A CLASSICAL FOUNDATION FOR ELECTRODYNAMICS†

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Electrostatics, the study of the effects of stationary electric charges, is well established. Electrodynamics, the study of what happens when the charges are moving, has not been free from difficulties. The special theory of relativity is commonly supposed to be used to bridge the gap between the static and dynamic situations. However, that theory involves some notions, such as the contraction of lengths and the dilation of times, which are not well established experimentally. Moreover, it leads to some seemingly absurd results, such as the notorious twin paradox.

In the present article, the authors use the idea of feedback, in which changing electical fields cause magnetic effects and vice versa. These facts have been established experimentally for a long time. In that way a theory of what happens with moving charges is established. The results agree with those from the previous theory; but they are obtained in a way which seems physically more meaningful, and which does not require one to assume effects for which there is no experimental evidence.

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I. Introduction

In 1865 James Clerk Maxwell introduced to the world his electromagnetic theory of light. On the basis of his four field equations, physicists have been able to explain almost the entire scope of electricity and magnetism.

Forty years later, Albert Einstein published his *special theory of relativity*. By introducing the postulate of the constancy of the speed of light and the two resulting concepts of length contraction and time dilation, he provided an explanation for the famous Michelson-Morley experiment.

In addition, Einstein's coordinate transformations (often termed the "Lorentz transformations"),[1] saved Maxwell's equations from the fault, as some saw it, of not being mathematically invariant in frames of reference, i.e., systems of coordinates, moving with respect to one another with constant velocity. The special theory of relativity has thus come to be considered one of the greatest achievements in science.

While it is true that special relativity has introduced to science many beneficial concepts, it must also be acknowledged that there are still various unresolved problems in electrodynamics for which no solution has been forthcoming for the last seventy years. It may be that the trouble lies in the fundamental postulates underlying the theory of relativity.

This paper will begin by reviewing the present state of electrodynamics and will conclude with the presentation of a new theory. This new approach introduces a more physically plausible formulation of electrodynamics using only classical concepts and transformations.

II. The Present Theory of Electrodynamics

A. The Michelson-Morley Experiment

The well known Michelson-Morley experiment gave an unexpected answer. In this experiment a light beam was split into two beams which had paths at right angles to each other, and included mirrors to reflect each beam back to the starting place. The thought was that in one beam light would travel upstream and back through the ether, and in the other beam light would travel across the ether stream and back.

Ether was thought to be a light-bearing medium affixed to space. Motion of the earth through space was supposed to be analogous to a stream of ether passing by the earth. Light sent upstream and back should take a little longer to make the round trip than light sent across stream and back the same distance. The time delay comes in especially when the light is traveling upstream. Its speed was supposed to be slowed in this "headwind" of ether.[2] Michelson and Morley obtained a negative result or much less than was expected; there seemed to be no difference in time.

Einstein assumed that there was no ether[3] and made his famous postulate that the speed of light c is a constant, that its measured value would come out the same in a moving laboratory as in a still laboratory. It is a little too lengthy to give the details of the strange results this postulated condition would produce.

To untangle those strange results Einstein reasoned that the meter sticks used in the two laboratories had to have different lengths and the watches had to be running at different rates. That is how time dilation and length contraction came into his theory.

B. Relative Length and Time

According to Einstein's special theory of relativity, therefore, neither length nor time (it would be better to say "duration", not "time") are absolute. Length and

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time are relative, i.e. they depend on relative velocity with respect to the observer. Length is supposed to contract in the direction of motion; and time or, rather, any physical process, is supposed to run slower in a body that is moving with respect to the observer. These presumed relativistic effects are referred to as *length contraction and time dilation.*

According to that theory, the amount of contraction or dilation is negligibly small except for speeds that are very great, approaching the speed of light. Hence the applications are restricted to electrodynamics where charged particles may travel with speeds approaching the speed of light. These speeds are much higher than the speeds one ever expects to achieve with rockets.

But electrons do move with speeds of this magnitude in particle accelerators such as the betatron. Special theory of relativity equations are useful in the design of those devices but give no insight into the actual nature of the electrons, and do not provide answers to some problems in electrodynamic radiation.

C. Beneficial Concepts of Special Relativity

According to special theory of relativity the mass of anything is not a constant. Mass m increases with speed v in accordance with the equation

$$m = m_0(1 - v^2/c^2)^{-1/2} \tag{1}$$

where m_o is the rest mass and c is the speed of light in a vacuum (where light speed is greatest). Note that the relativistic mass m becomes infinite as its speed reaches the velocity of light. The velocity of light c is thus the limiting speed; no mass or energy can travel faster than c.[4]

This increase in mass with speed seems to check with experiment. At least the ratio of mass to charge of the electron seems to increase in the betatron and the other accelerators. The charge of the electron is thought to remain constant. The mass increase shows up as the increase in this ratio. It is the ratio that appears in the design equations. But the increase can be checked experimentally only for charged elementary particles; and there may be another explanation.

The relativistic mass m in Equation (1) is sometimes referred to as the *transverse mass.* It is related to motion of the electron in circular orbit. That motion has acceleration which is toward the center, transverse to the motion along the circle. In order to condense the notation the factor in Equation (1) is replaced by the Greek letter gamma. That is,

$$\gamma = (1 - v^2/c^2)^{-1/2} \tag{2}$$

In that notation the transverse mass

$$m = \gamma m_o \tag{3}$$

A surprising development in relativity is that for straight line motion the mass is different from that of transverse mass. It is given by

$$m = \gamma^3 m_o \tag{4}$$

This relativistic mass is called the *longitudinal mass.* It takes more force, according to special relativity, to accelerate a mass in a straight line (longitudinally) than to produce an equal acceleration in uniform circular motion. This is because the longitudinal mass, for that same particle, is greater than its transverse mass.

From his special theory, Einstein also deduced the famous equation for the equivalence of mass and energy

$$E = mc^2 \tag{5}$$

The speed of light $c = 3 \times 10^8$ meters per second. Since the equation contains c^2 it is clear that it does not take much mass m to be equivalent to a very large amount of energy.[5] For example, a mass of just 0.5 kilograms will produce 4.5×10^{16} joules of energy when substituted into Equation (5), which is a very sizeable amount of energy.

III. Difficulties with the Present Theory of Electrodynamics

In spite of the successes achieved by the special theory of relativity there are nevertheless problems with the approach. ***First***, there appears to be a serious logical contradiction in the theory. ***Second***, some of the hypothetical conclusions appear to be very unrealistic. ***Third***, the theory has failed to provide answers to some basic problems in Electrodynamics, and finally, the theory has been developed from and sustained by particular interpretations of various experiments which may not be the best interpretations.

A. The Twin Paradox

The twin paradox of special relativity illustrates the extent of irrationality to which the theory leads. It is hypothesized that if one baby were to travel away from the earth in some theoretical type of space ship with a speed nearly equal to the speed of light, that he would not age as fast as his twin brother who remained at home. This is based on the concept of time dilation, which says that moving clocks run slower than clocks at rest, biological processes being equated with clocks. When the baby returns many years later from his high speed voyage he will still be a baby whereas his twin brother who remained on earth will be an old man.

This paradox might seem to be a humorous one except that it is implicitly believed by doctrinaire special relativity theorists. A great deal of mathematical manipulation is put forth as justification.

It seems logical to look for the weakness in a theory that leads to such an absurdity. The noted British scientist Herbert Dingle (a well known authority on special relativity who later became convinced of the untenability of the theory) has for years shown a logical fallacy in the special theory of relativity with regard to time dilation.[6] He has furthermore challenged scientists who are knowledgeable in the field to examine his criticism. No one has satisfactorily refuted his logic; although he sometimes had difficulty in getting a hearing.

Dingle points out that special theory assumes that there is no absolute frame of reference. Motion being relative according to the theory, it is not possible to tell which of the twins is at rest and which is in uniform motion. The so-called moving twin might be at rest while the earth moves away with uniform speed. Obviously, the same clock cannot run both fast and slow at the same time.

Relativity could not tell which twin was aging while the uniform relative speed was in existence (during essentially all of the hypothetical time involved). Dingle's arguments seem to make the twin paradox an absolute contradiction.

B. Lack of Direct Experimental Evidence

There has never been any direct experimental evidence for the length contraction predicted by the special theory of relativity. In his book entitled *Special Relativity*, A. Shadowitz states: "It is an amazing fact that there does not seem to exist any direct or simple experimental verification of the Lorentz-Einstein contraction."[7]

There are several presumed experimental verifications of time dilation. The most direct attempt to verify time dilation was the flying of an atomic clock around the world. It was reported that this clock showed less time lapse than a "fixed" reference clock. That report, however, is apparently not reliable. An eminent scientist, an expert on atomic clocks, has recalculated the "flight round the world" experiment using ***all*** of the experimental readings which were taken but for some reason not used. He found *no evidence for time dilation.*[8,9]

C. Energy Being Disregarded

There is as yet no acceptable model for the electron, and many questions remain unanswered. It apparently has a *magnetic dipole moment* $M = 9.285 \times 10^{-24}$ joules per tesla, but how it gets this magnetic property is anybody's guess. It is supposed to be associated with the electron's "spin" but no one really knows what is spinning, or whether the model of something spinning mechanically is just too crude.

There must be magnetic energy associated with this magnetic dipole moment. An approximate value of this magnetic energy can be computed by assuming that it is the energy of a uniformly magnetized sphere the same size as the electron. The general equation for the magnetic energy W of such a uniformly magnetized sphere can be written as[10] $W = (M^2/r^3) \times 10^{-7}$. Using the classical radius $r = 2.818 \times 10^{-15}$ meters for the electron and the above mentioned value for the magnetic dipole moment then yields $W = 3.85 \times 10^{-10}$ joules for the electron's magnetic energy.

This is an amazingly large amount of energy compared to the presumed rest energy of the electron. Using for the rest mass of the electron the quantity $m_o = 9.11 \times 10^{-31}$ kilograms and the equation $E = m_oc^2$ for the electron's rest mass energy one obtains $E = 8.20 \times 10^{-14}$ Joules.

Dividing the magnetic energy by the rest mass energy one sees that the electron's magnetic energy is nearly 5,000 times as large as its rest mass energy. The fact that the theory of relativity completely ignores this magnetic energy is a contradictory situation since special relativity is supposed to account for all of the energy. In this case, however, it has neglected the largest amount of self energy in the electron, if one can assume that there actually is such a magnetic moment and that the electron's classical radius is reasonably meaningful.

D. The Muon Time Dilation Experiment

An experiment that attempts to show time dilation in high speed mu-mesons is usually cited in support of special theory of relativity.[11] Mu-mesons are said to be produced by cosmic rays in the upper atmosphere and to move downward with speeds very near the velocity of light.

The idea is to count the number and measure the speed of mu-mesons reaching a 3000-meter level in the atmosphere, stop them, and measure their remaining life time. Mu-mesons decay in millionths of seconds. Knowing the number of arrivals at 3000-meter altitude, their life time and speeds one can compute the expected distance of travel before they expire.

A table of expected travel time indicated that only a small percent of the mu-mesons passing the 3000-meter altitude should make it to the ground. The experiment is said to have shown that a much higher percentage reached the ground. The conclusion was that the life time of *moving* mu-mesons was much longer than the life time measured for the stationary mu-mesons (stopped for measurement). That is what relativity predicts.

There are many problems with this experiment. Basically it is a "game of chance." No one really knows enough about particle decay processes to predict the decay of any one mu-meson nor *what physical processes may alter its decay rate.*

There are many extraneous physical processes involved. The mu-mesons come in with greatly different speeds and a speed separating process was included. Iron was inserted in the path to cause enough energy loss so that the mu-mesons (those with a particular spread of speed) would just make it through the iron and stop and die in a plastic scintillator. Many never made it and many overshot it. No origin time was known on any mu-meson, only the stay time in the timing device. Hence the actual life time was not measured. It is also known that radioactive decay rates can be altered by external conditions.[12]

Furthermore, "judgment" factors were necessary to "make allowance for the removal of mesons by collision with atoms in the atmosphere." No allowance was made for other influxes or originations of mu-mesons below 3000 meters.

There are many more questions with the experiment than will be acknowledged or answered in textbook descriptions of this and similar time dilation experiments. The mu-meson experiment may in fact give leads to the causes of decay rather than to the presumed time dilation effects assumed in the special theory of relativity. Also, the fact that the mesons are moving at high speeds in the magnetic field of the Earth may need to be considered.

IV. A New Interpretation of the Michelson-Morley Experiment

James Clerk Maxwell's concept of ether was that of a light-bearing medium affixed to space, but the Michelson-Morley experiment makes that concept less plausible. Einstein discarded all concepts of a light-bearing mechanism. This present paper proposes a light-bearing mechanism which seems to be a natural one and which explains the results actually obtained in the Michelson-Morley experiment.

The light-bearing mechanism is assumed to be the *self-field* of the source charge.[13] The electrostatic field of the charge carries the waves set up in that field by any acceleration of the charge. It is to be understood that light is an electromagnetic wave and that the term "light-bearing mechanism" applies to all electromagnetic waves, whether or not they happen to be in the frequency range of optics.

Every electric charge has an electrostatic field. It is well known that when the charge is accelerated it sets up a disturbance wave in that field. It is logical to assume that this electromagnetic wave obeys Maxwell's equations with reference to the frame of reference associated with that source's field. It is a ripple travelling outward in that field. This is the mechanism for the radiation of electromagnetic waves.

With this mechanism the Michelson-Morley experiment should come out the way it did, since the field is associated with the light source. Indeed, from this viewpoint the outcome was a forgone conclusion. There is no relative motion of this light-bearing field with respect to the two arms of the Michelson interferometer (the instrument employed in the experiment). The travel time should be the same in each beam, and thus no length contraction nor time dilation are needed to get the Michelson-Morley results.

V. A Classical Approach to Electrodynamics

At this point a new approach to electrodynamics will be explored which yields the same successful results as the special theory of relativity for the transformation of electrodynamic fields between frames of reference moving with respect to one another with constant velocity. These results, however, will be achieved classically without recourse to the concepts of length contraction, time dilation, and the constancy of the speed of light for all reference frames moving with uniform velocity.

The following set of basic electromagnetic relations will be used to demonstrate that an electric field $\mathbf{E}_f$ is *induced* in the "fixed" frame of reference when an elementary charge q (such as an electron) moves with uniform velocity $\mathbf{v}$: MKS or SI or Giorgi's units are used.

$$\mathbf{D} = \epsilon\mathbf{E} \tag{6}$$

$$\mathbf{H} = \mathbf{v} \times \mathbf{D} \tag{7}$$

$$\mathbf{B} = \mu\mathbf{H} \tag{8}$$

$$c = (\mu\epsilon)^{-1/2} \tag{9}$$

$$\nabla \times \mathbf{E}_f = -\dot{\mathbf{B}} \tag{10}$$

(**E** and **D** represent electric effects, **B** and **H** magnetic.)

The novel feature introduced into this present theory is the assumption that the induced electric field $\mathbf{E}_f$ is *feedback* into the moving frame of reference associated with the moving charge.[14] In picturesque language, the charge "sees" this induced electric field which is superimposed upon its original electrostatic field. The end result is a transformed electric field.

According to the special theory of relativity the charge actually never "sees" this induction. This "blindness" from one frame of reference to the other is supposed to be assured by the length contraction and time dilation in the moving frame of reference as seen by the fixed frame of reference. In this proposed theory, however, it is *assumed that there is no length contraction nor time dilation.* Under this assumption one would expect the electric field to be the same in both frames of reference.

It is customary to denote the fixed frame of reference by S and the moving frame of references by S'. The postulated feedback from the S frame to the S' frame assures that the electric field in the two frames will be identical. It must be noted, however, that only one S frame can be chosen with respect to the S' frame. This S frame is the one which contains what might be termed the *ambient* field with respect to which the charge was initially accelerated.

The consequence of this ambient field in the S frame of reference is extremely important and needs to be thoroughly investigated. This is a very different principle from that of the special theory of relativity in which any inertial frame of reference may be arbitrarily chosen as the "fixed" frame regardless of whether or not any force had ever accelerated the charge to the "relative" velocity of the two frames.

There is a physical reason to expect an interaction from the S frame to the S' frame. When a charge is accelerated by a force there must be, according to Newton's Third Law, a reaction force exerted by the field back on the charge—a feedback phenomenon. Thus an altered electric field must develop during the acceleration which acts back on the charge like an inertial force opposing the acceleration.

In addition to the production of a radiation field by the acceleration of the charge, an induction field is also developed. This induction field is associated with the velocity of the charge and stays with the charge as long as it is in uniform motion with respect to the ambient field of the fixed frame. One would expect this electric field feedback to persist during uniform motion, only in a balanced state such that the net feedback force on the charge is zero.

Having made the assumption that there is no length contraction nor time dilation, one may use the Galilean transformations and eliminate the more involved Lorentz-Einstein transformations. This is encouraging because the Galilean transformations utilize the kind of ordinary addition of length and time that one would physically expect to be correct.

A. Derivation of the Electric Field Transformation

Consider an elementary charge q. In the static case, the electric field, being radial and spherically symmetrical, can be written as the displacement

$$\mathbf{D} = \frac{q}{4\pi r^2}\,\mathbf{u}_r \tag{11}$$

where u_r is a unit vector in the radial direction. This equation can also be written as

$$\mathbf{E} = \frac{q}{4\pi\epsilon r^2}\,\mathbf{u}_r \tag{12}$$

since $\mathbf{D} = \epsilon\mathbf{E}$. The assumption is made that in the electrodynamic case the resultant electric field is still radial although not spherically symmetrical, since the field lines, as shall be seen later, are "squeezed" toward the direction transverse to the charge's velocity.

In Figure 1 a charge q is shown traveling with constant velocity $\mathbf{v}$ in the z-direction. Spherical coordinates are utilized. Since the **D** line strength is independent of the azimuthal angle ϕ, one may arbitrarily choose a particular **D** line in the x-z plane with polar angle θ without loss of generality.

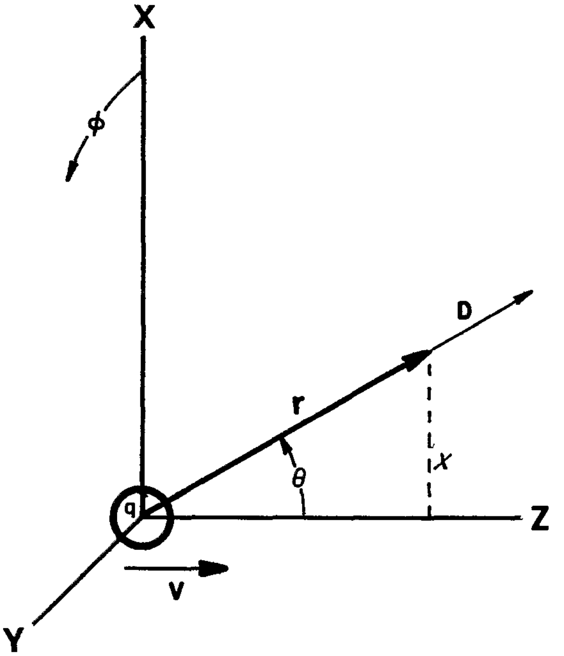

Figure 1. This shows the elementary charge q in uniform motion.

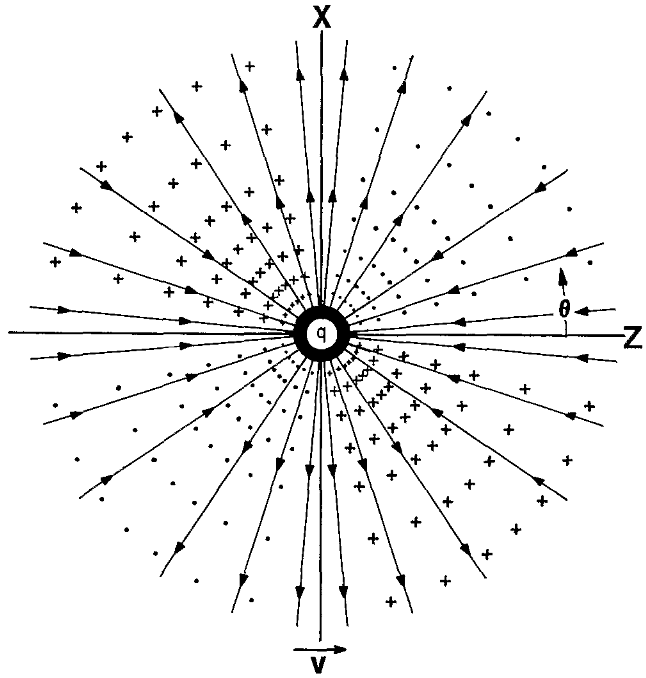

Figure 2. This is a plot of $\dot{\mathbf{B}}$ and the associated E_f lines, as discussed in the article. The crosses indicate $\dot{\mathbf{B}}$ into the plane of the drawing, the dots, $\dot{\mathbf{B}}$ out of it. The arrows indicate the induced E_f lines.

The movement of the **D** lines associated with the charge q produces a magnetic field **H** in the S frame in accordance with the equation

$$\mathbf{H} = \mathbf{v} \times \mathbf{D} \tag{13}$$

from which one obtains

$$\mathbf{H} = \frac{qv \sin\Theta}{4\pi r^2} \mathbf{u}_\phi \tag{14}$$

Since $\sin\theta = x/r$,

$$\mathbf{H} = \frac{qvx}{4\pi r^3} \mathbf{u}_\phi \tag{15}$$

Denoting the z-component of r as z in the fixed frame and z' in the moving frame, one may apply the Galilean transformation (which, from one viewpoint, is just to say that something is moving at speed v)

$$z' = z - vt \tag{16}$$

and the relation

$$r^2 = x^2 + (z - vt)^2 \tag{17}$$

to Equation (15) yielding

$$\mathbf{H} = \frac{qvx}{4\pi[x^2 + (z - vt)^2]^{3/2}} \mathbf{u}_\phi \tag{18}$$

By use of Equations (8) and (9) this becomes

$$\mathbf{B} = \frac{qvx}{4\pi\epsilon c^2 [x^2 + (z - vt)^2]^{3/2}} \mathbf{u}_\phi \tag{19}$$

Taking the partial derivative with respect to time, setting $t = 0$ when $z = z'$, and noting that $r^2 = x^2 + z^2$ results in

$$\dot{\mathbf{B}} = \frac{3qv^2xz}{4\pi\epsilon c^2 r^5} \mathbf{u}_\phi \tag{20}$$

Since $\beta = v/c$, $\sin\theta = x/r$, and $\cos\theta = z/r$ one obtains

$$\dot{\mathbf{B}} = \frac{3\beta^2 E_o \sin\theta \cos\theta}{r} \mathbf{u}_\phi \tag{21}$$

where the substitution

$$E_o = \frac{q}{4\pi\epsilon r^2} \tag{22}$$

has been made to express this in terms of the magnitude E_o of the original electrostatic field.

An observer (or instrument) in the S frame would "see" this $\dot{\mathbf{B}}$ field. By Maxwell's field equation

$$\nabla \times \mathbf{E}_f = -\dot{\mathbf{B}} \tag{23}$$

Thus the $-\dot{\mathbf{B}}$ induces an electric field $\mathbf{E}_f$ which "curls around" it and which is felt in the S' frame. The $\dot{\mathbf{B}}$ field is illustrated in Figure 2 along with the electric field $\mathbf{E}_f$ which is induced. This induced field $\mathbf{E}_f$ tends to reduce the original field at angles θ near 0 and π while tending to increase the original field at angles θ near $\pm\ \pi/2$.

B. A Useful Equation for the Radial Induction Field

Observation of the radial type of symmetry in the field pattern of $\dot{\mathbf{B}}$ *and* $\mathbf{E}_f$ in Figure 2 leads one to *assume that the electric field induction and the resultant electric field are radial during uniform motion of the charge q.* Under this assumption one may show, by applying Equation (23) to an infinitesimal loop of area $r\, d\theta\, dr$, as shown in Figure 3, that at every point in the field

$$\frac{dE_f}{r\, d\theta} = \dot{B} \tag{24}$$

The resultant electrodynamic field at any point will thus be a "superposition" of the original electric field $\mathbf{E}_o$ and the induced electric field which is "fed-back" onto it. Mathematically this may be expressed as

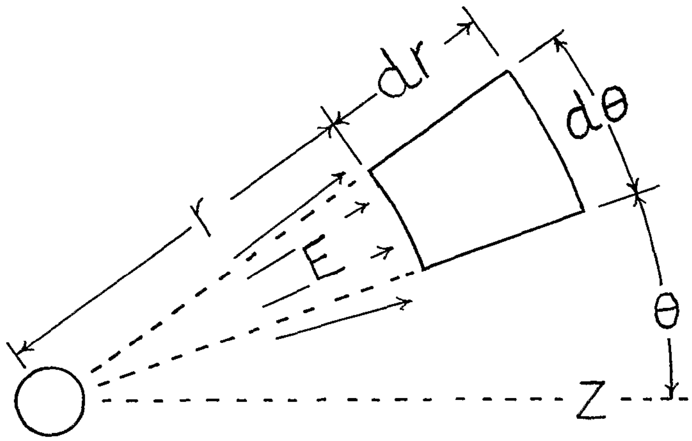

Figure 3. The integration, used in the text to calculate the electric field fed back, was taken in a counter-clockwise direction around the loop shown by the solid lines. This drawing might be considered superimposed onto Figure 2.

$$\mathbf{E} = \mathbf{E}_o + \mathbf{E}_f \quad (25)$$

where $\mathbf{E}_o$ is the original electric field as given in Equation (12) and $\mathbf{E}_f$ is the resultant of the feedback electric field. Since the stages of feedback form an infinite series, as will be seen later, Equation (25) may be rewritten as

$$E = E_o + E_{f1} + E_{f2} + \cdots + E_{fn} + \cdots \quad (26)$$

or

$$E = E_o + \sum_{n=1}^{\infty} E_{fn} \quad (27)$$

where the vector notation has been dropped.

C. First Stage of Feedback

For the first stage of feedback, one can write from Equations (21) and (24),

$$\int dE_{f1} = 3\beta^2 E_o \int_0^{\theta} \sin\theta \cos\theta \, d\theta \quad (28)$$

which reduces to

$$E_{f1}(\theta) - E_{f1}(0) = \frac{3}{2}\beta^2 \sin^2\theta \, E_o \quad (29)$$

where E_{f1} must be evaluated at the angles θ and 0. $E_{f1}(\theta)$ is the value of E_{f1} at some angle θ and thus is a function of θ while $E_{f1}(0)$ is the value of $E_{f1}(\theta)$ evaluated at a particular angle $\theta = 0°$. The value of $E_{f1}(0)$ may thus be termed the reference value of $E_{f1}(\theta)$ where $\theta = 0°$ is the reference angle. The reference value of $E_{f1}(\theta)$, $E_{f1}(0)$, is thus a constant and must be equal to some quantity $-\lambda_1 E_o$ where λ_1 may be termed the "diminishing factor" since $E_{f1}(0)$ diminishes the original electrostatic field E_o at the angle $\theta = 0$. Thus one may write

$$E_{f1}(\theta) = E_{f1}(0) + \frac{3}{2}\beta^2 \sin^2\theta \, E_o \quad (30)$$

or

$$E_{f1}(\theta) = \frac{3}{2}\beta^2 \sin^2\theta \, E_o - \lambda_1 E_o \quad (31)$$

Note that $E_{f1}(\theta)$ will be positive at values of θ near $\pm\pi/2$ and negative for values of θ near 0 and π. Dropping the functional notation one has

$$E_{f1} = \frac{3}{2}\beta^2 \sin^2\theta \, E_o - \lambda_1 E_o \quad (32)$$

for the first stage of feedback.

D. Second Stage of Feedback

Referring back to Equation (26): $E = E_o + E_{f1} + E_{f2} + \ldots + E_{fn} + \ldots$, E_{f1} was the induced field resulting from the motion of E_o and is solved for in Equation (32). The next step is to solve for the induction field E_{f2} which will be induced in turn by the motion of E_{f1}. One must begin with the equation

$$\mathbf{H}_2 = \mathbf{v} \times \epsilon \mathbf{E}_{f1} \quad (33)$$

which from Equations (8), (9), and (32) can be rewritten as

$$\mathbf{B}_2 = \frac{1}{c^2} [\mathbf{v} \times (-\lambda_1 E_o + \frac{3}{2}\beta^2 \sin^2\theta \, E_o)\mathbf{u}_r] \quad (34)$$

Noting Equation (22) for E_o and the relations for $\sin\theta$ and r as given in Equations (15) and (17) one arrives at

$$\mathbf{B}_2 = \frac{qv}{4\pi\epsilon c^2} [\frac{3}{2}\beta^2 (\frac{x^3}{[x^2 + (z-vt)^2]^{5/2}}) - \lambda_1 (\frac{x}{[x^2 + (z-vt)^2]^{3/2}})] \mathbf{u}_\phi \quad (35)$$

Taking the partial derivative with respect to time, setting t = 0 when $z = z'$, noting that $r^2 = x^2 + z^2$ yields,

$$\dot{\mathbf{B}}_2 = \frac{qv^2}{4\pi\epsilon c^2} [\frac{15}{2}\beta^2 (\frac{x^3 z}{r^7}) - 3\lambda_1 (\frac{xz}{r^5})] \mathbf{u}_\phi \quad (36)$$

which reduces to the scalar form

$$\dot{B}_2 = \frac{\beta^2 E_o}{r} [\frac{15}{2}\beta^2 \sin^3\theta \cos\theta - 3\lambda_1 \sin\theta \cos\theta] \quad (37)$$

since $\cos\theta = z/r$ and $\sin\theta = x/r$. Applying Equation (24) to this expression for $\dot{\mathbf{B}}_2$ and integrating as before from angles 0 to θ gives (38)

$$E_{f2}(\theta) = E_{f2}(0) + \frac{15}{8}\beta^4 \sin^4\theta \, E_o - \lambda_1 [\frac{3}{2}\beta^2 \sin^2\theta E_o]$$

Using the same reasoning as before, $E_{f2}(0)$ must diminish the original field E_o at angle $\theta = 0$ by some factor λ_2 where λ_2 will be less than λ_1 in magnitude. This will be true since the field inducing E_{f2} is less than the field inducing E_{f1}. Thus the final result for the second stage of feedback is

$$E_{f2} = \frac{15}{8}\beta^4 \sin^4\theta \, E_o - \lambda_1 [\frac{3}{2}\beta^2 \sin^2\theta \, E_o] - \lambda_2 E_o \quad (39)$$

E. Additional Stages of Feedback

The next step of course is to solve for the remaining "feedback terms" of Equation (26). Going through the same procedure as before and noting that E_{f3} will be induced by E_{f2} one obtains

$$E_{f3} = \frac{105}{48}\beta^6 \sin^6\theta \, E_o - \lambda_1 [\frac{15}{8}\beta^4 \sin^4\theta \, E_o] - \lambda_2 [\frac{3}{2}\beta^2 \sin^2\theta \, E_o] - \lambda_3 E_o \quad (40)$$

Combining the expressions for E_{f1}, E_{f2}, and E_{f3} and substituting into Equation (26) for the first four terms of the infinite series yields

$$E = E_o [1 + \frac{3}{2}\beta^2 \sin^2\theta + \frac{15}{8}\beta^4 \sin^4\theta + \frac{105}{48}\beta^6 \sin^6\theta] - \lambda_1 E_o [1 + \frac{3}{2}\beta^2 \sin^2\theta + \frac{15}{8}\beta^4 \sin^4\theta] - \lambda_2 E_o [1 + \frac{3}{2}\beta^2 \sin^2\theta] - \lambda_3 E_o \quad (41)$$

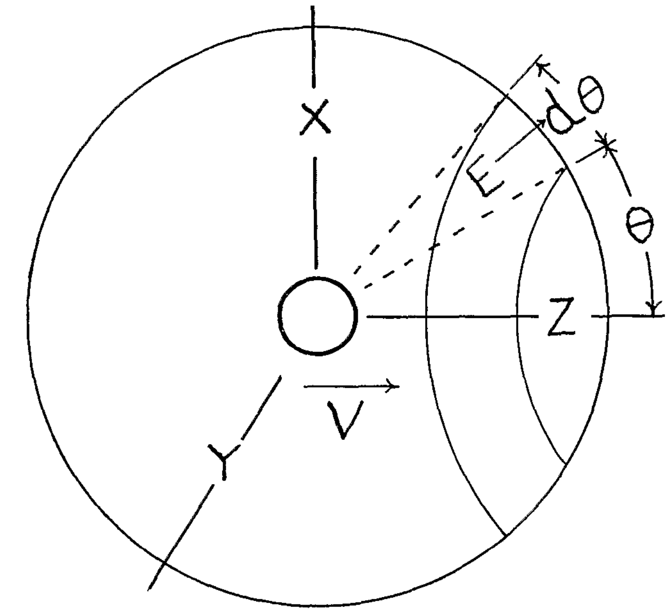

Figure 4. This shows the spherical coordinates used for the integration to find the total flux of the electric field. The element of area is of magnitude $2\pi a^2 \sin\theta\, d\theta$. Here $a d\theta$ is the width of the zone which forms the element of area, as shown; the radius of the sphere is a. Note that the electric field, being radial, is everywhere normal to the spherical surface.

Observation of this expression makes it clear where the series is heading since the term in each of the brackets is the binomial expansion for the quantity $(1-\beta^2 \sin^2\theta)^{-3/2}$ When the feedback is completed the expression (41) will become

$$E = E_o\left[\frac{1}{(1-\beta^2\sin^2\theta)^{3/2}}\right] - \sum_{n=1}^{\infty} \lambda_n E_o\left[\frac{1}{(1-\beta^2\sin^2\theta)^{3/2}}\right] \quad (42)$$

which further simplifies to the expression

$$E = E_o\left[\frac{1-\lambda}{(1-\beta^2\sin^2\theta)^{3/2}}\right] \quad (43)$$

where $\lambda = \sum_{n=1}^{\infty} \lambda_n$.

F. The Resultant Field and Conservation of Flux

The resultant electric field of a moving charge q as seen by an individual in the fixed frame of reference is thus given by Equation (43). The only task remaining is to solve for the constant λ which is the total sum of the diminishing factors λ_n. This can be done by noting that the total charge does not change with the motion; it is said to be invariant with velocity.[15] (At least, that seems commonly to be taken for granted. It is true that Ritz's proposed system of electrodynamics might have been interpreted otherwise; but a discussion of that would be out of place here.)

The total flux, then, of the electric field must be constant; in mathematical terms

$$\iint \mathbf{E} \cdot \mathbf{n}\ dA = \frac{q}{\epsilon} \quad (44)$$

The integral is to be taken over a surface enclosing the charge. dA is an element of that surface, and n a unit vector normal to it. **E** is the (total) electric field (at any velocity) as given in Equation (43).

Any surface would do; but a spherical one, its center at the charge, is convenient. The **E** and **n** are in the same direction, so the vectorial notation is no longer needed. The Equation (44) becomes

$$\iint E_o\left[\frac{1-\lambda}{(1-\beta^2\sin^2\theta)^{3/2}}\right] dA = \frac{q}{\epsilon} \quad (45)$$

It is convenient to take the polar axis in the direction of motion; then θ is the polar angle. The integration is quite simple, with the help of spherical coordinates, as in Figure 4. E_o as given in Equation (22) is substituted; and the integration comes to the intermediate stage

$$\frac{q(1-\lambda)}{2}\int_0^{\pi}\frac{\sin\theta\, d\theta}{(1-\beta^2\sin^2\theta)^{3/2}} = q \quad (46)$$

Since

$$\int_0^{\pi}\frac{\sin\theta\, d\theta}{(1-\beta^2\sin^2\theta)^{3/2}} = \frac{2}{1-\beta^2} \quad (47)$$

λ must then be equal to β^2 in order for the total flux of E to be conserved. The final expression for the total field can therefore be written as

$$\mathbf{E} = \frac{q}{4\pi\epsilon r^2}\left[\frac{1-\beta^2}{(1-\beta^2\sin^2\theta)^{3/2}}\right]\mathbf{u}_r \quad (48)$$

A plot for the cross section of this electric field equation is given in Figure 5 for a velocity equal to 94% the speed of light c (which makes σ = 3). Note that the electric field lines have been shifted up toward the direction transverse to the direction of motion, which means a decrease of E lines in the direction parallel to the motion,[16] as compared with the pattern for a stationary charge.

VI. Conclusion

Equation (48) is the same solution one would obtain using the special theory of relativity for the electric field seen in the fixed frame of reference for the case of a charge q traveling by with uniform velocity.[17] The remarkable thing about this new theory is that the assumptions of length contraction, time dilation, and constancy for the speed of light c were not necessary. ***Thus a classical foundation has been established for electrodynamics.***

Acknowledgement

The assistance of Kenneth Moses in the preparation of the figures is gratefully acknowledged.

References

[1]Lorentz had used the equations earlier, on different grounds. And Voigt had introduced them yet earlier, in 1887, as an algebraic trick. See O'Rahilly, Alfred 1965. Electromagnetic theory. Dover. (Originally published by Longmans, Green, and Co., in 1938, as Electromagnetics). Vol. 1, pp. 324-327.

[2]There may, though, be fallacies in the discussion of this experiment commonly given in the textbooks. For one thing, it jumbles ballistic notions, such as time of flight, with interference, a wave phenomenon. Also, if the ether wind be admitted, things become complicated: wave fronts are skewed upon reflection, angles are no longer equal, etc. See O'Rahilly, *Op. cit.*, pp. 258-259, 336-339, and 439 (Reference 1). It may be that there has never been an adequate analysis of the experiment.

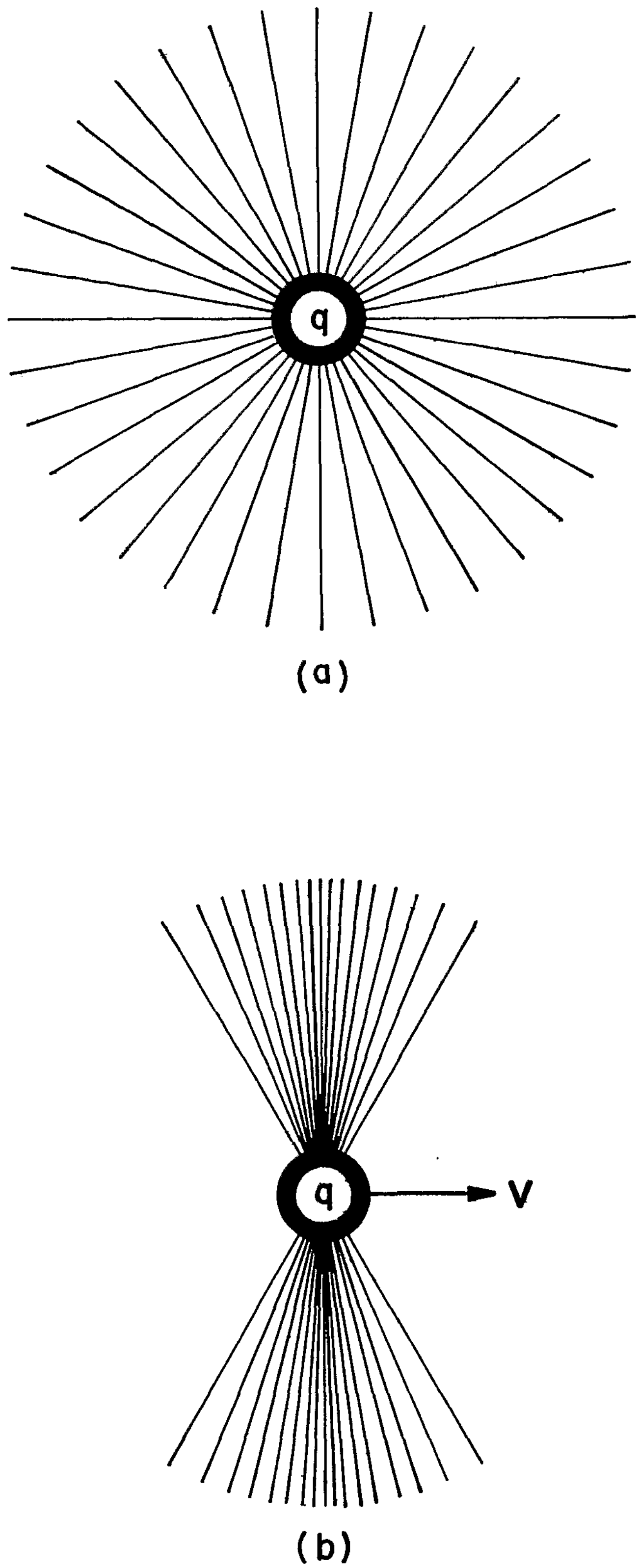

Figure 5. This shows the effect of the motion on the electric field lines. Part (a), the upper part, shows the field lines for the charge at rest. Part (b), the lower part, shows the lines for the same charge moving at a velocity 0.94c, so that β = 0.94 and thus σ = 3.

[3]It appears, though, that Einstein was of different opinions about the ether at different times. See Jánossy, L. 1971. Theory of relativity based on physical reality. Akadémiai Kiadó, Budapest, pp. 48-50. The author cites an article of Einstein's which is not generally known.

[4]The "tachyons", hypothetical particles moving at speeds greater than that of light, about which so much was written a year or two ago (see, e.g., Kreisler, Michael N. 1975. Faster than light particles —do they exist?, *The Physics Teacher* 13(7):429-434) seem to have gone out of fashion.

[5]This mass, incidentally, seems to be the transverse one. Indeed, the longitudinal mass seems often to be something of an embarrassment. See, e.g., Brown, G. Burniston 1958. The unification of macroscopic physics, *Science Progress* XLVI(181):15-29. See especially the footnote on p. 26.

[6]Dingle, Herbert 1972. Science at the crossroads. Martin Brian, and O'Keeffe, London.

[7]Shadowitz, A. 1968. Special relativity. W. B. Saunders, p. 168.

[8]Essen, L. 1977. Atomic clocks coming and going, *Creation Research Society Quarterly* 14(1):46.

[9]Indeed, even if the results claimed were established, they may not prove much. Even a pendulum clock, moving around the Earth, would run at a slightly different rate from one which was kept in position, because the effective acceleration of gravity would be a little different. Again, the moving clock was moving through the magnetic field of the Earth; that might have had some effect.

[10]Barnes, Thomas G. 1975. Earth's magnetic energy provides confirmation of its young age, *Creation Research Society Quarterly* 12 (1):11-13. (Corrected formulation.)

[11]French, A. P. 1968. Special relativity. The M. I. T. Introductory Physics Series, W. W. Norton and Co., New York, pp. 97-104.

[12]DeYoung, Don B. 1976. The precision of nuclear decay rates, *Creation Research Society Quarterly* 13(1):38-43.

[13]This is something like an idea which Faraday suggested about 1846. See Dingle, Herbert 1960. The Doppler effect and the foundations of physics II, *British Journal for the Philosophy of Science XI*(42): 113-129. See especially pp. 115-117. Apparently Faraday never followed the idea up; and Maxwell, when he came to follow up some of Faraday's ideas, gave this one a rather different aspect.

[14]The notion of feedback is much used by electronic engineers. It means, in the most general terms, that an effect somehow acts back on the cause. How that applies here will be seen later.

[15]Schwartz, Melvin 1972. Principles of electrodynamics. McGraw-Hill, New York, pp. 121 and 122.

[16]One might say that the field lines are contracted in the direction of motion. Is it possible, then, that this contraction of field lines came to be ascribed to the actual objects?

Incidentally, the name FitzGerald is often associated with the supposed contraction. However, what FitzGerald envisaged was apparently an expansion, transversely to the direction of motion. See Dingle, Science at the crossroads, pp. 162-164. (Reference 6).

[17]Jackson, J. D. 1975. Classical electrodynamics. Second Edition. John Wiley and Sons, p. 555.

(Editor's Note:) If some readers are surprised at finding an article on a topic in theoretical and mathematical physics in this creationist publication, the reasons, mentioned on page 197 of the *Quarterly* for March 1976 under "Further Editor's Comment", might be repeated. There are, moreover, two other points.

In the first place, electromagnetic theory affects practically all of physics. Surely it has to do, for instance, with the decay of radioactive materials, although the connection may not yet be well understood. Thus a better understanding of electrodynamics might help to throw some light onto the behavior of such isotopes as carbon 14, and help in solving problems having to do with the use, or attempted use, of isotopes in determining the ages of things.

The second point is rather different. I have seen writings in which the authors hoped to apply formulae from the theory of relativity to many questions, some from theology as well as from natural science. Sometimes, for instance, the thought has been that the dilation of time, considered well established as a universal happening, might be the key to reconciling a Biblical chronology with the long times proposed by uniformitarians. If, then, relativistic notions are not so well established after all, or if they are only so many tricks to be used in solving electrodynamic problems, those intending to make such attempts should know the facts of the case. Otherwise, they might find themselves leaning on a broken reed.)