Maxwell's Equations: Evidence for Special Relativity??

Maxwell's electromagnetic field equations are almost universally regarded as confirming Einstein's Special Theory of Relativity (SR). Einstein himself describes in his biography how, as a teenager,an apparent contradiction with regard to light waves formed in accordance with those equations first set him on the path that eventually led to his Theory. A crucial aspect of light as portrayed by those same equations would appear to make Einstein's interpretation of the situation a foregone conclusion.

But is it – or is it more a case of ***jumping*** to conclusions than foregone conclusions?

Let's first consider the young Einstein's teenage musings. He describes himself flying alongside a photon of light at the same speed, looking at the wave structure of that photon as he and it travel side-by-side. Maxwell's equations describe how the variations in magnetic field give rise to the fluctuating electric field, and how those electric field variations in turn give rise to the varying magnetic field; in this way those electric and magnetic components together perpetuate that process, travelling through space at exactly the speed given by Maxwell's equations.

But, reasoned young Einstein, for one travelling at the same speed as that photon – an equally valid point of observation to any other – there would be no fluctuation; that wave would simply hang in the air, unmoving from that perspective. And if the electric field component was unmoving it wouldn't generate the magnetic component, since it's variation in the electric field that perpetuates the magnetic field element; likewise a static magnetic field component wouldn't give rise to continuation of the electric field component, for exactly the same reason. So the light wave would die and be no more – just because it was being watched by someone travelling alongside it.

A faultless analysis – except for one thing: we know that anything (or anyone) moving at speed is subject to a slowing of time-experience, referred to as *time dilation*; this effect has a well-documented cause, from the perspective of the static observer, that's quite independent of SR. At the point where an object or observer is actually travelling at the speed of light their time-experience slows to zero – so young Einstein, looking at that photon whilst travelling at the same speed, would see zero variation of electric and magnetic fields in zero time.

Zero fluctuation in zero time is ***not*** a zero rate of change, it's ***indeterminate*** (maths-speak for 'could be anything').

The standard way to fix a value in such situations is to see what happens as the observer's speed gets closer and closer to light speed – in technical terms, as $(c - v)$ tends to zero. This gives us a rather different result from Einstein's.

If we simply take the classical relative speed, this gives the speed of light relative to that observer as $c - v$. We then have to allow for time dilation, making that fast-moving observer's clock (and brain) run slower by a factor $\sqrt{(1 - v^2/c^2)}$; we also need to factor in the universally-agreed contraction of physical objects in the direction of motion (independently of SR), shortening our fast-moving observer's measuring tape and so making all distances seem longer by another factor of $1/\sqrt{(1 - v^2/c^2)}$. This leads to overestimate of the light's speed by a composite factor of $1/(1 - v^2/c^2)$. Multiplying this by that relative light speed of $c - v$ gives the perceived speed of light by that moving observer of $c/(1 + v/c)$.

As the observer's speed v approaches light speed c this approaches $c/2$. So even with a very simple analysis independent of SR we get a figure that's far from being zero as observer speed approaches c. A rather more detailed approach, taking account of effects of motion on particle structure, shows perceived light speed to be c for ***any*** observer speed.

<u>So what about Maxwell's equations being frame-independent?</u>

One key argument for Einstein's Theory is that Maxwell's equations contain no term defining the state of motion from within which they apply. In other words those same equations are equally applicable for experiments conducted in a static lab, in a high-speed aircraft or even in a spacecraft travelling at a million miles an hour – and it's those equations that define the speed of light. So an experiment to measure the speed of light should give exactly the same result in each of those situations – so the speed of light is obviously independent of the speed of the observer or measuring instrument.

This then begs the question: what ***would*** have caused a frame-dependent (*i.e.* speed-dependent) factor to be included in Maxwell's equations, even if one ***did*** apply? Those equations are a combination of: Faraday's Law; Gauss' Law; Gauss' Law for magnetism; and Ampere's Law extended by Maxwell to include polarization current – all derived from readings taken from electro-mechanical devices operating in laboratories.

Each of those laws was formulated by one or more physicists of the highest standing – but it's no reflection on those top researchers to suggest that they were probably ***not*** looking for near-infinitesimal variations in their readings (of the order of v/c at most) as the earth varied its orientation in the heavens. It's extremely unlikely that their instruments would have been of sufficient accuracy to even pick up such tiny variations.

We're left, then, with a set of equations derived from experiments to identify effects on magnetic field strength, electric current, inductance etc as physical conditions were varied; ***that variation does not appear to include conducting those experiments at relativistic speeds. So how can inferences regarding effects of high-speed motion on field strength, current, inductance etc possibly be drawn from those experiments?*** **They can't.**

But that's exactly what's being done when Maxwell's equations are cited as 'proof' of SR.

[NB: Effects of motion on particle structure lead to the result that the *apparent* speed of light as measured by an observer travelling at any speed ***will*** in fact register as full light speed c. This result is totally independent of SR.]