SCIREA Journal of Physics
ISSN: 2706-8862
http://www.scirea.org/journal/Physics
August 12, 2020
Volume 5, Issue 3, June 2020

Lorentz Transformations - The Sound versus The Light

Jan Slowak
Hakarpsvägen 51, 561 38 Huskvarna, Sweden
jan.slowak@gmail.com

Abstract

What happens if we consider two inertial reference systems that communicate with each other with **sound signals** rather than **light signals** which are used in the theory of special relativity, SR?

Keywords: Light Signals, Sound Signals, Lorentz Transformations , Special Relativity

I. Introduction

My motto:

When we study physical phenomena, we always make a mathematical model of them. In such a model, there are built-in physical laws that are held together by mathematical tools. If the description of the physical phenomenon is correct, the mathematical model is also correct!

We consider two inertial reference systems S and S'. At the beginning of the experiment, these two systems are at the same point. Events we will talk about appear on the x-axis. S' moves from left to right at a constant velocity v relative to S.

When the two reference systems coincide, their clocks are synchronized, that is, the clocks are reset, $t = 0, t' = 0$.

We assume it is windless. **We denote the speed of sound with v_0.**

We consider S to be stationary in the air, its absolute velocity in the air is zero.

II. Experiment, Part 1

Initial Conditions:

S and S' are at the same point on the x-axis. Their relative velocity is zero, $v = 0$.

We synchronize their clocks.

Then an event occurs at the point x, to the right of S, S'. See Fig. 1.

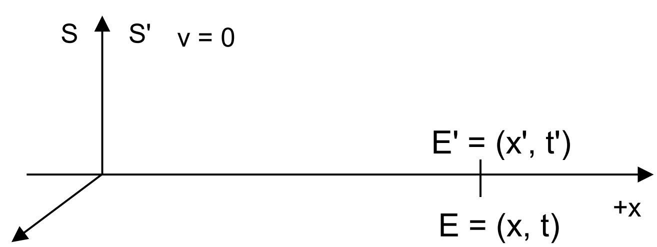

Fig. 1

When this part of experiment begins, we have $t = 0, t' = 0, x' = x$.

The event that occurs is a short beep. We analyze the event coordinates in the two reference systems. See Fig. 2.

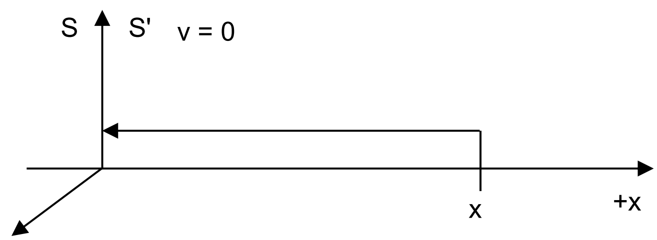

Fig. 2

Because both reference systems are at the same point and are stationary to each other, they will measure the same time.

$$t' = t = x/v_0.$$

Then the two reference systems will record the event as:

$$\text{S: } E = (x, t) = (x, x/v_0)$$

$$\text{S': } E' = (x', t') = (x, x/v_0).$$

II. Experiment, Part 2

Initial Conditions:

S and S' are on the x-axis. S' moves to the right at a constant velocity $v < v_0$.

When S' is at the same point as S, their clocks are synchronized.

At the same moment, an event occurs at the point x, to the right of S, S'. See Fig. 3.

At this moment, Fig. 1 and Fig. 3 are identical.

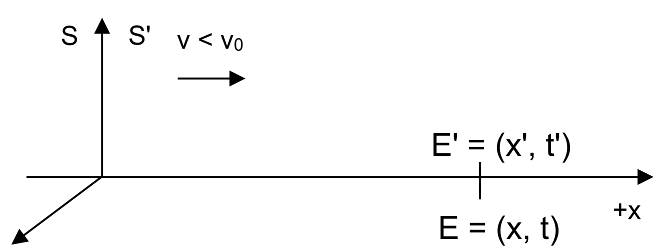

Fig. 3

What happens in this case? As the sound signal moves toward the two reference systems, S' moves to the right at a constant speed $v < v_0$.

After some time, S' meets the sound signal and registers its time to t', see Fig. 4.

We explain Fig. 4, what happens when the light signal reaches S':

When the light signal reaches S', its clock shows the time t'.

During this time, t', the signal has traveled from E to S', ES' = $v_0 t'$.

During this time, t', S' has been traveling at speed v from S, SS' = vt'.

We take a look at Fig. 5.

The beep continues towards S and when they meet, S registers its time t.

We wonder what relationship there is between coordinates of the event measured by the two reference systems. See Fig. 5.

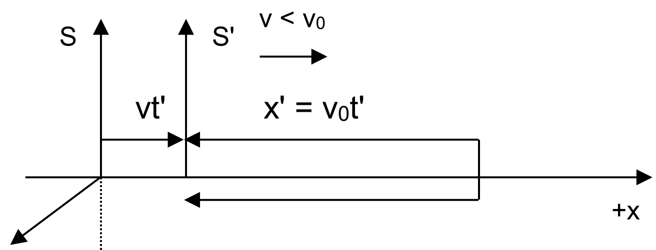

Fig. 4

Note that all distances and times containing primed variables in Fig. 5 represent the moment when the signal reaches S' (Fig. 4 or dashed lines in Fig. 5).

It is clear from Fig. 5 that $x = x' + vt' \rightarrow v_0 t = v_0 t' + vt' \rightarrow v_0 t = (v_0 + v)t' \rightarrow$

$$x = x' + vt', \; t = t'(v_0 + v)/v_0$$

and

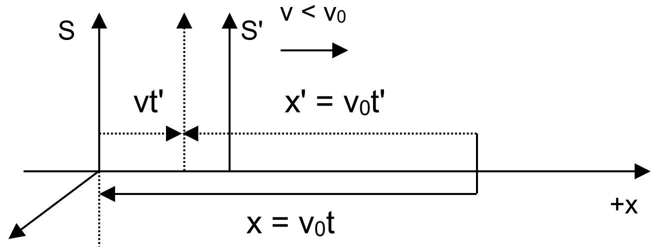

Fig. 5

$$x' = x - vt', \quad t' = tv_0/(v_0 + v) \rightarrow$$

$$x' = x - tv_0v/(v_0 + v),\ t' = tv_0/(v_0 + v).$$

III. Conclusions from experiments

The author's most important insight is that transformations between the event's measured coordinates for two inertial reference systems are the same if their relative velocity is strictly less than the velocity of the signal they are communicating with, no matter in what medium we do our experiments!

We would also like to point out that reference system S, reference system S' and the signal with which these two reference systems communicate with are **independent physical phenomena**.

The clock in S ticks at the same rate, regardless of whether there are one or more observers who are at rest against S or if they are moving relative to S.

The clock in S is ticking at the same rate, regardless of whether there are one or more signals going towards it or moving in different directions in space.

We could do similar experiments where the two reference systems are two people and where they communicate with the help of a cyclist. We would get the same transformations between the coordinates of the event.

We set these results against conditions in SR. The most important concept within SR is Lorentz transformations:

$$x' = (x - vt)\gamma \qquad (1)$$

$$t' = (t - vx/c^2)\gamma \qquad (2)$$

where $\gamma = 1/(1 - v^2/c^2)^{1/2}$ is called the Lorentz factor.

See the definition and derivation of the Lorentz transformations in [1], [2] or [3].

From the above experiment we have obtained the following:

We can conclude that for an event that occurs at a distance x from S-origo (S'-origo), the transformations between coordinates of event are as follow:

$$x' = x - tv_0v/(v_0 + v) \qquad (3)$$

$$t' = tv_0/(v_0 + v) \qquad (4)$$

where v_0 is the "signal" speed and v is the relative speed of reference systems, $v < v_0$.

IV. The Light versus The Sound

If the above experiment had been done in ether (vacuum) and instead of the sound signals we would have used light signals, we would have got the same result!

If we in (3) and (4) replace v_0 with c, the speed of light, we get:

$$x' = x - t\,cv/(c + v) \qquad (5)$$

$$t' = tc/(c + v) \qquad (6)$$

Lorentz transformations should apply to all events on the x-axis, including the event depicted in Fig. 4.

We replace (5) and (6) in Lorentz transformations (1) and (2) and make the necessary calculations.

V. Mathematical demonstration

We substitute the value of x' from (5) into (1):

$\rightarrow (x - vt)\gamma = x - t\,cv/(c + v) \rightarrow x\gamma - vt\gamma = x - t\,cv/(c + v) \rightarrow$

$\rightarrow x\gamma - x = vt\gamma - t\,cv/(c + v) \rightarrow x(\gamma - 1) = vt(\gamma - c/(c + v)) \rightarrow$

$$\rightarrow x = t(v/(\gamma - 1))(\gamma - c/(c + v) \qquad (7)$$

We substitute the value of t' from (6) into (2):

$\rightarrow (t - vx/c^2)\gamma = tc/(c + v) \rightarrow t\gamma - vx\gamma/c^2 = tc/(c + v) \rightarrow$

$\rightarrow vx\gamma/c^2 = t\gamma - tc/(c + v) \rightarrow x(v\gamma/c^2) = t(\gamma - c/(c + v) \rightarrow$

$$\rightarrow x = t(c^2/v\gamma)\,(\gamma - c/(c + v) \qquad (8)$$

From (7) and (8), results:

$(v/(\gamma - 1))(\gamma - c/(c + v) = (c^2/v\gamma)\,(\gamma - c/(c + v) \rightarrow v/(\gamma - 1) = c^2/v\gamma \rightarrow$

$\rightarrow c^2(\gamma - 1) = v^2\gamma \rightarrow c^2\gamma - v^2\gamma = c^2 \rightarrow \gamma(c^2 - v^2) = c^2 \rightarrow \gamma = c^2/(c^2 - v^2) \rightarrow$

$\rightarrow \gamma = 1/(1 - v^{2/}c^2) \rightarrow \gamma = \gamma^2$

Finally we come to the result:

$$\gamma = 1 \rightarrow \boldsymbol{v = 0}.$$

VI. Final conclusions

This is the same result that the author shows in the article

Mathematics shows that the Lorentz transformations are not self-consistent

in Physics Essays 33, 1 (2020).

This is the same result that the author of the book [4] gets in several chapters.

The reason for the above result, $v = 0$, is that we have used Lorentz transformations.

This result leads to contradiction with the initial conditions of the derivation of the Lorentz transformations. The Lorentz transformations are not self-consistent!

The Lorentz transformations are nonsense.

From this follows that the theory of special relativity is nonsense.

References

[1] R. Harris, *Modern Physics*, 2nd ed. (Pearson, London, 2008), pp. 14–15.

[2] A. Einstein, *Den Speciella Och den Allmänna Relativitetsteorin*, (Daidalos, Gothenburg, 2006), (The Special and General Theory of Relativity) (Swedish).

[3] A. Einstein, *Relativity: The Special and the General Theory*, 100th anniversary ed. (Princeton University Press, Princeton, NJ, 2015).

[4] J. Slowak, *Special Relativity is Nonsense,* 2nd ed. (Books on Demand, Stockholm, 2020).