Popular Arguments for Einstein's Special Theory of Relativity[1]

Patrick Mackenzie
University of Saskatchewan

Introduction

In this paper I shall argue in Section II that two of the standard arguments that have been put forth in support of Einstein's Special Theory of Relativity do not support that theory and are quite compatible with what might be called an updated and perhaps even an enlightened Newtonian view of the Universe. This view will be presented in Section I. I shall call it the neo-Newtonian Theory, though I hasten to add there are a number of things in it that Newton would not accept, though perhaps Galileo might have. Now there may be other arguments and/or pieces of empirical evidence which support the Special Theory of Relativity and cast doubt upon the neo-Newtonian view. Nevertheless, the two that I am going to examine are usually considered important. It might also be claimed that the two arguments that I am going to examine have only heuristic value. Perhaps this is so but they are usually put forward as supporting the Special Theory and refuting the neo-Newtonian Theory. Again I must stress that it is not my aim to cast any doubt on the Special Theory of Relativity nor on Einstein. His Special Theory and his General Theory stand at the zenith of human achievement. My only aim is to cast doubt on the assumption that the two arguments I examine support the Special Theory.

Section I

Let us begin by outlining the neo-Newtonian Theory. According to it the following tenets are true:

1. If there were only one physical body in existence — say the planet Earth — it would not make sense to say either that it was moving or at rest.[2] The reason this is so is that when a body is said to be moving at a constant speed, it is always implied that the body is moving relative to some other body. Similarly, if a body is said to be at rest it is always implied that the body is at rest relative to some other body. It might be noted that from the claim that a body at rest will remain at rest until acted upon by an external force it follows that a body in motion at a constant speed will remain in motion at that speed until acted upon by an external force. This point is present in Galileo's Law of Inertia.
This tenet would hold even if the Universe were filled with an all pervasive ether. If this were so we could say that Earth was moving relative to the ether or the ether was moving

[1] Editorial note: This is a paper that Patrick Mackenzie had been working on in the year before his death in January 2006. I was unsuccessful in getting it published "as is", so I have posted it here with the addition of Appendix IV, consisting of anonymous comments by a referee. Taken together, the paper plus comments can still serve a pedagogical purpose despite the paper's ostensible flaws. – Karl Pfeifer

[2] One could talk here about inertial frames of reference but I'd rather stick with physical objects. The danger with talk about frames of reference is that it suggests that there could be a frame of reference that was not composed of physical objects--say ethereal fixed stars.

relative to Earth, but if there were only the ether it would not strictly speaking make sense to say that it was moving or at rest.

2. If there were only two objects in the universe, (and no ether) say Earth and Mars, then if the two were getting closer at a constant rate and in a straight line one could say that Earth was moving relative to Mars or that Mars was moving relative to Earth.

3. If our universe consisted of three objects say the Earth and two objects on the surface of Earth say a train and a man on the train, then the speed of the man relative to the earth is a consequence of the speed of the man relative to the train and the speed of the train relative to the earth. So for example if the train is moving westward at 50 mph (relative to the earth) and the man is walking westward on the train at 3 mph (relative to the train) then the man walks at 53 mph relative to the earth. Furthermore if the Engineer on this train fires a bullet in a westward direction then the speed of the bullet, given that there is no atmosphere, relative to the earth will be the speed of the train (relative to the earth) plus the speed of the bullet (relative to the train). Finally if you are well in front of the train on the ground and fired a bullet at the train then the speed of the bullet relative to the train will be the speed of the train relative to the ground plus the speed of the bullet relative to the ground.

4. Given that we can only talk about the constant speed of something relative to something else it would seem that this would also be true of both sound and light. Let us examine sound first. You strike a log with an axe and sound travels by wave motion through the air at 730 mph at NAP relative to the air. Thus if I am a mile away then I will hear the sound 4.93 seconds later. If you were to strike the log on the flat deck of a railway car moving towards me and I were the same distance away then I would hear the sound after the same lapse of time (4.93 seconds). The motion of the railway car would not give an impetus to the striking of the log because the speed of the sound wave is relative to the air and to nothing else. However, if you were to strike a stationary log while I was moving towards you, then even though I was a mile away when you struck the log, the sound wave would reach me in *less* than 4.93 seconds. The reason that this is so is that since I am traveling towards you the sound has less distance to travel.

Let us now move on to light. We are told that either light travels by a wave motion or by the motion of tiny particles called photons. Let us assume first of all that it travels by wave motion in a mysterious substance called ether. Here it would seem that just as in the case of sound, the amount of time that a pulse of light would take to reach me from a source would not be dependent upon the speed of the source because its speed would be relative to the ether and to nothing else. However if the ether were stationary relative to the earth and I were to move towards the source of the light then the light would get to me in less time. The light takes some time to travel from its source to where I was when the pulse was sent. But during that time I would have moved towards the source of light and so it has less distance to travel and so takes less time; even though its speed relative to the ether is fixed.

Now as we all know the ether hypothesis has fallen into disrepute. Since this is the case it would seem that light cannot travel in empty space by wave motion, for in order for there to be waves there has to be something for there to be waves in a medium. Let us assume that light travels by means of something like little particles. These we shall call ‘photons’. When a light source sends out a pulse of light that light (photons) travels relative to that source at 186,300 miles per second. If we look at light in this manner it would seem at least at first blush that the amount of time it would take a pulse of light to travel from A to B is dependent on the distance between A and B when the light pulse was sent and upon the speed of A relative to B or B relative to A.

5. Let us now move on to what the neo-Newtonian theory has to say about time and space. I shall deal first with time. It is often said that Newtonians held that time was absolute. Although this is not very clear, an interpretation can be given which is fairly clear and is also I think, correct. It is as follows: Although it makes sense to say of processes that take some time, (for example making a cup of coffee) that they might have happened more quickly or more slowly, it does not make sense to say of time itself might have passed more quickly or more slowly. We can imagine a lump of sugar that dissolves in water in three seconds dissolving in two seconds or in four seconds, and we can imagine the minute hand of a watch that sweeps the dial in one hour sweeping it in less time or in more, but we cannot imagine the time it takes a sugar lump to dissolve taking less time or more time, nor can we imagine the time it takes a minute hand to sweep or dial taking less time or more time.

In other words, it does not make sense to say that the time it took the sugar lump to dissolve could have taken less or more time. Nor does it make sense to say that the time it took the minute hand to sweep the dial could have taken less or more time.

Of course it sometimes seems as though time passes more quickly or more slowly. Sometimes it hangs heavily and sometimes it flies. But what we mean when we say, for example, that time dragged during a lecture is something like ‘We thought he had been droning on for two hours but we were surprised to find that he had only been talking for one.’ We never mean that time itself takes less time because that would mean that an hour for example took less than an hour, and that would be absurd.

Let us now move on to space. Space has always been a problem for Newtonians and non-Newtonians alike. Newton as well as thinking that space was God’s Sensorium was inclined to think of the space of the universe as something akin to the space in a large room. The difficulty with this idea is that the space of the universe is not enclosed by anything that is comparable to a floor, walls and a ceiling. Although Newton can be criticized for thinking so, I think he was on the right track. One way that we might come to have an idea of empty space is as follows. Suppose we have three cubes side by side and we take the middle one away without allowing anything to take its place. The empty place left by the middle cube would provide us with our idea of empty space. Once we have arrived at the idea of empty space in this manner we can project it beyond the physical objects that there are. What we would mean when we say that there is empty space beyond these objects is that there could be objects beyond them with space in between.

There is, however, a difficulty with this way of thinking of space for it makes it look like it is a something whereas we would want to think of it as not being a something (but without it being a nothing either!) A different way in which we might come to have an idea of space is as follows. This way would avoid this problem. I take two points that are contiguous with one another and then move them apart without letting anything come between them. I cannot say that there is space between them because points areone-dimensional, but I can say that there is empty distance between them. Now suppose that instead of moving two points apart I move my hands apart. Can we not say here that the space between my two hands is the three-dimensional distance between them? In other words what I mean when I say that there is empty space between two objects is that there is a three-dimensional distance between two objects and its not the case that there is anything between those two objects. If we think of space as a three-dimensional distance, we can think of it as not being a something without thinking of it as a nothing either. Once we have come to the idea of space in this manner we can project it beyond all objects. We can say that there is (empty) space beyond all objects because there could be more objects with a three-dimensional distance between them and the objects that there actually are.

This is a better way of looking at space than the previous, because when I said we had three cubes and the middle one was removed leaving a space at least the size of either cube I was suggesting that the cubes were at rest. But since the cubes could also be considered in motion I can hardly talk about the space (at least not the place!) that the middle cube had occupied. But what I can still talk about is the empty three-dimensional *distance* between the two cubes.

6. Although, as we have seen, constant motion and rest are relative, the same cannot be said about inconstant motion. If I were the only thing in existence I would certainly know when a change in speed was taking or not taking place. (I shall call this 'change in my velocity status').[3] When I accelerate in a car relative to the road and there is no change in the velocity status of the road then I know that I am accelerating, for I feel myself being pushed into the back of the car seat. In the same way if I were accelerating in empty space I would experience, amongst other things, my arms being pushed backwards.

It is interesting to note that although I can claim absolutely that my velocity status is changing, I cannot say that I am accelerating in one direction and not decelerating in the opposite. I can say that I am accelerating relative to the road but I could also say that I am decelerating relative to some other car. We have this experience when the accelerating car that we are in is passed by a car that is going at a constant speed in the same direction but faster than we are. When we have accelerated to the speed of the other car it could be said that we were going backwards relative to the other car and have decelerated to the point where we are at rest relative to the other car. Life can be confusing on the Freeway!

Since circular motion is to be analyzed into acceleration in one direction relative to one object and deceleration in another direction relative to the same object, perhaps similar points can be made about circular motion. I shall not however pursue this topic here.

We may conclude from this that although constant velocity is relative, change in velocity status is in some sense absolute.

Section II

The Arguments for Relativity

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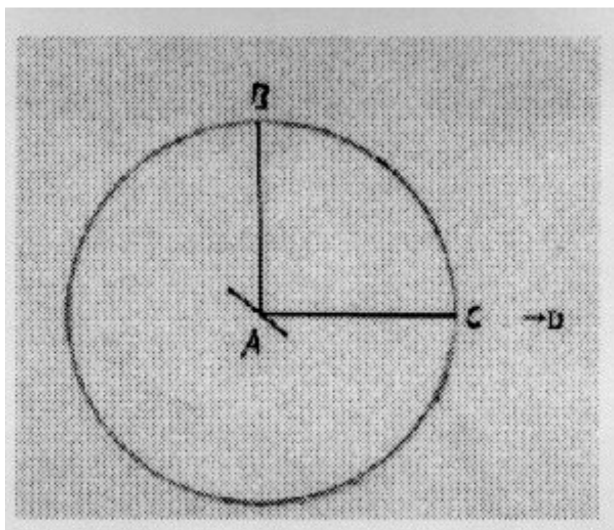
[3] It might be noted in passing that it was the absoluteness of acceleration and deceleration that led Newton to postulate absolute space. (See his discussion of the spinning bucket of water on page 22 in *Newton's Philosophy of Nature*, edited by H.S. Thayer and published by Hafner Publishing, New York in 1953.)

Let us now move on to examine the two standard arguments that have been used by expositors in support of the Special Theory of Relativity. The first argument is based upon the Michelson-Morley Experiment.

In 1887 Michelson and Morley, two American scientists, derived an experiment that was intended to show that ether existed. At that time it was assumed by most scientists a) that light travelled by wave motion and b) in order to have wave motion you had to have a substance to have the waves in. You cannot have big waves at the beach if there is no water. Now since light can travel to the earth from distant stars it must be the case that the space in between was filled with a substance in which the wave motion of light took place. This substance was called 'ether'. The only trouble with all this is that no one had ever detected the ether. The Michelson-Morley experiment was devised to do just that. They reasoned that as the earth revolves about the sun and rotates on its axis, sooner or later any given point on the surface of the earth will move relative to the ether. A circular apparatus was constructed in Morley's basement with a light source at the centre A and a couple of mirrors at B and C.



A pulse of light was sent out by aid of a mirror from the centre A to the two points on the circumference B and C where it was reflected back to A. The centre of A is the source of the pulse. They reckoned correctly that if the apparatus was moving in direction D relative to the ether the pulse of light sent to B would return to A later than the pulse of light that had been sent to C. If the two pulses arrived back at A at the same time, indicating that the apparatus was stationary relative to the ether, sooner or later as the earth rotated on its axis and revolved about the sun, the pulses would arrive back at different times indicating the presence of the ether. As no ether was ever detected since the two pulses always arrived back at the same time the experiment was declared a failure. It was designed to detect the presence of the ether that was assumed to exist and it failed to do so. Something must have gone wrong. Of course, as we now know what had gone wrong is that there wasn't any ether! But this thought never occurred to the two scientists. How could light travel through empty space if there was no ether?

Lorentz, a Dutch scientist who was also convinced of the omnipresence of ether, speculated that when the apparatus (and anything else) moved through the ether, the ether pushed against it and caused it (the apparatus) to contract. He even constructed a formulae which could be used to determine the extent of the contraction. If the apparatus contracted in accordance with the formulae then this would ensure that the two pulses would arrive back at the source at the same time.

Now, what it seems to me Michelson, Morley and Lorentz should have concluded is that (a) there is no ether, (b) there is no contraction, and (c) the reason why the two pulses always arrive back at the same time is that light travels at 186,300 miles per second relative to the source. Notice that on the neo-Newtonian view the apparatus cannot be said to be absolutely in motion or at rest. So, if the light always came back at the same time what this shows is that light is not transmitted by wave motion through a mysterious substance, but rather by small particles whose speed is relative to their source – the view of the neo Newtonian Theory.

Although one would have expected the Michelson-Morley experiment to be taken as confirmation of a view of this sort, one is surprised to learn that it was not. Instead it was taken as confirmation of Einstein's Special Theory of Relativity. For example C.M. Will in his book *Was Einstein Right?*[4], after presenting the Michelson-Morley experiment and its result that 'as far as the moving Earth was concerned the speed of light was the same along both arms, no matter what' (p. 251), goes on to point out that 'this is just what Einstein's principle of relativity demands: The speed of light should be the same in all inertial reference systems, whether at rest with respect to the universe, or at rest with respect to the Earth and no matter what the state of motion of the source of light' (p. 251). J. J. C. Smart writes in his *Encyclopedia of Philosophy* article on space: 'The experiment of Michelson-Morley showed however that the velocity of light relative to the observer is independent of the observer.'[5] Perhaps it is, but the experiment doesn't show that it is.

Now it might be argued that at least the findings of the experiment are compatible with the Special Theory. But note that order to make them compatible one has to incorporate into the Special Theory the claim that physical objects contract relative to the observer when they move away from the observer and also that time slows down. A high price to pay for the sake of making the results compatible.

The Train Argument

The second argument I want to examine, which might be called the Train Argument, comes from Einstein himself.[6] The function of the argument is to make us suspicious of the Newtonian notion of absolute time and receptive to the idea that time is relative to the frame of reference.

Einstein begins by asking us what we mean when we say that two bolts of lightning have struck a railway embankment at two different places at the same time? Let us call the two places A and B. He suggests that perhaps what we mean is that if an observer were placed on the embankment at M, which is half way between the two

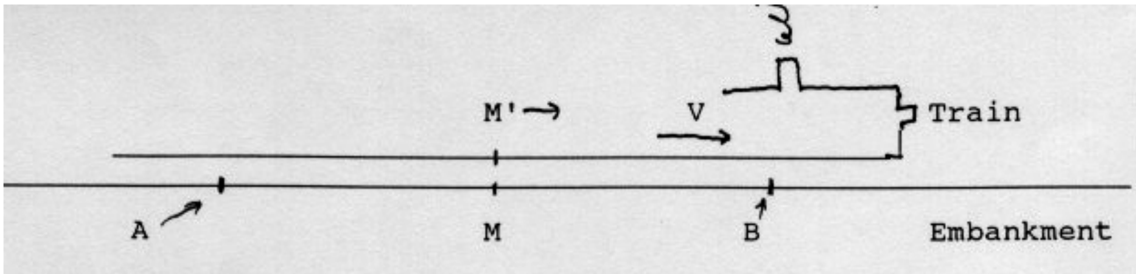
[4] Will, C.M. (1986) *Was Einstein Right?* (New York, Basic Books).

[5] Smart, J.J.C. (1967) 'Space', *Encyclopedia of Philosophy*, Vol. 7, p. 508.

[6] Einstein, A. (1931), *Relativity*, (New York, Crown Publishers).

flashes, he would observe the two flashes at the same time. He points out that this claim assumes that light would travel from A to M at the same speed as from B to M but does not feel that any harm is done in making this stipulation. In any operational definition some aspects have to be stipulated.

Suppose now that a long train had been travelling along the railway line, would the two flashes of lightning which were found to be simultaneous by the observer on the ground be found to be simultaneous by an observer on the train?



That is to say, suppose that M1 is the midpoint between A and B and that the lightning strikes just when M1 coincides with M, would the observer on the train at M1 find the bolts to be simultaneous? The answer that Einstein rightly gives is that he would not, for 'he is hastening towards the beam of light coming from B whilst he is riding ahead of the beam of light coming from A. Hence the observer will see the beam of light emitted from B earlier than he will see that emitted from A' (p. 31). Einstein concludes from this that 'Events which are simultaneous with reference to the embankment are not simultaneous with respect to the train and vice versa. Every reference body has its own particular time.'

But this conclusion of Einstein's seems to be mistaken. Notice first of all, that the results derived from this thought experiment are just what the neo-Newtonian would derive. Since for him the speed of light is 186,300 miles per second relative to the source and since the source is presumably where the lightning strikes the ground it is to be expected that the flashes which are observed to be simultaneous by the embankment observer will not appear to be simultaneous to the train observer, for while the light travels from B to M1 the observer at M1 (train observer) travels towards B, thus the light travelling from B to the train observer has less distance to travel than the light travelling from A to the train observer.

Notice secondly that in this example Einstein gives away that he understands what he feigns not to understand. And that is what it is for two events to be simultaneous. He asks what it means to say that the two flashes are simultaneous and suggests that what we mean is that they are seen at the same time. But in saying this Einstein is presupposing that he understands what it means to say that two events are simultaneous — in this case that the two perceptions of the flashes occur at the same time. There is the further problem of how we are to go about to determine whether or not the two flashes are simultaneous. But at least we know what we mean when we say that they are simultaneous.

To make these two points clearer let us tighten up Einstein's example. Suppose we have two devices each of which is capable of emitting a pulse of light. We place them on the embankment at points A and B. We then place an observer at M, halfway between A and B, and ask him to let us know whether he observes the flashes of light from the two devices at the same time. We also place an observer on the moving train and arrange things so that he will be at M1 when M1 is adjacent to M. The question we must now ask is if the observer on the embankment at M sees the pulses of light at the same time will the observer at M1 on the train see the pulses at the same time? The answer is of course, the same as before, he will not. Because he is hastening towards the device at B and away from the device at A he will see the pulse from B before the pulse from A.

But this doesn't show that events that are simultaneous in one reference frame might not be simultaneous in some other. The observer on the embankment will declare, given that he knows that the distance AM is equal to MB, that the two events are simultaneous. And the observer at M1 on the train will not declare that they are not simultaneous. Furthermore if the observer on the train is a good mathematician and knows the speed of the train etc. he will also declare that the pulse of light at A was simultaneous with the pulse of light at B. One has to be careful here to distinguish between the events and the perception of the events. No doubt the observer on the train will declare that his perceptions of the pulses are not simultaneous but still, given that he is a good mathematician, he will declare that the pulse that occurred at A is simultaneous with the pulse that occurred at B.

If we put the sources of light on the train at A1 and B1 where A1M1 is equal to M1B1 then the situation is the same only reversed. If the observer at M1 sees the two flashes at the same time then he will declare that they are simultaneous and the observer at M if he is a good mathematician and knows the speed of the train will also declare that they were simultaneous even though he saw the flash from A1 a bit before he saw the flash from B1.

It is important to notice that this feature has nothing to do with light. If the two devices fired bullets at the same speed at a target placed halfway between them, then assuming that everything is in empty space, if the devices are on the embankment and the target is on the embankment then the bullets will arrive at the target at the same time. While if the target is on the train they will not. If on the other hand the devices were on the train and the target was on the train then the bullets would arrive at the same time while if the target was on the ground they would not.

Although the results of Einstein's thought experiment are just what the neo-Newtonian would expect, many people including Einstein take this experiment as showing that simultaneity and hence time are relative to the frame of reference. Einstein says

> Now before the advent of the theory of relativity it had always tacitly been assumed in physics that the statement of time had absolute significance, i.e. that it is independent of the state of motion of the body of reference. But as we have seen this assumption is incompatible with the most natural definition of simultaneity; if we disregard this assumption, then the conflict between the law of the propagation of light *in vacuo* and the [Newtonian] principle of relativity... disappears. (p. 32)
>
> [And furthermore that] according to foregoing considerations, the time required by a particular occurrence with respect to the carriage must not be considered

equal to the duration of the same occurrence as judged from the embankment.' (p.33)

Martin Gardner[7] also arrives at the same conclusion as Einstein but since his argument is, surprisingly, a bit more sophisticated let me present it. According to Gardner's account lightning strikes simultaneously at points A and B on the railway embankment and that the observer who is on the ground at the midpoint knows that they are simultaneous. Gardner continues:

> Now assume that when the lightning strikes, a train is moving at great speed along the track in the direction from A to B. At the instant the two flashes occur, an observer on the train — we call him M1 — is exactly opposite observer M on the track. Since M1 is moving toward one flash and away from the other, he will see flash B before he sees flash A. Knowing that he is in motion, he will make allowances for the speed of light; he too will calculate that the two flashes occurred simultaneously.
>
> All well and good. But according to the two postulates of the special theory we have just as much right to assume that the train is at rest while the ground moves rapidly backward under the train wheels. From this point of view, M1 the observer on the train will conclude that the flash at B actually did occur ahead of the flash at A, just as he observed them. . . . M on the ground is forced to agree. True, he sees the flashes as simultaneous but *now* he is the one who is assumed to be moving. . . .
>
> We are driven to conclude therefore that the question of whether the flashes are simultaneous cannot be answered in any absolute way. The answer depends on the choice of frames of reference."(p.43)

Unfortunately no such conclusion can be drawn. If the lightning travels through the air and the air is at rest relative to the ground then at least where the lightning strikes the ground is at rest relative to the ground. Thus if M (the man who is at rest relative to the ground) sees the two flashes at the same instant then he knows that they happened at the same instant.

The trouble with Gardner's example, as with Einstein's, is it's not clear if where the lightning strikes is at rest relative to the ground or at rest relative to the train. In my example it is clear since the flashes come from devices that are either on the ground or on the train. If both devices are on the ground then both M and M1 will conclude, after making the necessary calculations, that the two flashes are simultaneous. The same conclusion will be reached if both devices are on the train.

On the basis of this error Gardner writes,

> When the concept of simultaneity falls, other concepts fall with it. Time becomes relative because observers differ in their estimates of the time that elapses between the same two events. Length also becomes relative. The length of a moving train cannot be measured without knowing exactly where the front and the back ends are at the same instant. (p. 49)

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[7] Gardner, M. (1976), *The Relativity Explosion*, (New York, Vintage Books).

No doubt if simultaneity falls, these other concepts fall with it. But as we have seen we have been given no good reason to believe that it does fall.

Finally C. M. Will again in *Was Einstein Right?* presents another variation on the same theme and of course repeats the same error. He writes,

> Consider two observers on the ground equidistant from a master central observer. The two wish to synchronize their clocks so they agree beforehand that when each receives a flash of light emitted in all directions from the master observer, he will set his clock to the prescribed time. Because they are equidistant from the master observer and the speed of light is the same in both directions, they naturally assume that they receive the signals simultaneously. Look what happens however from the point of view of a set of observers on a moving train who watch the same flash of light. The master observer emits his signal, which is seen to move with the same speed in both directions despite the motion of the train (principle of relativity). However while the signals are propagating, both ground observers are moving relative to the train, so the signal sent in the forward direction has less distance to cover before it intersects the forward [ground] observer, while the signal sent in the backward direction has greater distance to cover in catching up with the receding [ground] observer. Thus according to the train observer the signal is received by the forward [ground] observer before it is received by the near [ground] observer; whereas, in the ground frame the two observers viewed the receipts as simultaneous. This conclusion helped to abolish the previously accepted Newtonian concept of absolute universal time that was the same for all observers (p. 253).

This variation shares the same fault as the previous. It does not make clear whether the source of the flash of light is on the train or on the ground. If the source is on the ground then the ground observers will see it at the same time while the onboard observers will not. If on the other hand the source is on the train, the onboard observers will see it at the same time while the ground observers will not. Furthermore if all the observers are neo-Newtonians they will all agree on the simultaneity status of the observers. That is to say if the source is on the train, not only will the onboard observers see it at the same time and the ground observers will not, but also the onboard observers will know that the ground observers will not see it at the same time and the ground observers will also know that the onboard observers will see it at the same time.

Given that, regarding Einstein's train experiment, the neo-Newtonian will expect the ground observer to see the two flashes at the same time and the train observer to see them at different times, this raises the interesting question of what would the person who believed that the speed of light is absolute expect. Of course he would expect the ground observer to see the flashes at the same time but what would he expect the train observer to see? Since M1 is half way between A and B when the flashes occur and light travels at 186,000 miles per second relative to M1 it would seem, at first glance, that he would expect the train observer to also see the flashes at the same time! If he wanted to say that the train observer would see B before he saw A, as no doubt he would, he could only allow for this if he assumed that the distance between B and M1 had contracted. And of course this is what he would do.

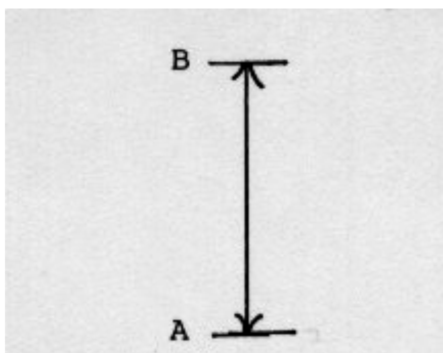
I think we may conclude from all this that neither the Michelson-Morley experiment nor the Einsteinian train thought experiment support the Special Theory of Relativity and that both are compatible with the neo-Newtonian position. As a result neither should be used by expositors as an argument in support of the Special Theory of Relativity. The theory is no doubt correct but these arguments do not support it.

Appendix I

Time Dilation

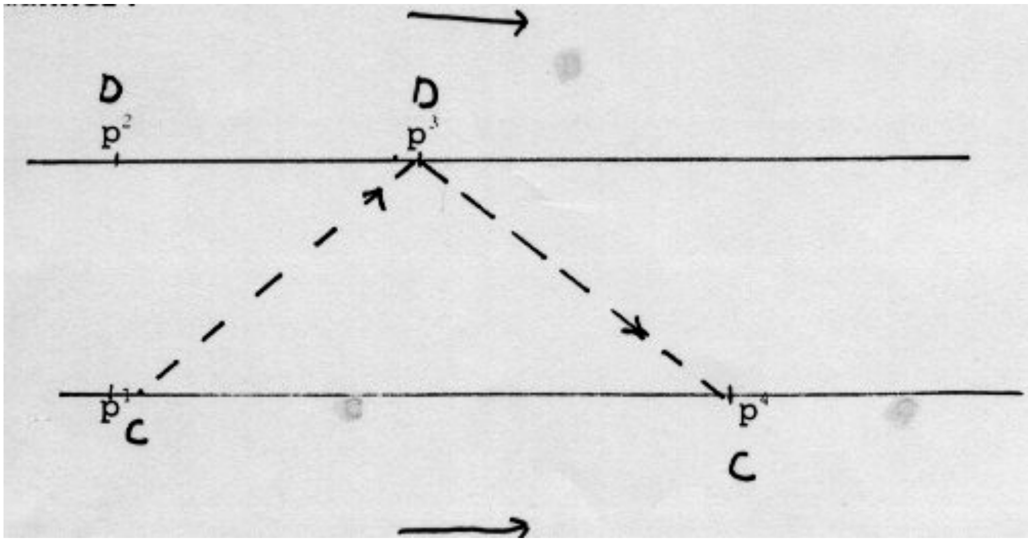
One of the interesting notions in relativity theory is time dilation. That is, it is possible for time to slow down? If what I have said on page five about time is correct the notion of time dilation is absurd. Processes that take time may go faster or slower but it makes no sense to say that the time they take could go faster or slower.
However let us put this point aside for the moment and see what is said in its support. Suppose I have a light clock. It works in the following way.

A pulse of light bounces back and forth between mirrors A and B as represented in the following diagram.



The basic unit of time is the time it takes a pulse of light to travel from A to B and back to A. We shall call this unit of time a Light Second. Let us also assume that everytime the pulse returns to A it ticks and that a counter is attached to the clock which counts the number of ticks.

Now suppose that you have an identical light clock and that your clock is in motion relative to my light clock. Now when I watch your light clock go by, say on a railway flat deck, I see the pulse of light go back and forth between C and D in the following manner.



The reason for this is that after the light leaves C at P1, D moves from P2 to P3, and before the light has returned to C, C has moved from P1 to P4. Thus relative to me the pulse of light has to travel a greater distance on its journey from C to D and back to C than does the pulse that travels from A to B and back to A. Now the neo-Newtonian, as Mook and Vargish (*Inside Relativity*, Princeton University Press, 1987, p.77) and others have pointed out, can take this all in his stride. He just says that when the light moves from C to D and back to C it travels a greater distance relative to me in the same amount of time and so goes at a greater speed. And so your clock ticks at the same rate as my clock. But what will the person who claims that the speed of light is constant say? He will say that since relative to me the light travels a greater distance at the same speed, it must have taken longer.

Now the main puzzle with all this is that if you were to bring your clock back to my clock each clock would have ticked the same number of times. But how can that be if the light pulse from your clock is taking longer to go back and forth? Surely it would have ticked fewer times. The only possible solution to this puzzle is that time has dilated or in other words has slowed down. But again, if what is said in page 4 and 5 is true this claim is incomprehensible.

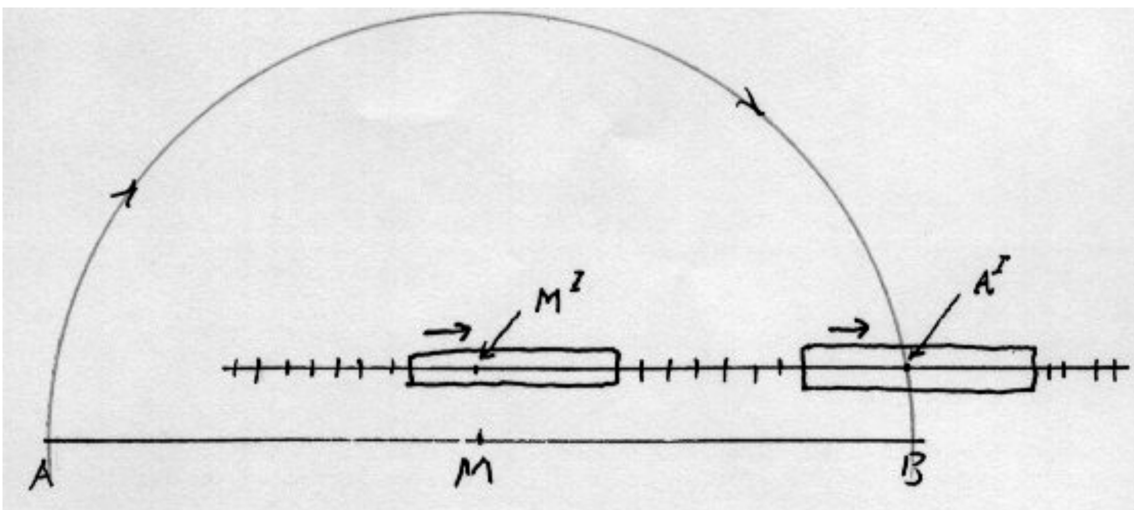
Appendix II

One of the reasons it is claimed that the speed of light is constant relative to the observer is that there is some evidence that the speed of light from Double Stars, even where one is receding and the other is proceeding towards us, is always the same. This phenomenon was first noticed by the Dutch astronomer De Sitter. Intriguingly enough, Einstein's train argument at least in the rendition that I have given it on p. 12, can be twisted around and used to show that speed of light from each double star cannot be the same. This doesn't show that the speed of light from each star is not the same but it does show that something is wrong with the argument. We obtain this result in the following manner. We take the diagram that we have on p. 10 and rotate A so that A is parallel with

B so as to give us a situation similar to the double star situation. Diagram A gives us the star situation and Diagram B gives us the altered train situation.

Diagram A

Diagram B



Here we are looking from above. The light device that was at A is moved so it is now on a train that is out in front of M1 and moving away from M1 and M. Let us assume that in the original diagram (p. 12) M1 was moving away from A at 10 mph and towards B at 10 mph. In order to duplicate this situation we have M1 moving towards B still at 10 mph and A1 moving away from M at 20 mph. Thus relative to M1 A1 is moving away at 10 mph. We can redescribe this and say that relative to B, M1 is moving towards B at 10 mph and relative to A1 M1 is moving *away* from A1 (towards the left at 10 mph).

Now given that in our original thought experiment that M1 will see the flash from B before the flash from A so in our new diagram, since everything has been duplicated, M1 will see the light flash from B before the light flash from A1. And since the distance from M1 to B is the same as the distance from M1 to A1, it must be the case that relative to M1 the light flash from B travels faster than the light flash from A1. Now since this situation is just the same as the double star situation, it must be the case that relative to us the light from the proceeding star is moving faster than the light from the receding star.

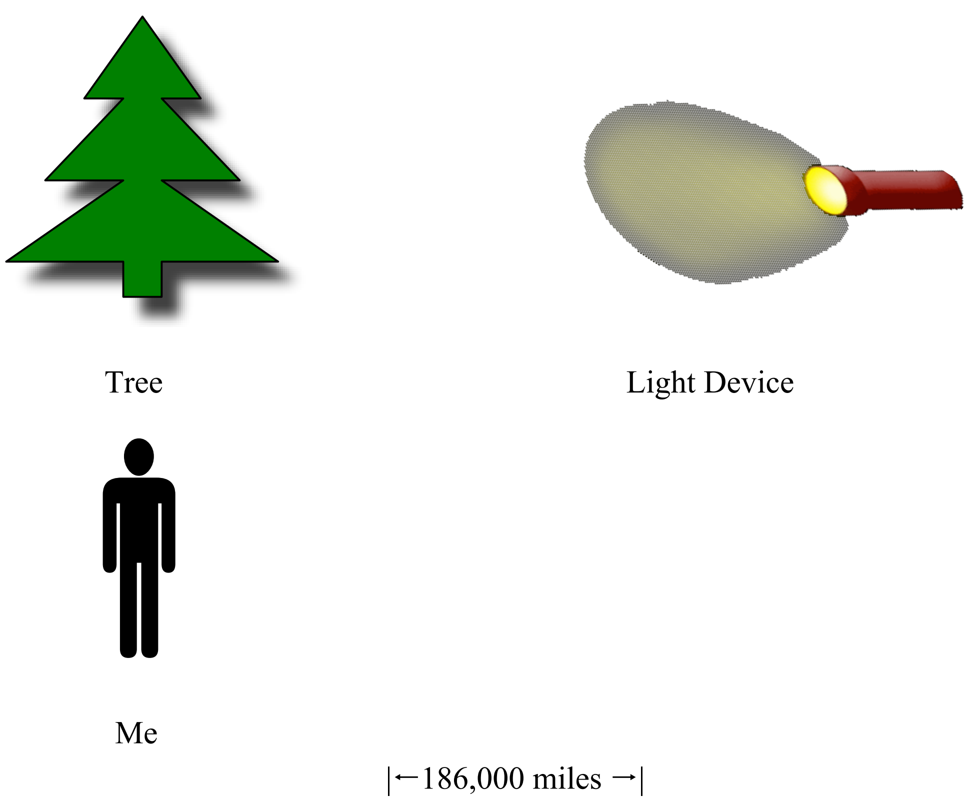
Appendix III

I now want to present one more argument in support of the claim that the speed of light like the speed of everything else is relative. I consider this argument, which is really based on much of what has been said before, to be irrefutable.

Suppose that I am standing by a tree and a light device 186,000 miles away, which is at rest relative to me and the tree, emits a pulse of light. The pulse is seen by me one second after it has been emitted.

Now, suppose that instead of standing by the tree, at the instant the pulse was emitted I had been passing the tree at a constant rate and moving to the left – towards the light source. In that case the pulse would have been seen by me sooner because it would have traveled a shorter distance at the same rate.

Now, let us look at this second scenario from my point of view. I am at rest and the platform, so to speak, which contains the tree and the light device as well as other things, is moving relative to me to the left. Just as the tree passes me the light device emits a pulse of light. Again the time that the pulse takes to travel to me is just the same – less than one second. But the *distance* is exactly the same as it was in the first scenario – 186,000 miles – and so the speed of the pulse relative to me must have been higher. The reason the distance is 186,000 miles is that that was the distance the light device was from me when the pulse was emitted.



It might be objected that if we measure the distance the light travels in light years and light seconds the constancy of the speed of light is preserved. No doubt this is true. The light got to me, from my point of view, in the second scenario in less than one second so it must have traveled a shorter distance – less than one light second.

But notice that although light years may be a convenient way to talk about great distances, the employment of light years and light seconds presupposes that light travels at a fixed rate. Thus on the scenario from my point of view, the light must have traveled a less distance because it took a shorter amount of time! Notice also that light years cannot count as a basic unit of distance – what it is is the distance a pulse of light travels in a year moving at 186,000 miles per second. Distance is distinct.

Appendix IV: Referee's comments (edited[8])

1) Professor McKenzie claims that he does not want to cast doubt on the Special Theory of Relativity (STR), but only wishes to cast doubt on the use of the null result of the Michelson Morley experiment and Einstein's train argument to support STR. However by rejecting the constancy of the speed of light in all inertial reference frames, otherwise known as Einstein's second postulate, he is indeed attacking one of the central postulates of Einstein's theory of relativity. He seems to misunderstand the significance of the arguments vis a vis the Michelson Morley experiment or the train argument. They are not usually presented as arguments in support of STR, but are used to show firstly, how given Einstein's second postulate, the null result of the Michelson Morley experiment can be explained and then secondly to demonstrate the counter-intuitive results associated with STR, such as the lack of simultaneity, as illustrated by the train argument, length contraction and time dilation. Also the twin paradox, over which much ink has been spilled. However it is well established, by for example consideration of particle decay rates [1] that 'moving clocks do go slow' and physicists have learned to live with the counter-intuitive results associated with STR, which are routinely verified on a day to day basis, in many labs up and down the country.

2) Einstein's motivation in advocating the constancy of the speed of light in all inertial reference frames, wasn't just based on trying to explain the null result of the Michelson Morley experiment, but in order to find a way to preserve the Lorentz invariance of Maxwell's equations in Newtonian mechanics. Maxwell's equations give an expression for the speed of light in free space or any material that make no reference to the velocity of the source. Thus according to Maxwell, the speed of light, on a prima facia basis, is constant in all inertial reference frames. This immediately gave rise to a conflict between Newtonian physics and Maxwell's equations, Einstein showed that the conflict could be resolved by modifying Newtonian physics to incorporate his second postulate. It is somewhat surprising to say the least, that if

[8] I have deleted some uncharitable remarks which I presume the referee would not have made had he known that the paper was from the author's Nachlass.

Professor McKenzie wishes to challenge the validity of Einstein's second postulate, he does not spell out in any detail, how he would modify Maxwell's equations, or that he totally ignores this motivation of Einstein in proposing his second postulate.

3) Despite not wanting to challenge STR, Professor McKenzie has unwittingly advocated a theory which was first proposed by Ritz in 1908 [2,3]. This is the so called emission theory, in this theory, light is considered to consist of particles whose velocity would be that of light plus that of the source. This appears to be the same as Professor McKenzie's 'Neo-Newtonian' viewpoint. Ritz was able to show that this hypothesis could also explain the null result of the Michelson Morley experiment, essentially because the source of light travels with the apparatus. However, unlike Professor McKenzie, Ritz realised that Maxwell's equations would have to be modified in order to take this into account and showed how this could be done. Thus in 1908, given the lack of experimental evidence, physicist's were arguably presented with a choice of either modifying Newtonian physics or Maxwell's equations in order to explain results such as the null result of the Michelson Morley experiment. Reference 3 describes the history of the emission theory and why it was rejected by most physicists. The key result appears to be De Sitter's analysis of binary star data in 1913. On the emission hypothesis, the spectra from binary stars should be continuous due to the varying relative velocity of the source, with respect to the earth as the system rotates. Instead they were found to be discrete, thus showing that the velocity of light from binary stars as seen by an observer on the earth was independent of the velocity of the source. It is a tragic fact, that Ritz died in 1909 so we do not have his response to such evidence.

Despite the general rejection of the emission hypothesis Fox [1] showed that by modifying Ritz's original hypothesis, agreement could be made between the results of emission theory and the binary star data. However, Fox goes onto show that the emission theory cannot account for the apparent extended life time of fast moving particles.

A further reason for rejecting the emission hypothesis is associated with the relativistic Doppler effect. Einstein's STR shows that a transverse Doppler effect is predicted which has no analogue in classical theory [4]. Ives and Stillwell [5] performed an experiment based on accelerating hydrogen atoms, which agrees with the relativistic predictions of the Doppler Effect. The emission hypothesis has also been shown [6] to produce an expression for this effect, which conflicts with the results from STR at high velocities. However this expression shows reasonable agreement with the results of the Ives – Stillwell experiment. This is because of the low velocities used in the experiment. More recently however an experiment has been performed along the lines of Ives-Stillwell for high velocities [7] this has been shown to agree with the results of STR, at these velocities and not those of emission theory [8].

From a theoretical point of view the modifications to Maxwell's equations advocated by Ritz appear to be quite inelegant, and somewhat ad-hoc. In contrast after the work of Minkowski, Einstein's theory was placed in an elegant framework. The subsequent use of Einstein's STR to promote new and novel research programs, because of it's generality, as opposed to the limited use of Ritz's emission hypothesis is arguably another reason why the emission hypothesis should be rejected.

Thus to summarise:

1) Professor McKenzie seems to have misunderstood the reason why accounts of STR, use the Michelson Morley experiment and the train argument. They are not used as arguments to support STR, but rather to illustrate the consequences of Einstein's second postulate which Professor McKenzie advocates rejecting.

2) He seems to have ignored the electrodynamical reasons for advocating Einstein's second postulate. Furthermore if we reject Einstein's second postulate as Professor McKenzie seems to advocate, that would require a modification to Maxwell's equations, which Professor McKenzie fails to give.

3) Professor McKenzie in his 'Neo-Newtonian' approach appears to be advocating something like the emission hypothesis of Ritz [2,3]. Whilst it is true that modifications to Ritz's hypothesis, along the lines of Fox [1] may account for the binary star data and the null result of the Michelson Morley experiment, it cannot account for the extended decay life times of fast moving particles, or the relativistic Doppler effect at high velocities. Furthermore from a theoretical point of view Einstein's STR seems much more capable of generating fruitful research programmes than Ritz's somewhat ad-hoc modifications to Maxwell's equations.

References

[1] Fox J.G. 1965 '*Evidence Against Emission theories'* American Journal of Physics Vol 33 No 1 pp 1-17.

[2] Ritz W 1908 "*Recherches critique sur l'ectrodynamique generale*". Annales de Chimie et de Physique Vol 13 pp. 145-275. (cited by 3 below).

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[4] Stephenson G, Kilmister C. W 1958 "*Special Relativity for Physicists*" pp 45-48 Dover 1958.

[5] Ives H.E, Stillwell G. R. 1941 Journal Optical Society of America Vol 38 pp 369.

[6] Faraj A.A *"The Ives Stilwell Experiment*" http://www.wbabin.net/physics/faraj.htm (Accessed Jan 3rd 2008)

[7] Saathoff G et al 2003 Phys Rev. Lett Vol 91 190403

[8] Sfarti A "*The Ives Stillwell Experiment vs the Emission Theory*" http://www.wbabin.net/sfarti/sfarti8.pdf (Accessed Jan 3rd 2008)

(NB Whilst 6 and 8 are not part of the peer reviewed literature given the relevance to the debate I thought it was worth including them).