

CHALLENGING SPECIAL RELATIVITY: A NEW TRAIN PARADOXON

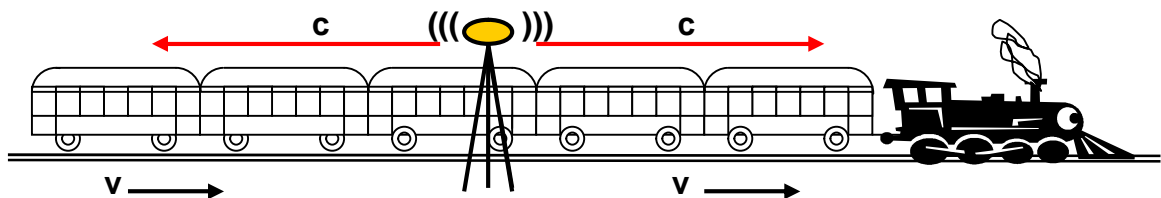
Can clock time depend on the direction of motion?

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Velocity is defined as distance travelled per time, hence $c = x/t$. The dilation of time in special relativity is given by the factor: $1/\sqrt{(1 - v^2/c^2)}$ i.e. the pace of clocks is stretched by this factor. Moreover, spaces will be stretched by $1/\sqrt{(1 - v^2/c^2)}$ as well, i.e. scales are shortened by this factor. Calculating space and time for $c' = x'/t'$, either stretching factor in the numerator and the denominator cancel out. This leads to a paradox: If the velocity of light is constant in any system, i.e. if $c = c'$, clocks will have to alter their pace depending on the direction of motion.

This is shown by the following simple example: Let a car be travelling with 60 km/h (equal 1 km/min) and let this velocity be invariant for anyone observer. Let a second car be travelling in opposite direction with 30 km/h. Hence, the relative velocity of both cars will be 90 km/h. If the car (driver) travelling in opposite direction was to measure the velocity relative to the other car as only 1 km/min, then clock time would have to be stretched from 60 min to 90 min, i.e. by the factor $1 + v/c$. If, however, the second car was travelling into the same direction, the relative velocity would be 30 km/s. If in this case, again, a relative velocity of 1 km/min was to be measured, this would mean that the clock time was shortened from 60 min to 30 min, i.e. by the factor $1 - v/c$.

Let us now consider a train passing by a shining light at rest (as shown in the figure). Let an observer in the train wish to measure the velocity of light before and after the train had passed by the source of light and let him have a look at the clock time in either case. The clock time, obviously, could not change by the sole fact that the train was passing by. What must happen?



Classically the observer in the train will obtain
before passing the light:

$$(a) \text{ velocity} = s/t \quad c' = x'/t = x \cdot (1 + v/c) / t = \underline{c + v}$$

$$(b) \text{ velocity} = \lambda \cdot f \quad c' = f' \cdot \lambda = f \cdot (1 + v/c) \cdot \lambda = \underline{c + v}$$

after passing the light:

$$c' = x'/t = x \cdot (1 - v/c) / t = \underline{c - v}$$

$$c' = f' \cdot \lambda = f \cdot (1 - v/c) \cdot \lambda = \underline{c - v}$$

Following Special Relativity the observer will obtain
Before passing the light

$$(a) \text{ velocity,} \quad x' = (x + vt) / \sqrt{(1 - v^2/c^2)}$$

$$\text{Lorentz-transformed} \quad t' = (t + vx/c^2) / \sqrt{(1 - v^2/c^2)}$$

after passing the light

$$x' = (x - vt) / \sqrt{(1 - v^2/c^2)}$$

$$t' = (t - vx/c^2) / \sqrt{(1 - v^2/c^2)}$$

$$\text{With } t = x/c \text{ and} \quad x' = x \cdot (1 + v/c) / \sqrt{(1 - v^2/c^2)}$$

$$x = c \cdot t \text{ one gets} \quad t' = t \cdot (1 + v/c) / \sqrt{(1 - v^2/c^2)}$$

$$\text{Yielding of course} \quad \underline{x'/t' = x/t = c}$$

$$x' = x \cdot (1 - v/c) / \sqrt{(1 - v^2/c^2)}$$

$$t' = t \cdot (1 - v/c) / \sqrt{(1 - v^2/c^2)}$$

$$\underline{x'/t' = x/t = c}$$

This result is obtained under the assumption that t must be transformed by the factor $1 + v/c$ or $1 - v/c$, respectively, depending on whether the measurement was done before or after the train passed by the light. Therefore, the pace of time would be larger before and smaller after the light was passed by. This would have to mean that **the same clock** (ticking with the frequency $1/t$) was **ticking slower when the light was in front** and **ticking faster when the light was behind**. This is impossible.

(b) Furthermore, the frequencies, given by the Doppler effect, would read

before passing the light, as: $f' = f \cdot (1 + v/c) / \sqrt{(1 - v^2/c^2)}$

and after passing the light as: $f' = f \cdot (1 - v/c) / \sqrt{(1 - v^2/c^2)}$

Multiplying f' with the wave length (as Lorentz shrunk) one may get c again only, if the clock time is stretched and clocks are ticking, thus, slower before passing the light. In this way, the increase in frequency caused by Doppler's effect will be outweighed, giving rise to $f \cdot \lambda = c$.

Conversely, when the light is past, clock time must be shorter and, hence, the clocks of the observer will have to tick faster in order to balance the Doppler decrease of the frequencies, giving rise to $f \cdot \lambda = c$ again.

(Alternatively, in order to get c despite Doppler's effect, the wave length would have to be shorter or longer, depending on the direction of motion – this being impossible as well.)

If the RT was correct, the Doppler effect should be absent. This is in agreement with logic principles, because, if the velocity of light is constant, as maintained by RT, the wave crests have to arrive at the observer with the same constant velocity and, hence, within the same time intervals, irrespective of any relative velocity.

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*) see further also earlier papers :

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