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THE FOUNDATIONS OF RELATIVITY

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Abstract

Maxwell's equations were, and still are, derived for a uniform stationary ether and are not, therefore, the general equations of electromagnetism. The true general equations, for an ether in general motion, have been derived and given in the literature for many years but are continually ignored. Here, a further attempt is made to bring home irrefutably the mathematics which negates the concepts of no-ether and non-Newtonian relativity. Alternative derivations of the general equations of electromagnetism are given in the simplest possible terms, from basic principles. It is shown that the mathematical techniques required are exactly the same as those which were used to derive the general equations of fluid motion, long before the advent of Maxwell's equations.

> *All these fifty years of conscious brooding have brought me no nearer to answer the question, 'What are light quanta?' Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken.*
>
> *Albert Einstein, 1951*

> *To agree with everything or to agree with nothing are two easy positions because each allows one to avoid making up one's own mind.*
>
> *Henri Poincaré (1854 - 1912)*

1 Introduction

Before Maxwell there was an ether. For Maxwell himself there was also an ether and, in deriving his electromagnetic equations, he regarded the ether, in a rest-frame inside a terrestrial laboratory, as stationary and uniform. He thus obtained the particular electromagnetic equations for a uniform stationary ether. This is the derivation still used today. His equations, however, were later interpreted as general equations, and this led to the discovery of the Lorentz transform and to the concepts of no-ether and non-Newtonian relativity which dominated theoretical physics throughout the 20^{th} century.

Maxwell's assumption and, therefore, his equations were supported by the observations of Michelson and Morley. This assumption, however, that the ether in the rest frame of a terrestrial laboratory is uniform and stationary, implies that this must be true generally for all observers near the surface of a large body like the Earth, wherever they are and however they are moving in the Universe. There are two possible explanations of how this may come about. One is to deny the existence of any ether at all, and this explanation was, to some extent, supported by the discovery of the Lorentz transform, which appeared to endorse the mistaken idea that Maxwell's equations could be general and invariant. This explanation is the one adopted at the end of the 19^{th} century which led to the concepts of no-ether and relativity. The other possible explanation is that the ether has viscosity like any other fluid. There must then be a viscous boundary layer surrounding any large body in the Universe that is moving relative to the local mainstream ether; and across this boundary layer the relative velocity between the ether and the body surface must tend to zero as the body surface is approached (cf Thornhill, 1996).

On the one hand, the denial of an ether is without physical reality since it is no more possible for electromagnetic waves to be fluctuations in a void than it is for sound waves to exist in the complete absence of air; nor can this situation be remedied by filling the void with massless "photons" and calling it "the vacuum", or by filling it with energy quanta $E = h\nu$, varying from zero to infinity, and calling it the "quantum vacuum". On the other hand, any possible ether must have Maxwellian statistics and conform to Planck's energy distribution, and the only medium known, at present, that satisfies these requirements is an ideal polytropic gas which, like any other gas, must have viscosity.

The nature and complete thermodynamics of this medium together with the general equations of electromagnetism for an ether in general motion, were first derived in the mid-1970's, and ultimately published in 1985 (Thornhill, 1985 a, b). Since then, these topics have been further developed and elaborated. It has been shown by the mathematical theory of characteristics (Thornhill, 1993) that the characteristic equations which determine the wave motions for Maxwell's equations are mathematically identical with those for the standard wave-equation, and these, in turn, have been shown to be the wave-motions for any and every uniform fluid at rest.Such wave-motions are not general, nor is the standard wave-equation general or invariant under Galilean transformation. It is indisputable, therefore, that to every electromagnetic wave-motion derived from Maxwell's equations there corresponds a mathematically identical fluid wave-motion in each and every uniform fluid at rest. There was, thus, no reason why Maxwell's equations should ever have been considered as general equations; nor, having made this mistake, was there any reason why it should have been compounded by appealing to a transformation as bizarre as the Lorentz transform to attempt to render Maxwell's equations invariant. Neither the Lorentz transform nor any other transform is capable of rendering Maxwell's equations invariant in the way that the Galilean transformation does this for all general equations. Ironically, the Lorentz transform was first discovered by Woldemar Voigt (1887) in an attempt to find a transformation which would render invariant not Maxwell's equations but the standard wave equation. Voigt thought that all electromagnetic wave-motions should satisfy the standard wave equation. If there were an alternative transformation which would render Maxwell's equations truly invariant, it would then be possible to treat and transform the *same* characteristic wave equations in different ways according as they were regarded, at any particular time, as being applied to sound waves or electromagnetic waves or considered purely as mathematical equations. This would be entirely in conflict with all concepts of mathematics (cf Thornhill, 1996). All these developments, however, continue to be completely ignored in the general literature, although they render the no-ether concept and non-Newtonian relativity completely untenable.

Here the general equations of electromagnetism are derived, from first principles, by alternative methods, so as to leave no doubt that they are mathematically sound. The mathematical approach is precisely that first used by Euler, before the advent of Maxwell's equations, to establish the general equations of fluid motion and was, therefore, available in Maxwell's time. On the other hand, the viscous boundary layer was only discovered by Ludwig Prandtl in 1904 (but generally accepted much later) so that the development of boundary layer theory and relativity were practically contemporaneous. It was, therefore, by no means understood in Maxwell's time, or for many years later, why the local ether in the rest-frame of a terrestrial laboratory is uniform and at rest.

2 The Eulerian General Equations of Electromagnetism

The standard mathematical derivation of Maxwell's equations from "laws" such as Faraday's "law" and Lenz's "law", inferred from laboratory observations, involves integrals taken around any circuit and over any area bounded by a circuit (see, for example, Bleaney and Bleaney, 1976). These are always taken to be finite circuits bounding finite areas, and the time-derivative is taken as $\partial/\partial t(x, y, z$ constant) i.e. the time-derivative at a *fixed position*, thus implying that the ether must be stationary so that the time-derivative $\partial/\partial t$ may always apply to the *same* circuit in the *same* volume of ether. Thus, Maxwell's equations are not general but apply only to a stationary and, therefore, uniform ether.

Exactly the same mathematics, however, can be applied, at any instant, to any elementary circuit bounding an elementary area, when the ether is in general motion, since the state of the ether may be considered uniform over an elementary volume. When the ether is in general motion, however, the time-derivative must always apply to the *same* elementary volume of ether which contains the circuit, i.e. it must be the time-derivative *moving with the ether*. The time-derivative moving with a fluid is well-known to be Euler's total time-derivative

$$\frac{D}{Dt} \equiv \frac{\partial}{\partial t} + u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y} + w\frac{\partial}{\partial z} \tag{2.1}$$

where (u, v, w) is the local velocity of the fluid. The notation D/Dt is thought to be due to Stokes. The simplest derivation of D/Dt, as given by Lamb (1879), is

$$\begin{aligned} \frac{DF}{Dt} &= \frac{[F\,(x + udt, y + vdt, z + wdt, t + dt) - F\,(x, y, z, t)]}{dt} \\ &= u\frac{\partial F}{\partial x} + v\frac{\partial F}{\partial y} + w\frac{\partial}{\partial z} + \frac{\partial F}{\partial t}\,. \end{aligned} \tag{2.2}$$

The Eulerian general equations of electromagnetism are then obtained from Maxwell's equations simply by replacing Maxwell's $\partial/\partial t$ by D/Dt and allowing the magnetic permeability, μ, the permittivity, ϵ, and the wave-speed $c = (\epsilon\mu)^{-\frac{1}{2}}$ to be functions of the local thermodynamic state of the ether. In Maxwell's equations ϵ, μ, and c must necessarily be constant since $u = v = w = 0$ implies a stationary uniform ether.

Precisely the same necessity for the time-derivative moving with the fluid occurs in the derivation of the Eulerian general equations of fluid motion. Sir Horace Lamb, in his classical treatise on Hydrodynamics, adopts the same method as used above in the derivation of these equations, namely to derive the equations, at any instant, for an element of fluid and then interpret them generally using the time-derivative moving with the fluid (Lamb, 1879). Although this method seems to have satisfied generations of fluid dynamicists, and is still used in more modern textbooks (cf Goldstein, 1938), it is apparently claimed not to be good enough for the purposes of relativity, so it is necessary to look for alternative methods of deriving the general equations of electromagnetism from basic principles.

3 The Lagrangian General Equations of Electromagnetism

In Lagrangian co-ordinates (ξ, η, ζ, τ), (ξ, η, ζ) denotes the initial position of a fluid element at time $\tau = 0$, so that the time-derivative $\partial/\partial t(\xi, \eta, \zeta$ constant) is the time derivative for a particular element of fluid i.e. the time-derivative moving with the fluid. The standard method of derivation of Maxwell's equations, applied to any elementary circuit, then gives very simply for the general electromagnetic equations, using suffixes for partial derivatives,

$$\begin{aligned} (\epsilon E_1)_x + (\epsilon E_2)_y + (\epsilon E_3)_z &= 0 \\ (\mu H_1)_x + (\mu H_2)_y + (\mu H_3)_z &= 0 \end{aligned} \tag{3.1}$$

$$\begin{aligned} (\epsilon E_1)_\tau &= (H_3)_y - (H_2)_z & \qquad (\mu H_1)_\tau &= (E_2)_z - (E_3)_y \\ (\epsilon E_2)_\tau &= (H_1)_z - (H_3)_x & \qquad (\mu H_2)_\tau &= (E_3)_x - (E_1)_z \\ (\epsilon E_3)_\tau &= (H_2)_x - (H_1)_y & \qquad (\mu H_3)_\tau &= (E_1)_y - (E_2)_x \end{aligned} \tag{3.2}$$

In these equations (E_1, E_2, E_3) is the electric field-strength, (H_1, H_2, H_3) is the magnetic field-strength and ϵ, μ, c are again functions of the local thermodynamic state of the ether (cf. Bleaney and Bleaney, 1976).

The differential relations between the two sets of coordinates are given by: -

$$
\begin{aligned}
dx &= d\xi + u d\tau \qquad & d\xi &= dx - u dt \\
dy &= d\eta + v d\tau \qquad & d\eta &= dy - v dt \\
dz &= d\zeta + w d\tau \qquad & d\zeta &= dz - w dt \\
dt &= d\tau \qquad & d\tau &= dt
\end{aligned}
\tag{3.3}
$$

Since, for any function F,

$$F_\tau = F_x x_\tau + F_y y_\tau + F_z z_\tau + F_t t_\tau \ ,$$

it follows that

$$\frac{\partial}{\partial \tau} \equiv u \frac{\partial}{\partial x} + v \frac{\partial}{\partial y} + w \frac{\partial}{\partial z} + \frac{\partial}{\partial t} \equiv \frac{D}{Dt}; \tag{3.4}$$

and similarly, since

$$F_\xi = F_x x_\xi + F_y y_\xi + F_z z_\xi + F_t t_\xi \ , \quad \text{etc.} \, ,$$

it follows that

$$\frac{\partial}{\partial \xi} \equiv \frac{\partial}{\partial x}, \quad \frac{\partial}{\partial \eta} \equiv \frac{\partial}{\partial y}, \quad \frac{\partial}{\partial \zeta} \equiv \frac{\partial}{\partial z} \, . \tag{3.5}$$

Thus, the Eulerian general electromagnetic equations are again derived as Maxwell's equations with $\partial/\partial t$ replaced by D/Dt and ϵ, μ, c variable; and in the Lagrangian general equations are simply Maxwell's equations in (ξ, η, ζ, τ) with ϵ, μ, c variable. The method of derivation used here is essentially that adopted by Courant and Friedrichs (1948) to derive the general equations of fluid motion.

These general equations are invariant under Galilean transformation as are all other general equations (Thornhill 1985b, 1993, 1996) and thus the necessity for the Lorentz transform, the assumption of no ether and the necessity for the electromagnetic wave-speed to be assumed universally constant are all completely unnecessary and physically unrealistic.

4 Further Considerations

The reason why Lorentz "invariance" gives so many correct results is because the viscosity of the ether ensures that the local ether moves with all observers (a consequence of the Prandtl boundary layer) and all observers who move with the local ether have the same unique local wave-hyperconoid (Thornhill, 1993) given by *the differential equation*,

$$\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2 = c^2 \tag{4.1}$$

This follows very simply, without any necessity for, or assistance from, the Lorentz transform, since the *general* wave-hyperconoid

$$\left(\frac{dx}{dt} - u\right)^2 + \left(\frac{dy}{dt} - v\right)^2 + \left(\frac{dz}{dt} - w\right)^2 = c^2 \tag{4.2}$$

is invariant under Galilean transformation (loc.cit) and, locally, for all observers, $u = v = w = 0$ in their rest-frames. thus the invariance of the relation (4.1) between all observers is entirely established by ethereal viscosity, Galilean transformation and Newtonian mechanics. It is not necessary to appeal to the no-ether concept, Lorentz invariance and relativity.

Newtonian mechanics is an *open* system. Observational disagreement can, therefore, at best, only discredit a particular physical model evaluated in the Newtonian system; it cannot discredit Newtonian mechanics completely. Relativity, on the other hand, is a *closed* system and one single observational disagreement is, consequently, sufficient to discredit it completely; such as, for instance, the observation, over the last 30 years or more, of superluminal motion outside the galaxy and, more recently, within the galaxy. Relativity has also failed, up to now, to provide any viable physical theory of the refraction of light in a moving refractive medium, but it has recently been shown that Newtonian mechanics is able to provide such a theory (Thornhill, 2001a).

The 'Big Bang' origin of the Universe and relativistic cosmology accept Hubble's empirical 'law' rather than provide its theoretical derivation, and they produce no raison d'être for, or *physical* theory of, gravitation. These objectives have now been accomplished by a Newtonian theory of ethereal cosmology which has a unique asymptotic form (Thornhill, 2001b). This cosmology also predicts that the universal expansion is continually accelerating and that the local speed of light is always continually declining everywhere in the Universe.

It would seem that the enunciated foundations of relativity are both mathematically and physically untenable. the time is now long overdue for this to be accepted, as the mathematics requires, or for it to be shown precisely what and where the error is in the basic mathematics. It has long been accepted that the primary duty of all scientists is to be continually examining and questioning the foundations of their subject.

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