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Lorentz Force Law checked by Lorentz transform and "correct" Lorentz transform

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There has a bodge to make the Lorentz transform have group properties. The analysis is now conducted on the Lorentz force law.

I am using information from David Bohm's book "The Special Theory of Relativity" [1] which gives the Lorentz force law (as per his numbering) [2] as:

$F = q(E_f + (v/c) X H_f)$ (21-4)

F = force
q = charge
E_f = electric field
v = velocity
c= speed of light in vacuum
H_f = magnetic field

Ideally F, E_f and H_f should be underlined to emphasise that they are vectors, but I shall forgo that.

1. Analysis of equation (21-4) by Lorentz transform

First I will analyse equation (21-4) by the standard Lorentz transform, which follows the method of Bohm; and later will analyse the equation (21-4) by "corrected" Lorentz transform.

So still going by Bohm [3]; noting that $v*(v X H_f) =0$ (by definition), we obtain the well-known Lorentz equations of motion for such a body:

$dp/dt = q(E_f +(v/c) X H_f)$ (21.5)

$dE/dt = q(E_f *v)$ (21-6)

p = momentum
E = energy

Bohm decides for his purposes that these can more conveniently be expressed in differential form with dx/dt =v,

$dp = q (E_f dt +(dx/c) X H_f)$ (21-7)

$dE = q(E_f * dx)$ (21-8)

when dx is the vector for the distance moved by the body in the time interval dt.

(this was for frame A)

Now investigating for B frame; the objective is to find out how the quantities E_f' and H_f', as observed in another frame B, must be related to E_f and H_f in order that the equations in frame B will have the same form, when expressed in terms of these variables.

$dp' = q (E_f' dt' + (dx'/c) X H_f')$ (21-9)

$dE' = q(E_f' * dx')$ (21-10)

Now we express dp' and dE' in terms of dp and dE by the Lorentz transformations (20-7) and (20-8) :

$E' = (E - (v * p))/(1 - v^2/c^2)^{1/2}$ (20-7)

$p' = p – (p * v_{unit})(v_{unit}) + ((p* v_{unit}) v_{unit} – vE/c^2)/sqrt(1 - v^2/ c^2)$ (20-8)

v_{unit} = unit vector in velocity v direction

and express dx' and dt' in terms of dx and dt by the similar transformation (15-12):

$x' = x – (v_{unit} *x) v_{unit} + ((v_{unit}*x) v_{unit} – vt)/ sqrt(1 - v^2/ c^2)$

$t' = (t – v*x/ c^2)/ sqrt(1 - v^2/ c^2)$

Bohm says in doing this we take the differentials of the corresponding equations noting that v and unit vector of v are constants. We obtain (with gamma = $1/sqrt(1 - v^2/ c^2)$) and we obtain:

$dp + (gamma - 1) (v_{unit} *dp) v_{unit} – gamma (v/ c^2) dE$

$= q\ gamma\ E_f'(dt –v*dx/c^2) +q/c(gamma -1)(v_{unit} *dx)(v_{unit} X H_f')$

$+(q/c)gamma\ dt(v X H_f')$ (21-11)

gamma(dE –vdp)

$= q E_f'*dx + q(gamma -1)(E_f' * v_{unit})(v_{unit} * dx)- gamma(E_f' * v)dt$ (21-12)

substitution of (21-7) and (21-8) for dE and dp yields

$dp + (gamma - 1)(v_{unit} *dp) v_{unit} – gamma\ v\ dE/ c^2$

$= q(E_f dt +(dx/c) X H_f) + q(gamma -1)(v_{unit} *dEdt + v_{unit} ((dx/c) x H_f)) v_{unit}$

$- (\text{gamma}/ c^2) v(E_f\ dx)$ (21-13)

$\text{gamma}(dE - V*dp) = q\ \text{gamma}(E_f\ *dx - (v* E_f)dt - (v/c)(dx\ X\ H_f)$ (21-14)

Equations (21-11) and (21-12) together yield [with $v*(dx\ X\ H_f) = - (v\ X\ H_f)*dx$]

$(E_f' + (\text{gamma}-1)(E_f' * v_{unit}) v_{unit} + \text{gamma}\ E_f + \text{gamma}((v/c)\ X\ H_f))*dx + \text{gamma}(E_f' - E_f)*v\ dt = 0$ (21-15)

Bohm tells us that the above equation must be true for arbitrary particle velocity v=dx/dt, hence it must hold independent of dx and dt. He leaves it for the reader to readily verify that this is possible only if the coefficients of dx and dt are separately zero, or if

$(E_f'\_- E_f)*v = 0$

$(E_f' - \text{gamma}\ E_f - (E_f' * v_{unit}) v_{unit} + \text{gamma}\ E_f + \text{gamma}((v/c) X\ H_f)) = 0$ (21-16)

He now tells us – it will now be convenient to express the field quantities E_f, H_f and E_f', H_f' in terms of components $E_{f\,1}$, $E_{f\,1}'$; $H_{f\,1}$, $H_{f\,1}'$ which are parallel to v and $E_{f\,2}$, $E_{f\,2}'$; $H_{f\,2}$, $H_{f\,2}'$, which are perpendicular to v. From $(E_f' - E_f)*v = 0$ it follows that $E_{f\,1}' = E_{f\,1}$. Since $E_{f\,1}' - (E_{f\,1}'*v)(v_{unit}) = 0$ and $E_{f\,2}'*v = 0$, it follows (using $E_{f\,1}'*v = E_f'\ v_{unit}$ and $E_{f\,1} = (E_{f\,1}'* v_{unit} (v_{unit}))$ that

$E_{f\,2}' = \text{gamma}(E_{f\,2} + (v/c)\ X\ H_{f\,2})$ (21-17)

Bohm then leaves it to the reader that going through a similar procedure with equations (21-11) and (21-13) the corresponding equations are obtained:

$H_{f\,1}' = H_{f\,1}$ (21-18)

$H_{f\,2}' = \text{gamma}(H_{f\,2} + (v/c) + E\_f2)$ (21-19)

The equations for E_f' and H_f' can be combined into the set

$E_f' = (E* v_{unit})(v_{unit}) + \text{gamma}\ [E_f - (v_{unit} *E) v_{unit} + (V/c)\ x\ H_f]$ (21-20)

$H_f' = (H_f * v_{unit})(v_{unit}) + \text{gamma}\ [H_f - (v_{unit} * H_f) v_{unit} - (v/c) x\ E\_f]$ (21-21)

The above equations define the transformation laws for E_f and H_f that will lead to the same equations of motion [(21-7) to (21-10)] for a charged particle, independent of the speed of the frame of reference.

Bohm tells us we should note that the transformation relationships (21-20) and (21-21) can also lead to an invariant form for Maxwell's equations, and refers us to C.C. Moller, The Theory of Relativity, and W. Panofsky and M. Phillips, Classical Electricity and Magnetism. Therefore, he tells us what has been achieved is the demonstration that the laws of electrodynamics (Maxwell's equations) and the laws of motion of a charged particle in an electromagnetic field can both be expressed in an invariant form (i.e. as the same set of relationships in all frames of reference connected by the Lorentz transformations).

2. Analysis of equation (21-4) by "corrected" Lorentz transform

We now just have to go through the same procedure as part 1 but for the "corrected" Lorentz transform [4].

We have same as before:

$F = q(E_f + (v/c) X H_f)$

$dp/dt = q(E_f +(v/c)X H_f)$ (21.5)

$dE/dt = q(E_f *v)$

Expressed in differential form with dx/dt =v,

$dp = q(E_f dt+(dx/c) X H_f)$

$dE = q(E_f *dx)$

when dx is the vector for the distance moved by the body in the time interval dt.

(this was for frame A)

Now investigating for B frame, we wish to find out how the quantities E_f' and H_f', as observed in another frame B, must be related to E_f and H_f in order that the equations in frame B will have the same form, when expressed in terms of these variables.

$dp' = q(E_f ' dt'+(dx'/c)X H_f ')$

$dE' = q(E_f ' *dx')$

Now the corrected equations of (20-7) and (20-8) without the relativistic factors become:

E' = (E-(v*p))

$p' = p – (p* v_{unit})(v_{unit}) +(p* v_{unit}) v_{unit} – vE/c^2)$

In doing this we take the differentials of the corresponding equations noting that v and unit vector of v are constants. We obtain

$dp + (1-1) (v_{unit} *dp) v_{unit} – v/c^2 dE =$

$q E_f ' (dt –v*dx/c^2) +(q/c)(1 -1)(v_{unit} *dx)(v_{unit} XH'\_f)$

$+(q/c)dt\,(v \times H_f')$ (21-11)

This reduces to:

$dp - v/c^2\,dE =$

$qE'\_f(dt - v*dx/c^2) + (q/c)dt(v \times H_f')$ (21-11a)

Next we have (21-12) without relativist factors corrected to:

$(dE - vdp) = q\,E_f'*dx + q(1-1)(E_f' * v_{unit})(v_{unit} *dx) - (E_f' *v)dt$

Which reduces to:

$(dE - vdp) = q\,E_f'*dx - (E_f' *v)dt$ (21-12a)

Substitution of (21-7) and (21-8) for dE and dp gives us:

$dp - v\,dE/c^2 = q(E_f\,dt + (dx/c) \times H_f) + v_{unit}((dx/c) \times H_f))\,v_{unit} - (1/c^2)v(E_f\,dx)$

$(dE - V*dp) = q(E_f\,*dx - (v*E_f)dt - (v/c)(dx \times H_f)$

Equations (21-11) and (21-12) corrected without the relativist factors together yield (with $v*(dx \times H_f) = -(v \times H_f)*dx$):

$E_f + ((v/c) \times H_f))*dx + (E_f' - E_f)*v\,dt = 0$

Having that equation true for arbitrary particle velocity v=dx/dt, means it must hold independent of dx and dt, and the condition for that is - the coefficients of dx and dt are separately zero, or if

$(E_f' - E_f)*v = 0$

$(E_f' - E_f - (E_f' * v_{unit})\,v_{unit} + E_f + ((v/c) \times H_f)) = 0$

Proceeding with the convenience of expressing the field quantities E_f, H_f and E_f', H_f' in terms of components E_{f1}, E_{f1}'; H_{f1}, H_{f1}'_ which are parallel to v and E_{f2}, E_{f2}'; H_{f2}, H_{f2}', which are perpendicular to v. From $(E_f' - E_f)*v = 0$ it follows that E_{f1}'_= E_{f1}. Since $E_{f1}' - (E_{f1}' * v_{unit})(v_{unit}) = 0$ and $E_{f2}' *v = 0$, it follows using $E_{f1}'* v = E_f'\,v_{unit}$ and $E_{f1} = (E_{f1}'* v_{unit}(v_{unit}))$ that:

E'_f2 = (E_f2+(v/c)xH_f2)

Then it is the same procedure for everything else of Bohm.

Conclusion

So "corrected" Lorentz transform works just as well as ordinary Lorentz transform in the Lorentz force equation and by inference in Maxwell's equations. And since the "corrected" Lorentz transform is part of Galileo relativity, the whole enterprise of proceeding along Special relativity in the context of Maxwell's theory has been a waste of time, because the pre-Einstein relativity of Galileo was still valid for Maxwell's theory.

So the issue is why is this not more realised. Well several people have noticed the problem such as Robert M Thorson (professor of geology at the University of Connecticut's College of Liberal Arts and Sciences) [5] who says:

"..main concern is that "many college-educated adults in the United States," including teachers, "fail to understand that science is a way of knowing completely different from mysticism, tradition and faith." Science is based on "evidence that can be logically and independently verified," rather than on personal authority."

"Most of the public accepted Einstein's 1915 theory of general relativity based on his authority, rather than on the evidence presented. Few teachers have worked their way through the logic, and fewer still have worked through the equations dominated by tensors and scalars. When teachers explain relativity to their students, they do so as if it were a revealed truth, in this case channelled to Earth by a super-smart scientist."

The influence on science/physics by Einstein is that many people have given up trying to understand science/physics and just take it as an article of faith that Einstein is a genius and must be correct even though they don't understand what he was talking about, so there is little point checking. That has changed science/physics into being more like a religion based on faith. If they had not given up on trying to understand, and started checking such equations as the Lorentz transformation, they would have found that such equations don't make any sense.

References

[1] The Special Theory of Relativity, David Bohm, Routledge, London, 1965, 1996, isbn 10:0-415-4

[2] ibid. p.123

[3] ibid. p. 123- 127

Note: Bohm has written both V and v for velocity, I will just write as v.

[4] see Summary: Corrected Galilean Transformation equations are the same as corrected Lorentz transformation equations, Roger J Anderton http://www.wbabin.net/science/anderton26.pdf

[5] Science Isn't Facts – It's Learning to Understand, Robert M Thorson, http://www.courant.com/news/opinion/op_ed/hc-thorson0326.artmar26,0,3136853.column