THE DEATH OF THE LORENTZ TRANSFORMATION

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1. Introduction.

In this paper the Lorentz transformations are examined in four different ways: (1) from a mathematical standpoint; (2) for implied consequences derived out of them in relation to De Fresnel's aether drag formula; (3) for their predictions of certain astronomical events compared to the actual occurrence of the associated happenings; and again (4) in relation to the invariance of Maxwell's equations of electromagnetism.

The transformations are found wanting in all four counts. First, it is shown that they constitute a set of inconsistent mathematical equations. Next, now that it has been demonstrated [1] that due to a serious mistake of analysis made by Fizeau he was deceived in believing that the DeFresnel aether drag formula had been experimentally verified, while in actuality he had counterindicated that formula with his experimentation, inasmuch as the Lorentz transformations agree with the erroneous formulation, they are therefore also in error. Thirdly, we briefly review an earlier effort of our own in collaboration with T. E. Phipps, Jr. [2] in which it has already been demonstrated that when the transformations are applied to astronomy they lead to conclusions that are discordant with actual happenings. Finally, we comment on the work of others [3, 4, 5], who have shown that Maxwell's equations become classically invariant when the partial time derivatives $\partial/\partial t$ appearing in them are replaced with total time derivatives D/Dt. We point out that these partial derivatives actually represent a total derivative in the degenerate case when the reference frame follows the event; when it does not, then it is necessary for the indicated replacement to be made for correct mathematical description to ensue. Not to do so is a mathematical error. Thus, these equations have always been classically invariant and it has been only by confusion of understanding of the conditions under which they were stated that they have ever appeared otherwise.

2. Notations.

Throughout the first four sections of this paper we shall use the symbol S to designate an inertial coordinate frame in a single variable, x, (y, z suppressed) and S' will designate any other similar inertial reference frame with single variable, x', which is coaligned with S, the coordinate axes of both lying on each other: figure 1. The origins of coordinates, O, O', respectively, are chosen so as to be coincident at initial times $t = t_0$, $t' = t'_0$ and clocks are then set in both systems so that $t_0 = t_0' = 0$. At that instant coordinate scales are marked off in the usual way on both axes. However, contrary to the usual convention in doing this, for later mathematical convenience, the orientation of increasing x and x' is opposed, so that increasing positive x in S corresponds to decreasing negative x' in S'; and vice versa. That is to say, the coordinate axes are oppositely oriented. S and S' are set in relative motion which, to an observer at rest in S stationed at O, causes the point O' of S' to move at velocity v, to the right in the figure, in the direction of increasing +x, as indicated by

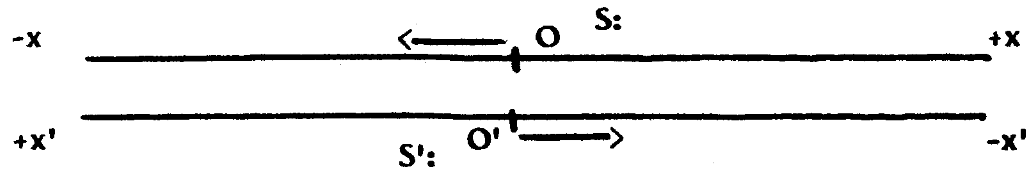

Figure 1.

the lower arrow. This same motion to an observer at O' in S', appears to cause the point O of S to move to the left at velocity v' in the direction of increasing +x', as indicated by the upper arrow. Primed symbols and functions are intended to apply to the observer's experience in S'; unprimed to the observer's in S.

To the observer in S at O, the position of O' is classically evaluated at time t according to his clock, by

$$d = v(t - t_0) = vt \tag{2.1 a}$$

while to the observer at O' in S', the position of O is similarly given as

$$d' = v'(t' - t_0') = v't' \tag{2.1 b}$$

Of course v' = v, but we presently choose to retain a notational distinction so as to make a significant point clear subsequently.

In later sections beginning with §5, we shall return to the usual convention in respect to the coorientation of S and S'.

3. The Mathematical Inconsistency of the Lorentz Transformations.

The Lorentz transform purports to relate the variables x and t of S to x' and t' of S' so that when O records an event in terms of x, t, he can compute O' 's parameters for its occurrence; and the inverse transformations permit O' to compute O 's parameters in terms of his own. The respective transformation equations are:

$$x' = (x - vt)/\surd(1 - v^2/c^2) \tag{3.1 a}$$

$$t' = (t - vx/c^2)/\surd(1 - v^2/c^2) \tag{3.1 b}$$

and

$$x = (x' - v't')/\surd(1 - v^2/c^2) \tag{3.2 a}$$

$$t = (t' - v'x'/c^2)/\surd(1 - v^2/c^2) \tag{3.2 b}$$

where c represents the velocity of light in vacuo. The reader may note the sign of v' in the inverse transformation (3.2) is negative rather than the positive sign that usually appears there; this is due to the convention of the previous section, of oppositely orienting the two coordinate systems. (Normally the axes are cooriented so that then (3.2) acquires a positive sign before v.)

The theory of relativity accepts the symmetry of distances, so that

$$\mathrm{dist}(O, O') = \mathrm{dist}(O', O) \tag{3.3}$$

at any time, t or t'. That is:

$$d = d(t) = d'(t') = d' \tag{3.4}$$

for all relativistically simultaneous events with t, t' related by (3.1, .2) and the positions of the specific points O' or O. For all t, t' we concentrate on the positions of these points only, replacing x, x' with d, d' in (3.1 b, .2 b) and then apply (3.4) to obtain the relations:

$$t' = (t - vd/c^2)/\sqrt{(1 - v^2/c^2)} \quad (3.5\text{ a})$$

$$t = (t' - v'd'/c^2)/\sqrt{(1 - v'^2/c^2)} \quad (3.5\text{ b})$$

$$= (t' - v'd/c^2)/\sqrt{(1 - v'^2/c^2)}.$$

A seemingly insignificant point has been overlooked by proponents of relativism that despite dropping the notion of absolute simultaneity and replacing it with the relativity of simultaneity, the two frames S, S' are not thereby totally dislinked from one another. A piece of information is carried between them: that is, the velocity between their relative apparent motions is the same to both observers, O and O'. This still carries time with it, despite the divorcement between the symbols t and t' which relativistic simultaneaity would seek to achieve. Thus,

$$v = v' \quad (3.6)$$

This is made quite apparent on considering the standard expressions for the Lorentz transformations in which the distinction between v and v' we preserved until now for emphasis of this point, is already dropped and both v and v' are simply denoted as v. We now apply (3.6) to (3.5) and obtain the relations:

$$t' = (t - vd/c^2)/\sqrt{(1 - v^2/c^2)} \quad (3.7\text{ a})$$

$$t = (t' - vd/c^2)/\sqrt{(1 - v^2/c^2)} \quad (3.7\text{ b})$$

We regroup these equations as two simultaneous linear equations in the variables t and t':

$$t - \sqrt{(1 - v^2/c^2)}t' = vd/c^2 \quad (3.8\text{ a})$$

$$-\sqrt{(1 - v^2/c^2)}t + t' = vd/c^2 \quad (3.8\text{ b})$$

The Jacobian of this system of equations is:

$$\Delta = \begin{vmatrix} 1 & -\sqrt{(1-v^2/c^2)} \\ -\sqrt{(1-v^2/c^2)} & 1 \end{vmatrix} = 1 - (1 - v^2/c^2) = v^2/c^2 \quad (3.9)$$

which vanishes if and only if $v = 0$, a case of no interest. Thus equations (3.8) have a unique solution easily seen to be when $t = t'$ or:

$$t' = t = \frac{vd}{c^2}\left(1 - \sqrt{(1-v^2/c^2)}\right)^{-1} \quad (3.10)$$

We now revert to (2.1 a, b) and solve these relations simultaneously as:

$$t' = t = d/v \quad (3.11)$$

On comparing (3.10) and (3.11) we see that the relations between t and t' are consistent between them, but their actual evaluations in terms of d and v are not. For if

$$\frac{d}{v} = \frac{vd/c^2}{1 - \sqrt{(1-v^2/c^2)}} \quad (3.12)$$

then

$$\frac{v^2}{c^2} = 1 - \sqrt{(1-v^2/c^2)} \quad (3.13)$$

which can occur if and only if $v = 0$ or $v = c$, cases of no interest again.

It is to be remarked that if (3.6) were not true, then v and v' would not have been related by equality and we could have gone no further than to write $t = d/v$ and $t' = d/v'$, the frames being then divorced from one another, as Lorentz and Einstein have thought they were. But this is not the case.

We have proven that (3.10) and (3.11) are inconsistent equations. By one ratiocination we are led to one of these relations; by another we are led to the second. In the setting of relativistic principle and the Lorentz transformations this is an undeniable conclusion, according to rather elementary algebraic manipulation. ¶

We could, for instance, by suitably picking v and d obtain from (3.10) and (3.11) the following simultaneous values for t:

$$\begin{cases} t = 6, & (3.14\ a) \\ t = 7. & (3.14\ b) \end{cases}$$

and then one may prove that t has any value one wishes to accord it. Would one wish t = 3? Then:

$$\begin{aligned} t &= (4 - 3)t = 4t - 3t \\ &= (4\times6 \mid \text{by } (3.14\ a)) - (3\times7 \mid \text{by } (3.14\ b)) = 24 - 21 \\ &= 3. \end{aligned} \tag{3.15}$$

Does one desire t = 0? Then:

$$t = (7 - 6)t = 7\times6 - 6\times7 = 0. \tag{3.16}$$

Inconsistent equations cannot be accepted mathematically as a reasonable conclusion from any analysis. Indeed, we say we have a contradiction whenever one arrives at the condition and the implication is then that a hypothesis is false. The hypothesis in this instance is the validity of the Lorentz transformations. Such equations are non-deterministic and one can arrive at any conclusion one wishes if one suitably uses them, as has just been illustrated above.

Rudakov has commented, in describing the relativistic system that it has *considerable conceptual elasticity*. One now realizes why. The degree of it is what may be said to be perfect elasticity; in fact, one can stretch it to any length one wishes. It is by this means, merely using an appropriate set of manipulations to accomplish the result, that the theory of relativity has been, seemingly, so successful in interpreting so many things.

None but fools ever attempt to use inconsistent mathematical equations. The extent of the folly can be measured by eighty years of it and a consequent mess in theoretical physics that it will take centuries to straighten out again, even if the ambiguities we have just demonstrated were generally recognized today and one endeavoured with all good will to start about doing it. Since that is quite unlikely, it will probably be a millennium before science can return to rationality. It is hardly to be believed that no one has bothered to critically examine the Lorentz-Einstein madness as it here appears in so evident and so elementary a form.

4. The Fizeau Experiment.

In a separate paper appearing in the same issue of this **Journal**, the hydrodynamics of the fluid flow involved in the Fizeau experiment has been determined for the first time, more than a century and a quarter after the experiment was performed, we add. The consequence of this analysis reveals that the conjecture made by Fizeau concerning the hydrodynamics of the water's flow in his tubes, namely, that it flowed at constant velocity throughout their length, was a false assumption on his part - an all too evident mistake, indeed, to anyone even slightly aware of hydrodynamical principles. This error is of paramount importance in relation to the Lorentz transforms, for the Lorentz transforms agree with the erroneous conclusion to which Fizeau was led, now proven to be flawed. A number, seven, in fact, of other fallacies of analysis are also involved in Fizeau's arguments and his paper [6] would be completely worthless, were it not for his having demonstrated that

¶. Author's Footnote: The reader who may have been following the **Fairytales of Physics** in the last issue and this, will be able to realize that the basis for the airplane flight to Houston made by the cuckoo clocks without gain or loss of time was in equations (3.8) which have been solved as one of the inconsistent pairs, to the exclusion of the other (2.1).

moving matter does convect light, according to some actual measurements made, which, however, we must remark, are uncorrelated to any positive awareness on his part of what the velocity was of that matter.

Only two valid inferences are consequent to the Fizeau experiment: (a) that light is convected by a moving medium; (b) that the conclusion he purported to have verified, is - quite to the contrary - not only unverified but has been experimentally demonstrated to be a fallacy. There is no room for doubt left in respect to (b), for the discrepancies between the flow rates presumed by Fizeau and what they actually were, are very large and negate unambiguously the conclusion, as false, that Fizeau was led to credit. This conclusion was that the aether was dragged according to a relationship proposed by Fizeau's friend, DeFresnel; i.e.:

$$V = \frac{c}{n} + (1 - n^{-2})v \ . \tag{4.1}$$

Here V is the velocity of light convected by a medium moving at velocity v, n is the refractive index of the medium and c is the velocity of light. We note that the reference point for the definition of all the velocities, V, c and v, was, and it still remains, the aether sea of the period, assumed to be at rest before DeFresnel made his postulate that it was dragged by matter moving through it. After DeFresnel introduced this postulate, the rest point for the aether was moved to somewhere out there, left undefined, but it was where the aether was not dragged by matter moving locally through it. If one presumes that the laboratory is in motion in the aether, at velocity α, say in the direction coincident with that of the ray of light, then to correct (4.1) one must replace it with:

$$(V - \alpha) = \frac{c - \alpha}{n} + (1 - n^{-2})(v - \alpha) \tag{4.2}$$

which reduces to:

$$V = \frac{c}{n} + (1 - n^{-2})v + [1 - \frac{1}{n} - (1 - n^{-2})]\alpha \tag{4.3}$$

The term in square brackets does not vanish when $n \neq 1$ and $\alpha \neq 0$, so that DeFresnel's relationship (4.1) is not classically invariant and would depend on what coordinate reference frame is used if the original aether frame is abandoned.

A half century or more after DeFresnel's time the fixed aether-sea-at-rest was abandoned and shown to be a false hypothesis by the M & M experiment (though some still dispute the outcome of that experiment, we realize). The formula (4.1) was then boldly transferred from the aether reference frame to which it was originally referred, to any old frame whatever, most particularly that of the laboratory in which an experiment such as Fizeau's was performed. Despite this the non-invariance, indicative enough in itself of the erroneous nature of (4.1), does not go away. If one moves from one laboratory to another that is comoving inertially with the first, (4.3) has to be taken into account, classically that is. Of course, it is not. A Fizeau experiment done in Paris, if repeated in Sydney, gives the same result in both places, although the velocity of Sydney is inertially very great in respect to Paris - much, much greater, in fact, than the velocity, v, of the water in Fizeau's water tubes - so that if (4.1) were correct, a different V would have to be observed in the two places, due to the $[1 - n^{-1} - (1-n^{-2})]\alpha$ term in (4.3); and this even for $v = 0$.

To get around all this while refusing to correct (4.1) properly, because it had crept into the unimpeachable reference books of pedantry, the Lorentz transform is invoked. The argument is interesting. Starting with the water at rest in the S-frame, it is stated that its velocity there is given by the formula

$$x = \frac{c}{n} t \tag{4.4}$$

which we note is one of the inconsistent equations and in that frame we recognize as the same as v = dx/dt = c/n or (3.11). Then one considers the S'-frame of the laboratory and transforms (4.4) by means of (3.2 a, b) to obtain:

$$x = \frac{x' - v't'}{\sqrt{(1 - v'^2/c^2)}} = \frac{c}{n}t = \frac{c}{n}\frac{(t' - v'x'/c^2)}{\sqrt{(1 - v'^2/c^2)}} \tag{4.5}$$

the second and the last terms being taken and then manipulated into:

$$x' = (\frac{c}{n} + v')t' \div (1 + \frac{v'}{nc}) \tag{4.6}$$

$$= \{ \frac{c}{n} - \frac{1/n^2 - 1}{1 + v'/nc} v' \} t'$$

which on putting v' = v according to (3.6) and terms to zero of order greater than one in v/c, i.e., putting v' = 0 in the denominator of the right-hand side of (4.6), leads to

$$x' \approx \{ \frac{c}{n} + (1 - n^{-2})v \} t' \tag{4.7}$$

which on differentiation gives DeFresnel's formula (4.1).

Now we note first that this all resulted from use of $x = (c/n)t$ in the S-frame, then an application of what has been chosen to be one of the inconsistent relations for changing from unprimed to primed variables, while suppressing and ignoring the other relation, thereby achieving a desired result. Had we used the other alternative instead, then

$$x' = [\frac{c}{n} + v] t' \qquad [4.8]$$

Indeed, if we went after it, starting out with

$$\tfrac{1}{2}x + \tfrac{1}{2}x = \frac{1}{2}\frac{c}{n} t + \frac{1}{2}\frac{c}{n} t \tag{4.9}$$

and applying the one inconsistent relation to the first half and the other to the second, there is little difficulty to come out with

$$x' = \frac{1}{2} \{ \frac{c}{n} + (1-n^{-2})v \} t' + \frac{1}{2} \{ \frac{c}{n} + v \} t' \tag{4.10}$$

or any other jolly conclusion one's happy little heart desires.

The argument repeated above to 'prove' DeFresnel's relation was given by Einstein and is repeated in every textbook that deals with the topic of Fizeau's experiment from a relativistic point of view. Thus, we see that the Lorentz transforms have predicted a result which we have shown now in [1] could not have been experimentally verified as Fizeau thought it was, due to his erroneous guess regarding what the velocity of flows were in his tubes. Thus the Lorentz transforms have predicted an erroneous result that does not accord with natural fact. They represent, therefore, a flawed hypothesis and consequently have no place in science.

5. Astronomical Counterevidence to the Lorentz Transformation.

In a paper [2] jointly with T. E. Phipps, Jr., this author has demonstrated that when the Lorentz transformations are applied to the light arriving at Earth from eclipsing binary stars, their predicted conclusions are not fulfilled. The argument is analogous to that of De Sitter that undid the emission theory of light, but in this case it is the moving observers who are involved rather than the moving sources of light as in his case. This paper has now appeared in three journals, including this one and has circulated widely through reprints since 1982 among mathematicians of stature without an objection having been found to it. We shall here only touch on its salient features as they relate to the topic in hand, referring the reader to any of the earlier publications of it for further elaboration of details.

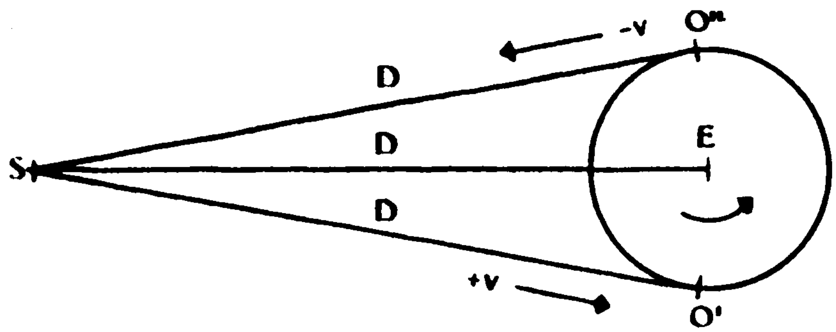

Figure 2.

Consider three observers, figure 2, O', O" and E and a source of light S. Four frames are considered with origins at each of these points, designated respectively as S: (x, t), E: (y, T), O': (x', t'), O": (x", t"). In the frame of S, O' is moving away at velocity +v, O" is approaching S at velocity -v, while E is at relative rest with S. In the frame-pairs S and E, S and O', S and O", the distances SE, SO', SO" are all equal to D at S-time τ. Initial S-time, t_0, is set when O' was coincident with S, and O' 's clock was also set to zero then, so that $t_0 = t_0' = 0$ and therefore

$$\tau = D/v \tag{5.1}$$

O" is progressing towards S and in their joint frames will arrive at S according to S's clock at time

$$\tau + D/v = 2\ D/v \tag{5.2}$$

O" 's clock is set so that its reading coincides with S 's clock when this event occurs. E, being at relative rest to S, records time so that T = t always.

Employing the usual convention in relation to the orientation of axes, rather than that of previous sections, the Lorentz transform relations between S and O' are:

$$x' = [x - vt]/\surd(1 - (v/c)^2) \tag{5.3}$$

$$t' = [t - (v/c^2)x]/\surd(1 - (v/c)^2)$$

while those between S and O" are

$$x'' = [x + v(t - t_c)]/\surd(1 - (v/c)^2) \tag{5.4}$$

$$(t'' - t_c'') = [(t - t_c) + (v/c^2)x]/\surd(1 - (v/c)^2)$$

where t_c'', t_c are the time of coincidence of O" and S when, by (5.2) $t_c'' = t_c = 2\ D/v$. Substituting this in (5.4) and reducing gives:

$$x'' = [x + v(t - 2D/v)]/\surd(1 - (v/c)^2) \tag{5.5}$$

$$t'' = \frac{2D}{v} + [(t - \frac{2D}{v}) + (v/c^2)x]/\surd(1 - (v/c)^2)$$

Suppose that three photons are simultaneously emitted from S, according to his clock, one of them going to E, one to O' and one to O". By the relativistic hypothesis, to all observers their velocity is c, so the time of flight is Δ = D/c. The instant of emission is taken to be τ - Δ = D/v - D/c, so that the photons arrive at present time, τ, according to observers S and E.

According to O' 's clock, however, the instant of arrival is, by the Lorentz transform (5.3)

$$t' = [\frac{D}{v} - \frac{vD}{c^2}]/\surd(1 - (v/c)^2) = \frac{D}{v}\surd(1 - (v/c)^2) \tag{5.6}$$

According to O" 's clock, the instant of arrival is given by (5.5) as:

$$t'' = \frac{2D}{v} + [\frac{D}{v} - \frac{2D}{v} + \frac{v}{c^2} D]/\sqrt{(1 - (v/c)^2)} \quad (5.7)$$

$$= \frac{2D}{v} - \frac{D}{v}\sqrt{(1 - (v/c)^2)} \quad .$$

We find consequently:

$$t'' - \tau = \tau - t' = \frac{D}{v} [1 - \sqrt{(1 - (v/c)^2)}] \approx \frac{\frac{1}{2}Dv}{c^2} \quad (5.8)$$

If now, instead of setting their clocks relativistically, the three observers set their clocks by E or S's time standard, then the arrival of O' 's photon would advance on the time τ by $\frac{1}{2}Dv/c^2$, while that seen by O" would lag after τ by $\frac{1}{2}$ Dv/c^2. There would be a total time discrepancy between O" 's sighting and O' 's of $t'' - t' = Dv/c^2$; according to standard time, although the events are relativistically simultaneous.

Two applications of this result to astronomy are to be considered. The two observers, in the first, are located on the Earth's equator, moving at equatorial velocities of $+v = 4.638 \times 10^4$ cm/sec, and $-v$, respectively. The event is the eclipsing of a binary star located at D = 250 pc = 7.72×10^{20} cm away. As is customary, the two observatory clocks are set synchronously by Earth's, or E, time. The time difference between the signal arriving at O' and O" is then found to be 11.05 hrs. The binary star Rigel is located approximately 250 pc from Earth.

In the second application, the observers are located at opposite sides of the Earth's orbit. The anomaly in time then amounts to 29.59 days.

It is hardly necessary to add that no such time anomalies and outphasing of the signal from the binary pair occurs, as De Sitter has already pointed out.

Thus, the Lorentz transformation fails on the experimental side as well, leading to a conclusion that is experimentally countered. It is false and discordant with nature.

6. Maxwell's Equations and the Lorentz Transform.

It has already been pointed out by others [3, 4, 5] that the partial differential equations currently accepted in the theory of electricity can be modified to become Galilean invariant, simply be replacing the partial time derivatives appearing in them by total time derivatives. It seems that Hertz [7] also had recognized this fact but having arrived at the result formally without an understanding of the basics behind Maxwell's derivations, he wondered what the suggested modification of them could mean physically. He failed in his unnatural interpretation of it. This conjecturing over meanings of mathematical consequences without going back to what the equations represent to begin with physically is to be deplored and is an hilarity in the long run. It still seems to be the vogue today. It is somewhat similar to the parlor game played at church socials: this is the answer, now find the question that fits it.

The author of [3] has postulated form invariance of all equations that are physically significant and he has discovered a means of operating on any that is not, so as to generate from it a related expression guaranteed to be an invariant. An application of his 'invariant recipe', as he is forthright enough to designate it, to Maxwell's equations converts them to his neo-Hertzian forms and one finds that the recipe is simply to replace $\partial/\partial t$ with D/Dt. The author of [4] has had enough mathematical insight to conjecture the same conclusion and then he verifies invariance. Finally, he inquires who might say that the Maxwell non-invariant form is any way superior to the form he exhibits. The author of [5] is not too explicit on what his ratiocinations are leading him to the same modification but he has it. It is evident that he is on the same track of invariant principle as is [3], that he recognizes the necessity for it, but no more than any of the other investigators does he demonstrate that the correction is an essential one.

We do not wish to enter upon the domain of endeavour of those who are good friends, taking from them any glory for such a significant scientific achievement as they have made. But we would wish to point out to them as we have tried to do tactfully in personal correspondence already, that the **sufficiency** of what they propose: i.e., to replace $\partial/\partial t$ with D/Dt, is inadequate to the purpose. The rational mind simply replies: So what? We remark that a dog also has four legs, which may be a fact quite equally an unrelated matter to Maxwell's equations as it is to replace one derivative with another. Also, because some animal has four legs does not make it a dog. Neither does form invariance of some expressions similar to the Maxwell equations make them pertinent to physics. The arguments of [3, 4, 5, 7] are quite unconvincing, therefore. Is what their authors have proposed of any real relevance? What must be demonstrated by them is the **necessity** of the substitution they propose; that it is an **essential** requirement; that it would be an **error of rationale** not to make it. This is so - all too evidently, in fact - and we have been trying for ever so long to have any one of the authors of [3, 4, 5] realize it, but have been about as unsuccessful in that as Cassandra. After all, no dissident other than number-one has any intelligence and therefore one need not bother to listen to what he might be saying, with even casual attention. It is difficult to forbear any longer patienly waiting for one of them to receive the dawning light of revelation; now we must go on here. We shall not directly apply what the following paragraphs have to indicate to Maxwell's equations, however, for the reasons indicated above. The first one of the group who grasps the significance of our points, applying them to these equations of electricity directly, receives the laurels striven for so hard and all but won by each of them already.

The necessity for the time derivatives to appear in the equations of electromagnetism is mathematically all but evident, once the sufficiency has been pointed out. It was that that was the difficult achievement, not this. In fact, total time derivatives are inherent in the equations already but are merely suppressed, having been replaced with the simpler partial derivatives, to which they degenerate under the conditions implied in how Maxwell set his equations up. This should be clear from a consideration of the following section.

6. The Physical Significance of the Total Derivative.

We devote this section to an exposition of the properties of a total derivative purely from an applied mathematical standpoint.

Total differentiation is frequently referred to as *differentiation following the flux* and this terminology is quite descriptive of it. Suppose we have some sample of something under study, such as matter, charge, a drop of dye in a moving stream of water, a cluster of massed particles to be treated as a moving unit in space, or the like, that is an identifiable unit and distinguishable from other material which may be of a similar nature around it, as is the dyed drop of H_2O from the rest of the water in the moving stream. To have a concrete example before us to consider, suppose the identifiable sample is some helium gas in a child's balloon, let loose in the air. We are interested in how the density of the gas alters with time as the balloon moves from place to place in the atmosphere, possibly blown about by the gusting of the wind. We are interested in this as a fuction of time.

The trajectory of this moving quantity of matter is referenced to an earth-based coordinate system so that its position at any given instant is known and given as:

$$x = x(t), \quad y = y(t), \quad z = z(t) \; . \tag{7.1}$$

Let us suppose that the density of the gas, ρ, is not only a function of its position in the coordinate system (for instance, its altitude above the Earth's surface) but depends on time independently of this as well (say, the rubber leaks some of the gas all the time). The density is then described mathematically as some function or another, thus:

$$\rho = \rho(x, y, z, t) = \rho(x(t), y(t), z(t), t) = \rho(t) \tag{7.2}$$

which is a function of t in its own right and also a function of t through x, y and z.

We note that if the coordinate system had been attached to the balloon, instead of being earth-bound as we supposed, then x, y and z would not appear directly in ρ, but ρ would be a function of time only, i.e., $\rho = \rho(t)$, formally the same as the rightmost member of (7.2) after x, y, z had already been eliminated out of it, replaced with the right-hand sides of (7.1). In this case the time rate of change of the density, $\rho = \rho(t)$, could be expressed as any of

$$\frac{D}{Dt} = \frac{d}{dt} = \frac{\partial}{\partial t} \tag{7.3}$$

since partial differentiation, ordinary differentiation and total differentiation are all the same thing when only one variable appears in a function; it is merely a matter of notation and d/dt is here preferred. There are intermediate cases between the two extremes: the balloon may have coordinates following its motion but one may be concerned with something going on spatially inside the balloon, such as the motion of the gas there as pressures alter, in which case another set of coordinates x, *y*, z can appear in the balloon's own system. In all problems involving differentiation following the flux it is absolutely essential to know what is a function of what and precisely what the variables represent. Thus it is essential to know how Maxwell set up his reference system and what are the implied conditions concerning it.

When the particular specialization with $\rho = \rho(t)$ is not the case and we return to the ground-based coordinate system, then we have the second expression of (7.2) together with (7.1). We ask the same question of how density varies with time through position that is also time dependent, that position altering the density. In this case, the total derivative is not a function of t alone; x, y, z must properly appear, and D/Dt must be used and not $\partial/\partial t$.

Now:

$$\frac{D\rho}{Dt} = \lim_{\Delta t \to 0} \frac{\rho(t+\Delta t) - \rho(t)}{\Delta t} = \lim_{\Delta t \to 0} \frac{\rho[x(t+\Delta t),y(t+\Delta t),z(t+\Delta t),t+\Delta t)] - \rho(x,y,z,t)}{\Delta t}$$

$$= \lim_{\Delta t \to 0} \frac{\rho[x(t+\Delta t),y(t+\Delta t),z(t+\Delta t),t+\Delta t] - \rho[x(t),y(t+\Delta t),z(t+\Delta t),t+\Delta t]}{\Delta t}$$

$$+ \lim_{\Delta t \to 0} \frac{\rho[x,y(t+\Delta t),z(t+\Delta t),t+\Delta t] - \rho[x,y(t),z(t+\Delta t),t+\Delta t]}{\Delta t}$$

$$+ \lim_{\Delta t \to 0} \frac{\rho[x,y,z(t+\Delta t),t+\Delta t] - \rho[x,y,z(t),t+\Delta t]}{\Delta t}$$

$$+ \lim_{\Delta \to 0} \frac{\rho[x,y,z,t+\Delta t] - \rho[x,y,z,t]}{\Delta t}$$

$$= \lim_{\substack{\Delta x \to 0 \\ \Delta t \to 0}} \left\{\frac{\rho[x+\Delta x,y(t+\Delta t),z(t+\Delta t),t+\Delta t] - \rho[x,y(t+\Delta t),z(t+\Delta t),t+\Delta t]}{\Delta x}\right\} \cdot \frac{\Delta x}{\Delta t}$$

$$+ \lim_{\substack{\Delta y \to 0 \\ \Delta t \to 0}} \left\{\frac{\rho[x,y+\Delta y,z(t+\Delta t),t+\Delta t] - \rho[x,y,z(t+\Delta t),t+\Delta t]}{\Delta y}\right\} \cdot \frac{\Delta y}{\Delta t}$$

$$+ \lim_{\substack{\Delta z \to 0 \\ \Delta t \to 0}} \left\{\frac{\rho[x,y,z+\Delta z,t+\Delta t] - \rho[x,y,z,t+\Delta t]}{\Delta z}\right\} \cdot \frac{\Delta z}{\Delta t}$$

$$+ \lim_{\Delta t \to 0} \left\{\frac{\rho[x,y,z,t+\Delta t] - \rho[x,y,z,t]}{\Delta t}\right\}$$

$$= \frac{\partial \rho}{\partial x} \cdot \frac{dx}{dt} + \frac{\partial \rho}{\partial y} \cdot \frac{dy}{dt} + \frac{\partial \rho}{\partial z} \cdot \frac{dz}{dt} + \frac{\partial \rho}{\partial t}$$

$$= \frac{\partial \rho}{\partial x} \cdot u + \frac{\partial \rho}{\partial y} \cdot v + \frac{\partial \rho}{\partial z} \cdot w + \frac{\partial \rho}{\partial t} \qquad (7.4)$$

where $u = dx/dt$, $v = dy/dt$, $w = dz/dt$ are the velocity components of the balloon derived from (7.1) Equation (7.4) is just the chain rule for differentiation but we notice it is here given a specific application in differentiation with the flux, or with the motion of the balloon. Again we see that if the coordinates were already in the balloon, then $u = v = w = 0$ and $D/Dt = \partial/\partial t$ as before; but we are careful to note that ρ would then be independent of x, y, z, since they are replaced with their equivalent functions of t already when the functional relationship for ρ in terms of t alone was set up in the frame of the moving balloon. Naturally, the function of ρ in terms of balloon coordinates is not the same expression as that for ρ in terms of ground-based coordinates, but the two must be the same after (7.1) has been substituted into the latter. Thus $\partial\rho/\partial t$ in $D/Dt = \partial/\partial t$ referenced to the balloon's system, is not the same thing as $\partial\rho/\partial t$ in (7.4), since the latter is referenced to the ground-based system.

Finally, if intermediate variables x, y, z were to appear in the balloon-based system, they have to be treated according to their meaning, depending on whether they are time dependent or only space dependent within the balloon's coordinate system. If they happen to have to be referred back to the ground-based system, as would ultimately be the case if one is going to consider invariance, one must understand what is involved, again depending on the meaning and significance physically of the symbols employed. One cannot just turn cranks mindlessly without an understanding of what one is about, as Hertz seemed to feel was possible. There was no need for him to run around wondering: "What have I got? What have I got?" like some chicken with its head cut off, just above the voice box. It is very clear that Maxwell was considering a coordinate system tied into the electrical event and associated with it, since nowhere do the variables u, v, w of the sample present themselves and therefore what we have called a ground-based system is not included in his set up. The spatial variables appearing in his equations are similar to the script variables x, y, z we have mentioned as the intermediate case, above, and they have to be handled according to sense. However, when invariance is to be discussed, the equations have to be set up according to an inertial system with the sample space referred to it, as was the balloon to our ground-based coordinates. Within that framework differentiation with respect to the flux occurs and the total time derivative simply must appear. There is no choice in the matter. The derivative is then a total derivative and anything else is mathematical error.

The author of [3] is correct in introducing what he has called a *detector volume* and following the electrical action in that moving volume. But this is nothing else than differentiation following the flux, moving with reference to some ground-based reference system. The whole thing hardly requires much sophistication of ideas for the total time derivatives are there already when the proper mathematical description of the physical system is made. The whole process may very rightfully be said to be well understood. Total time differentiation is inherent in the equations ab initio. Maxwell has merely simplified them, as any self-respecting mathematician would do, by selecting the reference system in the sample to begin with so that the added complication of u, v, w is done away with and $u = v = w = 0$; then D/Dt is reduced to $\partial/\partial t$. When this simplification is no longer pertinent, as it ceases to be when the sample is moving in the ground-based frame, then u, v, w re-enter the picture and the total time derivative has to be brought back. Otherwise the equations have no meaning and one may well run around wondering: "What have I got?" As a matter of fact one has nothing - deprived of all sense, too.

8. Summary.

It has been proven that the Lorentz transform relations lead to a set of inconsistent equations. It has been shown that their application to establish the DeFresnel equation for aether drag implies they are in error, since that relationship has now been shown never to have been proven by Fizeau to be physical, and, indeed, he actually showed experimentally that it is aphysical.

We have again reviewed an earlier result that the Lorentz transformations do not accord with astronomical events and the experimentally observed behaviour of light transmitted from eclipsing binary stars.

The last stronghold of their application to the electromagnetic equations has been assailed and taken by pointing out that the equations of Maxwell necessarily involve total time derivatives when they are expressed in a general reference frame which is unspecialized to the scene of the electrical action. The time derivatives appearing in those equations then do not reduce to the partial time derivatives, which are but a notational simplification for what are really total time derivatives in the special case when the reference frame is attached to the electrical event. It then appears as the consequence of the earlier work of others that Maxwell's equations are Galilean invariant and any need for the Lorentz transformations has vanished completely in respect to them.

Taken altogether, there is no domain left for an application of the transformations and there is no necessity to consider them. They lead, moreover, to manifest errors and are, mathematically, worthless nonsense.

We need scarcely add that without the Lorentz transformations, there is no theory of relativity.

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