


Figure 25: Opposite poles attract

These rows of magnets stick together because opposite poles attract.

Magnets stick together to make a helix out of a long string of magnets. Only the ends are exposed and show the polarity.

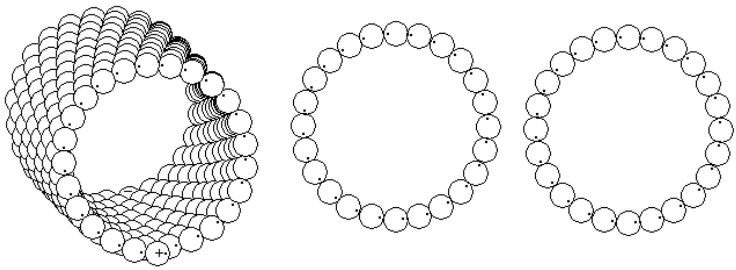


Figure 26: Loops of magnets

The two loops of magnets on the right attract each other because opposite poles attract. Loops of electrostatic dipoles attract each other in just this way.

6.3 Magnets and dipoles

Both have poles. Poles have polarity. Oppositely charged poles are bipoles or dipoles. The forces between their charged ends may be expressed, by us, with parallel and perpendicular components. They assemble in complex structures. Magnets are accessible. Magnets are magnetic dipoles which are a model for charge dipoles which are a model for gravity.

7 Loops of light as particles

The outside of the rings on figure (27) are left to right,

$$red,\ pink,\ green\ and\ cyan\ or\ +E,\ \neg E,\ +B\ and\ \neg B$$

The inside of the rings is largely hidden. There are four possible arrangements. These rings are particles which would attract or repell each other.

The left two rings are oppositely charged particles with a bipoler magnetic field like electrons and positrons.

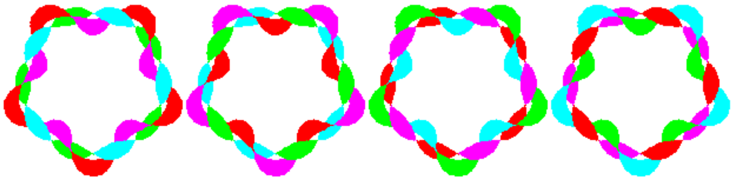


Figure 27: This is loops of light as particles

The left two rings would attract each other, stack and stick together.

The right two rings are magnetic monopoles which have a bipoler electrical field.

The right two rings would attract each other, stack and stick together.

The pair of monopoles stack becoming bipoles.

These are possible aspects of light which is deflected. We know that light can be deflected from numerous cases of gravitational lensing.

Light is also deflected into rings in a black hole [18].

These rings will illustrate our point but light can be deflected without being deflected into a ring.

First, on the left, the green-cyan ring is deflected into a circle. The red-pink ring is deflected into a circle which has a larger outside diameter than its inside diameter.

The energy density on the inside diameter is greater than on the outside diameter. These are magnetic or electric gradients.

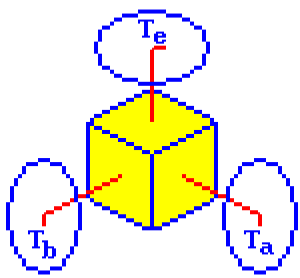
The rings are polarized and this imbalance has residual effects.

See Electric gravity [41]. This search for the origin of gravity is also articulated by Assis [19]. His books and on-line papers [20] are recommended.

8 Euler's equations and electromagnetic wave dynamics

Euler's equations are used to express three dimensional rotational motions; roll, pitch and yaw in aircraft or spacecraft and precession or nutation in gyroscopes [21] and rotating bodies. We use them to understand the flux and looping around of Faraday's and Ampere's laws in electromagnetic waves and light.

8.1 T is for torque and the subscript is for the axis



a, is the roll or axial axis which transfers the angular momentum or spin of the light. The transfer of torque as angular momentum or spin is along the, a, axis.

b, is the pitch or magnetic axis which is perpendicular to the axial axis.

e, is the yaw or electrical axis which is perpendicular to both the axial and magnetic axes.

E exerts a torque around the b axis.

B exerts a torque around the e axis.

E+B exerts a torque around the a axis.

$$T_a = I_a \cdot dw_a/dt + (I_b - I_e \cdot w_e \cdot w_b$$
$$T_b = I_b \cdot dw_b/dt + (I_e - I_a) \cdot w_a \cdot w_e$$
$$T_e = I_e \cdot dw_e/dt + (I_a - I_b) \cdot w_b \cdot w_a$$

w is angular velocity. dw/dt is the the angular acceleration, the rate of change of the angular velocity. I is the moment of inertia, $I = mass \cdot radius^2$, for the hoop or ring which we see along the spherical wavefront in figure (15). The mass is only that which is calculated from the energy. The total mass m_t, is proportional to energy and therefore proportional to E^2 or B^2 of the energy density and sin^2 or cos^2 of our waves. T is the torque or moment.
$torque = moment\ of\ inertia \cdot angular\ acceleration.$
h is the hypothenuse, of the right triangle, on figure (15). The moment of inertia is calculated using the parallel axis theorem, $I = I_{cm} + m \cdot D^2$, I_{cm} is the center of mass moment of inertia of the ring $I_{cm} = m \cdot r^2$. m is the mass. r is the ring radius. D is the distance I_{cm} moves from the central axis of the wave in the oscillation of the E and B rings. See figure (15).

8.2 If we have waves traveling unimpeded

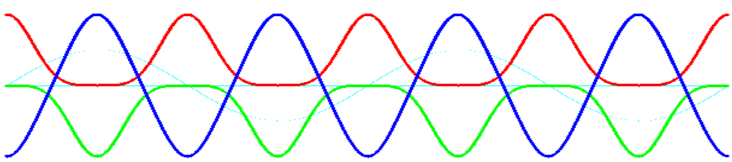


Figure 28: Unimpeded torques of the light wave
T_a, $blue$, $(cos^6 + cos^4 - sin^6 - sin^4)$
T_b, $green$, $(-cos^6 - cos^4)$
T_e, red, $(sin^6 + sin^4)$
$Cyan$, reference sine wave

$w_a = w_b = w_e = w$, since the angular velocity w is constant, the rate of change of the angular velocity, the angular acceleration, $d(w)/dt = 0$, and each equation is simplified.

$T_a = (I_b - I_e)\cdot w_e \cdot w_b$
$T_a = (m_t \cdot h^2 \cdot (cos^6 + cos^4) - m_t \cdot h^2 \cdot (sin^6 + sin^4))\cdot w^2$
$T_a = m_t \cdot h^2 \cdot w^2 \cdot (cos^6 + cos^4 - sin^6 - sin^4)$

$T_b = (I_e - I_a)\cdot w_a \cdot w_e$
$T_b = (m_t \cdot h^2 \cdot (sin^6 + sin^4) - m_t \cdot h^2 \cdot (cos^6 + cos^4 + sin^6 + sin^4))\cdot w^2$
$T_b = m_t \cdot h^2 \cdot w^2 \cdot (-cos^6 - cos^4)$

$T_e = (I_a - I_b)\cdot w_b \cdot w_a$
$T_e = (m_t \cdot h^2 \cdot (cos^6 + cos^4 + sin^6 + sin^4) - m_t \cdot h^2 \cdot (cos^6 + cos^4)\cdot w^2$
$T_e = m_t \cdot h^2 \cdot w^2 \cdot (sin^6 + sin^4)$

$T_a + T_b + T_e =$
$m_t \cdot h^2 \cdot w^2 \cdot ((cos^6 + cos^4 - sin^6 - sin^4) + (-cos^6 - cos^4) + (sin^6 + sin^4)) = 0$
The sum of the torques is zero while the waves travel unimpeded through space.

8.3 If the waves are impeded or impeded while being detected

Then the $d(w)/dt$ terms are no longer zero.
$T_a = I_a \cdot dw_a/dt + (I_b - I_e)\cdot w_e \cdot w_b$
$T_a = m_t \cdot h^2 \cdot (cos^6 + cos^4 + sin^6 + sin^4)\cdot dw_a/dt + m_t \cdot h^2 \cdot (cos^6 + cos^4 - sin^6 - sin^4)\cdot w_e \cdot w_b$
$T_a = m_t \cdot h^2 \cdot [(cos^6 + cos^4 + sin^6 + sin^4)\cdot dw_a/dt + ((cos^6 + cos^4 - sin^6 - sin^4)\cdot w_e \cdot w_b)] = mass\ torque\ or\ spin$

$T_b = I_b \cdot dw_b/dt + (I_e - I_a)\cdot w_a \cdot w_e$
$T_b = m_t \cdot h^2 \cdot (cos^6 + cos^4)\cdot dw_b/dt + m_t \cdot h^2 \cdot (-cos^6 - cos^4)\cdot w_a \cdot w_e$
$T_b = m_t \cdot h^2 \cdot (cos^6 + cos^4)\cdot [dw_b/dt + (-1 \cdot w_a \cdot w_e)] = magnetic\ torque$

$T_e = I_e \cdot dw_e/dt + (I_a - I_b)\cdot w_b \cdot w_a$
$T_e = m_t \cdot h^2 \cdot (sin^6 + sin^4)\cdot dw_e/dt + m_t \cdot h^2 \cdot (sin^6 + sin^4)\cdot w_b \cdot w_a$
$T_e = m_t \cdot h^2 \cdot (sin^6 + sin^4)\cdot [dw_e/dt + (w_b \cdot w_a)] = electrical\ torque$

The waves change their energy content or dump their energy as photons through angular momentum = spin, magnetic torque or electrical torque. The later two do their work with Faraday's and Ampere's laws. This is the primary mechanism for wave-wave or wave-particle interactions.

In figure (29) we see a stack of cross sections through the electromagnetic wave as it covers one wavelength. The lines in the middle are a reference between the circle which is expanding and the circle which is shrinking, the hypotenuse of the right triangle of figure (15). This is a summation of the movement in the animation [27] and the animation array figure (15). Science as art.

9 E = c·B

$E = force/q, \quad force_e = q\cdot E$
$B = force/(q\cdot v), \quad force_b = q\cdot v\cdot B$
$force_e = force_b$

$$q\cdot E = q\cdot v\cdot B, \quad v = c \; for \; an \; electromagnetic \; wave \quad (9.1)$$

We only use it with the velocity v equal to c in the electromagnetic wave with the two forces equal.

J. J. Thomson [22] determined the mass to charge ratio [23] of the electron using this equation: $q\cdot E = q\cdot v\cdot B$.

Here the forces are equal but this might be mistaken for:
Lorentz force [24] $= q\cdot E + q\cdot v\cdot B$.

$q\cdot E = q\cdot c\cdot B$
$E = c\cdot B$, canceled q, units are volts per meter or $kg\cdot m/(A\cdot s^3)$
E/B = c
E$^2/B^2 = c^2, \; square$
$E^2/B^2 = 1/(\mu_0\cdot \epsilon_0), \; c^2 = 1/(\mu_0\cdot \epsilon_0)$

$$E^2\cdot \epsilon_0 = \frac{B^2}{\mu_0}, \quad \frac{kg}{m\cdot s^2} = energy \; densities \; or \; pressures \quad (9.2)$$

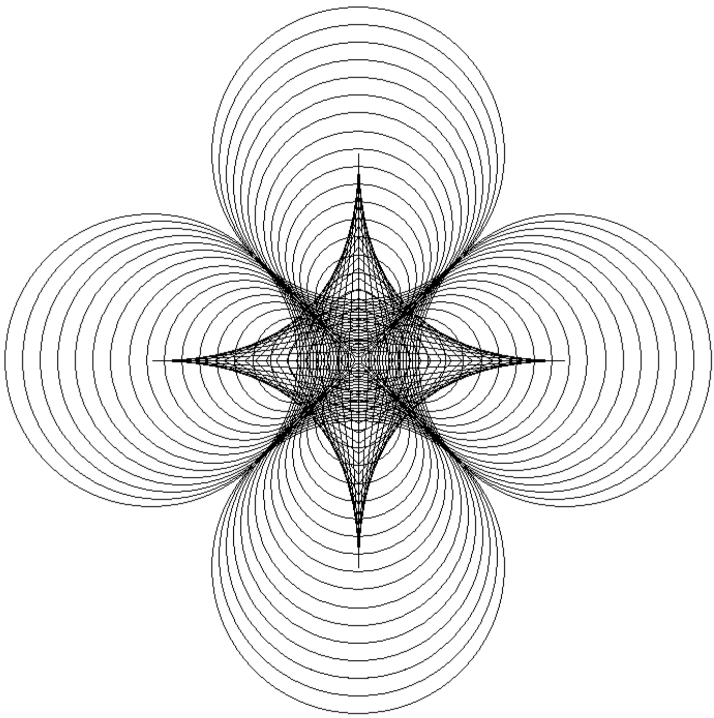


Figure 29: A stack of cross sections through the electromagnetic wave

Here the B and E energy densities or pressures are equal. This is the magnetic pinch pressure equals the electrostatic pressure of repulsion. This magnetic pinch pressure restrains the charge to the thin flux tube ring of the electron [34] like a hose restrains water. The electrostatic force of repulsion by the charge equals the magnetic pinch force of attraction on the charge.

10 Derivation of the wave parameters

There are four variables with values that we seek B, E, q and Amps.
$Faraday's\ law.\ \ 2\pi r\cdot E = volts = energy/charge,\ \ \ q = charge,$
We will call $2\pi r = wavelength$

$$E\cdot q = \ force\ = \frac{energy}{wavelength}$$

$energy = h_p\cdot c/wavelength,\ h_p\ is\ Plank's\ constant.$

$$E\cdot q = \frac{h_p\cdot c}{wavelength^2} \tag{10.1}$$

$substitute\ B\cdot c\cdot q = E\cdot q,$

$$B\cdot c\cdot q = \frac{h_p\cdot c}{wavelength^2} = \frac{kg\cdot m}{s^2} \tag{10.2}$$

cancel c's

$$B\cdot q = \frac{h_p}{wavelength} = \frac{kg}{s} \tag{10.3}$$

$$2\pi r\cdot B = wavelength\cdot B = Amps\cdot \mu_0,\ \ Ampere's\ law, \tag{10.4}$$

$$B = \frac{force}{Amps\cdot meters} = \frac{Amps\cdot \mu_0}{wavelength} = \frac{kg}{A\cdot s^2} \tag{10.5}$$

$$q1 = \frac{B \cdot q}{B} = \frac{h_p}{wavelength^2} \frac{wavelength}{Amps \cdot \mu_0}$$

$$q_1 = \frac{h_p}{wavelength \cdot Amps \cdot \mu_0} \tag{10.6}$$

$$\mu_0 = \frac{4\pi}{10000000} \frac{kg \cdot m}{A^2 \cdot s^2} \tag{10.7}$$

$$\frac{h_p \cdot c}{wavelength} = c \cdot \mu_0 \cdot q \cdot Amps = energy. \tag{10.8}$$

$2\pi r \cdot B = force/Amps, \;\; Ampere's\ law$
$2\pi r \cdot B = B \cdot c \cdot q/Amps, \;\; substituted\ B \cdot c \cdot q = force$
$q_2 = Amps \cdot 2\pi r/c = Amps \cdot wavelength/c$

$$q_2 = q_1 \tag{10.9}$$

$$\frac{Amps \cdot wavelength}{c} = \frac{h_p}{wavelength \cdot Amps \cdot \mu_0}$$

$$Amps^2 \cdot wavelength^2 = \frac{c \cdot h_p}{\mu_0}$$

$$Amps \cdot wavelength = \sqrt{\frac{c \cdot h_p}{\mu_0}} = 3.976E\neg 10\ A \cdot m \tag{10.10}$$

$Amps \cdot wavelength\ is\ a\ constant.$

$$Amps = \sqrt{\frac{c \cdot h_p}{\mu_0}} \cdot \frac{1}{wavelength} = 3.976E\neg 10 \frac{A \cdot m}{wavelength} \tag{10.11}$$

This is the maximum Amps flowing between both rings. There is a variable current which flows between the rings of figure (14) and (18).

$$q_w = Amps \cdot \frac{wavelength}{c} = charge$$

$$q_w = \frac{\sqrt{\frac{c \cdot h_p}{\mu_0}}}{wavelength} \frac{wavelength}{c} = charge$$

substituted for Amps from equation (10.11).

$$q_w = \sqrt{\frac{h_p}{c \cdot \mu_0}} = \sqrt{c \cdot h_p \cdot \epsilon_0} = 1.326E\neg 18\ A \cdot s \qquad (10.12)$$

We see that q_w = the charge of the electromagnetic wave is a constant that does not vary with wavelength if $2\pi r = wavelength$. For long wavelengths the charge is thinly spread. For shorter wave lengths the charge is denser.

$Amps = q_w \cdot frequency = q_w \cdot c/wavelength$

$h_p = q_w^2 \cdot c \cdot \mu_0 = q_w^2/(c \cdot \epsilon_0),\ q_w^2 = h_p/(c \cdot \mu_0)$
$h_p = q_w^2/(c \cdot \epsilon_0),\ h_p$ is Plank's constant. q_w is the charge of electromagnetic waves.
$h_p = Ce^2/(2 \cdot c \cdot \epsilon_0 \cdot \alpha)$, Ce is the charge of the electron. Alpha, α, is the fine structure constant.
$h_p = h_p$.
$Ce^2/(2 \cdot c \cdot \epsilon_0 \cdot \alpha) = q_w^2/(c \cdot \epsilon_0)$,
$Ce^2 = q_w^2 \cdot 2 \cdot \alpha$,
$q_w = Ce/\sqrt{2\alpha}$, This q_w is 8.277 times the charge of the electron. Why is this so?
This is the total charge, q_w, which is shared between the E and B rings. $q_w = q_x + q_y = q_w \cdot cos^2 + q_w \cdot sin^2$. This is the division of the charge in the, x y, plane between the two rings.
$B = Amps \cdot \mu_0/2\pi r, kg/(A \cdot s^2),\ Ampere's\ law.$

$B = \sqrt{c\cdot h_p/\mu_0}/\sqrt{wavelength\cdot 2\pi r}\cdot \mu_0/(2\pi r)$, substituted for Amps.
$\sqrt{c\cdot h_p\cdot \mu_0)} = h_p/q_w = 4.996E{-}16 kg\cdot m^2/(A\cdot s^2),\ energy/Amps\ is\ constant.$
$B = \sqrt{c\cdot h_p\cdot \mu_0}/\sqrt{wavelength\cdot 2\pi r}/(2\pi r)$ or
$B = \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2.$
$B^2/\mu_0 = energy\ density$
$B^2/\mu_0 = (\sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2)^2/\mu_0$
$B^2/\mu_0 = (c\cdot h_p\cdot \mu_0)/wavelength^4/\mu_0$
$B^2/\mu_0 = c\cdot h_p/wavelength^4$
$B^2\cdot wavelength^3/\mu_0 = c\cdot h_p/wavelength = energy.$

This is energy density times wavelength cube equals energy.
$E = c\cdot B = c\cdot \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2$
$E^2\cdot \epsilon_0 = energy\ density$
$E^2\cdot \epsilon_0 = (c\cdot \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2)^2\cdot \epsilon_0$
$E^2\cdot \epsilon_0 = c^3\cdot h_p\cdot \mu_0\cdot \epsilon_0/wavelength^4$
$E^2\cdot \epsilon_0 = c\cdot h_p/wavelength^4,$
$\mu_0\cdot \epsilon_0 = 1/c^2$
$E^2\cdot wavelength^3\cdot \epsilon_0 = c\cdot h_p/wavelength = energy.$

This is energy density times wavelength cube equals energy.
$\sqrt{c/(\mu_0\cdot h_p)} = 6.000359E23\cdot A\cdot s/(kg\cdot m)$, curiously close to Avogadro's number.

10.1 Powers of 1/wavelength

One over wavelength:
$energy = h_p\cdot c/wavelength:$
$Amps = q_w\cdot frequency = q_w\cdot c/wavelength =$
$\sqrt{h_p/(c\cdot \mu_0)}\cdot c/wavelength$

$One\ over\ wavelength^2:$
$B = \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2$
$E = B\cdot c = c\cdot \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2$

$One\ over\ wavelength^3:$

$dB/dt = 4\pi B\cdot frequency = 4\pi\sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2\cdot c/wavelength =$
$4\pi c\sqrt{c\cdot h_p\cdot \mu_0}/wavelength^3$
$dE/dt = 4\pi E\cdot frequency = 4\pi c\sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2\cdot c/wavelength =$
$4\pi c^2\cdot \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^3$

$One\ over\ wavelength^4$:
$B^2/\mu_0 = h_p\cdot c/wavelength^4$
$E^2\cdot \epsilon_0 = h_p\cdot c/wavelength^4$

10.2 Red light example

$wavelength = 633E\neg 9\cdot m,\ for\ red\ light$
$frequency = c/wavelength = 4.736E14\cdot 1/s$
$q_w = \sqrt{h_p/(c\cdot \mu_0)} = 1.326E\neg 18\cdot A\cdot s = charge$
$Amps = \sqrt{c\cdot h_p/\mu_0}/wavelength = q_w\cdot frequency =$
$q_w\cdot c/wavelength = 6.281E\neg 4\cdot A$
$B = \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2 = 1.2469E\neg 3\cdot kg/(A\cdot s^2),\ Teslas$
$dB/dt = 4\pi B\cdot frequency = 7.421E12\cdot kg/(A\cdot s^3),\ Teslas/second$
$E = c\cdot \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2 =$
$373815\cdot kg\cdot m/(A\cdot s^3) =\ volts/meter$
$B^2/\mu_0 = E^2\cdot \epsilon_0 = c\cdot h_p/wavelength^4 = 1.237\cdot kg/(m\cdot s^2)=$
energy density or pressure
$B^2/\mu_0\cdot wavelength^3 = 3.318E\neg 19\cdot kg\cdot m^2/s^2 = energy$

10.3 Electron gamma ray example

$me\cdot c^2 = h_p\cdot c/wavelength = 8.187E\neg 14\cdot kg\cdot m^2/s^2 = energy$
me = mass of the electron
$wavelength = h_p\cdot c/(me\cdot c^2) = h_p/(me\cdot c) = 2.4263E\neg 12\cdot m$
frequency = c/wavelength = 1.235E20 1/s
$q_w = \sqrt{h_p/(c\cdot \mu_0)} = 1.326E\neg 18\cdot A\cdot s,\ charge$
$Amps = \sqrt{c\cdot h_p/\mu_0}/wavelength = q_w\cdot frequency =$
$q_w\cdot c/wavelength = 163.865\cdot A$
$B = \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2 = 8.4869E7\cdot kg/(A\cdot s^2)\ Teslas$

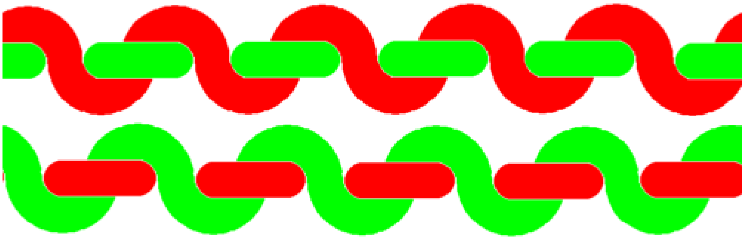


Figure 30: Wires can be woven

$dB/dt = 4\pi B\cdot frequency = 1.317E29\cdot kg/(A\cdot s^3) = Teslas/second$
$E = c\cdot \sqrt{c\cdot h_p\cdot \mu_0}/wavelength^2 =$
$2.5443E16\cdot kg\cdot m/(A\cdot s^3) = volts/meter$
$B^2/\mu_0 = E^2\cdot \epsilon_0 = c\cdot h_p/wavelength^4 = 5.7319E21\cdot kg/(m\cdot s^2) =$ energy density or pressure
$B^2/\mu_0\cdot wavelength^3 = 8.187E\neg 14\cdot kg\cdot m^2/s^2 = energy$

10.4 Ring electron and electron gamma ray

$A\ and\ q_w\ are\ 1/\sqrt{2\cdot alpha} = 8.277$ times bigger in the electron gamma ray than the ring electron. B and E are $2\pi/\sqrt{2\cdot alpha} =$ 52.009 times bigger in the ring electron than in the gamma ray.
Ring electron energy density= $me\cdot c^2/3.853E\neg 41\ m^3 =$ $2.12E27\ kg/(m\cdot s^2)\ is\ 3.69E5$ times bigger.
Ring electron density $= 2.364E10\ kg/m^3$.
Nuclear density is 42 billion times larger at $1E21\ kg/m^3$.

10.5 Braided Wires

Wires can be woven together to make quite good toy sine and cosine waves as shown on figure (30). Ribbons, felt or foam strips can also be used. Physical models are the best analogs for reality. I make the individual sine waves out of different colors of 12 or 14 gage solid core copper wires. I bend the wires around two nails held in a vise and move the "s" shape along while bending until the sine wave is complete. I then weave two of the sine waves together which produces a sine and cosine combination. This figure shows the top and side views of the resulting weaved wires. Tactile sensation amplifies visual sensation.

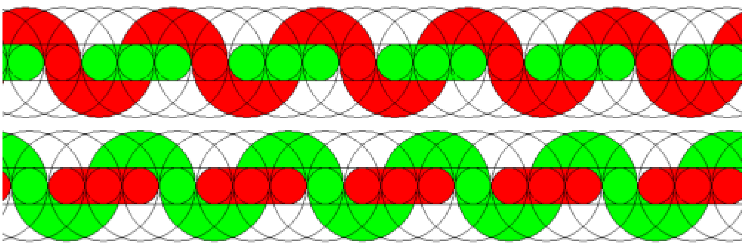


Figure 31: Figure construction

On figure (31) we see the construction of figure (30). I wrote a Liberty Basic program to draw the circles. A Paint program was used to color and clean up. Almost all of the black lines are removed by using Paint several times to fill the background first with black and then with white. The rest of the graphics and animations in this paper were also Basic programs and Paint.

10.6 Is energy stored in the area or the circumference of the flux tubes?

At the cosmic scale, objects are mostly volume and little surface. At the smallest scale, objects are mostly surface and little volume.
Volume/surface of a sphere = radius/3.
For the Cosmos, radius/3 = 4.73E25 m.
For red light, $wavelength/3 = 211E\neg 9\cdot m$. At the smallest scale, objects are mostly circumference and little area.
Area/circumference of a circle = radius/2.

For red light, $wavelength/2 = 316E\neg 9 \cdot m$. The circumference is 3 million times bigger than the area. We would expect circumference to be much more important. The circumference of the ring pair does carry the charge. We previously noticed that when Ampere's law was written to show Maxwell's displacement current, "The toroidal Amps in the loops equals the poloidal flux of Amps through the area of the loop." Both area and circumference are important.

10.7 The area of the rings

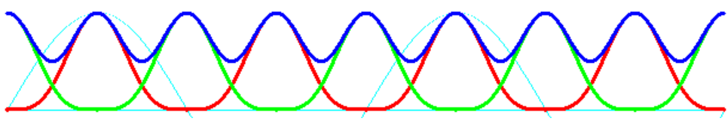
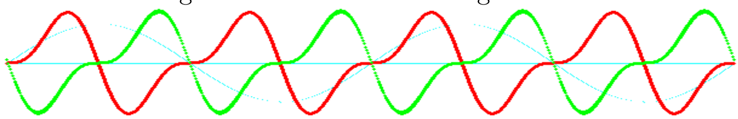


Figure 32: The area of the rings

Where $h = wavelength/8\pi$, the area of the rings =
$\pi r^2 = \pi h^2 = \pi h^2 \cdot sin^4 = wavelength^2 \cdot sin^4/64\pi$ or
$\pi r^2 = \pi h^2 = \pi h^2 \cdot cos^4 = wavelength^2 \cdot cos^4/64\pi$
$Red = E\ ring = sin^4$.
$Green = B\ ring = cos^4$.
$Blue = E + B\ rings = sin^4 + cos^4$.
$Cyan$ = frequency reference sine wave.
The graph of sin^4 and cos^4 are not sine waves as is their sum. The sum of the area of the rings is the elevated blue sine wave which oscillates around a value at four times the frequency of the wave. One might say they shimmer. Is this a residual field?

Graph of the rate of change of the area of the rings,
$d(\pi r^2)/dt = sin^4\ and\ cos^4$.
$Red = Ering = 4 \cdot cos \cdot sin^3$.
$Green = Bring = 4 \cdot sin \cdot cos^3$.

Figure 33: The rate of change of area



$Cyan$ = frequency reference sine wave.
$d(\pi r^2)/dt = wavelength^2 \cdot cos \cdot sin^3/16\pi$ or
$d(\pi r^2)/dt = wavelength^2 \cdot sin \cdot cos^3/16\pi$.
Does the rate of change of the area of the rings go anywhere?

10.8 Tipler's reciprocal results

Tipler [25] said, "Maxwell's modification of Ampere's law shows that a changing electric flux produces a magnetic field whose line integral around a curve is proportional to the rate of change of the electric flux. We thus have the interesting reciprocal result that a changing magnetic field produces an electric field (Faraday's law) and a changing electric field produces a magnetic field (generalized form of Ampere's law)."

10.9 Fat text books can be articulate old friends

Tipler's; "Physics for scientist and engineers" or Halliday and Resnick's; "Physics for students of science and engineering", both offer the comprehensive coverage and detail useful in understanding this field. They are not dumbed down.

The internet is like Lake Okeechobee with its shallows miles wide and its occasional pockets of deep water. Is this as shallow as a mud flat or is this a pocket of deep water?

Rose Anne says this website is like the mathematician in "A Beautiful Mind" putting his letters in an unused mailbox for pickup by imagined readers.

10.10 Storyland

Before there was writing there were stories. Theories are little stories we use to think about and describe reality; scientific, political or otherwise.

Apparently we prefer our ideas served on the platter of a story. Something in us wants us to believe a story. Repetition makes the heart grow fonder.

These are addictive memes. We are even seduced by a weak story. A story is an audio, visual, sensory experience as required by neuromarketing. Brain scans would show stories activate pleasure centers while facts do not. There is a narcotic effect in the mantra or in constant repetition of stories. The opiate of the masses is endorphine based. This makes us vulnerable to manipulation. Fancy theories, flag wavers, fundamentalist and fanatics all have their stories. The best stories to believe are based on evidence from multiple sources.

Some - which are widely accepted - have only hearsay (he said) evidence or anecdotal (more little stories) evidence.

Some - which are properly called dogma - are said to be accepted without evidence, as a requirement for membership in a group. Monkey see, monkey do.

We are primates if you prefer the story of evolution instead of the story of Noah's ark. Parotting a plethora of preposterous stories, taken unquestioned at face value, papers ones reality with a crazy quilt of pernicious percolating absurdities.

There are so many zombies addicted to stories, so many sacred cows, so many mad dogs ready to kill, if your story is different from theirs. Humor them. We seek clarity, (a clear simple story - like the following).

My son gave me a LED flashlight which uses Faraday's law. A magnet moving bi-directionally in a tube, through a coil of wire, provides a reversing current. That current charges a energy storage capacitor through diodes that keep the reversing current flowing in one direction. The capacitor acts like a battery to light the LED.

10.11 Does space have resistance?

Space is empty. If space had any resistance, electromagnetic waves would be damped quickly, dissipate their energy as I^2 R heat, instead of traveling for billions of light years. The impedance of space, is more properly described as shorthand for the ratio, V/I = Faraday's voltage divided by Ampere's current in electromagnetic waves = 376.73 ohms. Electromagnetic waves have this V/I ratio so antennas should be most efficient when matched to this V/I ratio. This ratio is called impedance because it has units of V/I or ohms.

10.12 Antenna theory

says accelerated charges radiate. Changes in direction are regarded as accelerations so something in a circular orbit is accelerated. Accelerated charges are changing Amps which are produced by d(B)/dt. The flux of B through the area or rate of change of the circumference of the loop radiates the $\neg E$ seen in the loop. Arcing, which is the radiation or emission of currents, occurs at a lower potential from pointed objects, those with a smaller radius of curvature. The radius of curvature of the flux or of the loop is the $wavelength/(2\pi)$ which can be very small so the radiation or emissions can be almost instantaneous.

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