Superluminal signal velocities without causality violations

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Abstract

Limits for signal velocities can be derived by requiring causality. This will be done to compare special relativity and a spacetime theory with an underlying absolute simultaneity as derived in [1]. It was calculated that in that theory clocks become de-synchronized when using slow clock transport or Einsteins synchronization procedure. By using the indicated times on these de-synchronized clocks as new time-labels, the underlying absolute simultaneity and preferred frame become hidden and the Lorentz transformations are obtained. The apparent relativity of simultaneity and apparent constant one-way velocity of light are derived instead of defined or postulated.

Let us call t_C and t_E the local time labels of the cause and effect when using Einstein synchronization, and T_C and T_E the 'true' but hidden times of the events of the cause and effect according to the theory with underlying absolute simultaneity.

Suppose we take $t_E \geq t_C$ for all frames as the causality condition in relativity theory. When describing a causal superluminal signal in one frame it is always possible to make a Lorentz-transformation to another frame in which the effect of the signal would happen before the cause ($t_E \leq t_C$). To prevent this and to have causality in all frames, the limit for a signal velocity in relativity theory is the velocity of light.

In our theory with absolute simultaneity causality means $T_E \geq T_C$. If this is true in one frame then it is true for all frames because the transformation of the times T in this theory only consists of a scaling factor and is independent of the location of the events. So in this theory it is possible to consistently describe superluminal signal velocities without causality violations in other frames. As was derived before [1], the relation between the time T and local time label t is $t = T - \vec{x} \cdot \vec{\aleph} \Big/ c^2$ where $\aleph$ is the hidden velocity of the current frame relative to the hidden preferred frame. Because we only know and use local times in experiments we can use this to express our last causality condition in terms of local time coordinates: $t_E + \vec{x}_E \cdot \vec{\aleph} \Big/ c^2 \geq t_C + \vec{x}_C \cdot \vec{\aleph} \Big/ c^2$ Rewriting this leads to the following general inequality:

$$\frac{t_E - t_C}{\|\vec{x}_E - \vec{x}_C\|} \geq -\frac{\aleph \cos\alpha}{c^2}$$

Here α is the angle between the direction of the signal $(\vec{x}_E - \vec{x}_C)$ and the direction of the hidden velocity $\aleph$. Note that for straight paths the left-hand side of the equation is equal to the inverse of the signal velocity. So now we have a general inequality for all possible faster then light signalling in this theory. When the right-hand side is negative we see that it is theoretically possible to have causal superluminal signals with $t_E \leq t_C$. If this would ever be observed experimentally we can make the following prediction: If the experiment is turned around (180 degrees) and repeated then we should get a different outcome: $\cos\alpha$ changes sign so the right-hand side becomes positive now. Because of the inequality we should now have $t_E \geq t_C$. It would also be possible to set limits on the magnitude and direction of the hidden velocity $\aleph$. According to relativity theory this velocity has to be zero and superluminal signalling cannot occur. To determine a difference and to really test the inequality, the existence of actual real superluminal signalling is needed. An advantage of this general derivation of the inequality is that it applies to any kind of possible superluminal signalling. It has been claimed that superluminal signal velocities have already been observed in experiments [2].

References

[1] A.A.J van de Ven, The principle of absolute simultaneity: Testing the conventionality of simultaneity, Presentation at International Conference on the Ontology of Spacetime, Concordia University, Canada, 11-14th May, 2004, http://alcor.concordia.ca/~scol/seminars/conference/abstracts/vandeven.rtf

[2] G. Nimtz, A.A. Stahlhofen, Macroscopic violation of special relativity, August 5th 2007, http://arxiv.org/abs/0708.0681v1

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