May New Relativistic Effect Appear for Simultaneous Events?

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Abstract

We are examining the possible existence of new relativistic effect that might experimentally be detected in order to provide a rational explanation to thought experiments involving simultaneous events.

The special theory of relativity has totally changed our perception of space and time[1-10], considered since long time ago as two separated concepts that special relativity has unified in a single entity called spacetime, leading to a reconsideration of many classical principles like the simultaneity of two events which is no longer absolute; in fact as a consequence of the non-universality of time suggested by special relativity, two simultaneous events relative to an inertial observer are necessarily not simultaneous for another inertial observer moving relative to the first one. However we can show from the Lorentz transformation of two inertial frames of reference $R(O,x,y,z)$, $R'(O',x',y',z')$, in standard configuration moving with speed V one relative to other :

$$\begin{cases} x' = \gamma(x - Vt) & (1) \\ y' = y & (2) \\ z' = z & (3) \\ t' = \gamma\left(t - \frac{V}{c^2}x\right) & (4) \end{cases}; \quad \gamma = \frac{1}{\sqrt{1-\frac{V^2}{c^2}}}, \qquad c \text{ is the speed of light,}$$

a necessary and a sufficient condition for having two simultaneous events in R and R'. Indeed let $A(ct_A, x_A, y_A, z_A)$ and $B(ct_B, x_B, y_B, z_B)$ be two simultaneous events relative to R. If $A\left(ct'_A, x'_A, y'_A, z'_A\right)$, $B\left(ct'_B, x'_B, y'_B, z'_B\right)$ are their coordinates relative to R' respectively, it's easy to show that :

$$\Delta t = \Delta t' = 0 \Rightarrow \Delta x = 0 \wedge \Delta x' = 0, \qquad (5)$$

where $\Delta t = t_B - t_A$, $\Delta x = x_B - x_A$, $\Delta t' = t'_B - t'_A$, $\Delta x' = x'_B - x'_A$. Conversely, if we assume that $\Delta x = \Delta x' = 0$, we can also show that

$$\Delta x = \Delta x' = 0 \Rightarrow \Delta t = 0 \wedge \Delta t' = 0, \qquad (6)$$

thus

$$\Delta t = 0 \wedge \Delta t' = 0 \Leftrightarrow \Delta x = 0 \wedge \Delta x' = 0, \qquad (7)$$

which means that two events are simultaneous relative to two moving inertial frames of reference in motion and in standard configuration if and only if their coordinates on the axis parallel to the direction of motion coincide in the two frames. In other words, special relativity states that:

« ***There can be no simultaneous events relative to two moving inertial frame of reference if their coordinates on the axis parallel to the direction of motion does not coincide in each of frame*** ».

This fundamental rule resulting from Lorentz transformation that we will call the principle of simultaneity must be respected when one deal with thought experiments involving simultaneous events, otherwise one get some mathematical condradictions; this is why if in general we assume that the x-coordinates of two simultaneous events in R and R' are such as

$$\Delta x \neq 0 \vee \Delta x' \neq 0, \quad (8)$$

we get from equations (1) and (4), the mathematical contradiction

$$\gamma = 0, \qquad (9)$$

which is basically caused by the violation of this principle rather than an inconsistency in the theory, explaining likewise the paradox of the thought experiment proposed in [11]. But even if the principle of simultaneity constitutes the main mathematical argument of the self-consistency of the Lorentz transformation when this one is used to analyze such thought experiments, a major difficulty arises from the possibility to conceive physically simultaneous events violating this principle, like it has been pointed out in a recent thought experiment [12] where the typical example of two simultaneous events violating the principle of simultaneity would be to imagine two inertial observers O and O', which agree to read a message written on a giant signboard once O' who is moving in a linear motion relative to O with a constant speed V encounters a point A on the axis (ox) at rest relative to O and located at a distance $OA = L$; for that we assume that the giant signboard is at rest relative to O, the same as the written text on the signboard; for instance the text could be the word: "Special Relativity. " which is big enough for being clearly readable from O and A, then O will read this text when his clock shows $T = \frac{L}{V}$, which correspond to the time at which O' reaches A, who will also read the signboard text exactly at that moment i.e. when his clock shows the time $T' = \gamma T$ in accordance with the Lorentz transformation (4), (see figure 1). Thus the arrival of O' to A and the reading of the text on the signboard by O and O' are two simultaneous events for both observers which does not necessarily satisfy the principle of simultaneity (7), due to the fact that the giant signboard is placed in an arbitrary location; indeed if we note by x_s, x'_s, the x-coordinate of a point on the signboard relative to O and O' respectively which is read by both observers, for example the full stop at the end of the sentence "Special Relativity.", we will have for these two events: $\Delta x = x_s - L \wedge \Delta x' = x'_s$, contrary to the condition (7). In fact to be in accordance with the principle of simultaneity there is only one particular location where the giant signboard must be placed, namely the plane containing the point A, perpendicular to the direction of motion, because it's the only place ensuring $\Delta x = \Delta x' = 0$ as it has been shown in [12]. But concretely there is no reason compelling us to place the signboard in a particular location. If we would like to perform this experiment, we should in principle be free to place the signboard at any location provided that the text written on the signboard will be readable from O and A. Should we hurry up to conclude that special theory of relativity is wrong because it has failed to provide a coherent interpretation to our thought experiment by imposing an unjustified constraint from the physical viewpoint?. Absolutely not; although it exists no experiment confirming the validity of special relativity for macroscopic objets due to the current incapacity to accelerate such objects at very high speeds; the great success of this theory and its validation by mean of many experimental tests [13-16] performed at the subatomic scale in addition to its everyday confirmation in different particle accelerators without any anomaly, prevents us to make such quick conclusion, instead, we must solve the issue towards a possible existence of new relativistic effect justifying the mathematical constraint (7); it could for instance be a physical effect generated by the high speed and energy of O', by creating a sort of cloud, a fog or an intense radiation rendering invisible the giant signboard or any object situated behind or beside the moving observer at short or long diastance so that the only place where the signboard can clearly be readable for O' i.e. the only region which is not affected by this effect, would be the location predicted by the principle of simultaneity namely the the plane in front of O' containing A, perpendicular to the direction of motion (see figure 1). But if this effect actually exists, it should experimentally be detectable, thus the first step before any speculation about its features should be the proposition of a realistic experiment for the detection of our relativistic effect, then this one should be performed to confirm the theoretical predictions. In this context we will try to propose an experiment which may be the way for the detection of this effect; for that we have to convert our thought experiment into a real experiment starting with considering that O' is a relativistic

elementary particle instead of being a man traveling on a spacecraft at very high speed; in this manner our experiment will be feasible at the subatomic scale. But what about the giant signboard which is a macroscopic object and the reading of text which is a human faculty?. As a matter of fact being able to

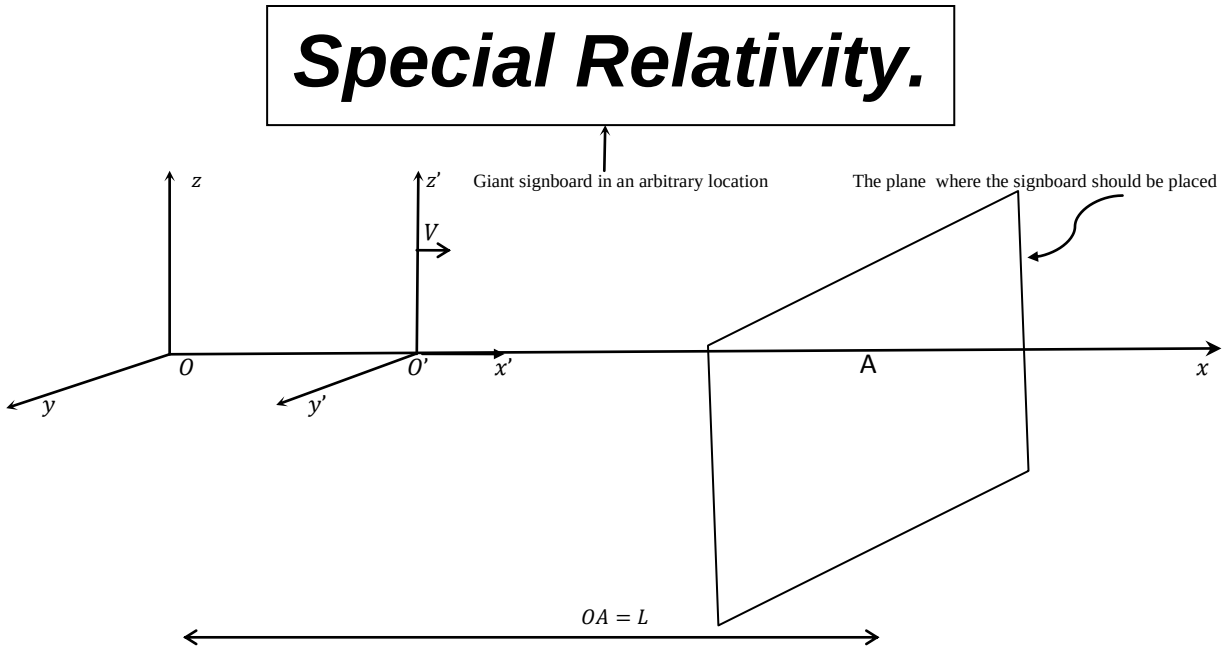

Figure 1: Two observers reading simultaneously a text written on a giant sigboard

read is above all being able to see, and the vision of the text written on the signboard is none other than the reception by the eye of the light coming from the text which is illuminated by the sun or any other source of light, so in the subatomic language this is translated into the reception of a sufficient luminous flux by a detector playing the role of eye, therfore the conversion of our thought experiment into a real experiment is to consider two light detectors $D1$ and $D2$ placed respectively in two points O and A separated with a distance $OA = L$, a relativistic elementary particle « P » is emitted from O to A with a constant velocity V relative to O where it will be detected by $D2$ at time $T = \frac{L}{V}$. It's convenient to point out that at the origin of time, « P » and O coincide, and the measure of time during the experiment is performed by the clock of O which is the origin of an inertial frame of reference (see figure 2).

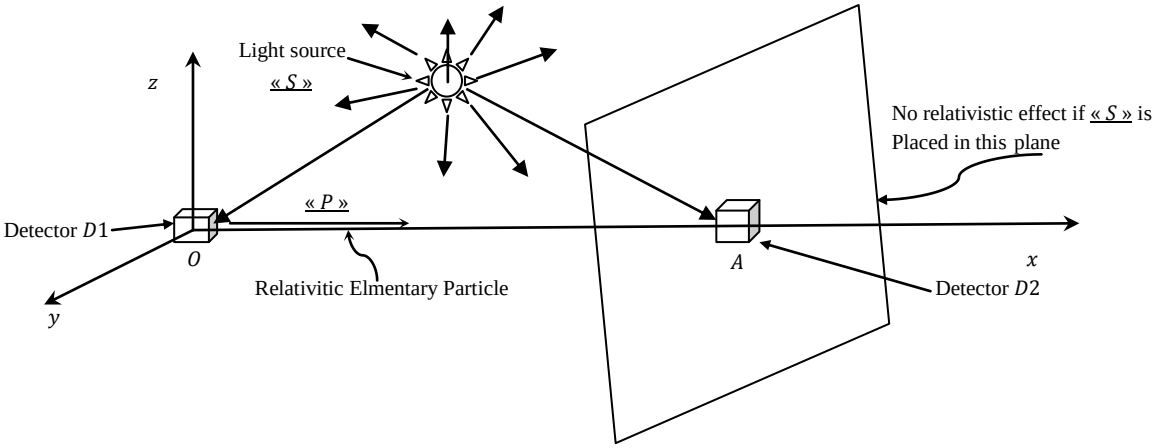

Figure 2: An experiment for the detection of new relativistic effect

A light source « S » at rest relative to O, $D1$ and $D2$, is placed in an arbitrary location for emitting a luminous flux illuminating permanently a large area surrounding the light source which include the point O and A, allowing thereby the luminous flow to be detected by $D1$ and $D2$, according to the principle of relativity, if O and « P » were two real observers they cannot read simultaneously a text written on the signboard placed in « S » otherwise the reading and the arrival of « P » to the detectors will be two simultaneous events violating the principle (7), so the only explanation for the impossibility of a simultaneous reading is in fact an incapacity for one or both observers to read the text on the signboard becoming blurred because of a blinding light or almost invisible due to the significant diminution of luminosity, unless the signboard i.e. its subatomic equivalent (the light source) is placed in the required location; consequently when « P » is emitted and the source of light isn't placed in the plane containing the point A which is perpendicular to the direction of motion of « P », a disturbance of the luminous flux detected by $D1$ (and / or) $D2$, is expected; this one may increase, owing to the presence of an intense radiation emitted for instance by « P », or one may witnessing a fall of luminosity as if the light emitted from « S » was absorbed or deviated out of the illuminated area. For the first possibility the signboard is blurred under influence of an intense light, for the second one it's unreadable due to the lack of light (darkness). These are two possible physical explanations susceptible to explain why it's impossible for both observer to read the text simultaneously, in accordance with the principle of simultaneity but it's to the experiment to determine whether the relativisitc motion of « P » induces an increase or a decrease of luminausity; one thing is certain: any anomaly related to luminosity should be the sign of a relativistic effect that this experiment aimes to detect in order to confirm the theoretical predictions of the principle of simultaneity. Since such effect has not yet been discovered, this experiment is of paramount importance.

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