Conclusions About the Simultaneity of Two Events

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Abstract

A '*gedanken*' experiment is presented whereby two simultaneous events (from the point of view of an obesrver in a train) trigger an explosion which destroys a train. A stationary observer using the Special Theory of Relativity (STR) to determine simultaneity in the train concludes that no simultaneous events have occurred on the train, hence the train is intact. It is pointed out that the conclusion the stationary observer makes is incorrect because it is based on STR as a method to determine simultaneity.

Introduction

In this text concerning probably the most important conclusion in the Special Theory of Relativity (STR) [1] – the relativity of time – we will deal with the consequences which such conclusion has in one simple '*gedanken*' experiment. Relativity of time in STR follows from the derivation in [1] indicating that two events that are simultaneous from the point of view of a stationary observer will not be simultaneous from the point of view of a moving one. Below, a simple example demonstrates that this conclusion is untenable.

STR has been the subject of criticism from the times of its inception. Nowadays, STR being at the very basis of all modern hard sciences, finds itself in a position of complete protection from criticism. Nevertheless, quite rarely, critics of the theory still can be found who resort mostly to criticizing STR by doubting the validity of the postulates (especially the second postulate – the constancy of the speed of light). Usually these critics express various doubts regarding the experiments that prove the validity of these postulates.

Criticism is also known in the form of paradoxes following from STR, the presentation of which is usually devoid of any mathematical details whatsoever. Perhaps one of the most prominent of these is

The Twin Paradox

It has been stated by many authors that the well-known "twin paradox" following from [1] is not a seeming but an actual paradox. Indeed, if we accept that the twin on earth ages faster than the twin moving at relativistic speed, then a very natural question arises. Is it not true that the twin on Earth moves, respectively, at relativistic speed versus the twin on the ship ? Then the twin on the ship should be aging faster than his twin-brother on earth. Can the same twin at the same time (at the same time, say, in the ship) age faster and not age faster than his brother ? Obviously, the answer is ‘no’. The twin cannot age faster and not age faster at the same time. According to STR, however, the answer cannot be anything but ‘yes’ which is paradoxical. Such paradoxical outcome from a theory puts into question its validity.

Probably, speaking of paradoxes, it would be interesting to mention the widely cited

Experiments with μ-mesons

as one of the most solid experimental proofs for the validity of STR. However, one may immediately notice that the μ-meson decay occurs not only in their own frame, as it is usually considered, but also in the frame of the stationary observer. The physical phenomenon designated as decay of μ-mesons is not known to be velocity dependent. Therefore, any discrepancy in the decay rate when observing, from the point of view of a laboratory frame, stationary decaying μ-mesons versus moving decaying μ-mesons would indicate a hitherto unknown property of the μ-mesons rather than time dilation in μ-mesons’ own frame (or it may be due to an experimental error [2]).

Let us elaborate on this a bit. Consider an experiment on μ-meson decay which has a beginning and an end. The beginning and the end of this experiment will be the same both for the moving (μ-mesons’ own frame) and for the laboratory frame. An observer flying with the μ-mesons knows exactly how many the μ-mesons were at the beginning and how many remained at the end. For such an observer according to STR his time is the proper time while the time in the laboratory frame (on Earth) is dilated. The observer flying with the μ-mesons, however, will notice that if he accepts the reality of such time dilation then he should accept that the observer on Earth should claim at the end of the experiment that fewer μ-mesons have decayed. “How come” – we almost hear the observer flying with the μ-mesons exclaiming – “I know with certainty what the initial and what the final number of μ-mesons is and if somebody says it is different then he is in error”. Thus, the observer flying with the μ-mesons concludes that there must not be time dilation if the hypothetical observer on Earth is to count properly the μ-mesons (notice, because the phenomenon of μ-meson decay exhibits itself the same way in all frames, the only reason for fewer decays would be shortening the time of the process of decay). As a result the observer flying with the μ-mesons concludes that STR leads to incorrect conclusions and should be abandoned.

Above discussion indicates that experiments with μ-mesons for the purposes of experimental confirmation of STR should not have even been undertaken. Nevertheless, as an exercise separate from the present discussion, it would be interesting to see what the reported anomalous behavior of the μ-mesons could be due to.

Although the paradoxes such as the discussed clearly put into question the validity of STR it appears that a simple *gedanken* experiment containing some decisive outcome is needed, which will abolish in an indisputable way many of the objections that might arise regarding the paradoxes such as the "twin paradox" or the μ-meson decay.

One may also notice that, although texts such as [3,4] written using the machinery of the original [1] clearly demonstrate the flaws in STR, experience shows that the specialized terminology used greatly obscures the problems for a wider audience of readers. Fortunately, for those who are not conversant with the intricacies of electrodynamics or vector algebra, it seems sufficient to present the intended argument conclusively in plain words, avoiding mathematical derivations, without the argument losing any rigor. Thus, probably even a superficial acquaintance by the reader with the STR will be sufficient to follow the arguments presented henceforth.

The 'Gedanken' Experiment

Let us observe, as is usually done, a train moving at a speed close to the speed of light. As most trains, this train has doors on opposite side of each car.

Imagine there is a powerful explosive-device in the train which is triggered only when the two doors open simultaneously (from the point of view of an observer situated in the same train) which causes the train to be destroyed completely. If these two doors do not open simultaneously (from the point of view of the same observer in the train) the explosive-device is not triggered and the train remains intact.

Let us imagine that as the train moves at a speed close to the speed of light a moment comes at which the two doors open simultaneously from the point of view of the already mentioned observer in the train – the simultaneous opening of the doors triggers an inevitable explosion and the train gets destroyed (this is only a *gedanken* experiment !).

On the other hand, as is well known, STR predicts that from the point of view of a stationary observer who is on the ground (not in the train) – we say that such an observer is in the "laboratory frame" – the two doors would not have opened simultaneously – the train, according to such stationary observer, using STR to determine said simultaneity, continues to travel intact.

Notice – the only way for the observer in the stationary system to determine whether the train is intact or not is through determining whether the two doors have opened simultaneously or not. In our "gedanken" experiment the observer in question is not in a position to observe directly the explosion even if such explosion has taken place.

Is it possible that the train is at the same time (at the time the experiment ends) destroyed and intact ? The answer is – decisively no, it is not possible. Why is then such a contradiction ?

We should emphasize that we accept, the observer in the laboratory frame to be an honest observer and not a hypocrite, i.e. the observer in question indeed believes in what he or she says. In other words, he or she does not assert that there has not been simultaneity in the train without being fully convinced that lack of simultaneity is the very truth about what happened in the train and not because from his or her point of view it just seems this way (while in the train itself who knows what actually happened). His or her statements about what happens on the moving train, when using STR to determine simultaneity, reflect his or her true belief that what he or she reports actually happens there. He or she reports there were no simultaneous openings of doors on the moving train. This observer believes that is what actually happened on the moving train (the stationary observer is fully convinced that the STR he or she uses for the purpose provides an undoubtedly correct method to determine simultaneity in the moving train). Therefore, said observer believes, there could not have been an explosion on the moving train and the train should be intact at the end of the experiment. For this observer, using STR, there is no question that the train is intact.

Therefore, the mistake the stationary observer makes is an unconditional mistake which could not be excused by a statement that, well, the observer in question simply "sees the events taking place in the train in a way different from the observer in the moving frame".

Thus, the possibility which such an observer could use (the possibility to apply reverse transformations) in no way could mend the mistake which the said observer makes regarding the synchronicity when the situation is as follows: while sitting in the stationary frame the observer in question accepts

STR as a correct basis to derive transformations and, therefore, bases his or her conclusions about synchronicity on it (on STR).

Another Variant of the 'Gedanken' Experiment – A Commission

Usually when discussing the problem in question it is implicitly accepted that the judgment for the truthfulness of the claims is given by someone who is not a participant in the experiment. Imagine, for instance, a commission which expects to obtain a written statement from the stationary observer as to whether that observer has seen simultaneous opening of two doors in a train moving at near-relativistic speed.

The commission accepts as true only answers which claim actual events in the moving train. Commission will not accept impressions of observers about what happened in the train based on anything that is considered axiomatically true. In other words, the commission will not use any transformations offered by such axiomatically true theory that when applied give the wrong answer as to what actually happened in the train.

As we know, the observer states (and writes on a piece of paper which he or she gives to the commission) that, based on, in his or her understanding a very reliable method (STR), at no moment during the experiment he or she has observed synchronous opening of doors.

The commission, however, goes for an inspection and determines that there in fact had been a violent explosion and the train is destroyed. The commission knows that such an explosion could occur only upon simultaneous opening of doors. If there had been no simultaneous opening of doors no explosion could have occurred. Stationary observer reports of no simultaneous opening of doors, i.e. there should have been no explosion. The conclusion of the commission is that the observer in the stationary frame is in error. The reason for this error is that as a criterion for simultaneity the observer in question has used nothing else but most notably a method offered by STR.

As already discussed, of course, if the action of these, leading to wrong conclusion, transformations is "undone" (i.e. if the observer in the stationary frame applies the transformations in the opposite sense) then the conclusion will inevitably be correct. However, then one cannot speak about application of STR (through applying transformations derived in it) – their action (respectively, the action of the theory) has been nullified.

Think about what would be the situation at the end of the experiment – the train has been destroyed because of a synchronous (as detected from the point of view of the observer in the train) opening of doors during its travel. On the other hand, the observer in the laboratory (stationary) system (who applies the theory (STR) conscientiously) asserts that the train must be intact because during its motion no synchronous opening of doors had been observed.

The conclusion which the observer in the stationary system makes is correct from the point of view of the theory, but is not confirmed by the experiment. Can one claim, if this is the case, that the theory is correct ? The answer obviously is that a theory leading to physically incorrect conclusions cannot be correct.

Of course, to avoid unnecessary discussion we can, for instance, imagine that the explosive-device is so constructed that the explosion itself takes place not at the moment of the synchronous opening of the doors but after passing of a certain time interval. Such a device is even technically realizable not only for the purposes of our "gedanken" experiment but in general as a functioning real machine. After the mentioned time interval has passed (from the point of view of the passenger in the train) the explosion will take place inevitably and the train will be destroyed. Observer in the stationary frame, however, would have already made the conclusion that there had not been a simultaneous opening of the doors, therefore, explosion could not have occurred and the train had remained intact. The stationary observer would have already written this conclusion on a piece of paper and would have given it to the commission.

Another Possible Approach by the Stationary Observer

Suppose that before giving his or her result to the commission in which he or she concludes that using the method in STR there has not been synchronous opening of doors from a stationary point of view, the observer carries out an independent experiment. Thus, suppose, that the same observer residing in the laboratory frame, using a different suitable method (or through mentioned reverse transformations) determines with certainty that such synchronous opening of doors in fact has indeed occurred. Is it not true that such a "discovery" would shock any honest researcher ?

So, it turns out, a theory whose truthfulness is asserted with such security in fact leads to conclusions in contradiction with undeniable experimental data.

Thus, if the observer in question happens to decide to make such an independent observation, i.e. an observation which is not based on STR then the inevitable conclusion will come out in a most natural way – if it is necessary to determine correctly from any frame the simultaneity of two events, application of the method offered by STR for this aim is unacceptable.

A Brief Identification of the Problem

As mentioned, the question for the simultaneity of two events is pivotal in [1]. Conclusions in [1] regarding simultaneity are the basis for the derivation of the Lorentz transformations in that paper.

Often the question for the validity of the Lorentz transformations is discussed.

The problems in STR begin before the derivation of the Lorentz transformations. At the very basis of this problem, as has been shown elsewhere, lies the inappropriate “instrument” (the device with rays of light) that has been used to study the simultaneity of two events. The description of this device is a favorite theme in popular science texts. The author of [1] considers that using this “instrument” he has succeeded to prove the relativity of time. However, the only thing which the author of [1] has succeeded to prove in his paper is that the use of such “instrument” is inappropriate for the study of simultaneity of two events.

Another Direct Argument

Aside from the arguments presented here one can see directly, by applying the author’s own criterion for validating his theory, that the criterion in question in fact is not fulfilled. The idea behind the criterion put forth by the author is to compare expressions for the Maxwell equations in the moving frame obtained by applying the first postulate with the expressions of the same Maxwell equations transformed using the second postulate (using the Lorentz transformations derived on the basis of the second postulate). The mentioned criterion requires that, as a result of this comparison, should the theory be correct, the same form of the expression for the Lorentz force must be obtained. If this is not achieved, it will be a clear proof, according to the mentioned criterion, that the theory is incorrect. The author claims that he has demonstrated the above equivalence of the form of Lorentz force obtained by applying the first compared to the form obtained by applying the second postulate. Unfortunately, a closer look at the derived expression shows that the author has not been able to show such equivalency, which is a proof that the theory he proposes is incorrect according to his own criterion. Details of this argument are presented elsewhere [4].

Conclusions

It follows from the above discussion that if one wants to determine truthfully from any point of view whether there is synchronicity between two events in a given system the method offered by STR is unacceptable. Conclusions about simultaneity of two events observed from different frames of reference must not differ.

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