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Chapter 3: Problems with Einstein's Train Thought Experiment

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Abstract: It is examined how Einstein's Train Thought Experiment leads to fallacies, in spite of ones interpretation of this thought experiment. This paper presumes that the reader has read my other paper "A Brief Overview of SRT" as well as "Relativity", by Einstein. This is especially important because the ideas proposed in this paper are of a very speculative nature, and one should know the theory before one begins to speculate with regards to the interpretations of the theory. The appendix presents a brief outline of the argument of this paper.

Contents

1. Introduction

The purpose in examining Einstein's Train Thought Experiment is to point out fallacies in Einstein's logic. It may seem like this is a relatively simple , visual thought experiment, and that therefore there cannot be multiple interpretations of the thought experiment. However, there can be and are multiple interpretations of this thought experiment.

Since there can be multiple interpretations of this thought experiment, it is best to direct our attention exclusively to what Einstein himself said about it, rather than what other people say about what they think Einstein meant by it. For this reason, I suggest that the reader get the book "Relativity", by Einstein (Einstein, Relativity). This book is good for three reasons: 1) It was written by Einstein, 2) It was written for the layperson, and 3) It was updated toward the end of Einstein's life, and so should reflect any modifications Einstein felt were necessary to his initial advancement of this thought experiment. This paper assumes that the reader has read the relevant passage on Einstein's Train Thought Experiment in this book.

What we want to do is to start from this point of reference, and look at every possible interpretation that can result from this point of reference. What we find is that, no matter which interpretation we choose, it leads to inconsistencies with his theory (i.e. contradicts special relativity) or internal contradictions within the interpretation itself. All possible interpretations are proven untenable.

Demonstrating that all possible interpretations are untenable, as we will see, does not prove that SRT is wrong. For one thing, there are no experiments which either confirm or deny the relativity of simultaneity. But it does reveal that even Einstein, himself, can make mistakes. It is instructive to learn this since faith in Einstein poses a stumbling block for one to believe in the possibility that SRT can be wrong. In other words, if Einstein can make a mistake, then maybe he made a bigger mistake by creating the theory (i.e. maybe he made other mistakes as well).

Similar arguments to the ones proposed here are duplicated, in a more elegant fashion, by Evans (Evans, Critique of Simultaneity). For further clarification of the issues proposed here, I refer the reader to that work.

2. Let us Use Assume Six Observers-Not Two

In the train thought experiment, Einstein places one observer in a train and one observer outside of the train. For our purposes, however, we want to start out with three observers inside the train, and three observers outside of the train. Let us call the observers A, B, C, and A', B', and C' respectively.

Let us say that the observers inside of the train are sticking their hands out of the train so that they can touch hands with the observers outside of the train as they pass by. Let us now say that just as the train passes by, observers A, B and C touch hands with observers A', B', and C', respectively.

Einstein only considers observers B and B', but we you will see that we have a reason for placing the other observers there in a moment. Note that, since A, B, and C are at rest to one another, they are supposed to deduce the same conclusions with regards to the simultaneity of events. Since A', B', and C' are all at rest to one another in the train frame of reference, they are supposed to deduce the same conclusions with regards to the simultaneity of events as well. Remember, simultaneity is relative only between frames of reference that are in motion with respect to one another. Simultaneity remains absolute throughout any given frame.

3. The Initial Conditions

Now let us say that just at the point that the primed observers touch hands with the non-primed observers, lightning strikes each end of the train. Let us stop here. It seems as

though we are actually stating an initial condition that applies to both frames, at the very outset. And in fact we are. But Einstein doesn't see it this way.

And here comes the reason for the extra four observers. Before we proceed to discuss the traveling light pulses, we note that the four observers are all aware of the light pulse. They can now begin walking to observers B and B' to tell them what registered on their clocks when they observed the light pulse. We don't even have to any further.

4. Einstein Proceeds Past the Initial Conditions

But Einstein feels that we do need to proceed further. To this purpose, he states how the light pulses travel relative to both coordinate systems. According to Einstein, the pulses of light (which contain the information about the event occurrence) will hit B at the same time, but they will not hit B' at the same time. Let's stop here again.

It is given that the events occur equidistant from B. It is given that the events occur equidistant from B'. It is given that light must be viewed to travel in S, by observers in S, at the constant velocity of c. It is given that light must be viewed in S', by observers in S', at the constant velocity of c. Given these conditions, the elapsed time of travel for the light pulse coming from the left should be equal to the elapsed time of travel for the light pulse coming from the right, in the frame of S, as viewed by observers in S. Also, given these conditions, the elapsed time of travel for the light pulse coming from the left should be equal to the elapsed time of travel for the light pulse coming from the right, in the frame of S', as viewed by observers in S'.

In other words, according to the given conditions, it is true that the light pulses should hit observer B at the same time. But it is also true, given the initial conditions, that the light pulses should hit observer B' at the same time. (But Einstein just said they hit observer B' at different times). It seems as though Einstein is giving preference to the S frame. And he is.

But according to his theory he is not allowed to give preference to any frame of reference. They are all to be treated equally. We could just as well have viewed the situation from the perspective of the train. In this case, instead as viewing S' to be moving to the right while S remains at rest, S is viewed as moving to the left while S' remains at rest.

Given the above perspective, Einstein might have inferred that the light pulses will hit observer B' at the same time, but hit observer B at different times. Let us call the situation when S is viewed to be at rest as situation one. Let us call the situation where S' is viewed to be at rest as situation two.

5. First Interpretation: S and S' View Situation One Only

Let us assume, for the time being, that Einstein meant for situation one to be the situation that is viewed by observers in both S and S'. In such a case, as Einstein argues, the light pulses do not hit B' at the same time. Rather, they hit B' at different times.

Specifically, Einstein says that it will take a longer amount of time for the light pulse from the back of the train to catch up with B' than it will take a pulse from the front of the train to reach him, since he is traveling toward the light pulse. It sounds like Einstein is describing c+v and c-v velocity of light relative to S'. And he is.

Observers C' and A' can attest to the fact that their measurements of the velocity of the velocity of the light pulses are c+v and c-v, respectively. Remember, we are assuming, for the time being, that Einstein meant for situation one, this situation, to be viewed by observers in both S and S'.

Obviously, there is something wrong here because the light pulses are not allowed to travel, or be measured to travel, at c+v or c-v by either observers in S or observers in S'.

6. Second Interpretation: S Views Situation One; S' Views Situation Two

The only way to attempt to reconcile this dilemma is to assume that there are two situations: situation one and situation two. Situation one represents the situation as it is perceived by observers in S. Situation two represents the situation as it is perceived by observers in S'.

Let us continue to examine the situation as it is perceived by an observer in S'. As mentioned, an observer in S' views S' to remain stationary while the system of S moves to the left. Let us examine the pulses as observed by the observers in S'.

These observers view the light to travel at c in S', and hence to hit B' at the same time. Consequently, the light pulses are seen to travel at c+v and c-v relative to S'.

However, this second interpretation is flawed because, suppose we were to place a stick of dynamite at B' to be set off by either of the pulses as they come in. Observers in S would see the dynamite to explode (the pulse from the front of the train would trigger it) before observers is S'. Hence, we have an event that occurs at a single point in space which create a wave front of light pulses in the system of S, before the wave front of light pulses is created in S'. This is because the light pulses would not be viewed to be in the same place at the same time in the system of S', as they are in the system of S.

It may be argued that a single event creating a wave front at two different times in two different systems may be allowed under the relativity of simultaneity. And it would. I agree. However, this description violates the process Einstein used at the very beginning,

which was to assume that the lightning bolts create pulses of light at the same time in both systems.

7. Conclusion

Einstein started off on the wrong foot in this thought experiment. He shot himself in the foot before he even began. This is because no amount of analysis is needed to state that simultaneity is relative. You just state it as a given and then proceed to use it in the initial conditions.

All Einstein needed to say was that an even creates a pulse of light in S, and a second later it creates a pulse of light in S'. Hence, simultaneity is relative. Of course, there would be no point in saying that because all he would really be saying is "I declare that simultaneity is relative".

The point is that you cannot derive relativity of simultaneity the way Einstein tried to, because the simultaneity is implied by the initial conditions.

In this paper we showed that there are two ways to interpret what Einstein was getting at in his Train Thought Experiment. The first interpretation is wrong because it places a preference of one frame over another, or b). The second interpretation is wrong because it leads to either a) implication that light will be measured by an observer to travel at c+v and c-v relative to him, or b) a result that conflicts with the process through which Einstein began the thought experiment.

Simultaneity, or the relativity of simultaneity, is implied by the initial conditions of the thought experiment, insofar as when an even occurs in two different reference frames is implied by the initial conditions of the thought experiment.

8. Appendix-Outline of argument

As is evident in the paper, there are two different interpretations that can arise from an analysis of Einstein's Train Thought Experiment. They are : (1) Observers in S view S at rest and observers in S' views S at rest as well, or (2) Observers in S view S at rest while observers in S' view S' at rest.

The problem with (1) is that it places preference on the reference frame of S over the reference frame of S'.

The problem with (2) is that it leads to either (2a) a situation where the light is measured in S' to travel at c+v and c-v, or (2b) a situation where a light pulse becomes located at a different location in each frame of reference.

Let us consider how these results arise from interpretation (2). Interpretation (2) states that observers in S' must view S' at rest.

If we consider the same light pulses that were viewed by S, the light will hit observer B' at different times. This can only be the case if the light pulses are traveling at c+v and c-v relative to S', because it is given that B' is equidistant from the two ends of the train, meaning that B' should view the light pulses to hit him at the same time, if they are really traveling at c relative to him. (2a)

Now we wish to make it so that observer B' also views the light pulses to hit him at the same time. This can only be accomplished if we consider different pulses of light traveling to B' than the pulses of light traveling to B. If we are looking at different pulses of light, it means that B' will view the light pulses to hit him at different times than B views the "same" pulses to hit B'. Thus, they will be viewing phenomenon at a single point in space to be occurring at different times. Although this does not conflict with relativity of simultaneity, per se, it conflicts with the procedure with which Einstein began the thought experiment-that an event will initiate a pulse of light to start its path of travel in both S and S' at the same time. (2b).

Most textbooks teach version (2a) and ignore the c+v and c-v velocity of light implied, stating that B' will not view it to travel at c+v and c-v. The problem with this is that they are ignoring the fact that conditions dictate that observer B' must view the light to travel and c+v and c-v relative to him. Conditions are: (A) The two events generate a light pulse at the same time, (B) B' is equidistant from the two ends of the train, and (C) the light pulses hit B' and different times. Equal distance over different time equals different velocity.

Relativists will rebut that condition (A) presupposes the simultaneity of the events, but it does not. (Well, actually it does, but not according to Einstein.) (A) merely restates the initial condition of the thought experiment as given be Einstein. It is saying that pulses are generated at the same time which is, according to Einstein, different from saying that the events are simultaneous. (He is wrong, but that is what he claimed).

9. References Used

Einstein, A. Relativity. Methuen and Co, London, (1920)

Evans, "Critique of Simultaneity".