Electromagnetism

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Note: This document is complete up until the explicit analysis of Maxwell's equations (where I have only addressed the third in Wikipedia), but I have discussed them fully in the context of the Electromagnetic Tensor (which represents them in matrix form), so this document will serve as a preliminary document with updates coming. I will return to complete it, but there are several important preliminary documents I need to address first, so will complete the discussion shortly after I have finished it..

Update: 5/6/2024 – Included an analysis of Gauss's Law and its extension to magnetic fields and a brief section on gravity, just before the specific analysis of Maxwell's equations (still to be done) below.

Coulomb's Law (Wikipedia)

Ampere's Law (Wikipedia)

Maxwell's Equations (Wikipedia)

Vector Calculus Identities (Wikipedia)

Groups and Vectors (my pdf)

Vector Products (my pdf)

The Relativistic Unit Circle (my pdf)

Working Document (my pdf) – links to all current articles

Interaction Equation (my pdf)

Fermions (my pdf)

The Lorentz Force (my pdf)

The first section "**Interaction Analysis**" of this paper shows how the interaction equation is related to the Lorentz force and therefore the equivalence of mass and charge. The second section "**Classical Electromagnetism**" is an analysis of Maxwell's equations individually and via the electromagnetic tensor to show that if mass and light interact, then light must be imaginary.

It is important to understand that Maxwell derives a specific value for the speed of light in a "vacuum" (displacement length in the earth's environment) using the force parameters of Gauss and Coulomb (permeability, permittivity) which are subject to variation in different field densities (e.g. altitudes, next to mountains, etc.) where in the Special Theory Einstein abandons the concept of mass entirely (or rather, renders it irrelevant in first order: $\beta := \frac{v}{c} = \frac{mv}{mc} = \frac{m^n v}{m^n c} = \frac{(f(m))^n v}{(f(m))^n c}, etc.$ which is also true in second order $\beta^2 := \left(\frac{v}{c}\right)^2$

, both in first and second order. That is, if there is interaction ("acceleration") between "inertial frames", mass (or interacting “space”, atmosphere, matter, or anything else) must be imaginary, and so for Einstein, there is no interaction between mass and (imaginary) light) in Special Theory of Relativity.

Sign in optics lab at LLNL: “Please do not gaze into laser with remaining eye.”

Interaction Analysis

For a system characterized by positive real numbers, two elements either do not interact in first order, or interact in second order. If they do not interact in second order, one must be characterized as an "imaginary" number (which means it doesn't exist in reality).

The fundamental element of a single system in a pure vacuum is a force, and its square (in second order as two equal and opposite interacting forces) characterizes inertial mass. If they are not equal, they can be parametrized to show the effect of radiation and accretion in relation to equilibrium (as the initial state)

Calculus

Note that the analysis is consistent for infinitesimals, provided that they are invariant. (which means they are not actually infinitesimals, just very small. ☺

Coulomb's Law

$$f_{qq} = f_{q^2} = \frac{1}{4\pi r^2}\frac{q^2}{\varepsilon_0}$$
$$V = \frac{4}{3}\pi r^3 + k_{(cbr)}, \frac{dV}{dr} = 4\pi r^2 = 4\pi A_r$$
$$f_{qq} = \left(\frac{1}{A_r}\right)\left(\frac{q^2}{\varepsilon_0}\right) = \frac{1}{4\pi r^2}\left(\frac{q^2}{\varepsilon_0}\right)$$

, where $4\pi r^2 = 4\pi A_r$ is the surface area of the sphere.

If $\frac{dV}{dr} = 0$ so there is no change in volume with respect to radius, then $f_{qq} = 0$.

Force due to a single charge

For $\varepsilon_0 := \frac{q}{A}$, setting $A_r = \frac{1}{4\pi r^2}$ yields $f_q = q\left(1_{Ar}\right)$ If the area is invariant, then $A_r = A_r\left(\frac{A_r}{A_r}\right) = A_r\left(1_{Ar}\right)$ and thus is represented by a prime number, and the interaction of a single charge interacting with a coordinate area (either a square or a disk) is given by $h^2 := 2(qA)$. That is, in order for such an interaction to occur, both the coordinate plate and the charge must exist:

$$\# = q + A$$
$$\#^2 = (q+A)^2 = \left[q^2 + A^2\right] + \left[2qA\right]$$

Complex Numbers

Note that for complex numbers: $\psi := q + iA,\ \psi^* := q - iA,\ \psi^*\psi = q^2 + A^2$ where the interaction products $\pm qA$ have been eliminated by conjugation so that $\#^2 \neq \psi\psi^*$, but that

$\#^2 = [\psi\psi^*] + [2qA] = [q^2 + A^2][2qA]$ so the count is preserved if complex elements are simply replaced by their real values in the full expansion.

Note: For $\# = Me + Thee$,

, where $\left[(Me)^2 + (Thee)^2\right]$ is our existence, and $\left[2(Me)(Thee)\right]$ is our interaction. Note that for the interaction to both of us must exist in second order as well as first order. The Universe, god, whatever, can be substituted for $(Thee)$. If (Me) and $(Thee)$ don't interact in second order, then $(Thee)$ must be imaginary. Similarly for the relation between $(Mass)$ and $(Light)$. There have been many physics limericks on this subject.

"Yesterday, upon the stair,

I saw a man who wasn't there.

He wasn't there again today

Oh, how I wish he'd go away." ---- Ogden Nash

Cosmology

For Coulomb forces the force between two charges is one-dimensional (for Maxwell, separated by a displacement "length") as will be addressed in following sections, so the area is irrelevant, and so $f_q = q$ at a single "coordinate" position (r,t) from our location in a perfect vacuum (no other elements (i.e. a empty spot in the Cosmic Background Radiation at position (r,t) from our (well, ok, my) location at $(0,0)$ where r is defined as "somewhere", and t is defined as "sometime". (If a "signal" from (r,t) is directed to us, it is considered positive, if negative, away from us. Negative signals from (r,t) are obviously not detectable beyond arm's length.

Force due to a single charge

Note that for the force due to a single charge to exist it must be a sum of equal and opposite half charges, where the $+$ sign indicates that the relative "motion" of the half forces forces is towards each other. At impact, the motion ceases at their common origin, so that:

$$q = f_q = \frac{q}{2} + \frac{q}{2}$$

$$q^2 = \left(f_q\right)^2 = \left[\frac{q}{2} + \frac{q}{2}\right]^2 = \left[\left(\frac{q}{2}\right)^2 + \left(\frac{q}{2}\right)^2\right] + \left[2\left(\frac{q}{2}\right)\left(\frac{q}{2}\right)\right]$$

Force between two equal charges

The force between two charges is then given by:

$f_{qq} = \left(f_q + f_q\right)^2 = (q+q)^2 = \left[q^2 + q^2\right] + \left[2qq\right]$ where $\left[q^2 + q^2\right]$ is the existence term and $\left[2qq\right]$ is the interaction term.

The forces can be parametrized so that $f_0 = ct_0$ for $c = c\left(1_c\right)$. This can also be interpreted as c a creation rate and t the creation time so that $q = ct$ is the force due to a single charge and also applied to the force due to a single mass: $f_{m_0} := ct_0$

Then the existence of two equal and opposite forces is characterized by their existence $\# = f + f$ and their interaction $\left[2(ct)(ct)\right]$ by $\#^2 = \left[(ct)^2 + (ct)^2\right] + \left[2(ct)(ct)\right]$ where $ct = (ct)\left(\frac{ct}{ct}\right) = (ct)1_{(ct)}$

In matrix representation

$\#^2 = Tr\begin{vmatrix} (ct)^2 & 0 \\ 0 & (ct)^2 \end{vmatrix} + Det\begin{vmatrix} (ct) & (ct) \\ -(ct) & (ct) \end{vmatrix}$ where $-(ct) = (-c)t = (c)(-t)$ is an artifact of the representation so that all terms are positive in the expanded form.

Force between two unequal charges

This can be represented by the relation

$\# := (ct') = (ct) \pm (vt')$ where for $\# := (ct') = (ct) - (vt')$, $0 \le vt' \le ct$ so that $(ct) - (vt')$ is a positive difference equation.

Then

$$\#^2 := (ct')^2 = \left[(ct)^2 + (vt')^2\right] \pm \left[2(ct)(vt')\right]$$
$$= \left[(ct)^2 + (vt')^2\right] \pm h^2,\ h^2 := \left[2(ct)(vt')\right] = 2S^2,\ S := \frac{h}{\sqrt{2}}$$

The matrix characterization is then

$$\#^2 = Tr\begin{bmatrix} (ct)^2 & 0 \\ 0 & (vt')^2 \end{bmatrix} + Det\begin{vmatrix} (ct) & (ct) \\ -(vt') & (vt') \end{vmatrix} \text{ where } Det\begin{vmatrix} S & S \\ -S & S \end{vmatrix} = 2S^2 = Det\begin{vmatrix} \left(h/\sqrt{2}\right)^2 & \left(h/\sqrt{2}\right)^2 \\ -\left(h/\sqrt{2}\right)^2 & \left(h/\sqrt{2}\right)^2 \end{vmatrix}$$

, where S characterizes "Spin")

There are three cases:

$$\gamma := \frac{t'}{t},\ \beta := \frac{v}{c}$$

1. $0 < vt' < ct$ "Radiation" $(1_{ct'})^2 = \left[\left(\frac{1}{\gamma}\right)^2 + \beta^2\right] + \left[2\left(\frac{\beta}{\gamma}\right)\right]$
2. $vt' = ct'$ "Equilibrium"
   $vt' = ct'$
   $2(ct) = (ct) + (ct)$
   $4(ct)^2 = \left[(ct)^2 + (ct)^2\right] + 2(ct)(ct)$
3. $vt' > ct'$ "Absorption" ("Accretion") $\gamma^2 = \left[(1_{ct})^2 + (\gamma\beta)^2\right] + \left[2\beta\gamma\right]$

1. Radiation characterizes the transition from an initial state $(ct')=(ct)=(ct)\cos(0)$ with the transition $\tan\theta=\left(\frac{vt'}{ct}\right)=\frac{\beta}{\gamma}<(ct')=(2ct)$, $\beta:=\frac{v}{c},\gamma:=\frac{t'}{t}$. Transition is represented from the initial state by:

$$ct'=ct+vt'$$
$$(ct')=(ct+vt')^2=\left[(ct)^2+(vt')^2\right]+2(ct)(vt')$$

Dividing by (ct') results in the expression $(1_{ct'})^2=\left[\left(\frac{1}{\gamma}\right)^2+\beta^2\right]+\left[2\left(\frac{\beta}{\gamma}\right)\right]$ where $\left[\left(\frac{1}{\gamma}\right)^2+\beta^2\right]$ represents the existence of the terms and $\left[2\left(\frac{\beta}{\gamma}\right)\right]:=h^2=2S^2,S=\frac{\beta}{\gamma}=\tan\theta$ where $\tan\theta=\frac{\sin\theta}{\cos(0)}=\sin\theta$. Then $\sin\theta$ represents the "probability" of the transition from $\cos^2(0)$ to $2\cos^2(0)$; i.e., from 1^2 to $2(1^2)$ due to the interaction. ($\sin\theta$ can also also represent the charge-to-mass ratio, or any other physical quantity in such a transition.

2. Equilibrium

   The term $2(ct)(ct)=4\left\{\left(\frac{1}{2}\right)(ct)^2\right\}$ represents the transition at the point where two equal elements have been created and $\left\{\left(\frac{1}{2}\right)(ct)^2\right\}$ represents the area of a right triangle with sides (ct) in each quadrant of of the of the 2D plane.

These cases are further expanded in the The Relativistic Unit Circle and Groups and Vectors in terms of the interaction angle θ where decrease in radiation is characterized by ccw rotation in quadrants I and III and cw rotation in quadrants II and IV, and increase in radiation by the converse . Absorption is characterized by the reverse process: cw rotation in quadrants I and III and ccw rotation in quadrants II and IV. Note that all terms are positive since $\sin(-\theta)=-\sin(\theta)$, so the negative difference is produced by the relations above where the total interaction is positive.

Consider a second system # in addition to the first # (represented by color to distinguish them) so that $\Sigma:=\#+\#$, so that their interaction is represented by

$\Sigma^2 := [\#^2 + \#^2] \pm [2\#\#]$ If both systems are radiating or accreting, they will repel each other, but if one system is radiating and the other is accreting, they will attract each other due to the relative rotations of θ and θ in their respective systems, i.e., whether h (and thus S is increasing or decreasing). Note that in the latter cases, the existence axes are not aligned as the systems struggle for equilibrium.

In a two element system, elements either interact or they do not. (first order vs. second order) However, If the final result is greater than the interaction of two particles, the system may break into different systems where all three elements interact, none of them interact (quarks), or two interact and one does not.

Lengths and Areas ("light cones")

In one dimension, the relation $ct' = ct + vt'$ is valid only if the lengths represented by ct and vt' are connected. Then the second order relation becomes a relation between areas:

"Rectangular Coordinates"

$(ct')^2 = [(ct)^2 + (vt')^2] + [2(ct)(vt')]$ where $[2(ct)(vt')] = 4\left(\frac{1}{2}(ct)(vt')\right)$ and $\left(\frac{1}{2}(ct)(vt')\right) = A_\triangle$, the area of the triangle in each quadrant of the The Relativistic Unit Circle.

"Radial Coordinates"

$$\pi(ct')^2 = [\pi(ct)^2 + \pi(vt')^2] + [2\pi(ct)(vt')]$$
$$\equiv [\pi(r_{ct})^2 + \pi(r_{vt'})^2] + [(r_{ct})2\pi(r_{vt'})]$$

The interaction expression $[(r_{ct})2\pi(r_{vt'})]$ can be visualized as a truncated cone or cylinder of length (r_{ct}) and circumference $2\pi(r_{vt'})$ with area $A = (r_{ct})2\pi(r_{vt'})$ For $0 < r_{vt'} \le ct$ and $r_{vt'} > ct$ the shape of the interaction expression is a truncated cone, while for $r_{vt'} = ct$ the volume is that of a cylinder.

For a complete cone, $2\pi(r_{vt'}) = 0 \leftrightarrow (r_{vt'}) = 0$ which means the cone does not exist.

For the interaction between two systems, attraction or repulsion will depend on the rotations of θ of their respective systems as above.

Thus the concept of "light cones" defined by either mass or light in a single system or two elements or in two interacting systems is wrong, since the cone implies that only one element (or "force" is under consideration).

Time

Note that the concept of "time" is not introduced explicitly in the Interaction Analysis, because analysis of interactive forces relating to $q := (ct)$ applies equivalently to $I_q = \frac{dq}{dt} := (vt')$ so that the force interaction between charge and current is where $q = ct$ or $m = ct$ characterizes charge or mass in terms of creation rates and creation times:

$$\# = \left(q + I_q\right)$$

$$\#^2 = \left(q + I_q\right)^2 = \left[q^2 + \left(\frac{dq}{dt}\right)^2\right] + \left[2q\left(\frac{dq}{dt}\right)\right]$$

$$\pi\left[2q\left(\frac{dq}{dt}\right)\right] = \left[q\left\{2\pi\left(\frac{dq}{dt}\right)\right\}\right], = C_q I_q,\ C_q := \left\{2\pi\left(\frac{dq}{dt}\right)\right\}$$

, where q represents a charge "radius" and the interaction term $C_I := I_{\frac{dq}{dt}} := \left\{2\pi\left(\frac{dq}{dt}\right)\right\}$ is represented as a current "loop" (i.e. a circumference).

Rulers ("space")

However, the creation of rulers in a one-dimensional coordinate systems where $x = ct$ (c interpreted as velocity) that preserves the addition of lengths (i.e., length creation) exists only in first order where $\# := (x) := (x)\left(\frac{(x)}{x}\right) = (x)(1_x) = (ct) = (ct)\left(\frac{(ct)}{(ct)}\right) = (ct)\left(1_{(ct)}\right)$, where x is an invariant (prime) with parameters c and t. However, the expression does not preserve the addition of lengths in second order, since

$$\# := x + x' = ct + vt'$$

$$(\#)^2 := (x + x')^2 = \left[(x)^2 + (x')^2\right] + [2xx']$$

$$(\#)^2 \neq (x + x')^2$$

Note that 2nd second order "space" is represented by areas, so that

$$(\#)^2 = \left[(x)^2 + (x')^2\right] + [2xx'], [2xx'] = 4\left[\frac{1}{2}xx'\right] \text{ and } (\#)^2 := (x+x')^2 = \left[(x)^2 + (x')^2\right] + [2xx']$$

Where $\frac{1}{2}xx'$ is the area of each quadrant in the The Relativistic Unit Circle

Note that for $\# := r + r'$, $\pi(\#)^2 = \pi\left[(r)^2 + (r')^2\right] + \left[r\{2\pi r'\}\right]$, where $C_{r'} := \{2\pi r'\}$ is interpreted as a circumference.

In order to preserve countable rulers on needs to introduce complex representation where $C_v := I_{\frac{dx'}{dt'}} := \left\{2\pi\left(\frac{x'}{t'}\right)\right\} = 2\pi v$ can be interpreted as

$i := \sqrt{-1}, ix' := x'$

$\psi := x + x', \psi^* := x - x'$

$\psi\psi^* := (x)^2 + (x')^2$

. where the interaction term $\pm[2xx']$ has been eliminated by the conjugation and $\psi\psi^* \neq \#^2$.

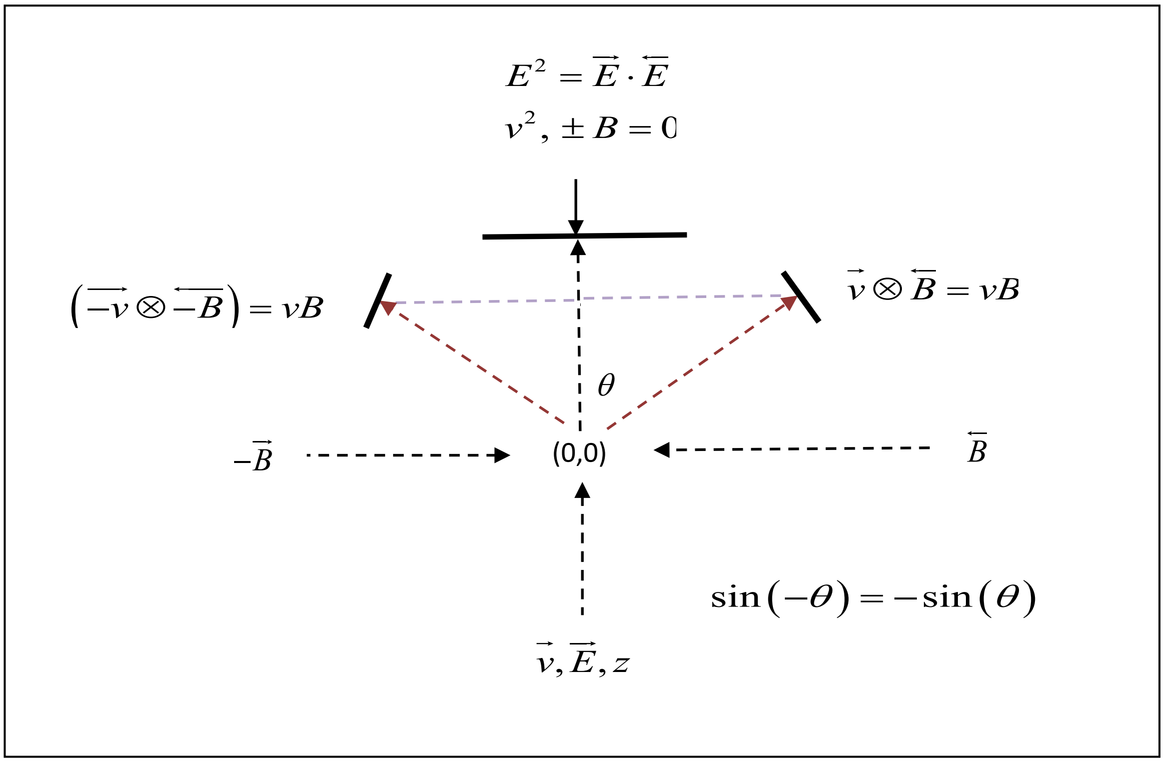
The Lorentz Force

The Lorentz force is defined by the relation: $\overrightarrow{F} = q\left(\overrightarrow{E} + \vec{v} \otimes \overleftarrow{B}\right)$, noting that E is first order (as a coordinate or momentum) but if v and B are first order, then $\vec{v} \otimes \overleftarrow{B}$ is second order, and must be interpreted as area or energy (mass). Note that if

$\# := E + vB$ then $\#^2 = E^2 + vB^2 + E(2vB)$ in contrast to the term $\vec{v} \otimes \overleftarrow{B}$ in the Lorentz force, which means that the only half the value appears – that is, the Lorentz force only expresses the "right hand" rule, whereas the complete expansion is $2vB = v \otimes B + \left[-(v \otimes -B)\right] = 2vB$.

The Lorentz force is therefore related to Fermions in the context of the Stern-Gerlach experiment, with the "Spin" S defined as $S = \frac{h}{\sqrt{2}} = \frac{\sqrt{E(vB)}}{\sqrt{2}}$ where $h^2 := 2E(vB) = 2S^2$

Consider the experimental apparatus where the z-axis represents the initial path of both ionized and un-ionized silver atoms, with a contact along the path at which a B field can be applied.



$\overrightarrow{E}$ represents the momentum of a stream of un-ionized atoms (moving bosons, or the atmosphere, which doesn't move, and surrounds the experiment), and does not interact with ionized silver atoms, initially moving toward $(0,0)$ at unit "momentum" v. If there is no B field, both streams impact the target at the top of the page.

When the B field is turned on, the ionized atoms are diverted to each side by the contact existence of the B field at $(0,0)$

Classical Electromagnetism

Classical Electromagnetism is a vector formalism, where the Theory of Relativity abandons the concept of space (as an interpretation of the results of the MM experiment) and so abandons Classical Electromagnetism by simply declaring the speed of light to be a constant (invariant), and so only addresses the result of Maxwell's derivation of the "speed" of light in a vacuum $c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ defined by the measured permittivity ε_0 and permeability μ_0 of the atmosphere in the absence of inertial mass.

It is emphasized that this speed is not a universal speed in an absolute vacuum (i.e. where there is not even any light – perhaps for brief periods and locations somewhere in the great void, where there are not even any forces, gravitational or otherwise).

The Lorentz Force

For a pair equal and opposite separated forces with a field $x := (\pm v)t$ or there is only a coordinate system $x := vt$, and x (or r) characterizes their relative difference where interaction with the field changes the values of the elements m_v or q_v as they approach, where $+v$.represents approaching relative velocity which will interact at a mutual contact point $(0,0)_{x=0}$ and $-v$ represents receding or non- existent forces f_m or f_q which are therefore unobservable at a mutual contact point $(0,0)$. In any case, $x = 0$ at the contact point, and the "rest" mass is defined by the field for equal and opposite forces $f_0 = \frac{f_0}{2} + \frac{f_0}{2}$ so that $m_0 = (f_0)^2 = \frac{1}{2}\left\{\left[(f_0) + (f_0)^2\right] + \left[2(f_0)(f_0)\right]\right\}$ and similarly for the force due to charge $q_0 = (f_0)^2$.

The Lorentz force is defined by the relation: $\vec{F} = q\left(\vec{E} + \vec{v} \otimes \overleftarrow{B}\right)$, noting that E is first order (as a coordinate or momentum) but if v and B are first order, then $\vec{v} \otimes \overleftarrow{B}$ is second order, and must be interpreted as area or energy (mass). Note that if

$\# := E + vB$ then $\#^2 = E^2 + vB^2 + E(2vB)$ in contrast to the term $\vec{v} \otimes \overleftarrow{B}$ in the Lorentz force, which means that the only half the value appears – that is, the Lorentz force only expresses the "right hand" rule, whereas the complete expansion is $2vB = v \otimes B + \left[-(v \otimes -B)\right] = 2vB$.

The Lorentz force is therefore related to Fermions in the context of the Stern-Gerlach experiment, with the "Spin" S defined as $S = \frac{h}{\sqrt{2}} = \frac{\sqrt{E(vB)}}{\sqrt{2}}$ where $h^2 := 2E(vB) = 2S^2$.

The Electromagnetic Tensor

Electromagnetic Tensor

Relation to Electromagnetic Tensor

$$\psi_{(m_0+i(m_0+m_0))} := m_0 + i(m_0 + m_0)$$
$$\psi_{(m_0+i(m_0+m_0))}* := m_0 - i(m_0 + m_0)$$
$$\left(\psi_{(m_0+i(m_0+m_0))}\right)\left(\psi_{(m_0+i(m_0+m_0))}\right)* = (m_0)^2 + (m_0 + m_0)^2$$

$$\psi_{(m_0+m_0)} = (m_0 + im_0)$$
$$\left(\psi_{(m_0+m_0)}\right)\left(\psi_{(m_0+m_0)}\right)* = (m_0)^2 + (m_0)^2$$
$$F^{\mu\nu}F_{\mu\nu} := (m_0)^2 + (m_0)^2$$

Setting f_0 real to distinguish it from imaginary forces, in first order the relation is:

$\# := \left(\psi_{f_0+f}\right) = f_0 + F^{\mu\nu}$ which can be represented in matrix form as

$$Tr|\#| := Tr\begin{vmatrix} f_0 & 0 \\ 0 & F^{\mu\nu} \end{vmatrix} = f_0 + F^{\mu\nu}.$$

If there is no interaction between mass and electromagnetism, then

$\psi := f_0 + iF^{\mu\nu}, \psi* := f_0 - iF^{\mu\nu}$ so that $\psi\psi* := (f_0)^2 + (iF^{\mu\nu})^2 = m_0 + (iF^{\mu\nu})^2$ where the interaction terms $\pm(f_0)F^{\mu\nu}$ have been removed by conjugation.

$$\# := f0 + i$$

$$|\#|^2 := \begin{vmatrix} f_0 & 0 \\ 0 & F^{\mu\nu} \end{vmatrix}^2 = \begin{vmatrix} (f_0)^2 & 0 \\ 0 & (F^{\mu\nu})^2 \end{vmatrix}$$ so that

$$Tr|\#|^2 := Tr\begin{vmatrix} f_0 & 0 \\ 0 & F^{\mu\nu} \end{vmatrix}^2 = Tr\begin{vmatrix} (f_0)^2 & 0 \\ 0 & (F^{\mu\nu})^2 \end{vmatrix} = (f_0)^2 + (F^{\mu\nu})^2$$

However, if there is interaction between the two fields, then

$\#^2 := \left(\psi_{f_0+f}\right)^2 = \left(f_0 + F^{\mu\nu}\right)^2 = \left[\left(f_0\right)^2 + \left(F^{\mu\nu}\right)^2\right] + \left[2\left(f_0\right)\left(F^{\mu\nu}\right)\right]$ where $\left[\left(f_0\right)^2 + \left(F^{\mu\nu}\right)^2\right]$ represents the existence of the second order terms and $\left[2\left(f_0\right)\left(F^{\mu\nu}\right)\right] = 4\left(\frac{1}{2}\left(f_0\right)\left(F^{\mu\nu}\right)\right)$ represents their (imaginary) interaction, but the real and complex axes are orthogonal, so that any pair of vectors defined on them are affine (have no common origin), so the area is imaginary as well.

Note that $\pi\left(\#^2\right) := \pi\left[\left(f_0\right)^2 + \left(F^{\mu\nu}\right)^2\right] + \left[\left(f_0\right)\left\{2\pi\left(F^{\mu\nu}\right)\right\}\right]$ introduces curvature where $\left\{2\pi\left(F^{\mu\nu}\right)\right\} = C_{F^{\mu\nu}}$ represents a circumference, and $\left[\left(f_0\right)\left\{2\pi\left(F^{\mu\nu}\right)\right\}\right]$ represents the surface area of a cylinder.

In this analysis, m_0 represents inertial mass (matter) and $F^{\mu\nu} = i^2$ represents light. Imaginary elements are represented by the color magenta where $i = \sqrt{-1}$, $i^2 = -1$, and $ia := a$. At the interaction ("contact") point of inertial mass, "velocity" ceases to scale the mass, and the result becomes $E_0 = m_0{}^2, P_0 = m_0$ For relativity, $c = 1$ in the "Time Dilation" equation

$(1)t' = (1)t\Gamma, \Gamma := \dfrac{1}{\sqrt{1-\beta^2}}, \beta = \dfrac{v}{c}$ where the time dilation equation is derived from the expression

$\psi := (ct') = (ct) + (vt') = (ct) + i(vt')$ where if one term in a product is imaginary, then both terms are. The "Time dilation" equation is then derived by solving for t' in the expression

$$\psi := ct' = ct + vt'$$
$$\psi^* := (ct')^* = ct - vt'$$
$$\psi\psi^* = (ct)^2 + (vt')^2 \neq ((ct) + (vt'))^2$$

1. The indices μ and ν anti-commute (Anti-Symmetry)

   $F^{uv} = -F^{vu} \leftrightarrow F^{uv} + F^{vu} = 0$

   This is analogous to $(\vec{v} \otimes \vec{B}) + (\vec{v} \otimes -\vec{B}) = (\vec{v} \otimes \vec{B}) - (\vec{v} \otimes \vec{B}) = 0$

2. Light is imaginary

   $$F_{\mu\nu}F^{\mu\nu} = -2\left(\frac{E^2}{c^2} - B^2\right)^2 = i^2 2\left(\frac{E^2}{c^2} - B^2\right)^2$$

   In particular, the interaction between mass and light is eliminated by conjugation:

   $$\psi := m + iF^{\mu\nu}$$
   $$\psi := m - iF^{\mu\nu}$$
   $$\psi\psi^* = \left[m^2 + \left(F^{\mu\nu}\right)^2\right] + m\left(iF^{\mu\nu}\right) - m\left(iF^{\mu\nu}\right)$$

   , so that $\psi\psi^* = \left[m^2 + \left(F^{\mu\nu}\right)^2\right]$

   However, $(m')^2 = [\psi\psi^*] + 2m\left(F^{\mu\nu}\right) = [\psi\psi^*] + 2m\left(F^{\mu\nu}\right)$

   So that $(m')^2 = [\psi\psi^*] + 2m\left(F^{\mu\nu}\right) = \left[m^2 + \left(F^{\mu\nu}\right)^2\right] + 2m\left(F^{\mu\nu}\right)$

   And $\# := m + F^{uv}$ where inertial mass and electromagnetic mass exist in first order

   $\# = Tr\begin{vmatrix} m & 0 \\ 0 & F^{uv} \end{vmatrix} = m + F^{uv}$ then

1. no interaction (mass does not interact with light),

$$\#^2 = Tr\begin{vmatrix} m & 0 \\ 0 & F^{uv} \end{vmatrix}^2 = m + \left(F^{uv}\right)^2,\ Det\begin{vmatrix} m & 0 \\ 0 & F^{uv} \end{vmatrix} = mF^{uv}.$$

2. Mass interacts with Light

$$\#^2 = \left(m + \left(F^{uv}\right)\right)^2 = \left[m^2 + \left(F^{uv}\right)^2\right] + \left[2m\left(F^{uv}\right)\right] = Tr\begin{vmatrix} m^2 & 0 \\ 0 & \left(F^{uv}\right)^2 \end{vmatrix} + Det\begin{vmatrix} m & m \\ -\left(F^{uv}\right) & \left(F^{uv}\right) \end{vmatrix}$$

3. Curvature

$\pi\left(\#^2\right) = \pi\left[m^2 + \left(F^{uv}\right)^2\right] + \left[m\left\{2\pi\left(F^{uv}\right)\right\}\right]$ where $\pi\left(m^2\right) + \pi\left[\left(F^{uv}\right)^2\right]$ suggests two areas (as end caps of a cylinder) and $m\left\{2\pi\left(F^{uv}\right)\right\}$ suggests the product of a radius m with a circumference $\left\{2\pi\left(F^{uv}\right)\right\}$ (the surface area of a cylinder).

Four Dimensions

$$\varphi := |f_m| + |f_c| = |f_m| + \left|\left(F^{\mu\nu}\right)_c\right| = \begin{vmatrix} f_m & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{vmatrix} + \begin{vmatrix} 0 & -E_x/c & -E_y/c & -E_z/c \\ E_x/c & 0 & -B_z & B_y \\ E_y/c & B_z & 0 & -B_x \\ E_z/c & B_y & B_x & 0 \end{vmatrix}$$

$$= \begin{vmatrix} f_m & -E_x/c & -E_y/c & -E_z/c \\ E_x/c & 0 & -B_z & B_y \\ E_y/c & B_z & 0 & -B_x \\ E_z/c & B_y & B_x & 0 \end{vmatrix}$$

$$\varphi^2 := \left(|f_m| + |f_c|\right)^2 = \left[|f_m|^2 + |f_c|^2\right] + \left[2|f_m||f_c|\right]$$

$$= Tr\begin{vmatrix} |f_m|^2 & 0 \\ 0 & |f_c| \end{vmatrix} + Det\begin{vmatrix} |f_m| & |f_m| \\ -|f_c| & |f_c| \end{vmatrix}$$

, where the term $Tr\begin{vmatrix} |f_m|^2 & 0 \\ 0 & |f_c|^2 \end{vmatrix}$ characterizes the existence of inertial mass $m = \left(f_m\right)^2$ and the mass of light $m_l = |f_c|^2$ and $Det\begin{vmatrix} |f_m| & |f_m| \\ -|f_c| & |f_c| \end{vmatrix} = \left[2f_m f_c\right]$ represents the interaction of mass and light. If mass and light exist but do not interact, then

$\#_f = f_m + f_c$, but the second order relation requires interaction.

The interaction can only be eliminated in second order complex conjugation:

$$\psi := |f_m| + i|f_c| = |f_m| + |iF^{\mu\nu}|$$

$$\psi\psi^* = |f_m|^2 + |f_c|^2 = |f_m|^2 + |F^{\mu\nu}|^2$$

3. Derivation of $F_{\mu\nu}F^{\mu\nu}$

$$F_{\mu\nu}F^{\mu\nu} = -2\left(\frac{E^2}{c^2} - B^2\right)^2 = i^2 2\left(\frac{E^2}{c^2} - B^2\right)^2$$

$$\psi := \frac{E}{c} + iB$$

$$\psi^2 = \left[\left(\frac{E}{c}\right)^2 - B^2\right] + \left[2\frac{E}{c}B\right]$$

$$\xi := \left[\left(\frac{E}{c}\right)^2 - B^2\right] + i\left[2\frac{E}{c}B\right]$$

$$\xi := \left[\left(\frac{E}{c}\right)^2 - B^2\right]^2$$

$$\sqrt{\xi} = \left[\left(\frac{E}{c}\right)^2 - B^2\right]$$

$$\left(\sqrt{\xi} - \sqrt{\xi}\right)^2 = [\xi + \xi] - [2\xi] = [\xi + \xi] - 2\left[\left(\frac{E}{c}\right)^2 - B^2\right]^2$$

$$0^2 = [\xi + \xi] - 2\left[\left(\frac{E}{c}\right)^2 - B^2\right]^2 = [\xi + \xi] + F_{\mu\nu}F^{\mu\nu}$$

$$F_{\mu\nu}F^{\mu\nu} = i^2[\xi + \xi] = -[\xi + \xi] = -2\left[\left(\frac{E}{c}\right)^2 - B^2\right]^2$$

Electric and Magnetic Fields

Gauss's Law

The equation for the volume of a sphere is given by:

$$V = \frac{4}{3}\pi r^3$$

The rate of change of Volume with respect to r is the flux through its surface:

$$\frac{dV}{dr} = 4\pi r^2 = Tr\begin{vmatrix} \pi r^2 & 0 & 0 & 0 \\ 0 & \pi r^2 & 0 & 0 \\ 0 & 0 & \pi r^2 & 0 \\ 0 & 0 & 0 & \pi r^2 \end{vmatrix} = A_{\frac{dV}{dr}}$$

which is the coordinate equation of the surface without reference to mass or charge and is equivalent to the sum of four equal areas of circles $A_{\bigcirc} = \pi r^2$. The "flux" is then represented by the product $E(A)$; however, to be defined, the following relation must exist:

$$\# = E + A$$
$$\#^2 = \left[E^2 + A^2\right] + \left[2EA\right]$$

, where $\left[2EA\right]$ represents the interaction of the "Electric Field E" through the area of the Sphere. This means that E must exist as a point source ("force") at the center of the sphere $ct := f_0 = \varepsilon_0 E$,and A is the flux related by the radius ("distance") r which defines four coordinate "sub-areas").

The Matrix relation for this expression is:

$$\#^2 = Tr\begin{vmatrix} E^2 & 0 \\ 0 & A^2 \end{vmatrix} + Det\begin{vmatrix} E & E \\ -A & A \end{vmatrix} = \left[E^2 + A^2\right] + \left[2EA\right]$$

If the forces are defined by:

$f_E = \varepsilon_0 E$ and $f_B = \mu_0 B$ then the sum of the (non-interacting) forces can be defined as:

$$\# := f_E + f_B = \varepsilon_0 E + \mu_0 B$$

And their interaction as

$$\#^2 := (f_E + f_B)^2 = \left[(f_E)^2 + (f_B)^2\right] + \left[2(f_E)(f_B)\right]$$

$$= (\varepsilon_0 E + \mu_0 B)^2 = \left[(\varepsilon_0 E)^2 + (\mu_0 B)^2\right] + \left[2(\varepsilon_0 E)(\mu_0 B)\right]$$

$$= \left[(\varepsilon_0 E)^2 + (\mu_0 B)^2\right] + 2\frac{(EB)}{c^2}$$

Setting $f_B(t) := \frac{f_B}{t}$ yields the result:

$$\#^2 = \left[(\varepsilon_0 E)^2 + \frac{(\mu_0 B)^2}{t^2}\right] + 2\frac{(EB)}{(ct)^2} = \left[(\varepsilon_0 E)^2 + \frac{(\mu_0 B)^2}{t^2}\right] + 2\left(\frac{EB}{(\overline{x_{EB}})^2}\right),\ x_{EB} := ct$$

The $\frac{1}{r^2}$ Law

Multiplying by π yields

$$\pi(\#^2) = \pi\left[(\varepsilon_0 E)^2 + \frac{(\mu_0 B)^2}{t^2}\right] + \left[E\left\{2\pi\frac{(B)}{(ct)^2}\right\}\right] = \left[(\varepsilon_0 E)^2 + \frac{(\mu_0 B)^2}{t^2}\right] + \left[E\left\{2\pi\frac{(B)}{(\overline{r})^2}\right\}\right]$$, noting that

the interaction term now represents a radius r_E interacting with a circumference

$C = \left\{2\pi\frac{(B)}{(\overline{r})^2}\right\} = 2\pi\frac{(r_B)}{(\overline{r})^2}$ where $\frac{1}{(\overline{r})^2} = \frac{r_E + r_B}{r_E r_B}$ where r_E and r_B are the relative distances between the center of distance from the center and circumference of the interaction "circles:, respectively, and the full expansion represents the sum of two areas ($A = \pi(\varepsilon_0 E)^2$ and $A = \pi\frac{(\mu_0 B)^2}{t^2}$) and the area of a cylinder $A_{cyl} := (L_E)(C_B) = (E)\left\{2\pi\frac{(B)}{(\overline{r})^2}\right\}$

The matrix representation then becomes

$$\pi\left(\#^2\right)=Tr\begin{vmatrix}\pi\left(\varepsilon_0 E\right)^2 & 0\\ 0 & \pi\frac{\left(\mu_0 B\right)^2}{t^2}\end{vmatrix}+Det\begin{vmatrix}E & E\\ -\left\{\pi\frac{(B)}{\left(\bar{r}\right)^2}\right\} & \pi\frac{(B)}{\left(\bar{r}\right)^2}\end{vmatrix}$$

$$\pi\left(\#^2\right)=Tr\begin{vmatrix}\left(A_E\right)^2 & 0\\ 0 & \left(A_B\right)^2\end{vmatrix}+Det\begin{vmatrix}L_E & L_E\\ -C_B & C_B\end{vmatrix}$$

$$=\left[\left(\varepsilon_0 E\right)^2+\frac{\left(\mu_0 B\right)^2}{t^2}\right]+\left[E\left\{2\pi\frac{(B)}{\left(\bar{r}\right)^2}\right\}\right]$$

The two equations represent the interaction $(\#)^2$ of two equal and opposite interacting mases $\left(\varepsilon_0 E\right)^2$ and $\frac{\left(\mu_0 B\right)^2}{t^2}$ together with their interaction $2\frac{(EB)}{(ct)^2}$, and thus $(\#)^2$ is the resultant mass of the system where

$$\#^2=\left[\left(\varepsilon_0 E\right)^2+\frac{\left(\mu_0 B\right)^2}{t^2}\right]+2\frac{(EB)}{(ct)^2}=\left[\left(\varepsilon_0 E\right)^2+\frac{\left(\mu_0 B\right)^2}{t^2}\right]+2\left(\frac{EB}{\left(\overline{x_{EB}}\right)^2}\right),\ x_{EB}:=ct$$

And

$\pi\left(\#^2\right)=Tr\begin{vmatrix}\left(A_E\right)^2 & 0\\ 0 & \left(A_B\right)^2\end{vmatrix}+Det\begin{vmatrix}L_E & L_E\\ -C_B & C_B\end{vmatrix}$ represent the interaction of forces in "rectangular" and "radial" coordinates respectively where "time" represents change in mass entropy (interaction, entanglement, etc) as the rotation of angles in the RUC (CCW in quadrants 1 and 3, and CW in quadrants 2 and 4) for increasing entropy) and vice versa for decreasing entropy for the interaction of an initial state ct via the transition:

$\#^2=\left[(ct)^2+(vt')^2\right]+\left[2(vt')(ct')\right],\ 0<vt'<ct$ to the state

$$\#=\left(ct\right)+\left(ct\right)$$
$$\#^2=4\left(ct\right)^2=\left[(ct)^2+(ct)^2\right]+2\left(ct\right)\left(ct\right)$$

Both momentum and acceleration are no longer relevant at the point of interaction, so that the counts are consistent in first and second order.

Gravity

The force of gravity is then represented by the equation:

$$F_g = m_0 + \frac{m'}{\bar{r}^2} = \#+\#'$$

$$m' = Gm_0$$

$$F_g = m_0 + G\frac{m_0}{\bar{r}} = \#+\#'$$

Where $G\frac{m_0}{\bar{r}} < m_0$ for the interacting masses.

$$M_g = \left(F_g\right)^2 = \left(m_0 + G\frac{m_0}{\bar{r}}\right)^2 = \left[\left(m_0\right)^2 + \left(G\frac{m_0}{\bar{r}}\right)^2\right] + \left[2\left(m_0\right)\left(G\frac{m_0}{\bar{r}}\right)\right]$$

$$\pi\left(M_g\right) = \left[\pi\left(m_0\right)^2 + \pi\left(G\frac{m_0}{\bar{r}}\right)^2\right] + \left(m_0\right)\left(2\pi\left(G\frac{m_0}{\bar{r}}\right)\right)$$

Note: The inclusion of more than two masses requires the Multinomial Theorem, and is beyond the scope of this paper.

TBD: ---

Maxwell's Equations

Maxwell's Equations (Wikipedia)

The speed of light

$$\# := \frac{\varepsilon_0}{t} + \frac{\mu_0}{t}$$

$$\#^2 := \left(\frac{\varepsilon_0}{t} + \frac{\mu_0}{t}\right)^2 = \left[\left(\frac{\varepsilon_0}{t}\right)^2 + \left(\frac{\mu_0}{t}\right)^2\right] + \left[2\left(\frac{\varepsilon_0}{t}\right)\left(\frac{\mu_0}{t}\right)\right]$$

$$\left[2\left(\frac{\varepsilon_0}{t}\right)\left(\frac{\mu_0}{t}\right)\right] = 2\left(\frac{1}{(ct)^2}\right) = 2\left(\frac{1}{(x)^2}\right) = 2\left(\frac{1}{(r)^2}\right)$$

1. $\nabla \cdot E = \frac{\rho}{\varepsilon_0}$
2. $\nabla \cdot B = 0$

$$\vec{\nabla} \cdot \overleftarrow{B} = 0 \leftrightarrow \begin{vmatrix} \nabla \\ 0 \end{vmatrix} \cdot \begin{vmatrix} 0 \\ B \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \end{vmatrix}$$

$$Tr\begin{vmatrix} \nabla & 0 \\ 0 & B \end{vmatrix} = \nabla + B,\ Det\begin{vmatrix} \nabla & 0 \\ 0 & B \end{vmatrix} = \nabla \cdot B = 0^2$$

$$\# = \nabla + B$$

$$\#^2 = (\nabla + B)^2 = \left[\nabla^2 + B^2\right] + \left[2\nabla B\right]$$

∇ and B exist in first order, but they do not interact ; either $\nabla = 0$ or $B = 0$. $\nabla = 0$ implies

$$\vec{\nabla} \cdot \overleftarrow{B} = 0 \leftrightarrow \begin{vmatrix} 0 \\ 0 \end{vmatrix} \cdot \begin{vmatrix} 0 \\ B \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \end{vmatrix}$$

$$Tr\begin{vmatrix} 0 & 0 \\ 0 & B \end{vmatrix} = B,\ Det\begin{vmatrix} 0 & 0 \\ 0 & B \end{vmatrix} = 0 \cdot B = 0$$

$$B\left|\sigma_3\right| = B\begin{vmatrix} 0 & i \\ -i & 0 \end{vmatrix} = \begin{vmatrix} 0 & Bi \\ -Bi & 0 \end{vmatrix} = \begin{vmatrix} 0 & iB \\ -B & 0 \end{vmatrix}$$

$$Tr\begin{vmatrix} 0 & iB \\ -iB & 0 \end{vmatrix} = 0,\ Det\begin{vmatrix} 0 & iB \\ -iB & 0 \end{vmatrix} = i^2B^2 = -B^2$$

3. $\nabla \otimes E = -\dfrac{\partial B}{\partial t}$

4. $\nabla \otimes B = \mu_0\left[J + \varepsilon_0\left(\dfrac{\partial E}{\partial t}\right)\right]$

$$J = \left(\frac{1}{A}\right)(I) = \left(\frac{1}{A}\right)\left(\frac{dq}{dt}\right)$$

Ampere's Law Ampere's Law (Wikipedia)

Vacuum Permeability

Biot-Savart Law

$$\frac{F_m}{L} = \frac{\mu_0}{2\pi}\frac{I^2}{|r|}$$

$$\frac{F_m}{L} = 2\kappa_A\frac{I_1 I_2}{r}$$

$$B_r = \frac{\mu_0}{4\pi} 4\pi \oiiint_C \frac{\overrightarrow{Idl} \otimes \overrightarrow{r'}}{|r'|^3} dV$$

$$B_r = \frac{\mu_0}{4\pi} 4\pi \oiiint_V \frac{\vec{J} \otimes \widehat{r'}}{|r'|} dV$$

$$B_r = \frac{\mu_0}{4\pi} I \oint_C \frac{dl \otimes \hat{r}'}{|r'|^3}$$

$$A := \frac{q}{t}$$

$$\frac{dA}{dt} := I := \frac{dq}{dt}$$

$$\nabla \otimes B = 0$$

$$\nabla \otimes B = \frac{1}{c^2} \frac{\partial E}{\partial t}$$

Introduction

The perspective of this analysis is that if vectors are wrong, then 4-vectors are wrong, and a different approach must be taken in the analysis. I begin with an analysis of two equal and opposite forces in a vacuum (i.e., a pure vacuum, no other particles or fields)

$f := \frac{f}{2} + \frac{f}{2} := (c\tau)$ Here the $+$ sign indicates the existence of both forces (as momentum in a pure vacuum; i.e. if nothing is interacting with them) moving toward each other. This can also be characterized as the count of elements of the system:

$$\# := \frac{\#}{2} + \frac{\#}{2}$$

At impact, the colliding forces result in a rest mass or rest charge, where the velocity is no longer relevant, so that:

$$m_0 := q_0 = f^2 = \left(\frac{f}{2} + \frac{f}{2}\right)^2 = \left[\left(\frac{f}{2}\right)^2 + \left(\frac{f}{2}\right)^2\right] + \left[2\left(\frac{f}{2}\right)\left(\frac{f}{2}\right)\right],$$

$$\left[2\left(\frac{f}{2}\right)\left(\frac{f}{2}\right)\right] = \frac{f}{2}\left(\frac{1}{4}\left(\frac{df^2}{df}\right)\right), \ \frac{f}{2} = \frac{1}{4}\left(\frac{df^2}{df}\right) = \frac{2f}{4}$$

where f is interpreted as the change to the initial state $f = f + 0$ as an equal and opposite force.

Then the first term $\left[\left(\frac{f}{2}\right)^2 + \left(\frac{f}{2}\right)^2\right]$ characterizes the existence of the interaction forces, and the second term $\left[\frac{f}{2}\left(\frac{1}{4}\left(\frac{df^2}{df}\right)\right)\right] = \left[2\left(\frac{f}{2}\right)\left(\frac{f}{2}\right)\right]$ characterizes the interaction resulting from addition of the second (equal and opposite) force.

However, if the forces are different, the result is a change in the mass or charge from the initial state of equal and opposite forces, resulting in the interaction equation:

$$m_0 v = m_0 c + m_v v$$

$$(m_0 v)^2 = \left[(m_0 c)^2 + (m_v v)^2\right] + \left[2(m_0 c)(m_v v)\right]$$

$$I_v := \frac{dq}{dt},\ q_0 = q_0\left(\frac{q_0}{q_0}\right) = q_0\left(1_{q_0}\right)$$

$$q_0 v = q_0 c + I_v v$$

$$\left(m_0 v\right)^2 = \left[\left(q_0 c\right)^2 + \left(I_v v\right)^2\right] + \left[2\left(q_0 c\right)\left(I_v v\right)\right]$$

, where q_0 is an invariant initial state, scaled by c in the term $q_0 c$

In order to scale the interaction terms explicitly,

$$m_0 v = m_0 c + (m_v v)\sin\theta,\ 0 \le \theta \le \frac{\pi}{4},\ (m_v v) \le m_0 c$$
$$(m_0 v)^2 = \left[(m_0 c)^2 + (m_v v)^2 \sin^2\theta\right] + \left[2(m_0 c)(m_v v)\sin\theta\right]$$

$$I_v := \frac{dq}{dt},\ q_0 = q_0\left(\frac{q_0}{q_0}\right) = q_0\left(1_{q_0}\right)$$
$$q_0 v = q_0 c + (I_v v)\sin\theta, 0 \le \theta \le \frac{\pi}{4},\ (I_v v) \le q_0 c$$
$$(q_0 v)^2 = \left[(q_0 c)^2 + (I_v v)^2 \sin^2\theta\right] + \left[2(q_0 c)(I_v v)\sin\theta\right],$$

For $m_0 c \le (m_v v)$, $q_0 c \le (I_v v)$, change $\sin\theta$ to $\sinh\theta$

The Existence Equation

Existence is modeled as the addition operator $+$ between two group elements, (ct) and (vt'), where $\# := (ct) + (vt')$; if there is no interaction (multiplication, entanglement, entropy, etc.) is not defined, then the second order relation is given by:

$\left(\#_{(ct)}\right)^2 := (ct)^2, \left(\#_{(vt')}\right)^2 := (vt')^2$. That is, they can be summed individually, so that

$\# = \left(\#_{(ct)}\right)^2 + \left(\#_{(vt')}\right)^2 = (ct)^2 + (vt')^2$, where neither $\#$ or $(ct)^2 + (vt')^2$ form a group, since $\#$ is a single element in first order, and addition relates two non-interacting groups in second order.

Interactions

Pythagorean Triplets and Complex Numbers

In the particular case of Pythagorean Triples, the imaginary relation (where multiplication by $i = \sqrt{-1}$ is indicated by the color magenta):

$\psi\psi^* = \left(\#_{(ct)}\right)^2 + \left(\#_{(vt')}\right)^2 = (ct)^2 + (vt')^2$ can be shown as a subset of the interaction equation:

$(ct')^2 = \left[(ct)^2 + (vt')^2\right] + \left[2(ct)(vt')\right]$ is logically equivalent to the relation:

$$(ct')^2 = \left[(ct)^2 + (vt')^2\right] + \left[2(ct)(vt')\right] = (ct')^2 = \left[\psi\psi^*\right] + \left[2(ct)(vt')\right]$$ where

$$\psi := \left[(ct) + (vt')\right]$$
$$\psi^* := \left[(ct) - (vt')\right]$$
$$\psi\psi^* = \left[(ct) + (vt')\right]\left[(ct) - (vt')\right] = \left[(ct)^2 + (vt')^2\right] + \left[(vt')(ct) - (vt')(ct)\right]$$

That is, $\psi\psi^* = \left[(ct)^2 + (vt')^2\right]$ (the reader is encouraged to calculate this for any Pythagorean Triplet, both for the real version and the complex version, e.g. $\left\{\sqrt{\psi\psi^*}, (ct), (vt')\right\} = \{5, 4, 3\}$

Electromagnetism

Multiplying the interaction by π results in the expression:

$\pi(ct')^2 = \left[\pi(ct)^2 + \pi(vt')^2\right] + \left[(ct)\{2\pi(vt')\}\right]$ where the term $C_{(vt')} := 2\pi(vt')$

This suggests the geometric relation:

$\pi(r')^2 = \left[\pi(r_0)^2 + \pi(r_v)^2\right] + \left[(r_0)\{2\pi(r_v)\}\right]$, where the term $(r_0)\{2\pi(r_v)\} = (r_0)\left\{C_{(r_v)}\right\}$ represents the volume of a cylinder of circumference $\left\{C_{(r_v)}\right\}$ and length (r_0) with the caps at the ends of areas $\pi(r_0)^2$ at $r_v = 0$ as an initial state, and the second cap of area $\pi(r_v)^2$ at length r_v.

This model in turn suggests the model of a section of current in a wire, where elements of the model is identified as $q_0 := (ct)_0 = (ct)_0\left(\frac{(ct)_0}{(ct)_0}\right) = (ct)_0 1_{(ct)_0}$ as an invariant and $I := \frac{dq}{dt}$ so the interaction equation becomes

$\pi(ct')^2 = \left[\pi(q_0)^2 + \pi(I_v)^2\right] + \left[(q_0)\{2\pi(I_v)\}\right]$ where $\pi(ct')^2$ represents the change from initial state $ct' = ct = q$ to final state $ct' = q_0 + I_v = q_0 + \frac{dq_v}{dt}$.

$\pi(r')^2 = \left[\pi(q_0)^2 + \pi(I_v)^2\right] + \left[(q_0)\{2\pi(I_v)\}\right]$ where $2\pi(I_v)$ is a current loop scaled by the initial charge q_0

Then $\pi(q_0)^2$ represents the charge ($I_v = 0$) at the initial cylinder (wire section) cap $(ct)_0 = r_0 = 0$ and the expression $\pi(I_v)^2$ represents the current at the end of the cylinder $r = r_v = (vt')$.

If $\pi(q_0)^2$ is changed to $\pi(I_0)^2$ then the two areas represent the flux through them along the length $r = I_0$ where the total flux is evaluated at the cap ends. As above, the interaction can be scaled by $\sin\theta$ or $\cosh\theta$ depending on whether (I_v) is decreasing or increasing from the initial state.

Note that in the formalism, the initial and perturbing states are interchangeable in the fundamental expression, where the state $(ct')^2$ represents the total state as t changes to t'.

However, if one attempts to divide by only one of the parameters c or t' the final state is no longer a group, so is no longer a relation between elements of even interacting existing qroups).

Two wires

The above analysis only models a single wire segment, which is represented by $(ct')^2$

The existence of a second wire can be represented by $(ct')^2$ where the parameters are not necessarily equal. However, if the current loops are rotating in the same direction, then they must both be increasing current (energy) from their initial states and so repel each other (since $\sin(-\theta) = -\sin\theta$).

If rotating in opposite directions, they must be decreasing in energy, and so attracting. However, in a pure vacuum, there is no medium, so they are independent, and do not interact.

Then the sum of the two current in the wires is

$$\# = (ct') + (ct')$$

So the force between them is given by the $\left(\frac{1}{\overline{r}^2}\right)$ geometric law

$$\left(\frac{1}{\overline{r}^2}\right)\pi\#^2 = \left(\frac{1}{\overline{r}^2}\right)\left[\pi(ct')^2 + \pi(ct')^2\right] + \left(\frac{1}{\overline{r}^2}\right)\left[(ct')2\pi(ct')\right], \left(\frac{1}{\overline{r}^2}\right) = \frac{(ct') + (ct')}{(ct')(ct')}$$

Note that if the medium is explicitly specified, in 3 dimensions

$\# = (ct') + (ct') + (ct')$ then one element can remain independent of two other elements, or all three can interact, or all three independent via the Multinomial Theorem. The model then suggests quarks in three dimensions. Much more to this story, but I don't have the space-time to write it here.

The Electromagnetic Tensor

$$E_i = x_i = ct_i \leftrightarrow \frac{E_i}{t_i} = c,\ t_i = \frac{E_i}{c}$$

$$B_i = -B_i \leftrightarrow B_i = B_i$$

$$Bra = -Ket$$

However, if $E \perp B$ ($x \perp y \perp z$) then either B (and therefore E must be imaginary so that

$$|\sigma_1| := \begin{vmatrix} 0 & 1 \\ 1 & 0 \end{vmatrix},\ f_0|\sigma_1| = \begin{vmatrix} 0 & f_0 \\ f_0 & 0 \end{vmatrix}$$

$$|\sigma_2| := \begin{vmatrix} 0 & i \\ -i & 0 \end{vmatrix}$$

$$F_{\mu\nu} = -F^{\nu\mu} \leftrightarrow F_{\mu\nu} = F^{\nu\mu}$$

$$|\sigma_2| = \begin{vmatrix} 0 & 0 \\ 0 & 0 \end{vmatrix} + F^{\nu\mu}\begin{vmatrix} 0 & i \\ -i & 0 \end{vmatrix} = \begin{vmatrix} 0 & F^{\nu\mu} \\ -F^{\nu\mu} & 0 \end{vmatrix} = \begin{vmatrix} 0 & Bra \\ -Ket & 0 \end{vmatrix}$$

$$Det|\sigma_2| = (< Bra \| Ket >) = (F^{\nu\mu})(F^{\nu\mu}) = -2\left(\frac{E^2}{c^2} - B^2\right)$$

$$|\sigma_{1+2}| := |\sigma_1| + |\sigma_2| = \begin{vmatrix} 0 & f_0 \\ f_0 & 0 \end{vmatrix} + \begin{vmatrix} 0 & F^{\nu\mu} \\ -F^{\nu\mu} & 0 \end{vmatrix} = \begin{vmatrix} 0 & f_0 + F^{\nu\mu} \\ f_0 - F^{\nu\mu} & 0 \end{vmatrix} = \begin{vmatrix} 0 & \psi \\ \psi * & 0 \end{vmatrix}$$

$$Tr|\sigma_{1+2}| = 0,\ Det|\sigma_{1+2}| = (f)^2 + (F^{\nu\mu})^2 = (m_0) - 2\left(\frac{E^2}{c^2} - B^2\right)$$

Note that ψ and $\psi *$ are no longer groups, since they include addition.

$$|\sigma_3| = F_{\mu\nu}\begin{vmatrix} 1 & 0 \\ 0 & -1 \end{vmatrix} = F^{\nu\mu}\begin{vmatrix} 1 & 0 \\ 0 & -1 \end{vmatrix}$$

$$Tr|\sigma_3| = 0, Det|\sigma_3| = -1^2 = i^2(1^2)$$

The Special Theory of Relativity (and Quantum Mechanics)

The "Time Dilation" equation of Special Relativity can be derived from the expression:

$(ct')^2 = (ct)^2 + (vt')^2$ which results in the "first order" expression:

$t' = t\Gamma,\ \Gamma = \frac{1}{\sqrt{1-\beta^2}},\ \beta = \frac{v}{c}$, observing that if t' is imaginary, then $t\Gamma$ must be also, since the product (vt'), so that $t' = t\Gamma = t\left(\frac{1}{\sqrt{1-\beta^2}}\right),\ \beta = \frac{v}{c}$ and finally, if the product of an imaginary element and a real element is imaginary, both sides of the equation are imaginary: $t' = t\Gamma,\ \beta = \frac{v}{c}$. This result is consistent with **Quantum Mechanics**, where $Px := \hbar$,

where classical physics maintains the result $Px = 0$ (complementary variables, implying that P and x do not interact), but that:

$$\psi := P + x$$
$$\psi^* := P - x$$
$$\psi\psi^* := P^2 + x^2$$

, where the interaction product $Px - Px$ has been eliminated from the expression by conjugation.

If $c\tau$ is interpreted as the force of light, the inertia of which is unobservable (a single photon on a freight train at absolute zero. (e.g., somewhere in the Great Void, where neither the photon or its impact on the train is observable, so the temperature change on the train is unobservable), then a subsequent (inertial) movement of the train will be unobservable, so vt is omitted in the interaction expression:

$$(ct')=(ct)+(vt')$$

This term is then omitted from the Lorentz space-time equations

$$x'=(x-vt)\Gamma,\ \Gamma:=\frac{1}{\sqrt{1-\beta^2}},\ \beta=\frac{v}{c}$$

$$t'=\left(t-\frac{vx}{c^2}\right)\Gamma$$

with the substitution condition $x=ct \leftrightarrow x'=ct'$. With the substitution, the equations become a single expression: $x'=(x-vt)\Gamma \leftrightarrow (ct')=(ct-vt)\Gamma$ Setting the translation expression $vt=0$ then results in the "Time Dilation" equation $t'=t\Gamma$

If the change in energy due to the interaction of a single photon with a freight train at absolute zero is unobservable, then the expression $\lambda:=vt$ can be changed to the expression $P:=m'=m_0v$ where $m_0:=t$. Note that $x:=vt \leftrightarrow \frac{x}{t}=v\left(\frac{t}{t}\right)=v(1_t)$ so that v is not an invariant unless $v:=t$; this is also true for $v=c$ so that $P=m_0c=c\tau(c)=m_0c^2,\ \tau:=m_0$

The expression $(ct')^2=(ct)^2+(vt')^2$ (which is solved for t' to generate the "Time Dilation" equation cannot be generated from the first order expression $\#:=(ct')=(ct)+(vt')$ $(\text{e.g. } 7=4+3)$, since $\#^2:=49=[4^2+3^2]+2(4)(3)$

However, setting $i=\sqrt{-1}$,

$$\psi:=4+3i$$
$$\psi^*:=4-3i$$
$$\psi\psi^*:=\left[4^2+3^2\right]+\left[4(3i)-4(3i)\right]=25$$
$$\#^2=49\neq\psi\psi^*=25$$

Where $\left[4^2+3^2\right]=25=5^2$ is an example of a Pythagorean Triple $\{4,3,5\}$

"The photon has no mass; photons do not interact with each other" – Urban Legend, supported by the null results of the Michelson-Morley experiment"

“Please do not gaze into laser with remaining eye” – sign in optics lab at LLNL…

Coordinates

Consider an infinitely long straight line of zero cross-section (i.e., of imaginary cross-section) in one dimension, extending from negative infinity to positive infinity where the direction is arbitrary:

Note that two such imaginary lines are necessary to define direction, and that any separation between them must also be imaginary: