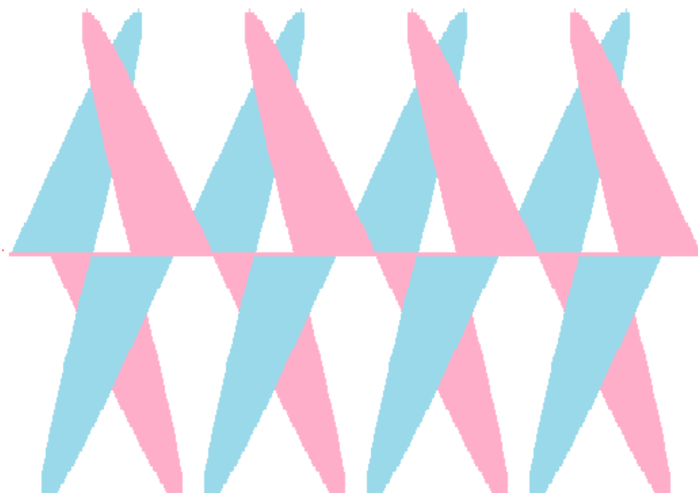
the general science journal

Electric and Magnetic Waves



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Abstract

Our objective is to look at the electromagnetic wave: an electric and magnetic wave duo like a sine and cosine. The one transforms into the other.

We simplify and imagine nature to be composed of machines which we can understand. We use these machines by analogy to explain the behavior of nature. J. C. Maxwell said; "Using mechanical illustrations to assist the imagination, but not to account for the phenomena."

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. This is a sequential machine. E⇒M⇒E⇒M⇒E⇒M. The total energy is continuous and conserved as the one becomes the other.

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 waves 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

Cover

Electric and magnetic waves. They are synchronized and 90 degrees out of phase. See the animation at [1].

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 booklet.

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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 becomes the other.

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.

We will also speculate on the underlying ring structure and mechanism of the "light wave". This paradigm also allows us to see that loops of light waves may be the basis of all elementary particles.

1.1 In-phase waves

Figure 1: Maxwell and Hertz: We see them as in-phase

We will look first at the far-field EM wave of Maxwell [2] and Hertz [3]. The red electric and blue magnetic waves are perpendicular and in-phase sine waves as shown on figure (1). The in-phase waves comes from a solution of Maxwell's wave equations.

It also comes from the idea that when the current in a wire is at maximum then its electric field is at maximum and the magnetic field is maximum.

When the current is minimum then the electic field is minimum and the magnetic field is minimum.

This is called a far field EM wave.

Here, the electric and magnetic fields are in-phase.

Figure 2: These are 90 degrees out of phase

With figure (2) we choose a slightly different path. This is the near-field EM wave. See the animation [1]. The total energy is continuous and conserved. The red and blue waves are perpendicular and out of phase by 90 degrees. They are sine and cosine waves. The one becomes the other. They blink *magnet* $\Rightarrow$ *charge* $\Rightarrow$ *magnet* $\Rightarrow$ *charge*. We will see them as sequential machines.

It is well known and seen on oscilloscopes that: Pendulums, potential energy and kinetic energy, Hook's law oscillators, current and voltage in capacitors and inductors, LC oscillators, MRI and transmitter antennas all share this same 90 degrees out of phase relationship. Light has the same behavior. All share the same math. It takes time for a electric wave to turn into a magnetic wave or a magnetic wave to turn into a electric wave. This is a transition over time. See section (4.4). We also have perpendicular transitions.

1.2 Not in-phase waves

[b]

1.3 Wire waves

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

These red and blue 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 section (11). The red and blue are correctly: 90 degrees out of phase, oscillate in perpendicular planes, demonstrate the right hand rule.

How does this work?

The blue flux of, B, times the area of the loop equals red $\neg E$ times the circumference. A poloidal flux through an area, causes

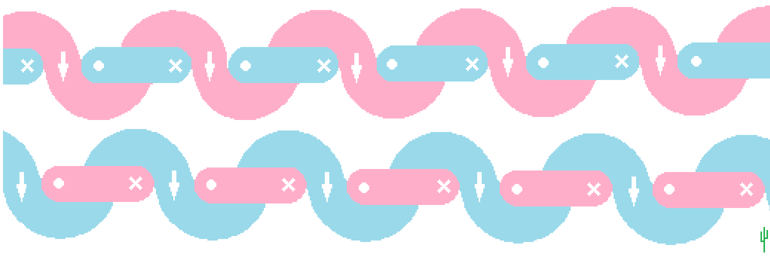


Figure 3: Top and side views of Braided Wires

a toroidal looping around or a toroidal looping around a circumference, causes a poloidal flux. A toroidal looping or rotating E causes a poloidal flux of B. A poloidal flux of B causes a toroidal looping or rotating E.

A torque=looping=rotation 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 an odd gyroscope. We will explore this later using Euler's equations in section (9.1).

Figure 4: Faraday's and Ampere's Laws

On the right in figure (4), we see Faraday's law. If your right thumb points in the direction of the up arrow then your fingers point in the toroidal direction around the torus. If you grasp the torus with your right hand and your thumb points in the direction of the arrow then your fingers curl around the torus in the poloidal

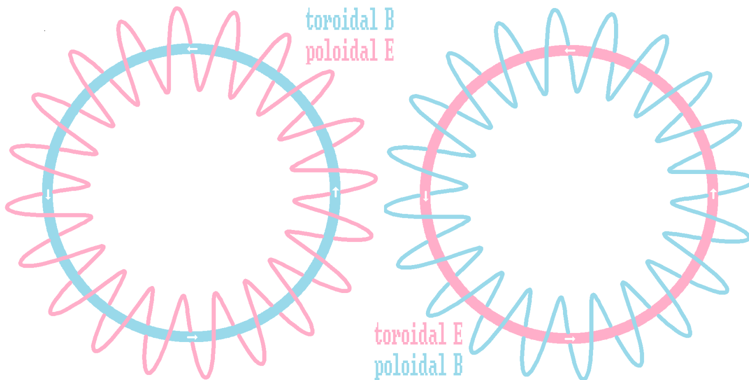


Figure 5: Toroidal and poloidal fields
Left: Blue magnetic toroidal and pink electric poloidal fields.
Right: Pink electric toroidal and blue magnetic poloidal fields.

direction. The little circles with the "dot" indicates approaching poloidal looping flux. The little circles with the "x" indiates a receding poloidal looping flux.

On the left in figure (4), we see Ampere-Maxwell's law. By the right hand rule, if your thumb points in the direction of red up then your fingers loop around blue. Look at the bottom of figure (3). The red flux of E times the area of the loop equals blue B times the circumference. A flux causes a looping around or a looping around a flux. A toroidal looping or rotating B causes a poloidal flux of E. A poloidal flux of E causes a toroidal looping or rotating B.

Galaxies and solar systems may form around currents in space as in the plasma universe [4]. This is a flux causing a looping around. The disks around proto-stars [5] 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.

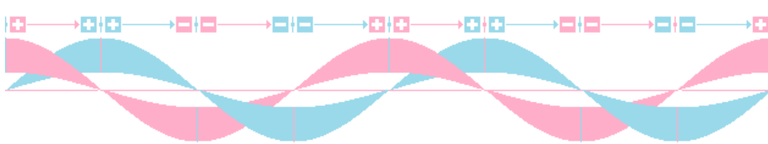


Figure 6: Transformation and an Induction Indicator

In figure (6), the red and blue 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.

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:

$$red\ up \Rightarrow blue\ left \Rightarrow red\ down \Rightarrow blue\ right \Rightarrow red\ up$$

Red becomes blue. Blue becomes red. Working sequentially left to right showing cause and effect for the four steps of one wavelength of figure (6) while using figure (4):
 Collapsing red becomes blue. Ampere's law.
 Collapsing blue becomes ¬red. Faraday's law.
 Collapsing ¬red becomes ¬blue. Ampere's law.
 Collapsing ¬blue becomes red. Faraday's law.

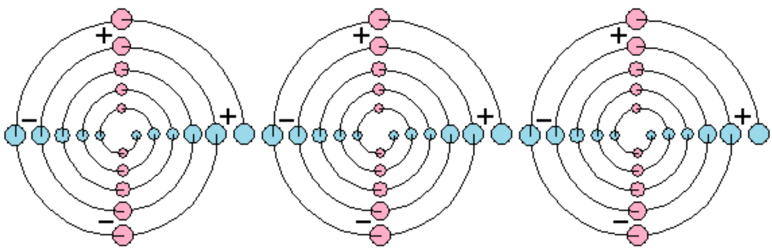


Figure 7: Helical Electromagnetic Waves

Figure (7) is an end view of three parallel approaching light beams of figure (6). We seem to be looking at approaching rotating cylinders with flux tubes on their 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 (6) where they are marked by the vertical lines through the flux tubes.

It is easy to follow a clockwise path around figure (7) starting at the top,

$$+E \Rightarrow +B \Rightarrow \neg E \Rightarrow \neg B \Rightarrow +E \text{ or with figure (6)}$$
$$red\ sine \Rightarrow blue\ cosine \Rightarrow red\ \neg sine \Rightarrow blue\ \neg cosine$$

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. See section (4.4).

The beams have opposite polarity, on figure (7), on opposite sides.

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

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

Use your pencil to hide the blue of figure (7), 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, the beams may be made to attract or repell each other. This is demonstrated in this Nature [14] article or this Discover [15] article.

1.4 Perpendicular Transformations

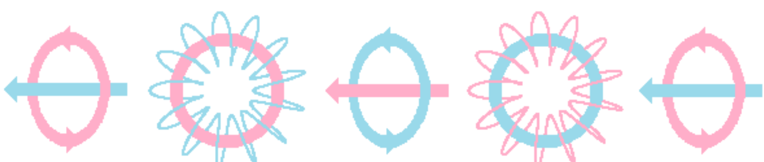


Figure 8: Perpendicular Transformations

• First from the left on figure (8): A poloidal flux through the loop equals the toroidal current around the loop. Blue flux of $B/(c\cdot \mu_0)$ times the area of the ring equals or becomes toroidal current, around the loop, red $E/(c\cdot \mu_0)$ times the circumference of the ring.

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

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 (8): The poloidal blue flux which was shown as a blue arrow is now shown, in a better representation, as a blue poloidal looping around the red toroidal current. The blue

flux is still out of the ring like the north pole of a magnet.
The blue and red are more or less confined to the plane of the torus. The blue is radial where the red is tangent and in this way they are perpendicular. • Third from the left on figure (8): This is a cross section through the second figure. It shows a single blue 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 poloidal and the former blue poloidal is now blue toroidal. This perpendicular transformation changes our viewpoint from Faraday to Ampere. Maxwell's changing red poloidal displacement current times the area of the tube equals or becomes toroidal blue current times the circumference of the tube.

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

• Fourth from the left on figure (8): The poloidal red flux which was shown as a red arrow is now shown as a red poloidal looping around a blue toroidal current. The red flux is still out of the ring.

2 Faraday's law

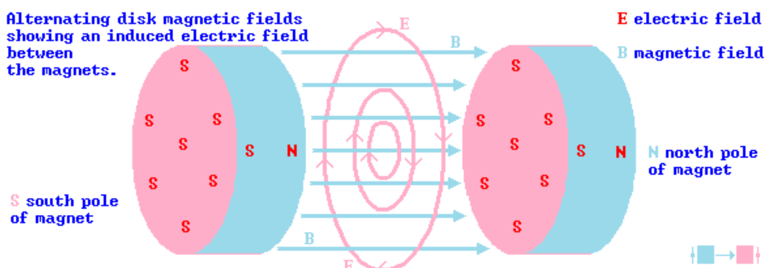


Figure 9: Faraday's law: The flux of B causes E.

A changing magnetic flux through a circular area generates a loop electric field which accelerates the electrons in a Betatron seen on figure (9). Blue is transformed into red.

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

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 [16] comes from the sign change in the derivative.

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

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

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

does not have a sign change.

2.1 Differential forms

$\circ$ Dot product $= A \circ B$.
A times B times the cosine of the angle between them.

$$Del\ or\ nabla \ = \vec{\nabla} = \left(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}\right) \tag{2.2}$$

$\vec{\nabla}\circ =$ *Del dot or nabla dot is the divergence.*
$\vec{\nabla} \circ \vec{A} =$ *The divergence of the vector field A.*

$$\vec{\nabla} \circ \vec{A} = \left(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}\right) \circ (\hat{i}A_x + \hat{j}A_y + \hat{k}A_z) \tag{2.3}$$

Since unit vectors $\hat{i} \circ \hat{i} = \hat{j} \circ \hat{j} = \hat{k} \circ \hat{k} = 1$ then:

$$\vec{\nabla} \circ \vec{A} = \left(\hat{i}\frac{\partial A_x}{\partial x} + \hat{j}\frac{\partial A_y}{\partial y} + \hat{k}\frac{\partial A_z}{\partial z}\right) \tag{2.4}$$

The divergence of the vector field "A" is the change in the x-component along the x-axis plus the change in the y-component along the y-axis plus the change in the z-component along the z-axis.
$\times$ Cross product $= A \times B$.
A times B times the sine of the angle between them.
$\vec{\nabla}\times =$ *Del cross or nabla cross is the curl.*
$\vec{\nabla} \times \vec{A} =$ *The curl of the vector field A.*

$$\vec{\nabla} \times \vec{A} = \left(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}\right) \tag{2.5}$$

$$\vec{\nabla} \times \vec{A} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix} \quad or \quad \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix} \tag{2.6}$$

$$\vec{\nabla} \times \vec{A} = \left(\frac{\partial A_z}{\partial y} + \frac{\partial A_y}{\partial z}\right)\hat{i} + \left(\frac{\partial A_x}{\partial z} + \frac{\partial A_z}{\partial x}\right)\hat{j} + \left(\frac{\partial A_y}{\partial x} + \frac{\partial A_x}{\partial y}\right)\hat{k} \tag{2.7}$$

2.2 The curl of the curl of a vector

Ampere-Maxwell's Law:

$$\vec{\nabla} \times \vec{B} = \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t} \tag{2.8}$$

Faraday's Law:

$$\vec{\nabla} \times \vec{E} = \neg \frac{\partial \vec{B}}{\partial t} \tag{2.9}$$

Start with Faraday's Law and then take the curl of both sides.

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = \vec{\nabla} \times \left(\neg \frac{\partial \vec{B}}{\partial t}\right) \tag{2.10}$$

The order of partial differentiation makes no difference so:

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = \frac{\partial}{\partial t}(\vec{\nabla} \times \vec{B}) \tag{2.11}$$

Substitute for the curl of $\vec{B}$ from above.

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = \frac{\partial}{\partial t}\left(\mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}\right) = \mu_0 \epsilon_0 \frac{\partial^2 \vec{E_y}}{\partial t^2} \tag{2.12}$$

The curl of the curl of E equals the gradient of the divergence of E minus the Laplacian.

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = \vec{\nabla}(\vec{\nabla} \circ \vec{E}) - \vec{\nabla}^2 \vec{E} \tag{2.13}$$

The divergence of E is zero since we have no free charge so:

$$\vec{\nabla}^2 \vec{E} = \mu_0 \epsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2} \tag{2.14}$$

The Laplacian is expanded in the Cartesian form:

$$\frac{\partial^2 \overrightarrow{E}_x}{\partial x^2} + \frac{\partial^2 \overrightarrow{E}_x}{\partial y^2} + \frac{\partial^2 \overrightarrow{E}_x}{\partial z^2} = \mu_0 \epsilon_0 \frac{\partial^2 \overrightarrow{E_x}}{\partial t^2}$$

$$\frac{\partial^2 \overrightarrow{E}_y}{\partial x^2} + \frac{\partial^2 \overrightarrow{E}_y}{\partial y^2} + \frac{\partial^2 \overrightarrow{E}_y}{\partial z^2} = \mu_0 \epsilon_0 \frac{\partial^2 \overrightarrow{E_y}}{\partial t^2}$$

$$\frac{\partial^2 \overrightarrow{E}_z}{\partial x^2} + \frac{\partial^2 \overrightarrow{E}_z}{\partial y^2} + \frac{\partial^2 \overrightarrow{E}_z}{\partial z^2} = \mu_0 \epsilon_0 \frac{\partial^2 \overrightarrow{E_z}}{\partial t^2} \tag{2.15}$$

If E_x and E_z do not exist and E_y is a function of x but not of y or z since it is confined to a plane, then we have a traveling-wave differential equation:

$$\frac{\partial^2 \overrightarrow{E}_y}{\partial x^2} = \mu_0 \epsilon_0 \frac{\partial^2 \overrightarrow{E_y}}{\partial t^2}$$

Expand Faraday's Law, equation (2.9), in 3 dimentions.

$$\frac{\partial \overrightarrow{B_x}}{\partial t} = \neg \left(\frac{\partial \overrightarrow{E_z}}{\partial y} - \frac{\partial \overrightarrow{E_y}}{\partial z} \right) \tag{2.16}$$

$$\frac{\partial \overrightarrow{B_y}}{\partial t} = \neg \left(\frac{\partial \overrightarrow{E_x}}{\partial z} - \frac{\partial \overrightarrow{E_z}}{\partial x} \right) \tag{2.17}$$

$$\frac{\partial \overrightarrow{B_z}}{\partial t} = \neg \left(\frac{\partial \overrightarrow{E_y}}{\partial x} - \frac{\partial \overrightarrow{E_x}}{\partial y} \right) \tag{2.18}$$

Since only B_z *and* E_y exist [**?**] then:

$$\frac{\partial \overrightarrow{B_z}}{\partial t} = \neg \frac{\partial \overrightarrow{E_y}}{\partial x} = \tag{2.19}$$

2.3 Differential form of Faraday's Law

$$\overrightarrow{\nabla} \times \overrightarrow{E} = \neg \frac{\partial \overrightarrow{B}}{\partial t} \tag{2.20}$$

The left hand side is the curl of the electric field, the tendency of the electric field to circulate around a point. The right hand side is the rate of change of the magnetic field with time [19].

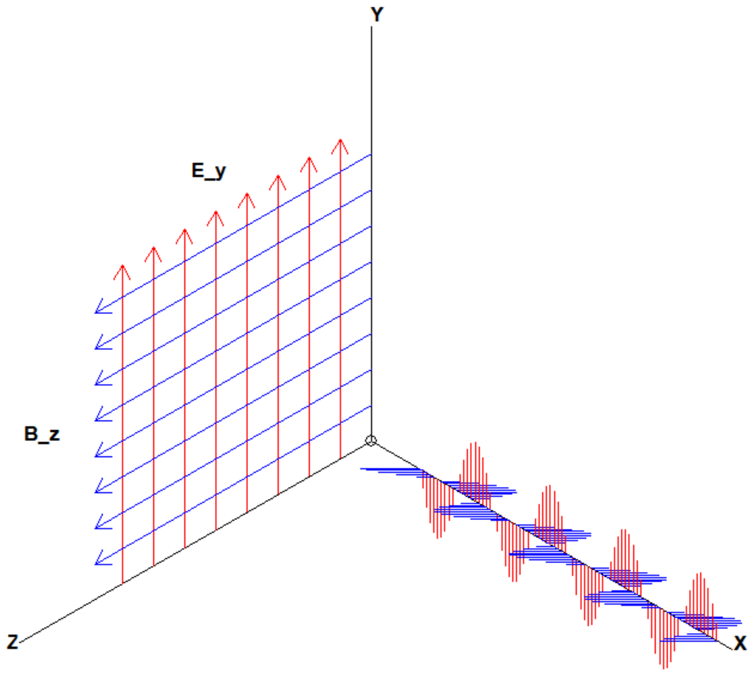


Figure 10: EM Waves

are confined to a traveling plane that here propagates along the x-axis.

2.4 Integral form of Faraday's Law

$$\oint_C \overrightarrow{E} \circ \overrightarrow{dl} = \neg \frac{d}{dt} \int_S \overrightarrow{B} \circ \hat{n}\ da \tag{2.21}$$

Integral form of Faraday's law from Fleisch [19]. The left hand side is the line integral around C of E the electric field tangent to the circumference $dl = 2\pi r$. The right hand side is the rate of change of the magnetic flux through any surface bounded by C.

$$Faraday's\ law \oint E\cdot ds = \neg \frac{d(\Phi_B)}{dt} \tag{2.22}$$

Integral form of Faraday's law from Hyperphysics [33] or Wiki [34].

$$\oint E\cdot ds = 2\pi r\cdot E\ or\ \frac{d(\Phi_B)}{dt} = \neg \frac{d(\pi r^2\cdot B)}{dt} \tag{2.23}$$

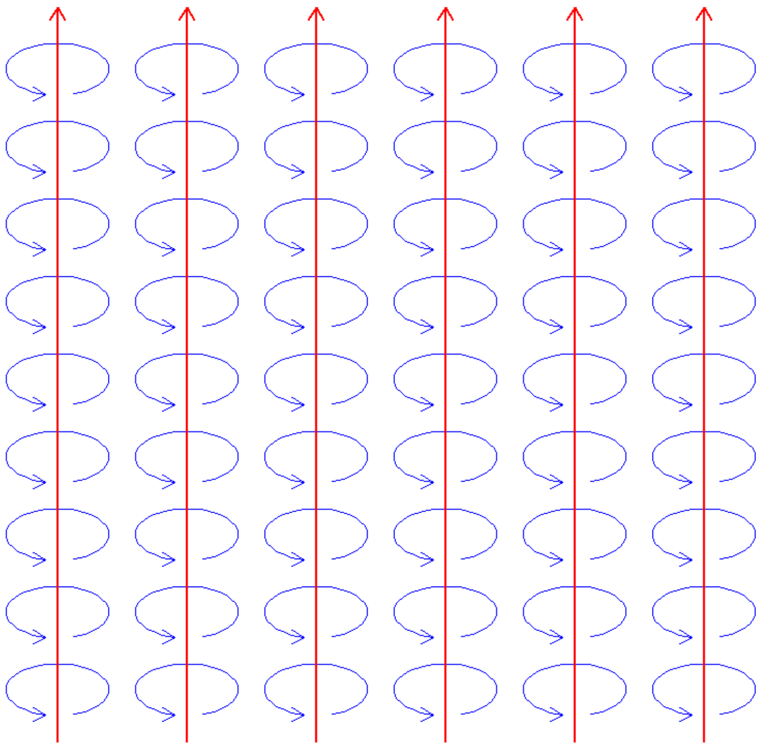


Figure 11: Stoke's up
A verticle electric field generates a magnetic field.

The line integral of the electric field equals the circumference of the loop times E or:

The rate of change of the magnetic flux equals the rate of change of the area of the loop times B.

2.5 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.

$$B = Tesla's = \frac{kg}{A\cdot s^2}$$

$$volts = \frac{energy}{charge} = \frac{kg\cdot m^2}{s^2}\cdot \frac{1}{A\cdot s} = \frac{watts}{amps} = \frac{kg\cdot m^2}{s^3}\cdot \frac{1}{A} = \frac{kg\cdot m^2}{A\cdot s^3}$$

$$volts = amps\cdot resistance = A\cdot \frac{kg\cdot m^2}{A^2\cdot s^3} = \frac{kg\cdot m^2}{A\cdot s^3}$$

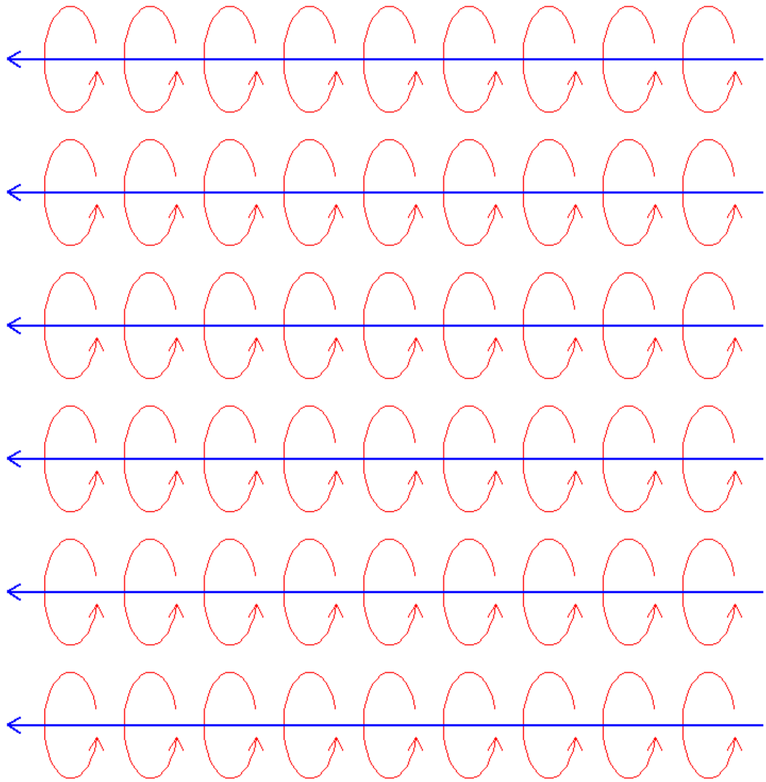


Figure 12: Stoke's left
A horizontal magnetic field generates a electric field.

$$\frac{d(B)}{dt} = 4\pi B \cdot frequency = \frac{Tesla's}{second} = \frac{kg}{A \cdot s^2}\frac{1}{s} = \frac{kg}{A \cdot s^3} \quad (2.24)$$

$$4\pi B \frac{c}{2\pi r} = \neg \frac{d(B)}{dt} \quad (2.25)$$

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.

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

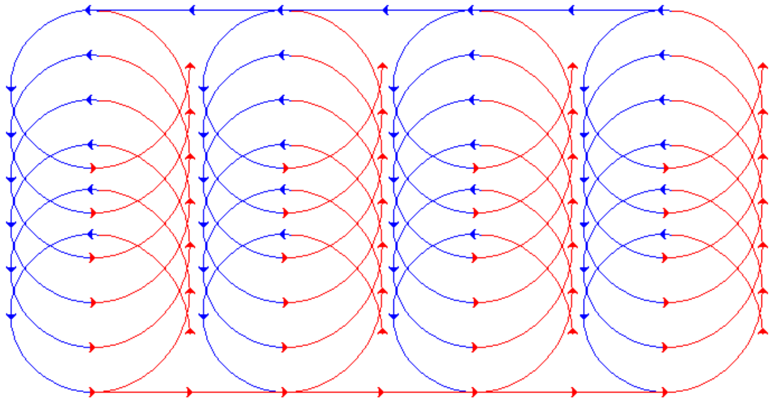


Figure 13: Stoke's Law
Magnetic fields around a solinoid. Opposite directed loops cancel. Loops turn into planes.

$$2\cdot E = \neg r \frac{d(B)}{dt} \tag{2.26}$$

group terms and multipy by πr to obtain Faraday's Law

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

Faraday's law. The circumference of the loop times toroidal red E equals the rate of change of the the area of the loop times the poloidal magnetic flux of blue B.

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.

$$\frac{2\pi r\cdot E}{resistance} = \neg \frac{d(\pi r^2\cdot B)}{dt}\frac{1}{resistance} = amps\ or \tag{2.27}$$

$$\oint E\cdot ds \frac{1}{resistance} = \neg \frac{d(\Phi_B)}{dt}\frac{1}{resistance} = amps \tag{2.28}$$

The toroidal amps on 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.

3 Ampere-Maxwell law

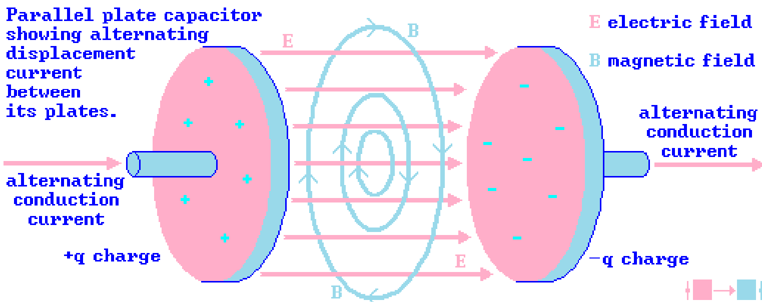


Figure 14: Ampere's law: The flux of E causes B.

A changing electric flux through the circular area of a plate capacitor generates a loop magnetic field as seen on figure (14).
 Red is transformed into blue.

3.1 Integrals of Ampere's law

$$\oint_C \vec{B} \circ \vec{dl} = \mu_0 \left(I_{(enc)} + \epsilon_0 \frac{d}{dt} \int_S \vec{B} \circ \hat{n}\, da \right) \tag{3.1}$$

$$\oint_C B \cdot ds = \frac{1}{c^2} \frac{d(\Phi_E)}{dt} \tag{3.2}$$

$$\oint_C B \cdot ds = 2\pi r \cdot B \tag{3.3}$$

The line integral around the curve equals the circumference of the loop times B [23].

$$\frac{d(\Phi_E)}{dt} = \frac{d(E \cdot \pi r^2)}{dt} \tag{3.4}$$

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

$$\oint_C B \cdot ds = I \cdot \mu_0 + \frac{1}{c^2} \frac{d(E \cdot da)}{dt} \tag{3.5}$$

I is amps. Maxwell's modification of Ampere's law per Hyperphysics [20] or per Wiki [21].

$$\oint_C B\cdot ds = I\cdot \mu_0 + \epsilon_0\cdot \mu_0 \frac{d(E)}{dt} \tag{3.6}$$

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

$$\frac{1}{\mu_0}\oint_C B\cdot ds = I + \epsilon_0 \frac{d(\Phi_E)}{dt} \tag{3.7}$$

Divided by μ_0.

$$\frac{2\pi r\cdot B}{\mu_0} = I + \epsilon_0 \frac{d(\pi r^2\cdot E)}{dt} = amps \tag{3.8}$$

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 [22] or [**?**]. The right hand side of the equations is Maxwell's displacement current. The toroidal amps in the loop equals the poloidal flux of amps through the area of the loop.

3.2 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.

$$E = \frac{volts}{meter} = \frac{kg\cdot m^2}{A\cdot s^3}\cdot \frac{1}{m} = B\cdot c = \frac{kg}{A\cdot s^2}\cdot \frac{m}{s} = \frac{kg\cdot m}{A\cdot s^3} \tag{3.9}$$

$$\frac{d(E)}{dt} = 4\pi E\cdot frequency = \frac{volts}{meter\cdot seconds} = \frac{kg\cdot m}{A\cdot s^4} \tag{3.10}$$

$$B\cdot c = E$$

$$\frac{d(E)}{dt} = 4\pi B\cdot c\cdot frequency \tag{3.11}$$

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

$$\frac{d(E)}{dt} = 4\pi B \frac{c^2}{2\pi r} \tag{3.12}$$

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

$$2 \cdot B = \frac{r}{c^2} \frac{d(E)}{dt} = Teslas = \frac{kg}{A \cdot s^2} \tag{3.13}$$

collected terms and multiply by πr

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

$$2\pi r \cdot B = \frac{1}{c^2} \frac{d(\pi r^2 \cdot E)}{dt} \quad or \quad \oint B \cdot ds = \frac{1}{c^2} \frac{d(\Phi_E)}{dt} \tag{3.15}$$

The circumference of the loop times toroidal blue B equals $1/c^2$ times the rate of change of the area of the loop times E or:

The line integral B equals
$1/c^2$ times the red poloidal flux of E.

$$B = \frac{kg}{A \cdot s^2} = \frac{kg \cdot m}{s^2} \frac{1}{A} \frac{1}{m} = \frac{force}{amps \cdot meters} \tag{3.16}$$

$$Force = B \cdot q \cdot v = B \cdot A \cdot s \frac{m}{s} = B \cdot A \cdot m \tag{3.17}$$

v is velocity.

$$2\pi r \cdot B = \epsilon_0 \cdot \mu_0 \frac{d(E \cdot \pi r^2)}{dt} \quad or \quad \oint B \cdot ds = \epsilon_0 \cdot \mu_0 \frac{d(E)}{dt} \tag{3.18}$$

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

$$2\pi r \cdot B \frac{1}{\mu_0} = \epsilon_0 \frac{d(\pi r^2 E)}{dt} \quad or \quad \frac{1}{\mu_0} \oint B \cdot ds = \epsilon_0 \frac{d(E)}{dt} = amps \tag{3.19}$$

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 [32]

4 Loops, tubes and rings

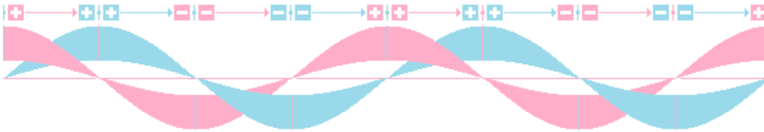


Figure 15: Scaled flux tubes

This looks like a double helix in figure (15) 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 (16) where we see top and side views of figure (15).

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.

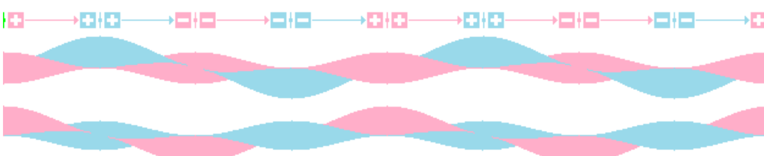


Figure 16: Flux tubes in three dimensions

The wavelength on figure (16) is 314 pixels and the maximum diameter of the flux tubes is 25 pixels. The flux tubes are twisted and pointy jelly beans strung together like sausages.

The loops which were visible, above and below the center line on figure (15), are now hard to see on figure (16) but they are clearly shown on figure (17) 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 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 rings 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 only 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.

Alternating electric field rings move up and down.

Alternating magnetic field rings move left and right.

A line between the centers of the E and B flux tubes, the hypotenuse, traces out the icon of life, a double helix. Life preceded 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.

4.1 Four steps of one wavelength

Working left to right on figure (16) or (17)

- Red becomes blue $= +E \Rightarrow +B =$ $d(sine)/dt \Rightarrow cosine = Row\ 1\ on\ figure\ (17).$

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

Maxwell's red changing poloidal current through the area of the loop or displacement current times the area of the loop equals the blue toroidal current around the ring circumference times the circumference of the loop.

- $Blue\ becomes\ \neg red = +B \Rightarrow \neg E =$ $d(cosine)/dt \Rightarrow \neg sine = Row\ 2\ on\ figure\ (17).$

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

The changing blue poloidal current times the area of the loop equals the toroidal red current times the circumference of the loop.

- $\neg Red\ becomes\ \neg blue\ = \neg E \Rightarrow \neg B = d(\neg sine)/dt \Rightarrow \neg cosine = Row\ 3\ on\ figure\ (17).$

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

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

- $\neg Blue\ becomes\ red = \neg B \Rightarrow +E = d(\neg cosine)/dt \Rightarrow sine = Row\ 4\ on\ figure\ (17).$

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

The changing poloidal blue current times the area of the loop equals the toroidal red current times the circumference of the loop. On the flux tubes of figure (16) we saw top and side views of sine and cosine flux tubes waves. Here on figure (17) we see an animation array showing 24 cross sections through those flux tubes per wavelength. See the animation [24].

We have end views of the cross sections of figure (16). 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

$$+red \ \Rightarrow \ +blue \ \Rightarrow \ \neg red \ \Rightarrow \ \neg blue \ \Rightarrow \ +red$$

4.2 Along the wavefront

The plane of the paper is the wavefront on figure (17). The rings are on the wavefront. Light is rings of current. Does this sound a little like string theory? These rings are the substance and hold the energy of electromagnetic waves.

Rings precede flux tubes. Any cross section through the hollow flux tube drawings 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.
$E\ is\ a\ +red\ or\ \neg red\ ring.$
Its radius is proportional to the $sine^2$.

The magnetic field rings move left and right.
$B\ is\ a\ +blue\ or\ \neg blue\ ring.$
Its radius is proportional to the $cosine^2$.

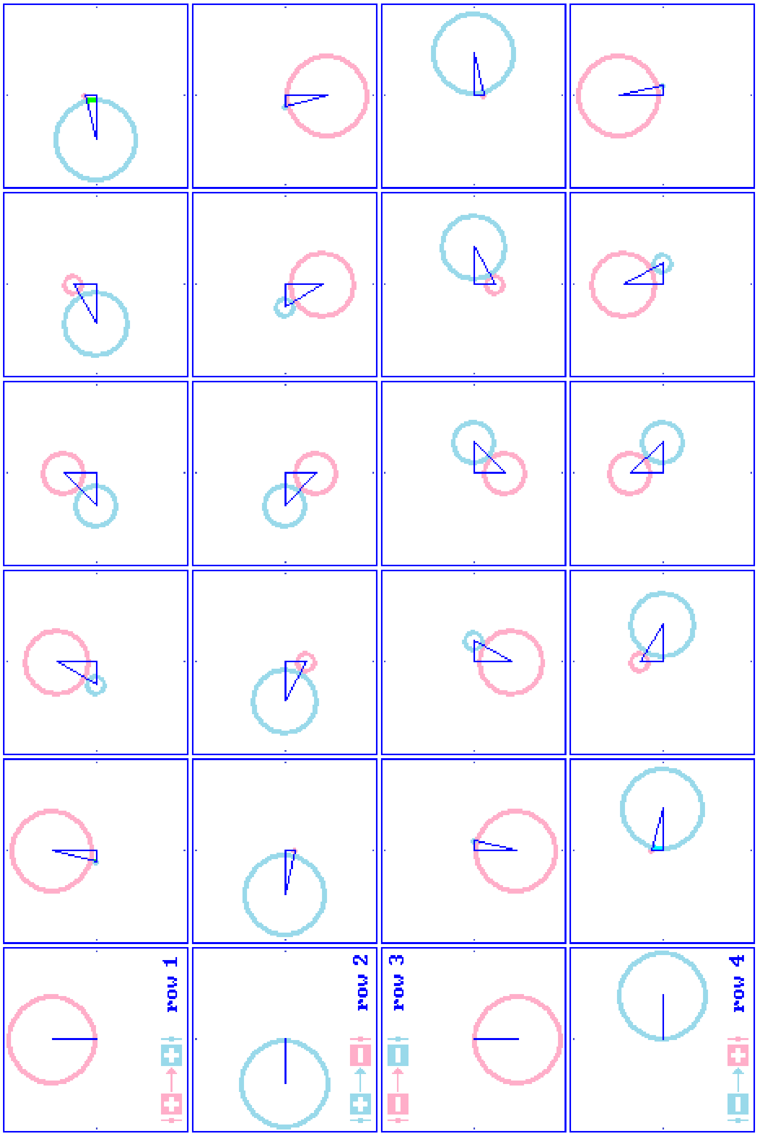


Figure 17: Rings on the wavefront
The plane of the paper is the wavefront of the EM waves flux tubes. See the animation [24].

The energy is located on the rotating circular rings of current along the circumference of the flux tubes. A flux emanates along the hypotenuse from the shrinking ring and terminating in the expanding ring. The energy is proportional to the radius or circumference of the rings.

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, created by expanding and shrinking ring pairs, which occurs over time, on the two dimensional surface of the expanding spherical wavefront.

The action is only on the wavefront. The flux tubes are an artifact or illusion created by the persistence of vision.

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 (17) are sine or cosine flux tube waves when seen over time from the perpendicular point of view of figure (16).

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 (16) through the persistence of vision of an oscilloscope.

4.3 Square units

On the upper left of this figure (18) we see a blow up of the fourth square on figure (17).

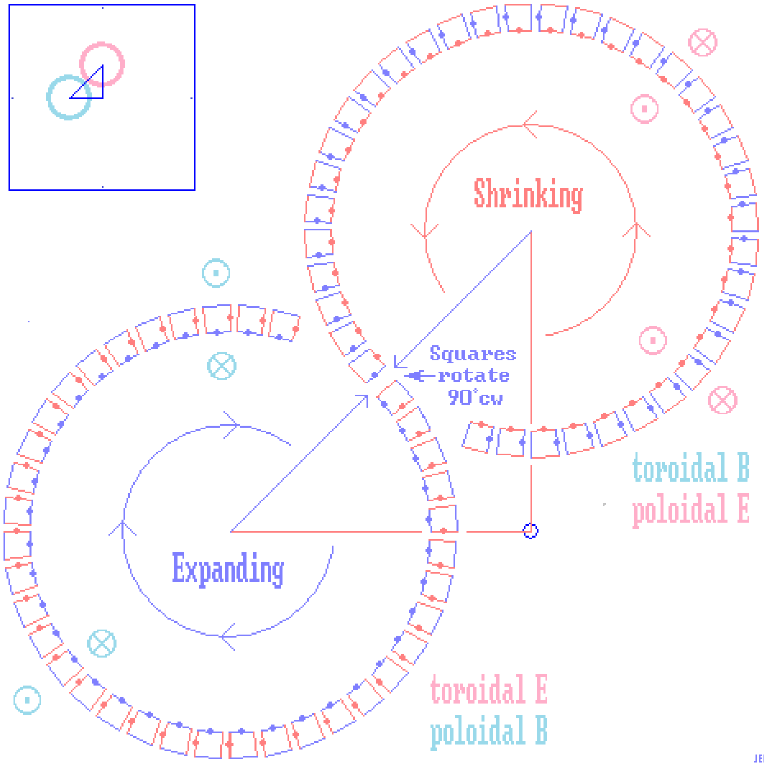


Figure 18: Blowup of rings on the wavefront

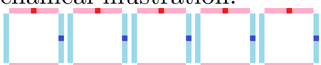
Both rings are the same size and the angle is 45 degrees at the moment imaged. The top ring is shrinking. The bottom ring is expanding. There is a transference of circumference and energy at the hypotenuse, where there is a clockwise rotation of the individual squares. The blue toroidal and pink poloidal fields of the top loop are transformed, along the hypotenuse, into pink toroidal and blue poloidal fields on the bottom loop. See the animation [24].

The direction of the E and B fields remain flat and perpendicular on the surface of the paper, for both rings, so the direction of the velocity of the rings is into the paper as they propagate at c.

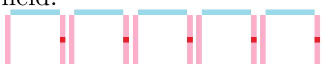
Hypothetically, the charge of the bottom loop pulls the squares off of the top loop, at the hypotenuse, where the squares rotate 90 degrees, and attach to the bottom loop making the bottom loop grow. For each square, a quantum of charge is transformed into a quantum of magnetism. Of course, the square units which transform, show another case of Maxwell's, "Using mechanical illustrations to assist the imagination, but not to account for the phenomena", which is the purpose of this website.

These rings evolved from earlier work on spirals [27]. See the spiral animation [28].

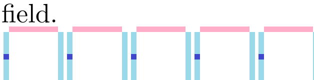
The following square units have perpendicular bipolar magnetism and electric fields arranged in a cross or square as a mechanical illustration.



See figure (18), top ring. Toroidal magnetic force holds the row together. It has a poloidal electric field.



See figure (18), bottom ring. Clockwise rotation of each square from the previous figure. Toroidal electric force holds the row together. It has a poloidal magnetic field.



Clockwise rotation of each square from the previous figure. Toroidal magnetic force holds the row together.

Clock wise rotation of each square from the previous figure. Toroidal electric force holds the row together.

Figure 19: Opposite poles hold the squares together

On the left: North and south magnetic poles hold the squares together. On the right: Positive and negative charged poles hold the squares together. Magnets and charge ignore each other.

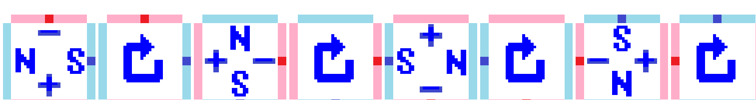


Figure 20: Clockwise rotation of the squares

The units rotate in ninety degree steps. The top and bottom faces, of each square, have opposite poles. The left and and right faces, of each square, have opposite poles, as we see in figure (20).

See the Beatty video [29] for this unusual and largely unnoticed characteristic of series magnets.

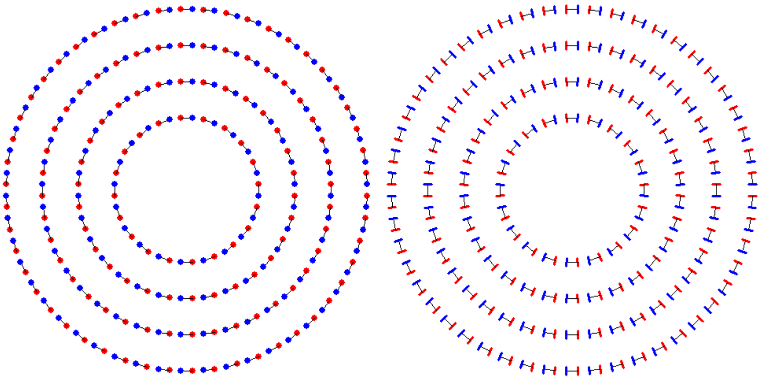


Figure 21: Shrinking and Expanding Rings
Left: a ring of magnets or magnetic dipoles is shown in four stages as it shrinks. The ring looses magnets as it shrinks.
The toroidal magnetic field vector B along the ring per unit length is uniform but the length and area is changing so it shows dB/dt. This is Faraday's law.
Right: a ring of capacitors or capacitive dipoles is shown in four stages as it shrinks. The ring looses capacitors as it shrinks.
The toroidal electric field vector E along the ring is constant but a shrinking or expanding ring with a charge per unit length would show dQ/dt which is Amps.
The electric field along the ring is uniform but the circumference and area is changing so it shows dE/dt.
This is the Ampere-Maxwell's law.

4.4 Transition math

$frequency \cdot wavelength = c$
$wavelength = 4 \cdot transition$
We have four ring-to-ring transitions per wavelength on figure (17):

$$red \Rightarrow blue \quad blue \Rightarrow \neg red \quad \neg red \Rightarrow \neg blue \quad \neg blue \Rightarrow red$$

$frequency \cdot transition = c/4$
$c = 4 \cdot frequency \cdot transition$
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.

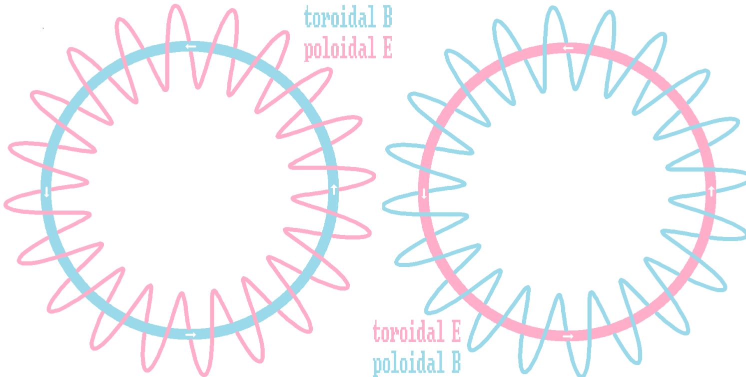


Figure 22: Toroidal and poloidal fields
Left: The toroidal and poloidal fields are more or less confined to the plane of the torus. The poloidal is radial where the toroidal is tangent and in this way they are perpendicular.

4.5 Hypotenuse, Wavelength and Ring Radius

The rings rotate in opposite directions where they touch on figure (17).

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 circumference of the donor ring, which decreases in size, to the circumference of the recipient which increases in size.

$hypotenuse = h = wavelength/(8\pi)$, is constant.
The hypotenuse of the triangles in figure (17) 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 dual ring orbit, making four ring to ring transfers per wavelength while traveling a distance of one wavelength at the speed of light.

$cos^2 + sin^2 = 1$
$2\pi r \cdot cos^2 + 2\pi r \cdot sin^2 = 2\pi r =$ circumference

$h \cdot cos^2 = wavelength \cdot cos^2/(8\pi)$, the radius of the x ring.
$h \cdot sin^2 = wavelength \cdot sin^2/(8\pi)$, the radius of the y ring.
$2\pi h \cdot cos^2 + 2\pi h \cdot sin^2 = 2\pi h = wavelength/4$, the sum of the circumferences of the ring pair.
The hypotenuse in figure (17) 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 (16), the wavelength is 314 pixels and h the maximum radius is 12.5 pixels, so the waveform is drawn to scale.

4.6 Ring radius or energy or mass

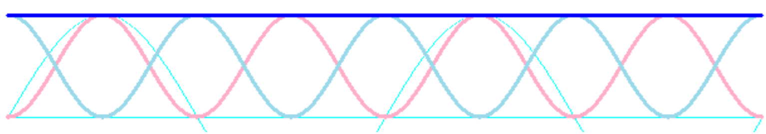


Figure 23: Ring radius or energy

On figure (23):
$Red = E\ ring = \ sin^2$.
$Blue = B\ ring = \ cos^2$.
$Darkblue = E + B\ rings = sin^2 + cos^2$.
$Cyan =$ 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 ring 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 (23) 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 (23) shows the division of the radius, circumference, charge or energy between the colors so we can write,

$$\frac{B^2}{\mu_0} = energy\ density = \frac{kg}{m \cdot s^2}$$

$$\frac{B^2}{\mu_0} = \left(\frac{\sqrt{c \cdot h_p \cdot \mu_0}}{wavelength^2}\right)^2 \frac{1}{\mu_0}$$
$$\frac{B^2}{\mu_0} = \frac{c \cdot h_p \cdot \mu_0}{wavelength^4} \frac{1}{\mu_0}$$
$$\frac{B^2}{\mu_0} = \frac{c \cdot h_p}{wavelength^4}$$

$$\frac{B^2}{\mu_0} \cdot wavelength^3 = \frac{c \cdot h_p}{wavelength} = energy = \frac{kg \cdot m^2}{s^2} \qquad (4.5)$$

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,

$$\frac{B^2}{\mu_0} wavelength^3 \cdot sine^2 + \epsilon_0 \cdot E^2 \cdot wavelength^3 \cdot cosine^2$$
$$= \frac{c \cdot h_p}{wavelength} = total\ energy = \frac{kg \cdot m^2}{s^2} \qquad (4.6)$$

4.7 The rate of change of the rings

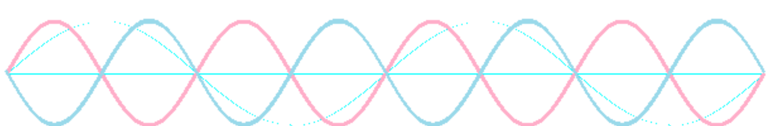


Figure 24: The rate of change of the rings

$Red = E\ ring = 2 \cdot sin \cdot cos.$

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

In figure (24) 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 (17) we expect a current to stream from one ring to the other at their point of contact. In figure (24), 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.

4.8 Rate of change of ring circumference

$$\frac{d(2\pi r)}{dt} = \frac{d(m)}{dt} = \frac{m}{s} \tag{4.7}$$

The rate of change of the circumference is a velocity,

$$\frac{d(2\pi r \cdot frequency)}{dt} = \frac{d(m/s)}{dt} = \frac{m}{s^2} \tag{4.8}$$

The rate of change of the circumference times a frequency is an acceleration.

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.

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

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

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

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

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

$$\frac{A \cdot s}{m} \cdot \frac{m}{s} = A \tag{5.5}$$

$$\frac{charge}{meter} \cdot \frac{meter}{second} = \frac{charge}{second} = \frac{Amps \cdot seconds}{seconds} = Amps \tag{5.6}$$

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 (18) are held together by this bipolar electric field the electric field is confined within the ring but the perpendicular bipolar magnetic field is exposed.

$$\frac{E_{total}}{total\ length\ of\ loops} = \frac{4 \cdot E_{total}}{wavelength} \tag{5.7}$$

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 $wavelength/4$.

$$\frac{dE}{dt} = \frac{4 \cdot E_{total}}{wavelength} \frac{d(2\pi r \cdot frequency)}{dt} = \frac{4 \cdot E_{total} \cdot c \cdot 2 \cdot sin \cdot cos}{wavelength} \tag{5.8}$$

This is in the form,

$$\frac{E}{meter} \cdot \frac{meter}{second} = \frac{E}{second} = \frac{dE}{dt} \tag{5.9}$$

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

$$E_{total} \cdot frequency \cdot 2 \cdot sin \cdot cos = 4\pi E \cdot frequency \tag{5.10}$$

This is Ampere's law if

$$E_{total} \cdot 2 \cdot sin \cdot cos = 4\pi E \cdot 2 \cdot sin \cdot cos = \frac{d(sin^2)}{dt} \tag{5.11}$$

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.

$$\frac{B_{total}}{total\ length\ of\ loops} = \frac{4 \cdot B_{total}}{wavelength} \tag{5.12}$$

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 $wavelength/4$.

$$\frac{dB}{dt} = \frac{4 \cdot B_{total}}{wavelength} \frac{d(2\pi r)}{dt} = \frac{4 \cdot c \cdot B_{total}}{wavelength} \cdot 2 \cdot sin \cdot cos \tag{5.13}$$

This is in the form,

$$\frac{B}{meter} \frac{meter}{second} = \frac{B}{second} = \frac{dB}{dt} =$$

$$\frac{B_{total}\cdot 2\cdot sin\cdot cos\cdot c}{wavelength} = B_{total}\cdot 2\cdot sin\cdot cos\cdot frequency \qquad (5.14)$$

$dB/dt = 4\pi B\cdot frequency.$
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 (24), are the maximum currents flowing ring to ring.

5.4 Pinch and repulsion

A row of parallel magnets not series, with their bi-poles pointing in the same direction, repel 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 not series, 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.

Can you see the the rings of figure (17) and (18) and the flux tubes of figure (16) in terms of series and parallel bipolar charges?

This detailed mechanistic view of electromagnetic waves makes falsifiable predictions. Standing waves of figure (16) 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.

6 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

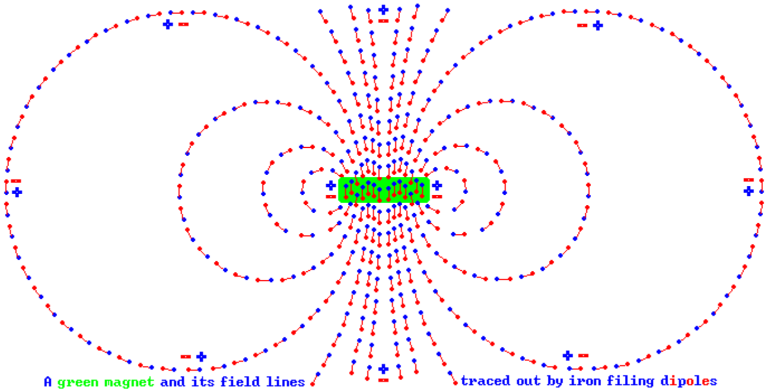


Figure 25: Iron filings and bar magnets

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 [30] has an interesting magnetic field calculator which shows a pattern similar to the above for thin disk magnets. Helmholtz coils are similar. See Hyperphysics [31] 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 figure (25) 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. See the Beatty video [29] for this unusual and largely unnoticed characteristic of series magnets.

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 [32], 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 = energy density=force/area = $Coulomb\ repulsion\ pressure = magnetic\ pinch\ pressure =$ $kg/(m\cdot s^2)$.

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 [29]. Magnets have other interesting structural assembly properties [35].

Interesting sources are K&J [30] and Neocube [36].

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 polarity and strong attractive and repulsive forces. Magnets are a fun way to experiment with bipolar ideas. The ends of rows

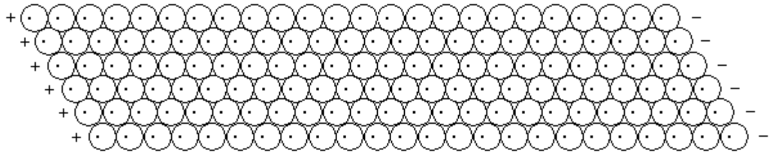


Figure 26: Neodymium magnets

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.

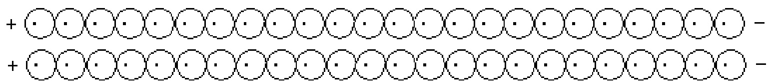


Figure 27: Like poles repel

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

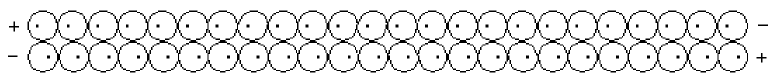


Figure 28: Opposite poles attract

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. 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.

In figure (30) 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

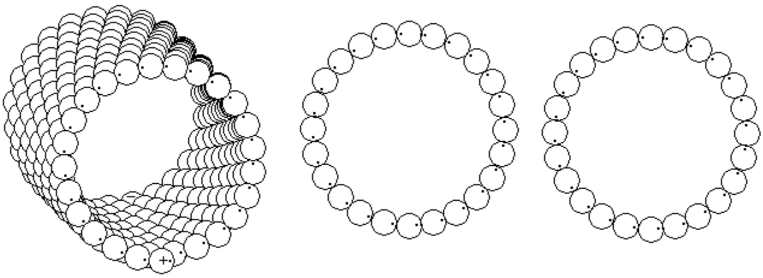


Figure 29: Loops of magnets

the circle which is shrinking, the hypotenuse of the right triangle of figure (17). This is a summation of the movement in the animation [24] and the animation array figure (17). Science as art.

7 E = c B

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

$$q\cdot E = q\cdot v\cdot B, \quad v = c \ for\ an\ electromagnetic\ wave \qquad (7.1)$$

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

J. J. Thomson [45] determined the mass to charge ratio [46] 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 [47] $= q\cdot E + q\cdot v\cdot B$.

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

$$E^2\cdot \epsilon_0 = \frac{B^2}{\mu_0}, \quad \frac{kg}{m\cdot s^2} = energy\ densities\ or\ pressures \qquad (7.2)$$

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 [32] like a hose restrains water.

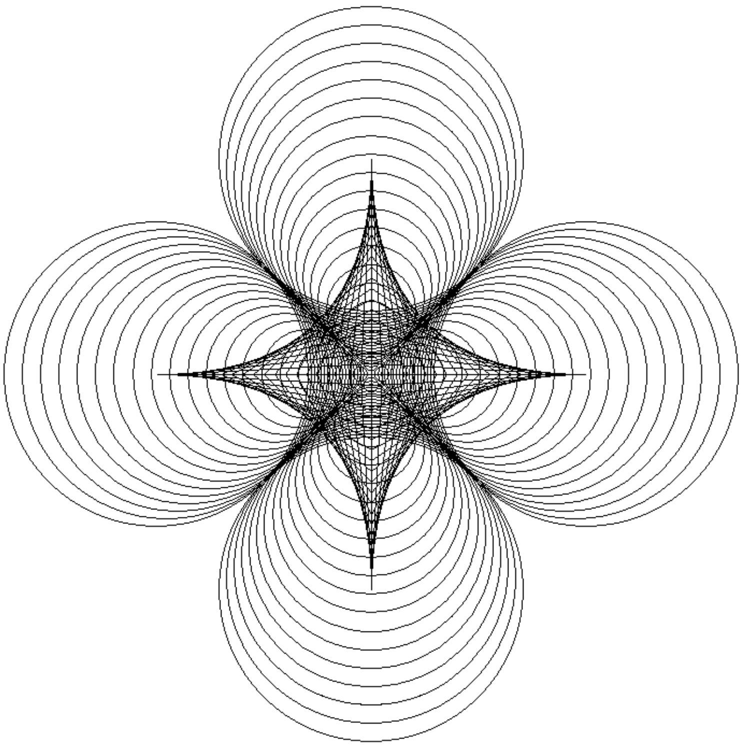


Figure 30: Cross sections through the electromagnetic wave

The electrostatic force of repulsion by the charge equals the magnetic pinch force of attraction on the charge.

8 Derivation of the wave parameters

There are four variables with values that we seek B, E, q and Amps.
$Faraday's\ law.\ \ 2\pi r{\cdot}\, E = volts = energy/charge$
$q = charge = A{\cdot}\, s$
$E = force/charge = force/A{\cdot}\, s$
$B = force/(amp{\cdot}\, meters) = force/(A{\cdot}\, m)$
$force\ \cdot\ wavelength = energy$
We will call $2\pi r = wavelength$

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

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

$$E{\cdot}\, q = \frac{h_p{\cdot}\, c}{wavelength^2} \tag{8.1}$$

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

$$B{\cdot}\, c{\cdot}\, q = \ force\ = \frac{energy}{wavelength} = \frac{h_p{\cdot}\, c}{wavelength^2} = \frac{kg{\cdot}\, m}{s^2} \tag{8.2}$$

cancel c's

$$B{\cdot}\, q = \frac{h_p}{wavelength^2} = \frac{kg}{s} \tag{8.3}$$

$$2\pi r{\cdot}\, B = wavelength{\cdot}\, B = Amps{\cdot}\, \mu_0,\quad Ampere's\ law, \tag{8.4}$$

$$B = \frac{Amps{\cdot}\, \mu_0}{wavelength} = \frac{kg}{A{\cdot}\, s^2} \tag{8.5}$$

$$q_1 = \frac{B{\cdot}\, q}{B} = \frac{h_p}{wavelength^2}\frac{wavelength}{Amps{\cdot}\, \mu_0}$$

$$q_1 = \frac{h_p}{wavelength{\cdot}\, Amps{\cdot}\, \mu_0} \tag{8.6}$$

$$\frac{h_p \cdot c}{wavelength} = c \cdot \mu_0 \cdot q_1 \cdot Amps = energy. \tag{8.7}$$

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

$$q_w = q_1 \tag{8.8}$$

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

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

$$Amps \cdot wavelength = \sqrt{\frac{c \cdot h_p}{\mu_0}} = 3.976E\neg 10\ A \cdot m \tag{8.9}$$

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

$$Amps = \sqrt{\frac{c \cdot h_p}{\mu_0}} \cdot \frac{1}{wavelength} = 3.976E\neg 10 \frac{A \cdot m}{wavelength} \tag{8.10}$$

This is the maximum Amps flowing between both rings. There is a variable current which flows between the rings of figure (16) and (24).

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

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

substituted for Amps from equation (8.10).

$$q_w = \sqrt{\frac{h_p}{c \cdot \mu_0}} = \sqrt{c \cdot h_p \cdot \epsilon_0} = 1.326E\neg 18\ A \cdot s \tag{8.11}$$

We see that q_w, the charge of the electromagnetic wave
is a constant 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.

8.1 Powers of $1/wavelength$

One over wavelength:
$energy = h_p \cdot c/wavelength:$

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

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

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

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

8.2 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
$B^2/\mu_0 \cdot wavelength^3 = 3.318E\neg 19 \cdot kg \cdot m^2/s^2 = energy$

8.3 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
$wavelength = h_p \cdot c/(me \cdot c^2) = h_p/(me \cdot c) = 2.4263E\neg 12 \cdot m$
$frequency = c/wavelength = 1.235E20\ 1/s$
$q_w = \sqrt{h_p/(c \cdot \mu_0)} = 1.326E\neg 18 \cdot A \cdot s,\ charge$
$Amps = \sqrt{c \cdot h_p/\mu_0}/wavelength = q_w \cdot frequency =$
$q_w \cdot c/wavelength = 163.865 \cdot A$
$B = \sqrt{c \cdot h_p \cdot \mu_0}/wavelength^2 = 8.4869E7 \cdot kg/(A \cdot s^2) = Teslas$

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

8.4 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 $1E21\ kg/m^3$.

8.5 Is energy stored in the area or the circumference of the rings?

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, $radius/3 = 4.73E25m$.
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.

8.6 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
$\pi r^2 = \pi h^2 = \pi h^2 \cdot cos^4 = wavelength^2 \cdot cos^4/64\pi$
$Red = E\ ring = sin^4$.
$Green = B\ ring = cos^4$.

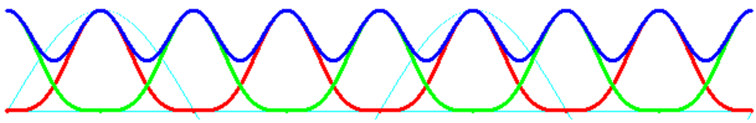
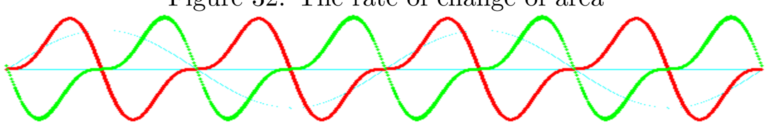


Figure 31: The area of the rings

$Blue = E + B\ rings = sin^4 + cos^4$.
$Cyan$ = 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?

Figure 32: The rate of change of area

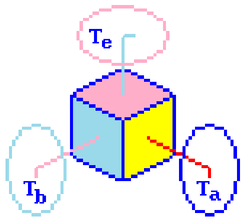


Graph of the rate of change of the area of the rings,
$d(\pi r^2)/dt = sin^4\ and\ cos^4$.
$Red = Ering = 4\cdot cos\cdot sin^3$.
$Green = Bring = 4\cdot sin\cdot cos^3$.
$Cyan$ = frequency reference sine wave.
$d(\pi r^2)/dt = wavelength^2\cdot cos\cdot sin^3/16\pi$ or
$d(\pi r^2)/dt = wavelength^2\cdot sin\cdot cos^3/16\pi$.
Does the rate of change of the area of the rings go anywhere?

9 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 [25]and precession or nutation in gyroscopes [41] 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.

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



Looping around is another word for torque in this context.
a is the roll or axial axis which transfers the angular momentum, torque or spin of the light.

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

e is the yaw, charge 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 (17). 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 (17). 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 (17).

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

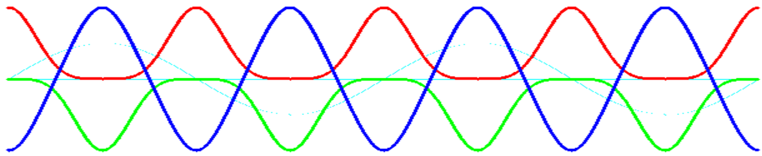


Figure 33: Unimpeded torques of the light wave

9.2 If we have waves traveling unimpeded

$w_a = w_b = w_e = w$, 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.

9.3 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.

10 Loops of light as particles

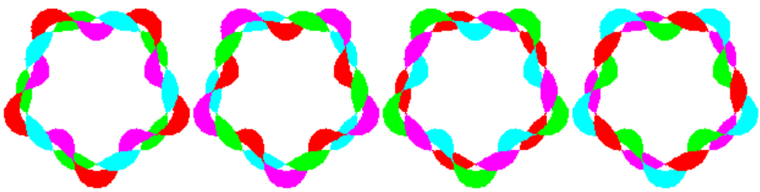


Figure 34: This is loops of light as particles

The outside of the rings on figure (34) 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.

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 [37].

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

First on the left on figure (34), 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 [38]. This search for the origin of gravity is also articulated by Assis [39]. His books and on-line papers [40] are recommended.

11 Braided Wires

Wires can be woven together to make quite good toy sine and cosine waves as shown on figure (3). 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.

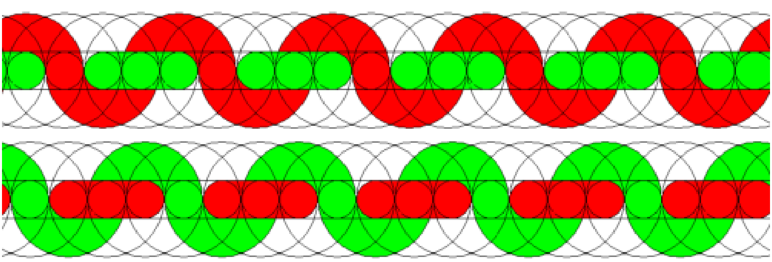


Figure 35: Figure construction

On figure (35) we see the construction of figure (3). I wrote a Liberty Basic program to draw the circles. Its graphics are much easier and faster than Python. A Paint program was used to color and clean up. Almost all of the black lines are removed by using Irfanview [44]: contrast, gamma correction and contrast or 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.

11.1 Tipler's reciprocal results

Tipler 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)" [22].

11.2 Fat text books can be articulate old friends

Tipler's; "Physics for scientist and engineers" [22] 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.

11.3 Lake Okeechobee

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.

11.4 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. Parroting 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.

11.5 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.

11.6 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?

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