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# The Fine Structure of Four-Dimensional Space-Time

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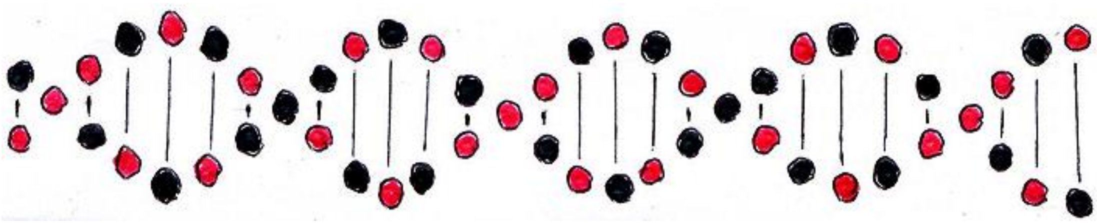
***Abstract*. In 1905 when Albert Einstein first attempted to perform a Lorentz transformation on Maxwell's equations, he left deliberate gaps in the spacing between the terms of the equations when they were presented in their transformed state. Careful scrutiny will also reveal that Einstein couldn't actually have got the results that he did by using the method which he claimed. The mysterious gaps seem to be alluding to a symmetry in four dimensions. It was almost as though he was saying *"this is what the solutions should be, but I can't get there using three-dimensional algebra"*. It will now be demonstrated that it is actually the non-relativistic part of the Lorentz transformations, and not the relativistic Lorentz factor, $1/\sqrt{(1 - v^2/c^2)}$, which betrays the existence of a 4D space-time continuum.**



## The Lorentz Force

**I.** The Lorentz force first appeared as an electromotive force term at equation (77) in Part II of Scottish physicist James Clerk Maxwell's 1861 seminal paper entitled ***"On Physical Lines of Force"*** **[1]**. It appeared in the basic form,

$$\mathbf{E} = \mu_0\mathbf{v}\times\mathbf{H} + \partial\mathbf{A}/\partial t - \nabla\psi \qquad \textbf{(1)}$$

and in 1864 he listed it as one of the original eight *"Maxwell's Equations"* in his paper entitled ***"A Dynamical Theory of the Electromagetic Field"*** **[2]**. The term, **E**, on the left-hand side is the force acting on *unity of the electric particles* within his proposed dielectric sea of molecular vortices. Today, **E** is referred to as *"force per unit charge"* while the term electromotive force is generally used for voltage, which of course plays the exact same role in electric circuit theory. In modern textbooks, the charge term, q, is taken over to the right-hand side, hence making equation **(1)** appear as,

$$\mathbf{F} = q[\mathbf{v}\times\mathbf{B} + \partial\mathbf{A}/\partial t - \nabla\psi] \qquad \textbf{(2)}$$

where,

$$\mathbf{B} = \mu_0\mathbf{H} \qquad \textbf{(3)}$$

The quantity, **B**, is the magnetic flux density which will be referred to as the *magnetic field*, while $\mu_0$ is the magnetic permeability which is closely related to the density of the sea of aethereal vortices, and **H** is the magnetic intensity. The second and third terms on the right-hand side of equation **(1)** are the *electric field* terms. The second term, which arises from Faraday's Law, is the partial time derivative of the *electromagnetic momentum*, **A**, nowadays referred to as the *magnetic vector potential*. The second term arises due to a changing magnetic field, while the third term is the electrostatic field as per Coulomb's law. Collectively they are represented as,

$$\mathbf{E} = \partial\mathbf{A}/\partial t - \nabla\psi \qquad \textbf{(4)}$$

It's common to have a negative sign in front of the $\partial\mathbf{A}/\partial t$ term in order to take account of Lenz's Law, but it will be left out here so as to maintain consistency with Maxwell's original convention. In modern textbooks, equation **(1)** is generally written in the familiar *Lorentz force* format,

$$\mathbf{F} = q[\mathbf{E} + \mathbf{v}\times\mathbf{B}] \qquad \textbf{(5)}$$

As regards the convective term, $\mathbf{v}\times\mathbf{B}$, which is often referred to as the Lorentz force on its own, it was derived by Maxwell in conjunction with his sea of molecular vortices long before Lorentz got involved in the topic, and so in this article it will be referred to as the *Maxwell-Lorentz*

*Force*. The $\mathbf{v}\times\mathbf{B}$ force is like a kind of compound centrifugal force arising from the differential pressure acting on either side of an element of electric current as it flows through the sea of tiny aethereal vortices. This differential pressure causes a deflection in the path of motion.

Prior to introducing electric particles into his sea of aethereal vortices in Part II of his 1861 paper, Maxwell had relied exclusively on three-dimensional aether hydrodynamics and he operated in terms of *force per unit volume*. Let us consider the two force terms which appear as parts 3 and 4 on the right-hand side of equation (5) in part I of his 1861 paper,

$$\mathbf{E} = \mu_0\mathbf{v}\times(\nabla\times\mathbf{v}) \qquad \textbf{(6)}$$

where **E** refers to force per unit volume. Since the velocity term, **v**, is the fine-grained circumferential velocity of the tiny vortices, then the vorticity must be expressed as,

$$\nabla\times\mathbf{v} = 2\boldsymbol{\omega} \qquad \textbf{(7)}$$

where $\boldsymbol{\omega}$ is the angular velocity at the edge of the vortices, and since the magnetic permeability, $\mu_0$, is related to the density of the sea of vortices, this brings us to,

$$\mathbf{F} = 2m\mathbf{v}\times\boldsymbol{\omega} \qquad \textbf{(Coriolis Force)} \qquad \textbf{(8)}$$

which is the familiar Coriolis force. Maxwell identified the circumferential velocity, **v**, with the magnetic intensity, **H**. Substituting equations **(3)** and **(7)** into equation **(6)** therefore leads to,

$$\mathbf{E} = \mathbf{B}\times(\nabla\times\mathbf{B}/\mu_0) \qquad \textbf{(9)}$$

Comparing with Ampère's Circuital Law, and substituting $\mathbf{J} = \rho\mathbf{v}$, where $\rho$ is the charge density, we obtain,

$$\mathbf{E} = \mathbf{B}\times\rho\mathbf{v} \qquad \textbf{(10)}$$

which is the familiar Maxwell-Lorentz force. A subtle difference between the Coriolis force when observed in atmospheric cyclones on the one hand, and the Maxwell-Lorentz force when observed in a magnetic field on the other hand, is that in the atmospheric case, we are observing inertial motion in a vortex, whereas in the electromagnetic case, we are observing motion between vortices. See ***“The Coriolis Force in Maxwell’s Equations”*** **[3]**.

## The Three-Dimensional Aether Hydrodynamical Analysis

**II**. In Maxwell’s hydrodynamical analysis in Section **I** above, he bases the magnetic intensity, **H**, and the magnetic flux density, **B**, on the circumferential aether circulation in his sea of tiny vortices. It has been shown however that this fine-grained electric fluid flow is in fact displacement current **[4]**, **[5]**. In demonstrating this, all papers relating to ***“The Double Helix Theory of the Magnetic field”***, **[6]**, **[7]**, instead apply **H** directly to the vorticity of the vortices, and hence Maxwell’s electromagnetic momentum, **A**, becomes his displacement current. It’s upon this basis that we will operate in this article. The scalar potential, $\psi$, represents hydrostatic aether pressure, and together with the dynamic momentum/displacement current, **A**, they make up the two important ingredients of Bernoulli’s Principle within the sea of fine-grained aethereal vortices. While the Maxwell-Lorentz term, $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$, follows naturally from three-dimensional aether hydrodynamics as shown in Section **I** above, and also in **Appendix A** at the end, there are important issues relating to the speed of light, and what will be explained later as *“The Lorentz Condition”*, which need to be carefully considered.

Relativists claim that Einstein’s Special theory of Relativity covers all these hydrodynamical relationships, hence rendering Maxwell’s pioneering works redundant. This is despite the fact that relativity completely removes the aether from the entire picture, yet it’s very hard to comprehend how a force such as the Maxwell-Lorentz force, $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$, which follows from differential pressure within a sea of tiny aethereal vortices could still exist after we have removed the aether itself. Could an aeroplane fly if we removed the atmosphere? The relativists’ argument is based on the Lorentz transformations which can indeed produce the Maxwell-Lorentz force, $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$, from the combined electric field term on the right-hand side of equation **(4)**, $\partial\mathbf{A}/\partial t - \nabla\psi$.

But what the Lorentz transformation of the electric field is actually doing is, it is creating a Coriolis force out of the momentum field, **A**, in a similar manner as we do when using rotating polar coordinates in connection with a radial position vector. While it might then be argued that this aspect of the Lorentz transformations amounts to pure three-dimensional hydrodynamics, the matter is not so simple when extended across electromagnetism in general. The Lorentz transformations also introduce the *beta factor* v/c, which is sourced in Wilhelm Eduard Weber’s force law of 1846, and in the famous Weber-Kohlrausch experiment of 1855 **[8]**. In this experiment, the connection between electromagnetism and the speed of light was first established by discharging a Leyden jar (capacitor) and measuring the ratio between electrostatic and electrodynamic units of charge. The Lorentz transformations accurately distribute this beta factor, v/c, across the electromagnetic equations in a manner that could never be achieved using three-dimensional vector analysis.

Additionally, the Lorentz transformations also introduce the *gamma factor*, or *Lorentz factor*, $\gamma = 1/(\sqrt{1 - v^2/c^2})$. While this is not relevant to the Maxwell-Lorentz force, which is observed at laboratory speeds, it is nevertheless relevant as regards the bridge to Einstein's Special Theory of Relativity, a bridge which should never have been crossed. Matters relating to the gamma factor are only observed at very high speeds, normally in the order of the speed of light, although gamma factor effects are noticed in the atomic clocks on board GPS satellites.

## The Lorentz Transformations

**III**. In a letter entitled ***"The Ether and the Earth's Atmosphere"*** written by the Anglo-Irish physicist George Francis Fitzgerald, dated 2nd May 1889 and published in the ***"Science"*** illustrated weekly journal **[9]**, Professor Fitzgerald expressed great interest in the recent experiment carried out in 1887 by Messrs. Michelson and Morley at Cleveland, Ohio, in the USA. Michelson and Morley, using an interferometer in an attempt to measure the speed of the Earth relative to the luminiferous medium, had obtained no significant fringe shifts. Professor Fitzgerald stated that the only hypothesis that could be reconciled with this negative observation is that the length of moving bodies changes due to electrical interaction with the aether.

In 1892 the Dutch physicist Hendrik Lorentz began working on a project aimed at reconciling Maxwell's equations with certain experiments involving optics and relative motion **[10]**. Initially attention was focused on stellar aberration and Fizeau's 1851 experiment involving the speed of light in a moving column of water, but Lorentz extended the investigation to include inter-molecular forces and length contraction in order to try and explain the null result of the 1887 Michelson-Morley experiment. In 1897 the Ulster physicist and mathematician Sir Joseph Larmor extended Lorentz's work further, paying particular attention to the electrical interaction between matter in motion and the luminiferous aether **[11]**. Lorentz on the other hand was largely working on an *ad hoc* mathematical basis. It was Larmor who first suggested that length contraction would have to also involve some kind of retardation of local time, a concept which he never clearly explained but which is understood by some to relate to the frequency of natural processes, and it was Larmor who is said to have been the first to have arrived at the Lorentz transformations as we know them today [12]. See **Appendix B**.

In 1905, French physicist Henri Poincaré formulated equivalent transformation equations and named them the *Lorentz transformations* as it seems that he was unaware of Larmor's contributions [13]. Shortly afterwards, Albert Einstein published an alternative derivation of the Lorentz transformation equations and gave them a brand-new interpretation which removed the need for the aether altogether [14]. It's this act of mindless vandalism on Einstein's part which is central to a major controversy which rages to this day.

## The Luminiferous Aether

**IV**. Maxwell never overtly mentioned electric charge in his 1861 paper. Instead he talked about the density of *free electricity*, a concept which he never elaborated upon. This is highly significant since the term free electricity is likely to refer to the electric fluid, which is the primordial aether from which everything is made. This would equate electric charge to the state of compression of space itself, space being something that can be compressed or stretched, and which can also flow. Maxwell considered the luminiferous medium to be a sea of tiny aethereal vortices exhibiting 3D cylindrical symmetry and obeying the classical laws of hydrodynamics, and from the arguments in Sections **I** and **II** above, there would seem to be no compelling reason to see the matter any differently.

The idea that the luminiferous medium is a 4D space-time continuum can however be argued from the relationship which was established from two successive applications of the 3D Pythagoras's Theorem,

$$\sigma^2 = x^2 + y^2 + z^2 - c^2t^2 \qquad \mathbf{(11)}$$

Equation **(11)** is the foundation stone of the Lorentz transformations, and the quantity, σ, is *Lorentz invariant*, meaning that it doesn't change under a Lorentz transformation. In this article, the physical significance of equation **(11)** will be discussed only within the context of electromagnetism. Once this significance has been fully understood, the degree to which it can be extrapolated more generally into other physical contexts, such as in the case of atomic clocks in GPS satellites [15], will be left to conjecture, although it seems that the pioneers mentioned in the previous section did believe strongly that Lorentz invariance does in fact extend into ponderable matter. Sir Joseph Larmor in particular was actually working directly on this problem in connection with a rotationally elastic aether and rotating dipoles **[11], [12]**, and it's not unreasonable to believe that the molecules of ponderable matter, if they constitute rotating dipoles, would be Doppler shifted when moving through a sea of tiny vortices. Sir Joseph Larmor's papers would be the ideal place to begin if this matter is to be investigated further. Larmor talked about positive and negative electrons being singularities in the aether and he connected this idea with electromagnetic radiation. See page 211 in his 1897 paper **[11]**, and Section 114, pages 179-180, in his 1900 paper **[12]**.

Einstein interpreted equation **(11)** on the basis that c is a universal constant. This interpretation will now be rejected and replaced with the proposition that equation **(11)** is a fine-grained application of Bernoulli's Principle in an elastic medium whose elasticity is governed by the quantity, c, which is numerically equal to the speed at which light waves propagate through this medium. This elastic medium will be taken to be Maxwell's sea of molecular vortices as modified by ***"The Double Helix Theory of the Magnetic Field"*** **[6], [7]**, which replaces his molecular vortices with rotating electron-positron dipoles. The three space dimensions in equation **(11)**, x, y, and z, will refer to physical space itself, as in the all-pervading aether which is rendered into tiny dipolar vortices that are pressing against each other while striving to dilate **[16]**, **[17]**, **[18]**. This primordial aether, or electric fluid will be deemed to be compressible and stretchable, and the concept of *length contraction* will be understood in this context.

The *"time"* term in equation **(11)** will be understood in terms of its reciprocal, *frequency*, and in relation locally to the fine-grained angular oscillations of the tiny dipolar vortices that fill all of space, and *"time dilation"* will be taken to refer to a slowing down of their natural frequency. Time dilation will have no bearing on the more general understanding of time such as where one year is measured by a complete orbit of the Earth about the Sun, relative to the background stars, and where a year in this context will be observed equally by everybody in the universe. Equation **(11)** will be taken to mean, that in the context of an electromagnetic wave, when the aether compresses along its direction of flow, the rotation frequency of the tiny vortices decreases. This oscillation between pressure and flow propagates through the sea of tiny vortices at a speed which averages the measured speed of light.

## The 4D Space-Time Continuum

**V**. In Einstein's 1905 paper **[14]**, he derived the kinematical Lorentz transformations in his own way and then went on to apply them to Ampère's Circuital Law and Faraday's Law. On page 907, Einstein wrote out these two curl equations side by side in a perfectly symmetrical format involving three rows and two columns. He split each equation into three, one for each of the three Cartesian components, and he used Gaussian units so that the speed of light was overtly displayed. The kinematical Lorentz transformations would have ruined this symmetry, yet Einstein nevertheless maintained the symmetry in the solutions, while inserting gaps on each line as if to hint at an underlying 4D symmetry. It seems as if Einstein, on discovering that the Lorentz transformations breached the 3D symmetry, then force fits a 4D symmetry which actually turns out to give the correct results, $\mathbf{E_L} = \gamma(1/c)\mathbf{v}\times\mathbf{B}$ and $\mathbf{B} = \gamma(1/c)\mathbf{v}\times\mathbf{E}$. See **Appendix C**. In the same year, French mathematician and theoretical physicist Henri Poincaré devised an analytical tool known as *four-vectors* which shed more light upon this mysterious state of affairs. This was written up in his *"Palermo paper"*, **[19]**, and the same idea was later developed further in 1908 by German mathematician Hermann Minkowski whose name is now associated with the 4D space-time continuum.

The Lorentz transformation equations can be converted into four-vector format by treating time as a fourth dimension. We can then re-write equation **(11)** as,

$$s^2 = x_1^2 + x_2^2 + x_3^2 + x_4^2 \tag{12}$$

The term $x_4$ involves the imaginary number, $i^2 = -1$, such that,

$$x_4 = ict \tag{13}$$

In four-vector format, the Lorentz transformations for motion, exclusively along the x-axis, then take on the form,

$$x_1' = \gamma(x_1 + iv_x x_4/c) \tag{14}$$

$$x_2' = x_2 \tag{15}$$

$$x_3' = x_3 \tag{16}$$

$$x_4' = \gamma(x_4 - iv_x x_1/c) \quad \textbf{(17)}$$

A qualitative assessment of equations **(14)** and **(17)** tells of a wave propagating at speed ‘c’ in an elastic medium which is oscillating between pressure and flow. The space component represents volume of aether, where volume and pressure are related through Boyle’s Law, while the time component represents rate of flow. This suggests that as the pressure increases during each cycle, then the rate of flow decreases in line with Bernoulli’s Principle. The speed ‘c’ is therefore the average speed of aether flow within the wave.

Whatever, the physical effects that are implied by the Lorentz transformations in relation to light, they must have their root cause in Maxwell’s sea of molecular vortices. The Lorentz transformations introduce a three-dimensional curl into the **A** field in the context of a charged particle in motion through the sea of vortices, as well as introducing a Doppler shift into the electric field, such that it bunches up and flattens along its line of motion. An example will now be illustrated in which a Coriolis force will be induced in the aether by applying a Lorentz transformation. This will introduce a linear motion on top of a 3D curl, in connection with Lorentz invariance. Consider a stationary frame of reference, S, in which there exists an **E** field, which is the sum of an electrostatic field $\mathbf{E_S}$ and a field, $\mathbf{E_K}$, which has been induced by a time-varying magnetic field, **B**. Under Lorentz transformation in frame S', we will consider the Z-component of **E'**,

$$E'_z = \partial A'_z/\partial t' - \partial\psi'/\partial z' \quad \textbf{(18)}$$

Note that when equation **(18)** uses electromagnetic units as Maxwell did, or SI units as modern textbooks do, that it doesn’t explicitly show up the speed of light. We will now re-write equation **(18)** in four-vector notation, and this incorporates what is mistakenly known as the *Lorentz condition*. The term *‘Lorentz condition’* is highly appropriate despite the fact that it originated in the *Lorenz gauge*, named after the Danish physicist Ludvig Lorenz who conceived it, as opposed to being named after the Dutch physicist Hendrik Lorentz of the Lorentz transformations. But since the Lorenz gauge fits so perfectly with the Lorentz transformations, it’s convenient to continue referring to the *Lorentz condition* as such, since it is indeed exactly a condition that needs to be satisfied in order to comply with the Lorentz transformations. The Lorenz gauge introduced the speed of light into the equation of continuity of charge. When considered in the special circumstances of electromagnetic radiation, we use Maxwell’s displacement current, **A**, and the electrostatic potential, $\psi$, where $\psi$ is in all physical respects equivalent to charge density. The Lorenz gauge introduces the speed of light into the equation in the form,

$$\nabla\cdot\mathbf{A} + 1/c^2\partial\psi/\partial t = 0 \qquad \textbf{(19)}$$

This brings us back again to Bernoulli's Principle which in effect is the conservation of energy. It's all about the interchange between pressure and flow. But the Lorenz gauge has added in the additional factor of the speed of light which relates directly to the elasticity of the medium for the propagation of light, as in Maxwell's sea of molecular vortices.

With the Lorentz condition satisfied, the four-vector for **A** and $\psi$ takes the form ($A_1$, $A_2$, $A_3$, $i\psi/c$). The Z-component of the momentum (displacement current), $A_z$, becomes $A_3$ while the scalar potential (pressure), $\psi$, becomes $i\psi/c$. The four-vector for $\nabla$ and $\partial/\partial t$ becomes, ($\partial/\partial x$, $\partial/\partial y$, $\partial/\partial z$, $i/c.\partial/\partial t$). Hence, we can write,

$$E'_z = ic[\ \partial A'_4/\partial x'_3 - \partial A'_3/\partial x'_4] \qquad \textbf{(20)}$$

Note that the speed of light has now been introduced explicitly into the equation even though we don't want it to be there in the end result. From equation **(17)**, ***while deliberately omitting the gamma factor, $\gamma$,*** we can use the Lorentz transformations,

$$A'_4 = (A_4 - iv_xA_1/c) \qquad \textbf{(21)}$$

and

$$\partial/\partial x'_4 = (\partial/\partial x_4 - iv_x/c.\partial/\partial x_1) \qquad \textbf{(22)}$$

Then trivially, since motion is only along the x-axis, it follows from equation **(16)** that $A'_3 = A_3$ and $\partial/\partial x'_3 = \partial/\partial x_3$. Applying these transformations to equation **(20)** leads to,

$$E'_z = ic[\partial/\partial x_3(A_4 - iv_xA_1/c) - (\partial/\partial x_4 - iv_x/c.\partial/\partial x_1)A_3] \qquad \textbf{(23)}$$

therefore,

$$E'_z = ic(\partial A_4/\partial x_3 - \partial A_3/\partial x_4) + v_x(\partial A_1/\partial x_3 - \partial A_3/\partial x_1) \qquad \textbf{(24)}$$

We can now get rid of the speed of light again by comparing the first bracketed term on the right-hand side of equation **(24)** with the starting equation **(18)**. It simply becomes $E_z$. The second bracketed term on the right-hand side applies purely within 3D space and it is readily identifiable as the y-component of the curl of **A**. It's of interest to note that curl is a purely spatial operation which exists only in three and seven dimensions. There can be no curl in four dimensions **[20]**, but curl can still operate in tandem with time in 4D space-time. Hence, we have,

$$E'_z = E_z + v_x B_y \qquad \textbf{(25)}$$

Repeating this exercise across all the Cartesian components leads us to,

$$\mathbf{E'} = \mathbf{E} + \mathbf{v}\times\mathbf{B} \qquad \textbf{(26)}$$

We have extracted the Maxwell-Lorentz force using a Lorentz transformation, hence establishing a clear bridge between Maxwell's sea of aethereal vortices and the Lorentz aether theory. This could not have been done without invoking Hermann Minkowski's concept of 4D space-time. There was no need to invoke the gamma factor for this particular purpose. The gamma factor however predicts other effects as already mentioned above.

## The Biot-Savart Law

**VI**. In order to further emphasize the importance of 4D space-time and the Lorentz condition which is introduced using four-vectors, it will now be shown how the speed of light can be accurately and explicitly introduced into the Biot-Savart Law where we desire it to be seen.

Consider a charged particle in motion along the x-axis. As per Ampère's Circuital Law, it will be surrounded by a magnetic field, **B**, in which the field lines will form concentric rings around the path of motion. The component of **B** along the y-axis, as measured in frame S', will take the form,

$$B'_z = \partial A'_y/\partial x' - \partial A'_x/\partial y' \qquad \textbf{(27)}$$

In four-vector notation this becomes,

$$B'_z = \partial A'_2/\partial x'_1 - \partial A'_1/\partial x'_2 \qquad \textbf{(28)}$$

Using the Lorentz transformation equations **(14)** to **(17)**, ***and once again deliberately omitting the gamma factor,*** equation **(28)** expands to,

$$B'_z = (\partial/\partial x_1 + iv_x/c.\partial/\partial x_4)A_2) - \partial/\partial x_2(A_1 + iv_xA_4/c) \qquad \textbf{(29)}$$

Hence,

$$B'_z = (\partial A_2/\partial x_1 - \partial A_1/\partial x_2) + (iv_x/c)(\partial A_2/\partial x_4 - \partial A_4/\partial x_2) \qquad \textbf{(30)}$$

The first bracketed term on the right-hand side of equation **(30)** should already be recognizable as the z-component of $\nabla\times\mathbf{A}$, which is $B_z$. As regards the second bracketed component on the right-hand side of equation **(30)**, we must remember that $\partial/\partial x_4$ is $(i/c)\partial/\partial t$ while $A_4$ is $i\psi/c$. Hence,

$$B'_z = B_z - (v_x/c^2)(\partial A_y/\partial t - \partial\psi/\partial y) \qquad \textbf{(31)}$$

The term $\partial A_y/\partial t$ is the component of $E_y$ that is induced by time-varying electromagnetic induction, while $\partial\psi/\partial y$ is the electrostatic component of $E_y$ that arises from Coulomb's Law. Hence,

$$B'_z = B_z - v_xE_y/c^2 \qquad \textbf{(32)}$$

This is the z-component of the already existing **B** field added to the **B** field that is induced by the charged particle moving along the x-axis. The complete equation over all three Cartesian components is,

$$\mathbf{B'} = \mathbf{B} - \mu_0\varepsilon_0\mathbf{v}\times\mathbf{E} \qquad \textbf{(33)}$$

where $\mu_0$ is the magnetic permeability of space, $\varepsilon_0$ is the electric permittivity of space, and where from the 1856 Weber-Kohlrausch experiment **[8]**, we can write,

$$c^2 = 1/\mu_0\varepsilon_0 \qquad \textbf{(34)}$$

## The Physical Interpretation

**VII**. A Lorentz transformation should not be considered in the manner of a Galilean transformation whereby we are viewing the same event from a different frame of reference. A Lorentz transformation only makes sense in terms of the physical force fields that are induced around a charged particle or an electric current due to its motion through the aether rest frame. In Section **V** we saw how a Lorentz transformation confirmed the Maxwellian result whereby an element of electric current flowing through a magnetic field, or a charged particle in motion through a magnetic field, experiences a force acting at right-angles to both the magnetic field and to the component of its motion that is at right-angles to the magnetic field. When we add in the gamma factor, $1/\sqrt{(1 - v^2/c^2)}$, this creates an additional effect which is only significant at very high speeds, and which causes a dramatic increase in the **E** field strength at right-angles to the direction of motion. In reality, this aspect could only apply to the **E** field that is actually induced by the motion itself. This will be the centrifugal pressure field which constitutes the **B** field that was derived in section **VI**.

A magnetic field takes the form of concentric rings around the path of motion as described by Ampère's Circuital Law, and in Maxwell's theory, the field lines are traced out by the rotation axes of the tiny aethereal vortices that fill all of space, and hence a centrifugal pressure field, **E**, acts at right-angles to the induced **B** field **[1]**, **[16]**, **[17]**. Hence, if a charged particle begins at rest in the aether and accelerates to near the speed of light, it will begin with a perfectly radial electrostatic field and no magnetic field. When it moves, it will have both. Initially the magnetic field will be very weak, but as the particle approaches the speed of light, the original radial electrostatic field will have flattened into a thin disc containing the concentric rings of a strong magnetic field, while the **E** field will have converted into a radial centrifugal pressure field pressing inwards all around the particle at right-angles to its direction of motion. The electric field and the magnetic field will have merged. If there is an already existing background magnetic field superimposed, this will result in a compound centrifugal force, or a Coriolis force, and the particle will be deflected at right-angles to the component of its motion that is at right-angles to the external magnetic field.

In the case of two parallel current carrying wires, if the current is travelling in the same direction in both wires, then in the region between the two wires, the combined magnetic field is parallel to the electric field that is contained within it. In the double helix electron-positron aether model, **[6]**, **[7]**, this is because the electrostatic attraction is channelled along the helix axis, which is the magnetic axis, and this electrostatic field pulls the two wires together. If the currents are flowing in opposite directions, the two magnetic fields are split, and they press against each other. This time the electric field is due to the centrifugal pressure in the equatorial plane of the rotating electron-positron dipoles, at right-angles to the magnetic field, and this centrifugal pressure pushes the two wires apart.

## Lorentz-Fitzgerald Contraction in Electric Currents

**VIII**. American physicist Edward Mills Purcell wrote a book in 1963 entitled ***"Electricity and Magnetism"*** **[21]**. When introducing the Lorentz transformations in relation to electric and magnetic fields, Purcell involved the concept of Lorentz-Fitzgerald contraction in relation to the source charge of the electrostatic field. However, the Lorentz-Fitzgerald contraction is actually supposed to be a consequence of the Lorentz transformations and not a source. Yet the application of the Lorentz-Fitzgerald contraction to electric current, as a source of charge density, seems to have progressed into the myth that the Maxwell-Lorentz force, $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$, as viewed in a stationary frame of reference is equivalent to an electrostatic force, $\mathbf{E_S} = -\nabla\psi$, as viewed in a moving frame of reference. This is a totally fictitious idea which muddies the waters, and it must be swiftly ruled out, since it is based on the relativistic gamma factor, truncated to first order binomial approximation, which plays no part in the core inter-relationships between electric and magnetic fields under Lorentz transformation. And there is also the issue that the Lorentz contraction is being applied selectively to either the positive particles or the negative particles in the conducting wire, hence creating the equivalent of the clock paradox, but this time for the case of length contraction.

## Conclusion

**IX**. Lorentz forms a connecting bridge between Maxwell and Einstein in the evolution of modern electromagnetism. While the original intention of the Lorentz transformations was to reconcile Maxwell's equations with the 1887 Michelson-Morley experiment and other experiments in optics, they are often seen as the foundation stone of Einstein's Special Theory of Relativity. However, whether or not they do actually resolve the issue of the Michelson-Morley experiment in favour of length contraction, to the exclusion of the aether entrainment hypothesis of Anglo-Irish physicist Sir George G. Stokes **[22]**, the arguments put forward in this article pull up the drawbridge on Einstein. The core inter-relationships between electric and magnetic fields under Lorentz transformation are rooted in Maxwell's three-dimensional aether hydrodynamics. They do not hinge on the Lorentz factor, $\gamma = 1/(\sqrt{1 - v^2/c^2})$, and hence they have no bearing on what would normally be considered to be relativistic effects. The convective aspect of electromagnetic induction in the form $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$ is closely linked with the Coriolis force whether it is derived hydrodynamically by Maxwell or whether it results from a Lorentz transformation. The Lorentz transformations induce a curl into the aether momentum field, **A**, followed by a vector cross product with the actual velocity, **v**, of a charged particle in motion through the curled aether. Lorentz need have had no worries about vortices forming high up at the interface of Stokes's entrained aether since vortices are actually the essence of the electromagnetic wave propagation mechanism in the first place, and they already exist everywhere.

In eliciting the Maxwell-Lorentz force, $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$, the Lorentz transformations act upon an electric field, **E**, which is a combination of the two components in Bernoulli's Principle. There is the electrostatic field, $\mathbf{E_S} = -\nabla\varphi$, which corresponds to hydrostatic aether pressure and which does not involve a current flow, which is why it plays no part in the Poynting vector, $\mathbf{S} = \mathbf{E_K}\times\mathbf{H}$ **[23]**. Then there is the electromagnetic force field, $\mathbf{E_K} = -\partial\mathbf{A}/\partial t$, which is induced by an already existing time-varying magnetic field, and which is associated with the energy flow in the Poynting vector. The Lorentz transformation produces the convective electromagnetic force, $\mathbf{E_L} = \mathbf{v}\times\mathbf{B}$, and the operation is very similar in principle to that which produces the Coriolis force when a radial position vector is differentiated twice in polar coordinates. So, since the gamma factor is not needed in this particular context, there is therefore no basis whatsoever to claim, as some relativists do, that a magnetic field is the relativistic component or manifestation of an electric field, since the operation can be easily observed at laboratory speeds. The claim that Maxwell's equations have been subsumed by Einstein's theories of relativity is patently false. The connection between Maxwell and Lorentz is through the aether, and when we remove the aether, as Einstein did, we remove the linkage between Maxwell and Einstein, leaving Einstein with no physical basis whatsoever to justify his theories. With Einstein's interpretation, we have no rest frame upon which to base the Lorentz transformations and we end up in an absurd universe where waves propagate in empty space, and where two clocks can both tick slower than each other. If we then lay down a direct bridge between Einstein and Maxwell, leaving Lorentz out of the picture, as is done in modern textbooks, then Maxwell's equations become a skeleton of their former selves, having been stripped of the aether hydrodynamics upon which they were founded. Einstein's removal of the aether was as devastating to electromagnetism as removing the atmosphere would be to the theories of sound and aerodynamics. If, however we retain the aether, then Maxwell's aether hydrodynamics, in conjunction with his sea of tiny molecular vortices, provides the physical mechanism and the standard of rest for the Lorentz aether theory [24].

The electromagnetic aether momentum, **A**, is Maxwell's displacement current, and it flows at the speed of light, c, in and around the tiny vortices of the luminiferous medium. Time dilation within the context of the Lorentz aether theory represents the slowing down of all physical processes when the aether pressure and the aether density increase, and the volume decreases. It does not have any impact on the measurement of time as based on the astronomical orbits relative to the background stars. Maxwell's sea of tiny aethereal vortices is a 4D space-time continuum, and when ponderable bodies move through it, then due to the Lorentz factor, their surrounding electric fields compress along their direction of motion. The radial electrostatic field surrounding a body at rest will flatten into a circular disc containing solenoidal magnetic field lines, concentric on the line of motion, as it accelerates towards the speed of light. This magnetic field which still contains the electrostatic field within its fine-grained structure.

The extent to which these time dilation and Lorentz-Fitzgerald contraction effects extend into the ponderable matter, that is the actual source of the electric and magnetic fields, was central to the original investigations in the 1890s, and the answer to this will largely lie with experiments. Meanwhile, all experimental results which are claimed for Einstein are in fact verifications of the Lorentz aether theory and of Maxwell's sea of molecular vortices. Maxwell's sea of molecular vortices possesses an elasticity related to the speed of light, and which maintains a conservation between time (electric current flow, **A**) and space (potential energy/pressure, $\psi$).

## Appendix A
**(Three-Dimensional Aether Hydrodynamics)**

The gradient of the scalar product of two vectors can be expanded by the standard vector identity,

$$\nabla(\mathbf{A}\cdot\mathbf{v}) = \mathbf{A}\times(\nabla\times\mathbf{v}) + \mathbf{v}\times(\nabla\times\mathbf{A}) + (\mathbf{A}\cdot\nabla)\mathbf{v} + (\mathbf{v}\cdot\nabla)\mathbf{A} \qquad \textbf{(35)}$$

Let us consider only the vector **A** to be a vector field. If **v** represents arbitrary particle motion, the first and the third terms on the right-hand side of equation **(35)** will vanish, and from the relationship $\nabla\times\mathbf{A} = \mathbf{B}$, we will obtain,

$$\nabla(\mathbf{A}\cdot\mathbf{v}) = \mathbf{v}\times\mathbf{B} + (\mathbf{v}\cdot\nabla)\mathbf{A} \qquad \textbf{(36)}$$

Hence,

$$(\mathbf{v}\cdot\nabla)\mathbf{A} = -\mathbf{v}\times\mathbf{B} + \nabla(\mathbf{A}\cdot\mathbf{v}) \qquad \textbf{(37)}$$

Since by the theorem of total derivatives,

$$d\mathbf{A}/dt = \partial\mathbf{A}/\partial t + (\mathbf{v}\cdot\nabla)\mathbf{A} \qquad \textbf{(38)}$$

it then follows that,

$$d\mathbf{A}/dt = \partial\mathbf{A}/\partial t - \mathbf{v}\times\mathbf{B} + \nabla(\mathbf{A}\cdot\mathbf{v}) \qquad \textbf{(39)}$$

Using the vector identity for the curl of a cross product in conjunction with the same reasoning as per the derivation of equation **(36)** above, we can safely conclude that,

$$\nabla\times(\mathbf{v}\times\mathbf{B}) = -(\mathbf{v}\cdot\nabla)\mathbf{B} \qquad \textbf{(40)}$$

Hence taking the curl of equation **(39)** leads to,

$$d\mathbf{B}/dt = \partial\mathbf{B}/\partial t + (\mathbf{v}\cdot\nabla)\mathbf{B} \qquad \textbf{(41)}$$

since the curl of a gradient is always zero, hence eliminating the $\nabla(\mathbf{A}\cdot\mathbf{v})$ term. Then with reference to equation **(40)**, if we take the curl of Maxwell's equation **(1)** at the beginning of the article, which is broadly the same as equation **(39)**, we obtain,

$$\nabla\times\mathbf{E} = \partial\mathbf{B}/\partial t + (\mathbf{v}\cdot\nabla)\mathbf{B} \qquad \textbf{(42)}$$

This time it was the electrostatic term that was eliminated by the fact that the curl of a gradient is always zero. From equation **(41)** this is equivalent to,

$$\nabla\times\mathbf{E} = d\mathbf{B}/dt \tag{43}$$

which when the negative sign is added to take account of Lenz's Law, is a complete total time derivative version of Faraday's Law covering for both convective and time-varying electromagnetic induction. Faraday's Law is therefore equivalent to Maxwell electromotive force equation, which is in turn equivalent to what is known today as the Lorentz Force.

## Appendix B

**(The Lorentz Transformations)**

In 1897, Ulster physicist Sir Joseph Larmor presented equations in a paper which was published in *Philosophical Transactions of the Royal Society* **[11]**. On page 229, Larmor wrote $x_1 = x\epsilon^{½}$, where the more familiar gamma factor, $\gamma$, appears in the form $\epsilon^{½}$. He probably meant to write, $x_1 = x'\epsilon^{½}$, where $x' = (x - vt)$. He also wrote $dt_1 = dt'\epsilon^{-½}$, where $t' = t - vx/c^2$. These equations approximate to what we know today as the Lorentz transformations. Then in the year 1900, on page 174 in his article entitled ***"Aether and Matter"*** **[12]**, Larmor transformed $x_1$, $y_1$, $z_1$, and $t_1$ into $\epsilon^{½}x'$, $y'$, $z'$, and $\epsilon^{-½}t' - (v/c^2)\,\epsilon^{½}x'$.

Whatever the finer details are, because they are not always very clear, Lorentz and Larmor were the two pioneers who first worked on the problem throughout the 1890s. They achieved what they believed to be justification for length contraction, but as regards their twin aim of finding a transformation that would make Maxwell's equations invariant, this wasn't possible until Henri Poincaré invented four-vectors in 1905. In that same year, Einstein re-derived the Lorentz transformations in the form below, which is unequivocally that which is used in modern textbooks,

$$x' = \gamma(x - vt) \tag{44}$$

$$y' = y \tag{45}$$

$$z' = z \tag{46}$$

$$t' = \gamma(t - vx/c^2) \tag{47}$$

# Appendix C
## (The Advent of Four-Vectors)

On page 907 of his 1905 Bern paper **[14]**, Einstein purported to subject Ampère’s Circuital Law and Faraday’s Law to a Lorentz transformation. He wrote these two curl equations out in a perfectly symmetrical format, using Gaussian units, which expose the speed of light, and he expanded them into their three Cartesian components, hence resulting in six equations in total. The primed versions were then displayed on pages 907-908 as seen below, with the solutions shown within the curved brackets. The deliberate gaps which Einstein left in the spacings have been highlighted in yellow,

$$1/c.\partial E_x/\partial t'\underline{\qquad\qquad} = \partial/\partial y'[\gamma(B_z - v/c.E_y)] - \partial/\partial z'[\gamma(B_y + v/c.E_z)]$$

$$1/c.\partial/\partial t'[\gamma(E_y - v/c.B_z)] = \partial B_x/\partial z'\underline{\qquad\qquad} - \partial/\partial x'[\gamma(B_z - v/c.E_y)]$$

$$1/c.\partial/\partial t'[\gamma(E_z + v/c.B_y)] = \partial/\partial x'[\gamma(B_y + v/c.E_z)] - \partial B_x/\partial y'\underline{\qquad\qquad}$$

$$1/c.\partial B_x/\partial t'\underline{\qquad\qquad} = \partial/\partial z'[\gamma(E_y - v/c.B_z)] - \partial/\partial y'[\gamma(E_z + v/c.B_y)]$$

$$1/c.\partial/\partial t'[\gamma(B_y + v/c.E_z)] = \partial/\partial x'[\gamma(E_z + v/c.B_y)] - \partial E_x/\partial z'\underline{\qquad\qquad}$$

$$1/c.\partial/\partial t'[\gamma(B_z - v/c.E_y)] = \partial E_x/\partial y'\underline{\qquad\qquad} - \partial/\partial x'[\gamma(E_y - v/c.B_z)]$$

This would not have been possible using the kinematical Lorentz transformations which he had derived on page 902. He would not have been able to introduce the beta factor, v/c, so symmetrically. The fact that he deliberately left spacings in the equations above hints at the fact that Einstein force fit what he believed the correct result should be, albeit that he was unable to attain this using 3D algebra.

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*"All space, according to the younger Bernoulli, is permeated by* ***a fluid aether, containing an immense number of excessively small whirlpools.*** *The elasticity which the aether appears to possess, and in virtue of which it is able to transmit vibrations, is really due to the presence of these whirlpools;* ***for, owing to centrifugal force, each whirlpool is continually striving to dilate, and so presses against the neighbouring whirlpools****."*

**[17]** O'Neill, John J., ***"PRODIGAL GENIUS, Biography of Nikola Tesla"***, Long Island, New York, 15th July 1944, quoting Tesla from his 1907 paper ***"Man's Greatest Achievement"*** which was published in 1930 in the Milwaukee Sentinel,
*"Long ago he (mankind) recognized that all perceptible matter comes from a primary substance, of a tenuity beyond conception and filling all space - the Akasha or luminiferous ether - which is acted upon by the life-giving Prana or creative force, calling into existence, in never ending cycles, all things and phenomena. The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance".*
http://www.rastko.rs/istorija/tesla/oniell-tesla.html
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In relation to the speed of light, *"The most probable surmise or guess at present is that* ***the ether is a perfectly incompressible continuous fluid, in a state of fine-grained vortex motion,*** *circulating with that same enormous speed. For it has been partly, though as yet incompletely, shown that such a vortex fluid would transmit waves of the same general nature as light waves— i.e., periodic disturbances across the line of propagation—and would transmit them at a rate of the same order of magnitude as the vortex or circulation speed"*

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