

Conflict in General Relativity

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There is conflict with those who set themselves up as experts on relativity over issues such as that of speed of light – some say it varies other than its constant in the context of general relativity. Such conflict can easily be seen on the Internet, and I pick two examples of such supposed expert opinion. It means of course that because of this conflict – for those who are supposed supporters of Einstein’s relativity, that not all supporters believe the same thing. In appendix I will deal with explanation as to why some relativity texts insist on saying light-speed (in vacuum) is constant contrary to the facts and deal with unification of forces.

A FAQ (Frequently asked questions) site that gives the appearance of being connected with NASA says that the speed of light is constant in connection with gravity.

The question asked was [1]: “Is light affected by gravity? If so, how can the speed of light be constant? Wouldn’t the light coming off of the Sun be slower than the light we make here? If not, why doesn’t light escape a black hole?”

Dr. Eric Christian answers that the speed of light is constant [1]: “Yes, light is affected by gravity, but not in its speed. General Relativity (our best guess as to how the Universe works) gives two effects of gravity on light. It can bend light (which includes effects such as gravitational lensing), and it can change the energy of light. But it changes the energy by shifting the frequency of the light (gravitational redshift) not by changing light speed. Gravity bends light by warping space so that what the light beam sees as “straight” is not straight to an outside observer. The speed of light is still constant.”

First, we note that he says “light-speed”, does not use anything like “light-speed in vacuum” or “light-speed in inertial frames” et al. This presents a problem, but for the sake of argument, let us accept the use of “light-speed”. We presume he means just “light-speed” in connection with gravity and no other factors. So, he is saying “light-speed” without gravity (and no other factors) is constant same as “light-speed” under the effects of gravity (with no other factors).

Whereas – Warren Davis, Ph.D., President, Davis Associates, Inc., Newton tells us that the speed of light is variable in connection with gravity. [2]

Warren Davis goes into a lot more details than Dr Eric Christian (which I will deal with anon).

Warren Davis would be a correction over Eric Christian, except he makes a few mistakes.

But the point is that we have these supposed experts in relativity on the Internet saying different things about relativity i.e. there is no consistency in the supposed experts.

Charles Poor - an early critic of Einstein's relativity noticed this [3] and said: "The followers of Einstein do not always agree among themselves as to the details of the theory and as to the meaning of certain principles and statements."

Charles Poor noted this in 1922 and things have not changed since then among the supposed experts.

If we look to the article "General covariance and the foundations of general relativity: eight decades of dispute" by John D Norton he says [4]: "In November 1915, Einstein completed his general theory of relativity. Almost eight decades later, we universally acclaim his discovery as one of the most sublime acts of human speculative thought."

However, he then goes on to point out "we" don't know what Einstein discovered [4]: "However, the question of precisely what Einstein discovered remains unanswered, for we have no consensus over the exact nature of the theory's foundations."

So that's 80 years of dispute and not knowing what Einstein really discovered, reason for why Charles Poor noted the followers of Einstein did not agree in 1922 and why today we find different supposed experts on Einstein's theories making different claims on the Internet – Einstein's general relativity (and special relativity) is not properly defined.

Eric Christian can be said to be wrong on several counts, one of the most significant is that he does not go into enough detail in his answers and so some might try to excuse his answer as an oversimplification.

The point then is - the oversimplification (if that is admitted) with the admission that a better more complicated answer is required– then the oversimplification has completely distorted the relativity and presented it falsely; thus, there are then some supposed experts that are presenting relativity falsely.

We can imagine a scenario where there are (1) Eric Christian followers who insist that speed of light is constant AND that what was said was not an oversimplification versus (2) Warren Davis followers. So once again highlighting that GR (general relativity) has not been clearly defined; it is ambiguous.

Anyway, from my position – Warren Davis account is nearer to the "truth" than Eric Christian's account; but still there are areas of mistake within the followers of Davis type version of GR.

Now to Warren Davis account in more detail [2]: “Contrary to intuition, the speed of light (properly defined) decreases as the black hole is approached. In fact, one way to understand the bending of light by the gravitational field of a star is to regard it as resulting from the refraction of the wave front due to the fact that the part of the wave front that is nearer to the star moves more slowly than the part farther away from the star. The result is that the direction of advance of the wave front is deflected toward (or around) the star.”

That is variable light-speed in other words, just taking it as light in vacuum affected by gravity.

Davis: “If the photon, the 'particle' of light, is thought of as behaving like a massive object, it would indeed be accelerated to higher speeds as it falls toward a black hole. However, the photon has no mass and so behaves in a manner that is not intuitively obvious.”

Now he's getting confused over the mass of light issue. By Newtonian physics for light bending under gravity we would be treating the light as having mass. But in special relativity the attempt is to say that light has zero rest mass which gets said as light is massless, and so tries to treat light as having no mass when extended to general relativity.

This mass issue of light is causing all sorts of problems, in paragraph before last had it that light-speed was variable by gravity, now with this latest paragraph is almost like trying to backtrack when says “behaves in a manner that is not intuitively obvious.”

So, let's consider the following [5]:

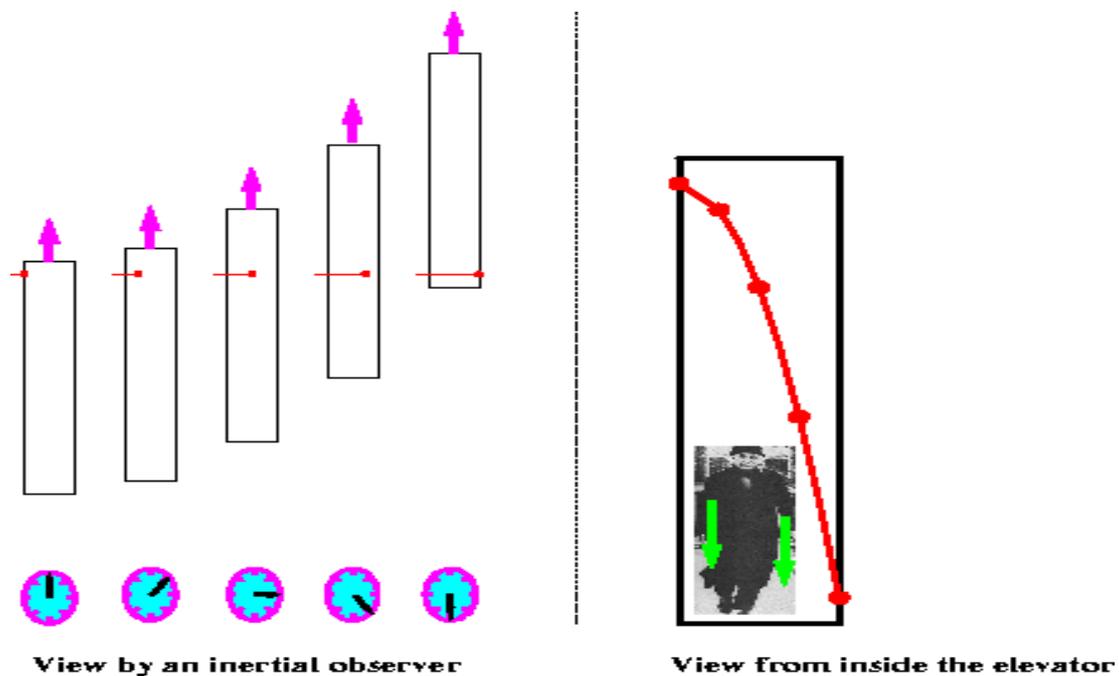


fig.1

Jose Wudka tells us this is [5]: “Sequence of events seen by an crane operator lifting an elevator at constant acceleration (the speed increases uniformly with time). The short horizontal line indicates a laser pulse which, at the initial time, enters through an opening on the left-hand side of the elevator. At the final time the light beam hits the back wall of the elevator. Right: same sequence of events seen by a passenger in an elevator being hoisted by a crane. The line joining the dots indicates the path of a laser which, at the initial time, enters through an opening on the left-hand side of the elevator. At the final time the light beam hits the back wall of the elevator.”

The path of the light from inside the elevator is curved downwards; this effect is same as if it was a ball or bullet used instead of light particle. i.e. light particle acts the same as any other particle in this regard, and by equivalence principle this same effect of bending if there is gravity. So, nothing to do with Davis confusion over light having no mass; light particle bends downwards by gravity same as any other particle; and if observing from frame where non-light particle accelerates down then so too would light particle.

After this hiccup, Warren Davis's next paragraph goes back to variable light-speed under gravity and says [2]: “The reason for the qualification 'properly defined' above is that the speed of light depends upon the vantage point (frame of reference) of the observer. When we say that the speed of light is decreased, we mean from the perspective of an observer fixed relative to the black hole and at an essentially infinite distance.”

In other words, he is saying there are some frames of reference where light-speed is variable.

Warren Davis continues [2]: “On the contrary, to an observer free falling into the black hole, the speed of light, measured locally, would be unaltered from the standard value of c . “

If we look back at Eric Christian was saying, then it could be looked upon that he should have stated he was talking about free falling frames only but omitted to do so by mistake.

However, a free-falling frame is one subject to acceleration. It is an accelerating frame i.e. non-inertial (non-constant velocity). So, the author Warren Davis is getting confused again; one moment accepts in non-inertial frames that light-speed is variable and the next says otherwise.

Warren Davis continues [2]: “Most of us have heard of the result from special relativity that the speed of light is the same for all observers in inertial frames. The result is not the same in general relativity. In general relativity, the statement becomes that the speed of light is the same (i.e., good old ' c ') for all observers in local inertial frames.”

What he has now done is revised the concept of the constancy of speed of light (in vacuum).

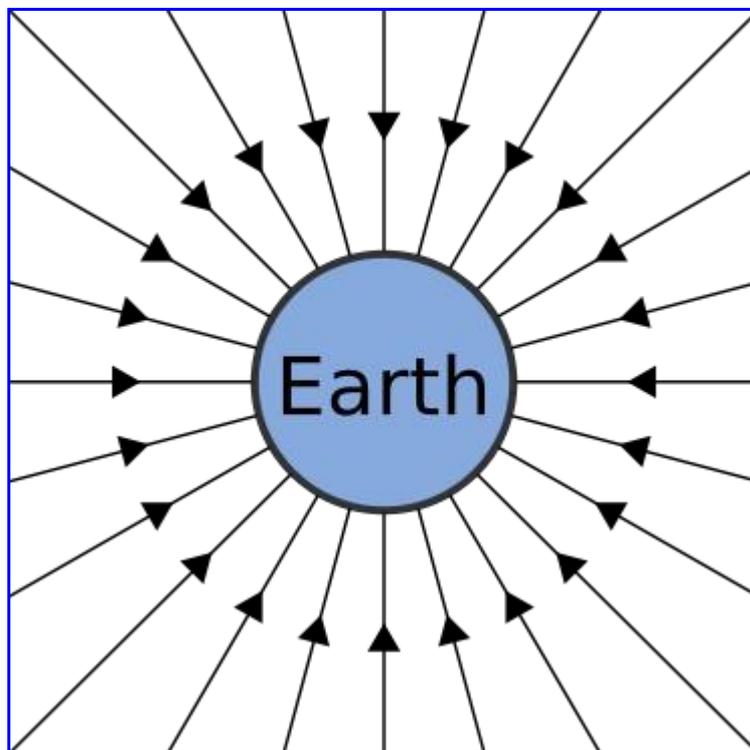
He wants the constancy of speed of light (in vacuum) to only apply to local inertial frames.

In this interpretation we then have special relativity dealing with constancy of light speed (in vacuum) in inertial frames but update to include non-inertial frames and the light speed (in vacuum) is no longer constant. Thus, the update from special to general relativity is to have light-speed (in vacuum) as variable.

Then what he means by “local” is that for a non-inertial frame, can treat as approximation it being inertial if its acceleration is so small can treat as negligible.

However, my investigations reveal this is not quite correct.

Considering the scenario of constant magnitude of acceleration, there is still a difference between uniform and non-uniform acceleration; between that of lines of acceleration all pointing in the same direction and acceleration lines pointing to a common centre as in example of following diagram:



from http://en.wikipedia.org/wiki/File:Gravity_field_lines.svg 29May2012 fig 2

If we are thinking in terms of changing from one inertial frame into another inertial frame, then what we are talking about is acceleration. Special relativity is set up to deal with inertial frame. It is then simple maths update to go further and deal with change from one inertial frame to another, then that is updating to dealing with acceleration, but it is acceleration acting on an object is all in one parallel direction. To have the update to deal with acceleration not parallel but instead acting like above diagram, the update was then made to general relativity.

So local inertial frames refer to when we can still use special relativity, and when people like Warren Davis have said that there has been a bit of confusion and incorrect use.

In my article on Andertonian relativity I explain that Einstein's relativity seeks to deal with scenario of light-speed constancy in inertial case, and then have variable time intervals (and length intervals) between observations, which Newtonian physics would treat as to keep those intervals the same but have light-speed variable. There is this a mathematical conversion from one way of dealing with it to the other.

So back to where we were:

When Eric Christian talked of light-speed it seems to be that what special relativity usually has as “the speed of light is the same for all observers in inertial frames” is to become for him changed to “speed of light is the same in local inertial frames”. So that light-speed is not constant in non-local non-inertial frames.

Anyway, it can be looked upon that Eric Christian and Davis demonstrate that they cannot agree on definition for constancy of light-speed.

Davis explains what “local” means: “Local inertial frames in general relativity are just those frames of reference in which the observer is in gravitational free fall.”

He is going wrong here. A freely falling frame is an accelerating frame i.e. it's not inertial, while he is calling it “inertial”. What he is probably trying to say and fail is that he is considering a non-inertial frame that can be treated approximately as an inertial frame because its acceleration is small, and so by “local” really means a noninertial frame that can be treated as approximately inertial frame because locally around small region of space-time its acceleration is small.

Davis continues: “A fancy way of looking at it is that the local frame of reference of a free falling observer corresponds to a small patch of flat spacetime tangent to the globally curved spacetime. As long as the observer confines measurements to a small enough local region, the approximation provided by the small tangent patch of flat spacetime can be made to be an arbitrarily good approximation to the true spacetime, which is actually curved in the main.”

That's just a complicated way of dealing with what I just said but now in language of GR. A curved spacetime in GR corresponds to a force in Newtonian paradigm, so dealing with acceleration when talks of that. And if a curved spacetime can treat as approximately flat and if treat as not changing inertial frames then that means treating the acceleration as negligible as approximation.

Davis: “The speed of light in flat spacetime is, of course, the usual value of c .”

So, he is treating lightspeed as constant in flat spacetime of SR.

I think it needs to be emphasised that in flat spacetime that acceleration can be dealt with if that acceleration is all acting in parallel. If it's not parallel, then its treated as curved as see last diagram. So, we have two types of acceleration and which

Newtonian physics would deem two types of force. Where confusion has reigned is many people have not realised that acceleration is possible in flat space time.

What needs to be emphasised in flat spacetime is the difference between flat spacetime when there is no change in inertial frame and the other scenario of when there is change of inertial frame.

Anyway, Davis in his confused way he has variable light-speed in curved spacetime of GR.

Davis: “For example, if one had a closed laboratory in orbit (i.e., in free fall) around the earth and one did an experiment inside that laboratory to measure the speed of light, one would get the usual published value of c . All such observers would get one and the same value for c .”

That is of course the approximation he has been talking about; curved spacetime being treated as approximately flat. Unfortunately, he has missed out the word “approximate”, because he is a bit confused. Really saying – in spacetime around earth where there is gravity –the spacetime is curved and that would give variable light-speed; but treating as approximation as flat spacetime AND treating as no change in inertial frame so treating light-speed as constant to approximation (and of course that is from perspective of assuming SR, which by Andertonian relativity that is optional.) - So, there is a lot of conditions missed out.

Davis: “If, however, the distance through which the light travelled in the course of measuring its speed was too great, the deviation of the reference frame from being 'flat' would become apparent. That is, gravitational effects would begin to become apparent. “

In other words, if gravity too strong or considering over a large enough region of curved spacetime then the approximation of treating it as flat starts to fail as it becomes more apparent that it's not really flat.

And I would have the last sentence as better said as: That is, gravitational effects of the type as per diagram lines of acceleration not parallel would begin to become apparent.

Davis: “So, it is absolutely true that the speed of light is not constant in a gravitational field [which, by the equivalence principle, applies as well to accelerating (no inertial) frames of reference]. “

Now he is stating light-speed variable in gravity, when he got a bit muddled earlier over the issue of light's mass.

Davis: “If this were not so, there would be no bending of light by the gravitational field of stars. One can do a simple Huyghens reconstruction of a wave front, taking into account the different speed of advance of the wave front at different distances

from the star (variation of speed of light), to derive the deflection of the light by the star.”

Davis: “Indeed, this is exactly how Einstein did the calculation in: 'On the Influence of Gravitation on the Propagation of Light,' Annalen der Physik, 35, 1911. “

He points out the 1911 paper was not the full development of GR:

Davis: “..which pre-dated the full formal development of general relativity by about four years. This paper is widely available in English. You can find a copy beginning on page 99 of the Dover book 'The Principle of Relativity.' You will find in section 3 of that paper, Einstein's derivation of the (variable) speed of light in a gravitational potential, eqn (3). The result is, $c' = c_0 (1 + V / c^2)$

where V is the gravitational potential relative to the point where the speed of light c_0 is measured. “

The constant speed of light which earlier was denoted by c is now being denoted c_0

There are problems with the 1911 maths because it looks to me that the use of c in the V / c^2 should also be c_0 but I will not enter into that.

He goes next to the supposedly full version of GR:

Davis: “You can find a more sophisticated result derived later by Einstein from the full general theory in the weak field approximation in the book: 'The Meaning of Relativity,' A. Einstein, Princeton University Press (1955). See pp. 92-93, eqn (107). This book is widely available, and should be in your university library. A nonmathematical discussion of this can be found in: 'The Riddle of Gravitation,' Peter G. Bergmann, Charles Scribner's Sons, NY (1987). See, in particular, pages 65-66 and, especially, the first full paragraph on page 66. Here, Bergmann takes the deflection of light by the gravitational field of a star as evidence of the decreased speed of light in a gravitational field. The speed of light is not constant in a gravitational field, but depends upon the reference frame of the observer. An observer anywhere in free fall will measure (locally) the traditional value of c.”

He is flipping over again with his use of c and c_0 so getting a bit muddled here, but essentially correct light-speed variable in gravity from a certain interpretation of GR dealing with frames

Davis: “An observer sufficiently far away from the source of the field will conclude likewise that the speed of light is c (locally). “ Again, with the c and c_0 issue.

Davis: “But, the observer far away from the source will likewise conclude that the speed of light closer in to the source decreases as the source is approached.”

No one mention of what type of observer – whether inertial or non-inertial, but the point is well taken that speed of light (in vacuum) is variable in general.

Conclusion

So, there is conflict between the supposed experts in relativity. One says it's constant, while another gets a bit muddled over saying its variable. Even trying to make allowances for their mistakes i.e. one expert might have meant that speed of light (in vacuum) is constant for inertial observers but forgot to say inertial observers, there is still fundamental mistakes that these experts have when trying to talk about Einstein's relativity. And the Internet is littered with various supposed experts on relativity all making their different mistakes.

When the critic of Einstein's relativity has tried to raise his objections, he finds himself met by a confused group of supposed experts in Einstein's relativity that are not providing a consistent and coherent account of what they are defending.

Appendix: Unification of forces

Some relativity texts insist on saying that the speed of light (in vacuum is a constant) and Xavier Borg gives an interesting perspective on this, he says [6]: “ Sometimes I find out that what's written in our textbooks is just a biased version taken from the original work, so after searching within the original text of the theory of GR by Einstein, I found this quote: *“In the second place our result shows that, according to the general theory of relativity, the law of the constancy of the velocity of light in vacuo, which constitutes one of the two fundamental assumptions in the special theory of relativity and to which we have already frequently referred, cannot claim any unlimited validity. A curvature of rays of light can only take place when the velocity of propagation of light varies with position. Now we might think that as a consequence of this, the special theory of relativity and with it the whole theory of relativity would be laid in the dust. But in reality this is not the case. We can only conclude that the special theory of relativity cannot claim an unlimited domain of validity ; its results hold only so long as we are able to disregard the influences of gravitational fields on the phenomena (e.g. of light).”* - Albert Einstein (1879-1955) - *The General Theory of Relativity: Chapter 22 - A Few Inferences from the General Principle of Relativity-*”

“Today we find that since the Special Theory of Relativity unfortunately became part of the so called mainstream science, it is considered a sacrilege to even suggest that the speed of light be anything other than a constant. This is somewhat surprising since even Einstein himself suggested in a paper "On the Influence of Gravitation on the Propagation of Light," *Annalen der Physik*, 35, 1911, that the speed of light might vary with the gravitational potential.”

So, some believers in Einstein's relativity will insist on speed of light (in vacuum) as constant even though this is contrary to Einstein's relativity for the reason Xavier gives; it shows how corrupted Einstein's relativity has become.

Xavier Borg goes on to say: “Indeed, the variation of the speed of light in a vacuum or space is explicitly shown in Einstein's calculation for the angle at which light should bend upon the influence of gravity. One can find his calculation in his paper. The result is $c' = c (1 + V / c^2)$ where V is the gravitational potential relative to the point

where the measurement is taken. $1 + V / c^2$ is also known as the gravitational redshift factor.”

It is interesting to note that this equation $c' = c (1 + V / c^2)$ does not have errors of the equation by Warren Davis that were mentioned in the main part of my article above.

Xavier Borg continues: “The speed of light is **not constant** in a gravitational field, but depends upon the reference frame of the observer. An observer anywhere in free fall or sufficiently close to the gravitational field will conclude that the speed of light is the well known c . But, the observer far away from the source, will conclude that the speed of light decreases with proximity to the massive body. So, in general relativity, the speed of light is the same value ' c ' for all observers in local inertial frames, but not the same when the observer is outside the inertial frame. This effect is one of the variants of Mach's principle, according to which inertial properties of particles depend on the gravitational action of the surrounding masses. Unfortunately, Einstein lost (actually he said he could not find it!) this concept later on in his special relativity version, which was aimed to unify gravity with the other forces, an aim which Einstein sadly admitted he couldn't succeed at with SR.”

The problem with the forces was dealt with in the main built of my article. SR can actually deal with acceleration, by update of considering changing inertial frames, so that it is dealing with force in this context. It is how it deals with the Lorentz force of Maxwell's electromagnetic theory as a force in flat spacetime. If we want to deal with acceleration lines as per fig 2 above, then Newtonian physics has that as like another force. In the general relativity context that second type of force is being treated like a curvature of spacetime. Thus, we have unification of forces.

(Xavier Borg then wants to go on to deal with his pet theory, something he calls EMRP theory.)

References

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Typo corrections: 10 Oct 2018