the general science journal

An Analysis of the Special Theory of Relativity

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Ultimo aggiornamento/modifica: 9 settembre 2006
Last update: 9 september 2006
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1 *Introduction*

I find it difficult to accept the Special Theory of Relativity. I have therefore made an analysis of some of its formulas by using only elementary mathematics, and found that many of its most fundamental formulas are incorrect. If the reader does not agree, it is requested that he point out to me where I may have committed errors.

In the mathematical passages in the "discussion" toward the end of these notes, I have proposed a theory which explains the famous Michelson-Morley experiment without the use of Lorentz's transformation equations. Note that for centuries, it was supposed that the Sun orbited the Earth. Elaborate formulas were devised to calculate the orbit of the planets to agree with this supposition until the heliocentric theory of Copernicus accurately resolved the problem in a simple manner. That is to say, although certain effects may be explained by relativity theory, this does not exclude the possibility of explaining them using another.

2 *Lorentz's transformation formula according to [1]*

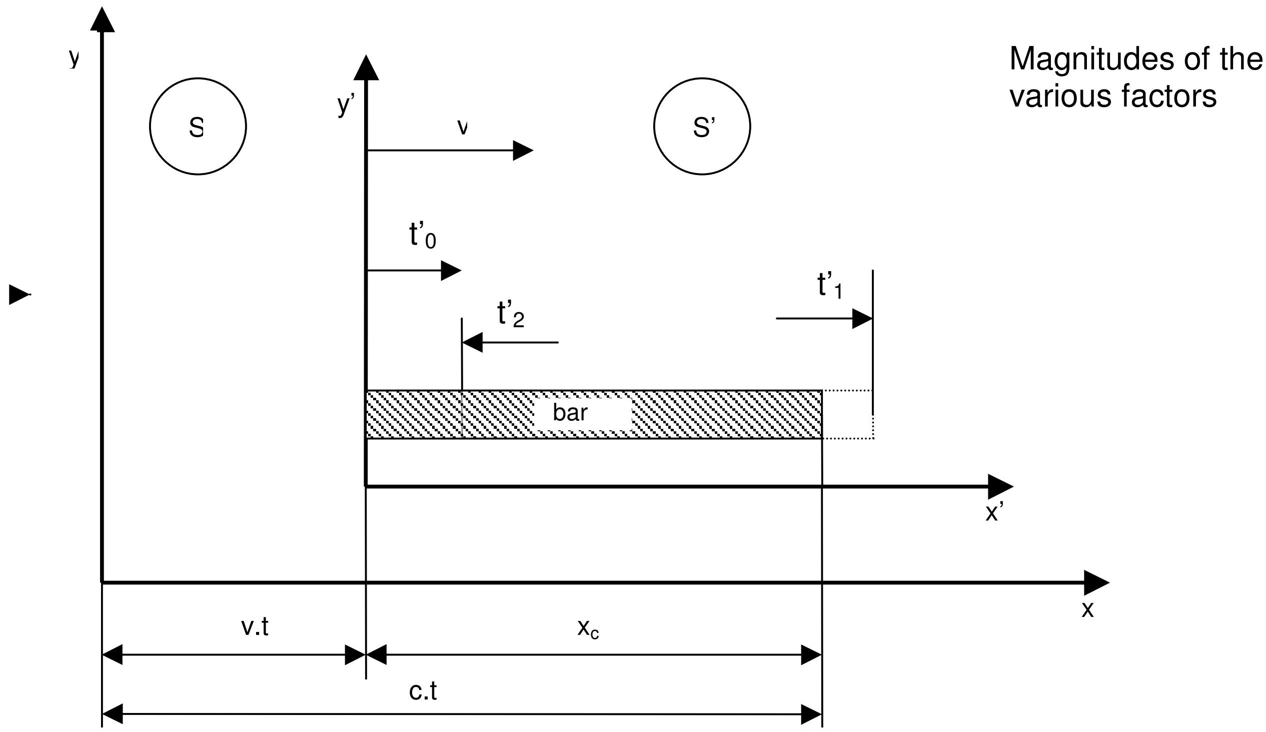
Reference is made to some passages of the book "ELEVEREMO QUESTA CONGETTURA … Percorso storico verso la teoria della Relatività Ristretta" which is the Italian translation of the famous article of Einstein's, "Zur Elektrodynamik bewegter Körper". The quotations and the formulas of the translation are found in the original article with different page number references. The article of interested is found in the Annalen der Physik und Chemie, of 1905, at pages 891 to 907.

I have substituted conventional symbols, S for K, S' for k, t' for τ, x' for ξ, y' for η e z' for ζ and so on for x' of Einstein's formulas $x_{c,}$ in the various passages to derive the formulas of transformation:

page 48	$x_c = x - vt$
page 50	$x_c = ct - vt$
page 54	$x = vt$

This system of equations, with *c* and t known, has as the solution, $x_c = 0$; $x = ct$; $v = c$
Introducing these values in the formulas of page 53 we have:

t' = 0/0 indefinite; x' = 0/0 indefinite; y' = y; z' = z



The formula can also be examined on page 54 at the bottom:

$t' = \frac{1}{\sqrt{1 - v^2/c^2}}.\left(t - vx/c^2\right)$ and $x = vt$ (the same formula is also found in page 60 of [2])

from which we have $t' = t.\sqrt{1 - v^2/c^2}$
But using the formula of page 53, $x' = \beta.(x - vt)$ with $x = vt$ we have x' = 0 and therefore using the formula at the bottom of page 51, $x'^2 + y'^2 + z'^2 = c^2 t'^2$
with y' = 0 and z' = 0 (that is a possible variant) we have $c = x'/t' = 0$!!!

3 *Perplexity regarding the development of the formulas from Einstein to [1]*

On page 50, I found the formula $t' = a\left(t - \frac{v}{c^2 - v^2}.x_c\right)$ where $a = \varphi(v)$: on page 53 $\varphi(v) = 1 \Rightarrow a = 1$ and $t' = \beta\left(t - vx/c^2\right)$ and $\beta = \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{c}{\sqrt{c^2 - v^2}}$ and at page 48, $x_c = x - vt$

so: $\beta(t - vx/c^2) = t - \dfrac{v}{c^2 - v^2}.x_c$

$\dfrac{c}{\sqrt{c^2 - v^2}}\left(t - vx/c^2\right) = t - \dfrac{v}{c^2 - v^2}.(x - vt)$ and after simplification we have

$ct\sqrt{c^2 - v^2} - (vx/c).\sqrt{c^2 - v^2} = c^2 t - vx$ where we see that to have equality, one needs to multiply the member on the left with β. This lack appears even if the development of the formulas follows the method of page 50 to 51.

For example, passing from the formula to page 51, $y' = a\dfrac{c}{\sqrt{c^2 - v^2}}.y$ to $y' = \varphi(v).y$ where $a = \varphi(v)$ [see page 50] and $\varphi(v) = 1$ [see page 53] it is not understood where the factor $\beta = \dfrac{c}{\sqrt{c^2 - v^2}}$ has gone.

As a first step for the derivation of the formulas that appear on page 53, it is said that "From the origin of system S', a beam of light is sent along the axis x toward x_c , …" It is clear therefore that no component of *c* will be found in the directions of the axes, y and z. So an indication of the time necessary to cross distance y, as indicated in the formula $\dfrac{y}{\sqrt{c^2 - v^2}} = t$ on page 50 is deprived of sense.

Taking as the base of departure for the development of the Lorentz's transformation equations of page 49, the "values" *c*-v , *c*+v and $\sqrt{c^2 - v^2}$ for light, it is also said: "and using the principle of constancy of the speed of the light in the static system"

In [2], (page 21), these are the "values" used for the speed of the light to explain the Michelson-Morley experiment. For then to conclude on page 26, that similar reasoning cannot be used and that the speed of the light [c] is always the same in all the directions is confusing.

In [3], on page 340, it is said that: "3. The speed of the light in the empty space is independent of the system of reference from which is observed. If the speed of a light signal in a Galilean reference system is *c* = 2,99733 x 10^{10} cm/sec, it will still be *c* and not *c* + V or *c* – V, in a second Galilean system moving in the same direction with speed V relative to the first system of reference."

Also in [4] on page 498, it is said that "…the negative result can be easily foreseen, since the speed of the light is *c* for all systems. The earth's motion around the sun and the rotation of 90° of the interferometer do not influence (based on the hypothesis of Einstein,) the speed of light in the interferometer. "

Why develop Lorentz's transformation equations where these "values" of *c* are used and not use them to explain the Michelson-Morley experiment? Is it not the same thing?

4 *Measurement of time by the use of light beams*

On page 46 and 47 of [1], the underlying experience is described:
"We now imagine that the axis of the bar lies along the axis x of the static system of coordinates and that a uniform motion is imparted, parallel to the axis x, with speed v, toward increasing x. …"

"We also imagine that clocks are set at the two extremities, A and B of the bar. "We imagine that beside every clock is an observer in motion, and observations apply to both the clocks according to the criterion established in paragraph 1 for their synchronization. A beam of light departs from A. at time t_A, is reflected in B at time t_B, and again reaches A at time t'_A. In consideration of the principle of the constancy of light speed, we find that

$$t_B - t_A = \frac{r_{AB}}{c - v} \qquad\qquad t'_A - t_B = \frac{r_{AB}}{c + v}$$

where r_{AB} it points the length of the bar in motion …"

On page 48 and 49, another experiment is described:
"A constant speed *v* is now given to the origin of one of the two systems (*k*), in the direction of increasing x in the fixed system, (K) and this speed is communicated to the coordinate axes,… "
"To such end we have to express by equations, the fact that τ is nothing other than the whole information of the clocks fixed in system k, that have been synchronised according to the method outlined in paragraph 1. A light beam issues from the origin of system k along the *X* axis, to *x'*, at time τ_0, then at time τ_1 it is reflected toward the origin of the coordinates, reaching it at time τ_2; as such, it has to be

$$\frac{1}{2}(\tau_0 + \tau_2) = \tau_1$$ or, introducing the matters of the function and using… "

The two experiences are not equal?
Then using the above symbols for this last formula we will have:

$$\frac{1}{2}(t_A + t'_A) = t_B \qquad \Rightarrow \qquad t_A + t'_A = 2t_B \qquad (4.1)$$

and, with the formulas of page 47, replacing r_{AB} with r :

$$t_B - t_A = \frac{r}{c - v} \qquad \text{(4. 2) e} \qquad t'_A - t_B = \frac{r}{c + v} \qquad (4.3)$$

$$-(-t_B + t'_A = \frac{r}{c + v})$$

$$2t_B - t_A - t'_A = \frac{r}{c - v} - \frac{r}{c + v} \qquad (4.2) - (4.3)$$

$$(t_A + t'_A) + \frac{2rv}{c^2 - v^2} = 2t_B$$ that is clearly not equal to (4.1) above**.**

5 The *Lorentz transformation formula according to [2]*

On page 58 to the passages explaining the derivation of the Lorentz transformation formula, there appears the formula x = v.t . This x is not the same as formula (2-4) $x^2 + y^2 + z^2 = c^2t^2$ because in setting conditions y = 0 and z = 0, we have x = *c*.t. The only way this can be dealt with is to set *c* = v (since t is the same).

We deduce therefore, that the procedure to derive the formulas of Lorentz is no longer correct. If I admit, as just shown, that with the condition x = v.t then v = *c* is obligatory and x = *c*.t, If I replace this last in formulas (2-7) I have:
x' = 0 / 0 indefinite, and also t' = 0 / 0 is indefinite.

Another consideration:

$x^2 + y^2 + z^2 = c^2t^2$ from $t = \frac{1}{c}\sqrt{x^2 + y^2 + z^2}$

and accordingly, x' and t' are functions of a variable x or t. So x and t are in fact "tied together" because choosing one, with *c*, y and z known, the other value is determined.

Example: with *c* = 8 m/s, v = 3 m/s and z = 0

x	y	t randomly		x'	y'	$\sqrt{x'^2+y'^2}$	t'	$c = \sqrt{x'^2 + y'^2} / t'$
10.0	4.0	1.000		7.551	4.0	8.545	0.573	14.911
10.0	4.0	1.346	*	6.430	4.0	7.573	0.947	8.000
10.0	4.0	2.000		4.315	4.0	5.884	1.652	3.562
10.0	4.0	3.333		0.000	4.0	4.000	3.090	1.294
10.0	4.0	4.000		-2.157	4.0	4.545	3.809	1.193

* $t = \sqrt{10^2 + 4^2} / 8 = 1{,}346 \ s$ we see therefore, since in the system in motion with the coordinates x', y' and the time t' (and also in the static system) one must always have *c* as the speed of propagation of light (for this example 8,0 m/s), and that time t and the coordinate x are "tied together". This requires an adjustment of formulas (2-7):

$$x' = \frac{x - v/c\sqrt{x^2 + y^2 + z^2}}{\sqrt{1 - v^2/c^2}}$$

$$y' = y$$

$$z' = z$$

$$t' = \frac{t - v/c^2\sqrt{c^2t^2 - y^2 - z^2}}{\sqrt{1 - v^2/c^2}}$$

$x'^2 + y'^2 + z'^2 = c^2 t'^2 \quad \Rightarrow \quad c = \frac{\sqrt{x'^2 + y'^2 + z'^2}}{t'}$ and replacing the expressions for x' and t', as used above, the speed if light is found to be *c*.

Or even more evident, if in the formulas for x' and t' above, the values y = 0 and z = 0 are inserted, we have:

$$x' = x\sqrt{\frac{c-v}{c+v}}$$

$$y' = y$$

$$z' = z$$

$$t' = t\sqrt{\frac{c-v}{c+v}}$$

which evidently results in x'/t' = x/t = *c*

With the example that follows I wish to place in evidence, the incongruity of Lorentz's transformation formula as regards time. I take three beams of light that define a spherical-surface with the centre in the origin of the coordinates of system S (see charts and the following drawing)

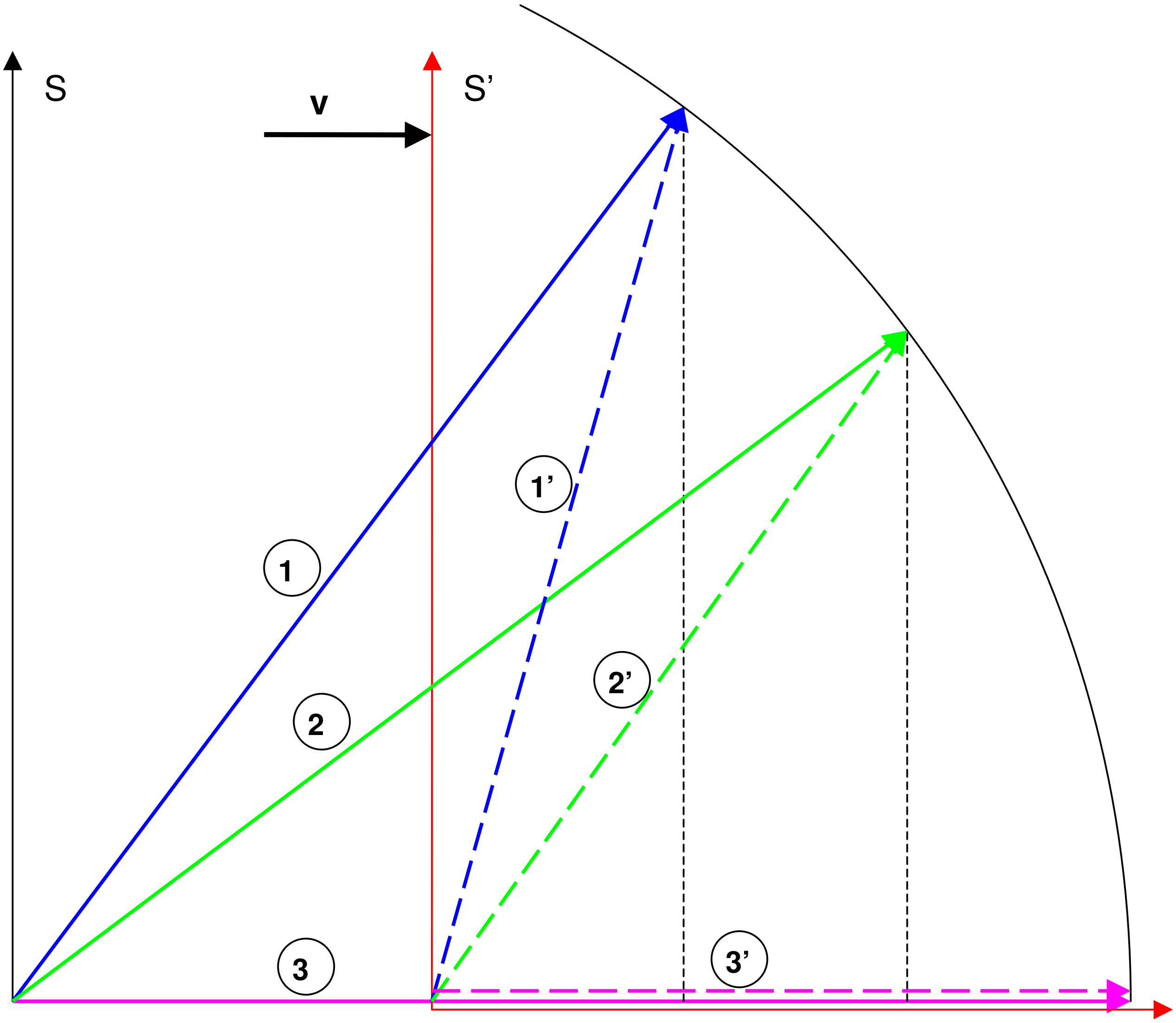
Magnitudes in system S

	c [m/s]	v [m/s]	x [m]	y [m]	z [m]	t [s]	$\sqrt{x^2+y^2+z^2}$ [m]
1	8.00	3.00	9.60	12.80	0.00	2.00	16.00
2	8.00	3.00	12.80	9.60	0.00	2.00	16.00
3	8.00	3.00	16.00	0.00	0.00	2.00	16.00

I then calculate through the famous formulas of transformation, how these magnitudes are viewed in system S'.

Magnitudes in system S'

	$\sqrt{1-v^2/c^2}$ [-]	x' [m]	y' [m]	z' [m]	$\sqrt{x'^2+y'^2+z'^2}$ [m]	t' [s]	$\sqrt{x'^2+y'^2+z'^2}\ /t'$ [m/s]
1'	0.9270	3.8834	12.80	0.00	13.3761	1.6720	8.000
2'	0.9270	7.3353	9.60	0.00	12.0817	1.5102	8.000
3'	0.9270	10.7872	0.00	0.00	10.7872	1.3484	8.000



I see that the three rays departing at the same instant both in S and S'. That is, when the origin of S' coincides with the origin of S, they have reached a destination in same instant in S, but in S' they have travelled for a different time. So the more I depart from axis x (in the direction y and/or z) the greater is the time employed,

From the formula introduced in chapter 5, this clearly results in:

$t' = \frac{t - v/c^2 \sqrt{c^2 t^2 - y^2 - z^2}}{\sqrt{1 - v^2/c^2}}$ where with *c*, v and t given, t' is a function of y and z.

In book [2] to page 74 it is admitted that you can have:
$x_2' = x_1'$ and contemporarily $t_1' \neq t_2'$, and respectively
$t_2' = t_1'$ and contemporarily $x_1' \neq x_2'$.

From the formula $x'^2 + y'^2 + z'^2 = c^2 t'^2$ (2-5) of page 58
We have:

$x' = \sqrt{c^2 t'^2 - y'^2 - z'^2}$ respectively $x_1' = \sqrt{c^2 t_1'^2 - y'^2 - z'^2}$ $x_2' = \sqrt{c^2 t_2'^2 - y'^2 - z'^2}$

considering that the coordinates y' and z' do not vary, $y_1' = y_2'$ and $z_1' = z_2'$

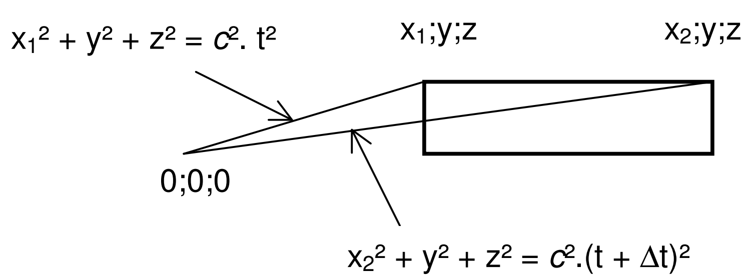
and setting: $x_2' - x_1' = 0 = \sqrt{c^2 t_2'^2 - y'^2 - z'^2} - \sqrt{c^2 t_1'^2 - y'^2 - z'^2}$

$c^2 t_2'^2 - y'^2 - z'^2 = c^2 t_1'^2 - y'^2 - z'^2$ $c^2 t_2'^2 = c^2 t_1'^2$ $\Rightarrow$ $t_2' = t_1'$

Then the hypotheses used for the two sets of problems do not hold up because with $x_2' = x_1'$, it necessarily follows that $t_1' = t_2'$ if formula (2-5) must be satisfied.

On the other hand, if I take formula $x^2 + y^2 + z^2 = c^2 t^2$ (2-4) of page 58 and I use the same reasoning, I reach the conclusion that I cannot have $x_2 \neq x_1$ with $t_1 = t_2$. This is absurd because in the same instant, the bar fixed in system S has a beginning and an end with two different x coordinates! The decision to use formula (2-4) above, was indicated by page 58 of [1] : "The wave is propagated with speed *c* in all the directions in every inertial reference system. Its propagation is then described by the equation of a sphere whose ray expands in time with speed *c* both in the primed and unprimend system of coordinates."

It is clear that the same beam of light at a determined instant can only be at one distance from its origin, and not to multiple distances. There is therefore an incongruity ! Is it correct to use formula (2-4) above to derive the Lorentz's transformation equation?



When the $x^2 + y^2 + z^2 = c^2 t^2$ formula is used, time t represents the "time of the trip" of the beam of light (beginning from origin), therefore it cannot be confused with the time represented by the instant in which the two extremities of the bar are observed. This second time is obviously only one in order to find the point where the images of the two extremities that reach the eye have departed at that same instant. The "time of the trip" will be different for the two extremities.

6 Contraction of the length and expansion of time for a bar and clock in motion

In connection with the preceding paragraph, I examined the chapter "Contraction of lengths" of [3]. On page 385 it is said: "To determine the length of the rigid bar in S', we will establish, at a certain time t', what the positions are for x_1' and x_2', so that they coincide with the ends of the bar: the distance is then the positions that coincide *simultaneously* (in S') with the ends of the bar. This is the natural definition of the length *L* in the system in motion, S':" Also for this paragraph it is the valid the observation done to the preceding point.

Also, in chapter 2.3 at page 60 of [2], the demonstrations of the contraction of the length and the expansion of time use the procedures criticized in the preceding chapter.
Also, at the bottom of page 60 is found the formula, $t' = t\sqrt{1 - v^2/c^2}$, obtained by using the Lorentz's transformation equations and admitting the condition $x = v.t$ (Einstein also used the same reasoning); while at page 389 of [3] with the same formula and the condition $x = 0$ we get the formula $t' = t\big/\sqrt{1 - v^2/c^2}$.

Another incongruity or a mistake? If space is homogeneous (Homogenitätseigenschaften) as Einstein says, because of the dependence of the value of x chosen, the time t' varies?

<u>Attention !</u>
In [2] at page 63 it is said: "Likewise *the interval of proper time* it is the interval of time recorded by a clock connected with the observed body. The interval of proper time can be thought equivalently as the interval of time among two events that happen in the same place in the reference frame S' or as the interval of time measured by an only clock in a certain place. An interval of improper time is an interval of time measured by two different clocks in two different places. This way, from the preceding discussion we see that if $d\tau$ represents an interval of proper time …"

While in [3] at page 389 it is said: "We now consider a fixed clock in the system of reference S: the result of the measure of an interval of time in the system in which the clock is *fixed* it is always consistent with τ and it is designated an *interval of proper time*. In the first text it is said that the *interval of proper time* is that measured by the clock set in a fixed point of S' and it moves with this system of reference. In the second it is said that the *interval of proper time* it is that measured by the fixed clock in the system of reference S. The two definitions of *interval* contradict one another.

To get the formula for the contraction of the lengths, Einstein reasons: "We consider a rigid sphere of ray R, in a fixed system relative to the system *k* which is in motion, whose centre is the origin of the coordinates of k. The equation of the surface of this sphere, in motion with speed v relatively to K, is

$$\xi^2 + \eta^2 + \zeta^2 = R^2$$

The equation of this surface is expressible in x, y, z at time t = 0 like …"

If the formula $x^2 + y^2 + z^2 = c^2 t^2$, with t = 0, always has to be satisfied, it is obligatory that a x, y and z must be 0. Then introducing x = 0 (besides t = 0) in the Lorentz's transformation formula we get x' = 0 and t' = 0,. That is, nothing can show the contraction of the lengths ! In [2] on page 61 formula for the contraction of length is developed with the following passages:

$x_2' = \gamma(x_2 - vt_2)$ $\quad$ $x_1' = \gamma(x_1 - vt_1)$ $\quad$ where $\gamma = \dfrac{1}{\sqrt{1 - v^2/c^2}}$

$x_2' - x_1' = \gamma[(x_2 - x_1) - v(t_2 - t_1)]$ and therefore with $t_2 = t_1$ we have $x_2' - x_1' = \gamma(x_2 - x_1)$

I proceed with the same development using the formula introduced in chapter 5, or rather:

$x' = \gamma\left(x - v/c\sqrt{x^2 + y^2 + z^2}\right)$ and I have:

$x_2' = \gamma\left(x_2 - v/c\sqrt{x_2^2 + y^2 + z^2}\right)$ and $x_1' = \gamma\left(x_1 - v/c\sqrt{x_1^2 + y^2 + z^2}\right)$

from which $x_2' - x_1' = \gamma\left[x_2 - x_1 - \underbrace{v/c\left(\sqrt{x_2^2 + y^2 + z^2} - \sqrt{x_1^2 + y^2 + z^2}\right)}_{\downarrow}\right]$

it is not simplified !

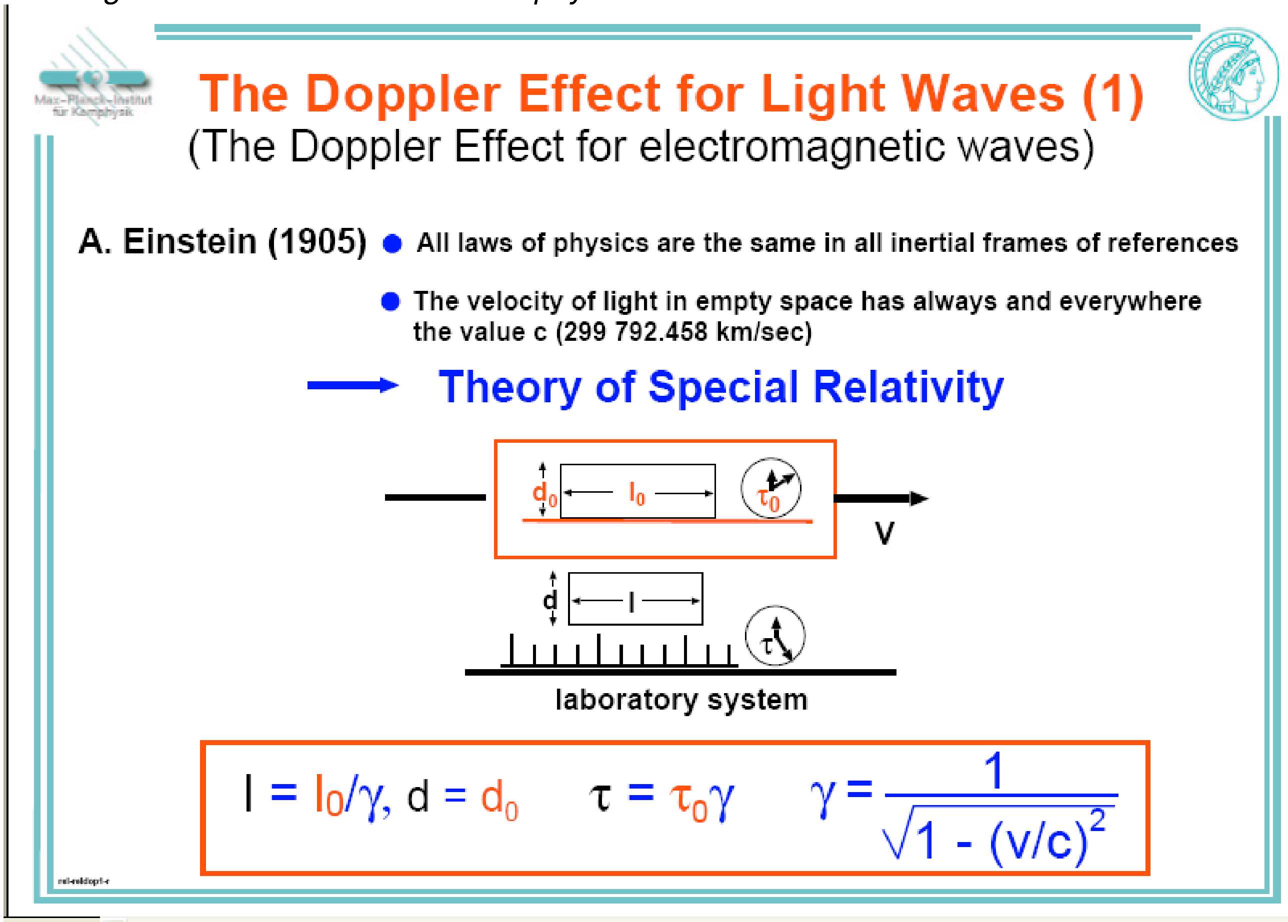
To be able to simplify the term above to the brackets, there should be $x_1 = x_2$, but in this case, the term to the right of the expression would reduce to zero!

It is given in system S, the length L_S of a bar and the speed of the light *c*.
The time in system S, for a photon that departs from the right extreme of the bar to arrive at the left is: $t_S = L_S/c$

In S' the length of the bar will be (according to the Lorentz transformation):
$L_{S'} = L_S\sqrt{1 - v^2/c^2}$ and the interval of time, $t_{S'} = t_S / \sqrt{1 - v^2/c^2}$ (6.1) ; on the other hand, the time employed by the photon to cover the length of the bar, (considering that the speed of light is also c in system S') will be;

$t_{S'} = L_{S'}/c = \left(L_S\sqrt{1 - v^2/c^2}\right)/c = (L_S/c)\sqrt{1 - v^2/c^2} = t_S\sqrt{1 - v^2/c^2}$ this is not at all equal to (6.1) determined above!

Drawing: Max-Planck-Institut für Kernphysik

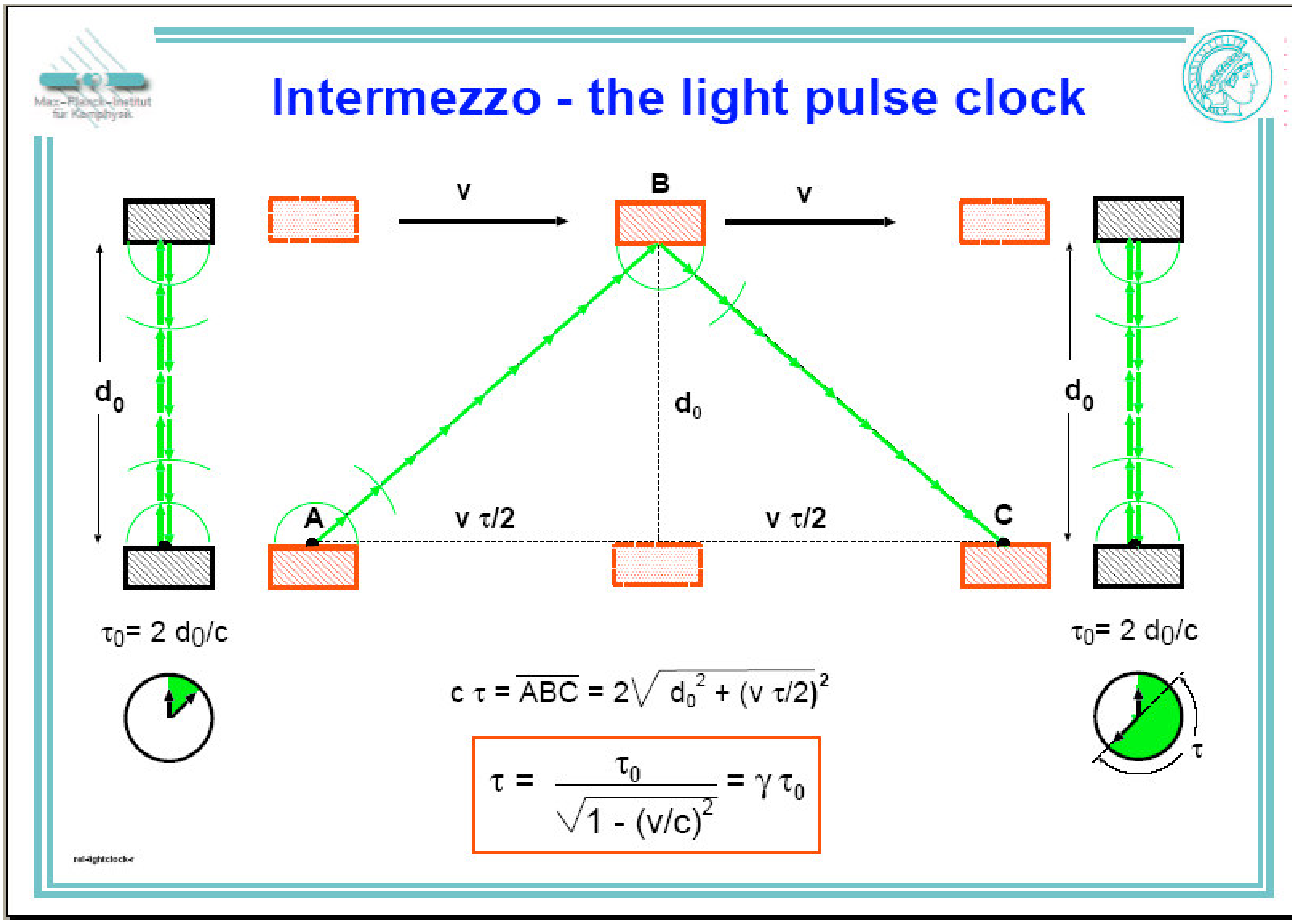


Also from the above figure, considering that the speed of light is the same in the fixed system and in the system in motion I get:

$l_0 / \tau_0 = c$ e $l / \tau = l_0 / \gamma \; . \; 1/(\tau_0 \gamma) = l_0 /(\tau_0 \gamma^2) = c / \gamma^2 \neq c$!

To explain the "expansion of the time" in [2] at page 66 and also in Max-Planck-Institut für Kernphysik , see below - they say that the passenger on the train (S') sees the light ray traverse the vertical distance and return. The observer on earth (S) see the light ray crossing the path indicated in the picture below. So the two paths have different lengths and since the speed of light is *c* for both the observers, the observer's time on earth is greater than the time measured by the passenger on the train.

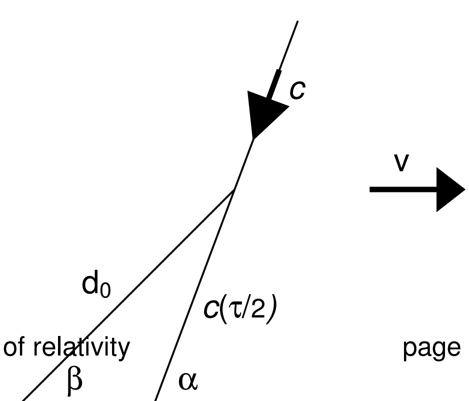
Draw: Max-Planck-Institut für Kernphysik



Attention !
The beam of light is not influenced by the speed of the source. Therefore it covers the same distance for the two observers. The observer on the train (S') doesn't have aberration! It is this phenomenon that makes it seem that the beam of light traverses a shorter path than that seen by the observer on earth.

As displayed in the figure above, the fixed observer (S) see the beam of light cover the distance: $c\tau = 2\sqrt{d_0^2 + (v\tau/2)^2}$ while the observer in motion (S') see the ray cover the distance $c\tau_0 = 2d_0$

For this second case we have to consider the effect of aberration.



d_0 = path of the beam of light seen by the observer in motion

$c(\tau/2)$ = true path of the beam of light

$v(\tau/2)$ = distance observed during the time that the beam of light has covered the space $c(\tau/2)$

$c^2(\tau/2)^2 = d_0^2 + v^2(\tau/2)^2 - 2d_0 v(\tau/2)\cos\beta$ (cosine theorem)

For $\beta = 90°$, the ray is seen to complete a vertical run, from:

$c^2(\tau/2)^2 = d_0^2 + v^2(\tau/2)^2$ $c(\tau/2) = \sqrt{d_0^2 + v^2(\tau/2)^2}$ multiplied by 2 (slope and descent)

from $c\tau = 2\sqrt{d_0^2 + v^2(\tau/2)^2}$ and is exactly what the fixed observer (S) sees. Therefore the "procedure" used here to explain the expansion of the time doesn't hold up !

I now return to the figure of the Max-Planck-Institut für Kernphysik above and we see what happens if the beam of light also has a horizontal component (l_0) for the passenger of the train. To simplify things I examine only the slope from the source to the mirror.

Observer in motion: $d_0^2 + l_0^2 = c^2\tau_0^2 \quad \Rightarrow \quad \tau_0 = \dfrac{\sqrt{d_0^2 + l_0^2}}{c}$

Fixed observer $d_0^2 + (l_0/\gamma + v\tau)^2 = c^2\tau^2$

$$d_0^2 + \frac{l_0^2}{\gamma^2} + v^2\tau^2 + \frac{2l_0 v\tau}{\gamma} = c^2\tau^2 \qquad (c^2 - v^2)\tau^2 - \frac{2l_0 v}{\gamma}\tau - d_0^2 - \frac{l_0^2}{\gamma^2} = 0$$

$$\tau = \frac{\dfrac{l_0 v}{\gamma} \pm \sqrt{\dfrac{l_0^2 v^2}{\gamma^2} + c^2 d_0^2 + \dfrac{l_0^2 c^2}{\gamma^2} - v^2 d_0^2 - \dfrac{l_0^2 v^2}{\gamma^2}}}{c^2 - v^2}$$

$$\tau = \frac{l_0 v/\gamma \pm \sqrt{d_0^2(c^2 - v^2) + l_0^2 c^2/\gamma^2}}{c^2 - v^2} \qquad c^2 - v^2 = c^2/\gamma^2$$

$$\tau = \frac{l_0 v\gamma \pm \gamma\sqrt{d_0^2 c^2 + l_0^2 c^2}}{c^2} = \frac{\gamma}{c}\left(l_0 v/c \pm \sqrt{d_0^2 + l_0^2}\right) \quad \neq \quad \gamma\tau_0 = \frac{\gamma}{c}\sqrt{d_0^2 + l_0^2}$$

In this case the explanation doesn't hold up. I conclude that only for a perfectly vertical path does it work.

An analogous experiment to explain the expansion of the time is also described in [2] in page 392 and 393. In this example however, it is considered that the light impulse covers a length L, in direction y, in the system of reference S (fixed). The observer in system S', that uniformly moves in direction x in comparison to S, sees that the distance covered is longer $2\left[L^2 + \left(\tfrac{1}{2}Vt'\right)^2\right]^{1/2}$. Also in this case aberration must not be neglected, and therefore the "expansion of time", as explained in [2], of the formulas of page 68 gives

$$\Delta t' = \Delta t.\sqrt{1 - v^2/c^2} \qquad (6.2)$$

considering that the passenger on the train sees a vertical beam of light, while the observer on the earth sees the beam of light cover an oblique path.

We see what happens if the beam of light covers a horizontal distance for the passenger of the train. He always sees the ray cover the distance in time $\Delta t' = 2d/c$. The person on earth sees the beam of light cover the distance forward in time $\Delta t_1^{'} = \dfrac{d}{c-v}$, and back in the time $\Delta t_2^{'} = \dfrac{d}{c+v}$ that give a total time of $\Delta t = \dfrac{2d}{c.(1-v^2/c^2)}$. The relationship of the two times is therefore:

$\Delta t' = \Delta t.(1-v^2/c^2)$ (6.3) is different from (6.2) !!

Does the expansion of time depend on the direction of the motion of system S' in comparison to the phenomenon that he is observing? Then we have different times in the same system S'.

7 *Formulas for composition of speeds*

Einstein, introduces at page 55 of [1] the formula $\xi = w_\xi.\tau$ to develop then the formula for composite speed. But at page 50 he has already admitted $\xi = c.\tau$, so $w_\xi = c$ by definition!

$$x^2 + y^2 + z^2 = c^2 t^2 \quad \Rightarrow \quad t = \frac{1}{c}\sqrt{x^2 + y^2 + z^2}$$

$$x' = \frac{x - vt}{\sqrt{1 - v^2/c^2}} = \frac{x - (v/c).\sqrt{x^2 + y^2 + z^2}}{\sqrt{1 - v^2/c^2}}$$

$$t' = \frac{t - vx/c^2}{\sqrt{1 - v^2/c^2}} = \frac{(1/c).\sqrt{x^2 + y^2 + z^2} - vx/c^2}{\sqrt{1 - v^2/c^2}}$$

$$x'^2 + y'^2 + z'^2 = c_{S'}^2 t'^2 \quad \Rightarrow \quad c_{S'}^2 = \frac{x'^2 + y'^2 + z'^2}{t'^2}$$

$c_{S'}$ The speed of light in the system in motion S' is equal to *c*. I have introduced this symbol not to confuse it with *c* in the following demonstration that the two magnitudes are identical.

This is logical since in the derivation of the Lorentz transformation formula it is imposed that *c* in the system S is equal to *c* in the system S'.

$$c_{S'}^2 = \left(\frac{x - v/c\sqrt{x^2 + y^2 + z^2}}{1/c\sqrt{x^2 + y^2 + z^2} - vx/c^2}\right)^2 + \frac{y^2(1 - v^2/c^2)}{\left(1/c\sqrt{x^2 + y^2 + z^2} - vx/c^2\right)^2} + \frac{z^2(1 - v^2/c^2)}{\left(1/c\sqrt{x^2 + y^2 + z^2} - vx/c^2\right)^2}$$

$$x^2 + y^2 + z^2 = c^2 t^2 \quad \Rightarrow \quad c^2 = \frac{x^2}{t^2} + \frac{y^2}{t^2} + \frac{z^2}{t^2} = w_x^2 + w_y^2 + w_z^2$$

$$c_{S'}^2 = \left(\frac{x/t - v/c\sqrt{x^2/t^2 + y^2/t^2 + z^2/t^2}}{1/c\sqrt{x^2/t^2 + y^2/t^2 + z^2/t^2} - v/c^2\, x/t} \right)^2 + \frac{y^2/t^2\left(1 - v^2/c^2\right)}{\left(1/c\sqrt{x^2/t^2 + y^2/t^2 + z^2/t^2} - v/c^2\, x/t\right)^2} +$$

$$+ \frac{z^2/t^2\left(1 - v^2/c^2\right)}{\left(1/c\sqrt{x^2/t^2 + y^2/t^2 + z^2/t^2} - v/c^2\, x/t\right)^2}$$

$$c_{S'}^2 = \left(\frac{w_x - v/c\sqrt{w_x^2 + w_y^2 + w_z^2}}{1/c\sqrt{w_x^2 + w_y^2 + w_z^2} - v/c^2\, w_x} \right)^2 + \frac{w_y^2\left(1 - v^2/c^2\right)}{\left(1/c\sqrt{w_x^2 + w_y^2 + w_z^2} - v/c^2\, w_x\right)^2} + \frac{w_z^2\left(1 - v^2/c^2\right)}{\left(1/c\sqrt{w_x^2 + w_y^2 + w_z^2} - v/c^2\, w_x\right)^2}$$

$$c_{S'}^2 = \frac{w_x^2 + \frac{v^2}{c^2} w_x^2 + \frac{v^2}{c^2} w_y^2 + \frac{v^2}{c^2} w_z^2 - 2 w_x \frac{v}{c}\sqrt{w_x^2 + w_y^2 + w_z^2} + w_y^2 - \frac{v^2}{c^2} w_y^2 + w_z^2 - \frac{v^2}{c^2} w_z^2}{\left(\frac{1}{c}\sqrt{w_x^2 + w_y^2 + w_z^2} - \frac{v}{c^2} w_x \right)^2}$$

$$c_{S'}^2 = \frac{w_x^2 + w_y^2 + w_z^2 + \frac{v^2}{c^2} w_x^2 - 2 w_x \frac{v}{c}\sqrt{w_x^2 + w_y^2 + w_z^2}}{\left(\frac{1}{c}\sqrt{w_x^2 + w_y^2 + w_z^2} - \frac{v}{c^2} w_x \right)^2} = c^2 \frac{\left(\sqrt{w_x^2 + w_y^2 + w_z^2} - w_x \frac{v}{c} \right)^2}{\left(\sqrt{w_x^2 + w_y^2 + w_z^2} - w_x \frac{v}{c} \right)^2} = c^2$$

From the above we draw the conclusion that the components of the speeds w_x, w_y and w_z cannot arbitrarily be selected, but they have to respect the condition: $w_x^2 + w_y^2 + w_z^2 = c^2$
Then for example if $w_y = 0$ and $w_z = 0$, w_x is obliged to equal *c*.

I show in the following, the formula of [2] page 79; where I have replaced u' with w'_x, since it deals with the speed along the x axis as per page 78, “For the moment we consider the particular case where all the speeds are directed along the same distance x-x’ of the two inertial references S and S’.” and on the page 81, "we have considered only untill now the transformation of parallel speed in the direction of the relative motion of the two reference systems, (the direction x-x')…. "

$x' = \dfrac{x - vt}{\sqrt{1 - v^2/c^2}} = w'_x\, t'$ and I believe that the speed w'_x can only be *c*, as also determined by formula (2-5) of page 58, $x'^2 + y'^2 + z'^2 = c^2 t'^2$, if the speeds relate to the y' and z' axes, then they are 0.

Derivation of the speed using the “conventional” method

$x' = \frac{x - vt}{\sqrt{1 - v^2/c^2}}$ and $x^2 + y^2 + z^2 = c^2t^2 \Rightarrow x = \sqrt{c^2t^2 - y^2 - z^2}$

$$x' = \frac{\sqrt{c^2t^2 - y^2 - z^2} - vt}{\sqrt{1 - v^2/c^2}}$$

I proceed to that derived for x' and get the speed w_x

$$w_x = \left(\frac{1}{2}.\frac{2c^2t}{\sqrt{c^2t^2 - y^2 - z^2}} - v\right).\frac{1}{\sqrt{1 - v^2/c^2}} = \frac{c^2t}{\sqrt{c^2t^2 - y^2 - z^2}\sqrt{1 - v^2/c^2}} - \frac{v}{\sqrt{1 - v^2/c^2}}$$

With y = 0 and z = 0; I consider only the speed in the direction x-x', and get:

$$w_x = c.\frac{c - v}{\sqrt{c^2 - v^2}} = c.\sqrt{\frac{c - v}{c + v}}$$

Book [2] example 5 of page 80

$$u = \frac{u' + v}{1 + u'v/c^2}$$

where: u is the speed of the object in comparison to system S
u' is the speed of the object in comparison to system S'
v is the speed of system S' in comparison to system S

it is said: "We can consider an electron as the reference system S, the source as the reference system S', and the other electron as the object of which we seek the speed in the reference system S."

Therefore for calculation, the reference system S' assumes the role of the source with a speed v = 0,67 *c*, and this value is used for calculating u.

But was it not determined that the speed of the light could not be influenced by the speed of the source? And the formulas preceding (those of Lorentz and therefore those for the composition of speed) were seen to be valid only for the speed of light. They were introduced particularly to be able to derive the formulas**:**

$x^2 + y^2 + z^2 = c^2t^2$ (2-4) and $x'^2 + y'^2 + z'^2 = c^2t'^2$ (2-5)

They admit only the possibility that the object moves at *c* (and entirely at *c*) both in system S and in system S'.

8 *Analysis of the formula for composition of speed*

From the formula $v = \dfrac{v'+u}{1+v'u/c^2}$ Einstein ascertains that v' and u are "symmetrical" therefore the value for v' is for u. We therefore set v' = *c* (the same result is also gotten by setting u = *c*)

$v = \dfrac{c+u}{1+u/c} = c.\dfrac{c+u}{c+u} = c$ Then if v' = *c*, and independently from the value of u, which could be also negative, v is always equal to *c*.

The paradox is that: with v' = *c* and u = - 0,9*c*, we have two speeds opposite to each other and almost of the same value, v = *c* (with v' = *c* and u = - *c* the result is indefinite); while v' = 0,9*c* and u = 0,9*c* then speed v is 180/181*c*, therefore smaller than *c* !!

9 *Longitudinal Doppler effect according to [3]*

On page 394 of [3] after having made use of Lorentz's transformations, suddenly it is said: "The necessary time for the second impulse to pass in S', from $-v\tau/(1-\beta^2)^{1/2}$ to the origin is $\Delta t' = \dfrac{\tau v/c}{(1-\beta^2)^{1/2}}$ This way, the total time in S', at receiving the two impulses in point x' = 0 and $t'+\Delta t' = ...$

We should not forget that during the time Δt', the point x' moves with speed v, therefore we will have $\Delta t' c = \dfrac{\tau v}{(1-\beta^2)^{1/2}} + v.\Delta t' \Rightarrow \Delta t' = \dfrac{\tau v}{(c-v)(1-\beta^2)^{1/2}}$

The rest of the calculation and the derivation of the final formula are no more reliable.

Still:

it is acknowledged that to have in S'; t' = 0, with x' = 0 and $t' = \dfrac{\tau}{\sqrt{1-v^2/c^2}}$ with

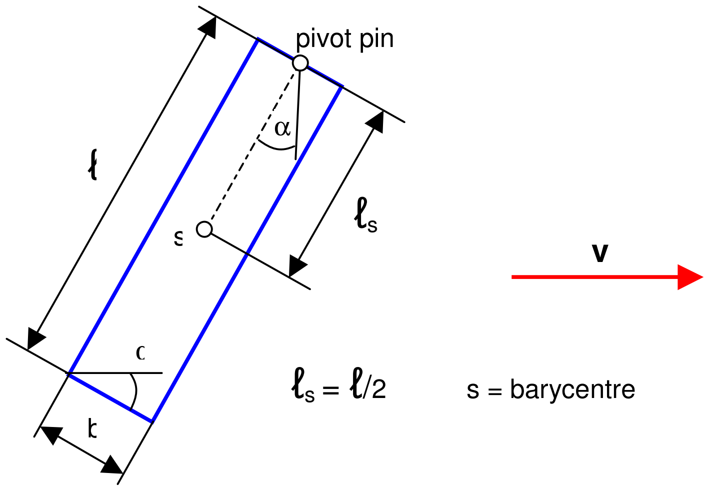
$x' = \dfrac{-v\tau}{\sqrt{1-v^2/c^2}}$

it has to be consistent with formula (2) of page 376, as a basis for developing the Lorentz's transformation $x'^2+y'^2+z'^2 = c^2t'^2$.
With the first two values above, I get: $0+y'^2+z'^2 = c.0$ and therefore it is deduced that y' = 0 and z' = 0 (if these values were different from 0 the respective squares could not cancel)

With the other two values: $x'^2 = c^2t'^2$ $\left(\dfrac{-v\tau}{\sqrt{1-v^2/c^2}}\right)^2 = c^2\left(\dfrac{\tau}{\sqrt{1-v^2/c^2}}\right)^2$ $\dfrac{v^2\tau^2}{1-v^2/c^2} = \dfrac{c^2\tau^2}{1-v^2/c^2}$

it is deduced that v = *c*; Note however with this equality, the denominator of the two members is equal to 0 ! (also see the final part of chapter 5)

10 The physical pendulum and the Lorentz's transformation



$$T = 2\pi\sqrt{\frac{J_0}{G.\ell_s}} \qquad G = m.g \qquad J_0 = J_s + m.\ell_s^2 = \frac{1}{12}m(\ell^2 + b^2) + m\ell_s^2$$

with $\ell_s = \ell/2$ $\qquad J_0 = \frac{1}{12}m(16\ell_s^2 + b^2)$

$$T = 2\pi\sqrt{\frac{1}{12}\frac{m\left(16\ell_s^2 + b^2\right)}{m.g.\ell_s}} = \pi\sqrt{\frac{4}{12}\frac{\left(16\ell_s^2 + b^2\right)}{g.\ell_s}} = \pi\sqrt{\frac{1}{3}\frac{\left(16\ell_s^2 + b^2\right)}{g.\ell_s}}$$

with the movement: in the direction of the x axis the lengths are shortened with the factor $k = \sqrt{1 - v^2/c^2}$; while in the direction of the Y axis are unchanged.

Time increases by the factor $1/k = \frac{1}{\sqrt{1 - v^2/c^2}}$

$$\ell'_s = \sqrt{(k.\ell_s.\sin\alpha)^2 + (\ell_s.\cos\alpha)^2} = \ell_s\sqrt{k^2.\sin^2\alpha + \cos^2\alpha}$$
$$b' = \sqrt{(k.b.\cos\alpha)^2 + (b.\sin\alpha)^2} = b\sqrt{k^2.\cos^2\alpha + \sin^2\alpha}$$

for α « 1 $\quad \sin\alpha \cong 0$ and $\cos\alpha \cong 1$ $\quad$ da cui $\ell'_s \cong \ell_s$ e $b' \cong k.b$
then:

$$T' \cong \pi\sqrt{\frac{1}{3}\frac{\left(16\ell_s^2 + k^2 b^2\right)}{g.\ell_s}}$$ (10.1) is obviously not equal to

$$T' = T/k = \pi\sqrt{\frac{1}{3}\frac{(16\ell_s^2 + b^2)}{k^2.g.\ell_s}}$$ (10.2)

With ℓ_s = 0,5 m; b = 0,05 m e g = 9,81 m/s²

k	T ' (10.1) [s]	T ' (10.2) [s]
0.6	0.9160	1.5276
0.8	0.9162	1.1457

11 *The mass*

Gives the three sides of a solid to form of parallelepiped: to it is the parallel length to the axis x and x', b is the width (y) and d is the height (z), the mass to rest is: $m_0 = \rho.a.b.d$

and the relativistic mass, with $a' = a.\sqrt{1 - v^2/c^2}$; $b' = b$; $d' = d$ and $\rho' = k.\rho$ is:

$$m = k\rho.a\sqrt{1 - v^2/c^2}.b.d \qquad = \rho.a.b.d.k\sqrt{1 - v^2/c^2} \qquad = m_0.k.\sqrt{1 - v^2/c^2}$$

on the other hand it is found, (for example page 115 of [2],) that $m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$

equalizing: $m_0.k.\sqrt{1 - v^2/c^2} = \frac{m_0}{\sqrt{1 - v^2/c^2}}$

$$k = \frac{1}{1 - v^2/c^2} \qquad \Rightarrow \qquad \rho' = \frac{\rho}{1 - v^2/c^2}$$

Then the density of a body in movement also changes!

In [2], problem 1 of page 149, with the solution to page 224 are said that an observer in motion "it sees the" the volume $V = abc\sqrt{1 - \beta^2}$ the mass $m = m_0/\sqrt{1 - \beta^2}$ and it concludes that $\rho' = \rho_0/\sqrt{1 - \beta^2}$; but as the density mass is not calculated divided volume? And therefore with the mass and the volume relativistic here above I would get:

$$\rho' = \frac{m_0/\sqrt{1 - \beta^2}}{abc\sqrt{1 - \beta^2}} = \frac{m_0}{abc}\frac{1}{(1 - \beta^2)} = \rho_0\frac{1}{(1 - \beta^2)}$$

what the result of the book is not.

To page 35, always of this book, it is said; "1) the laws of the physics are the same in all the inertial system. A privileged inertial system doesn't exist (Principle of relativity). "
The "formula" to calculate the density of a body is not one "physical law?"

(For an analogy also see [3] problem 3 of page 397 that determines volume.)

12 *The mass and the energy of the photon*

Taking the formulas here above $m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$ and applying it to the photon that has m_0 = 0, if this travels to v = *c*; m = 0/0 and is therefore indefinite. If however the photon in a mean transparency to a speed $c_n < c$, the mass is 0 since the numerator is 0 but the denominator is ≠ 0.
The photons are everywhere there is "light" and not only in the empty space!

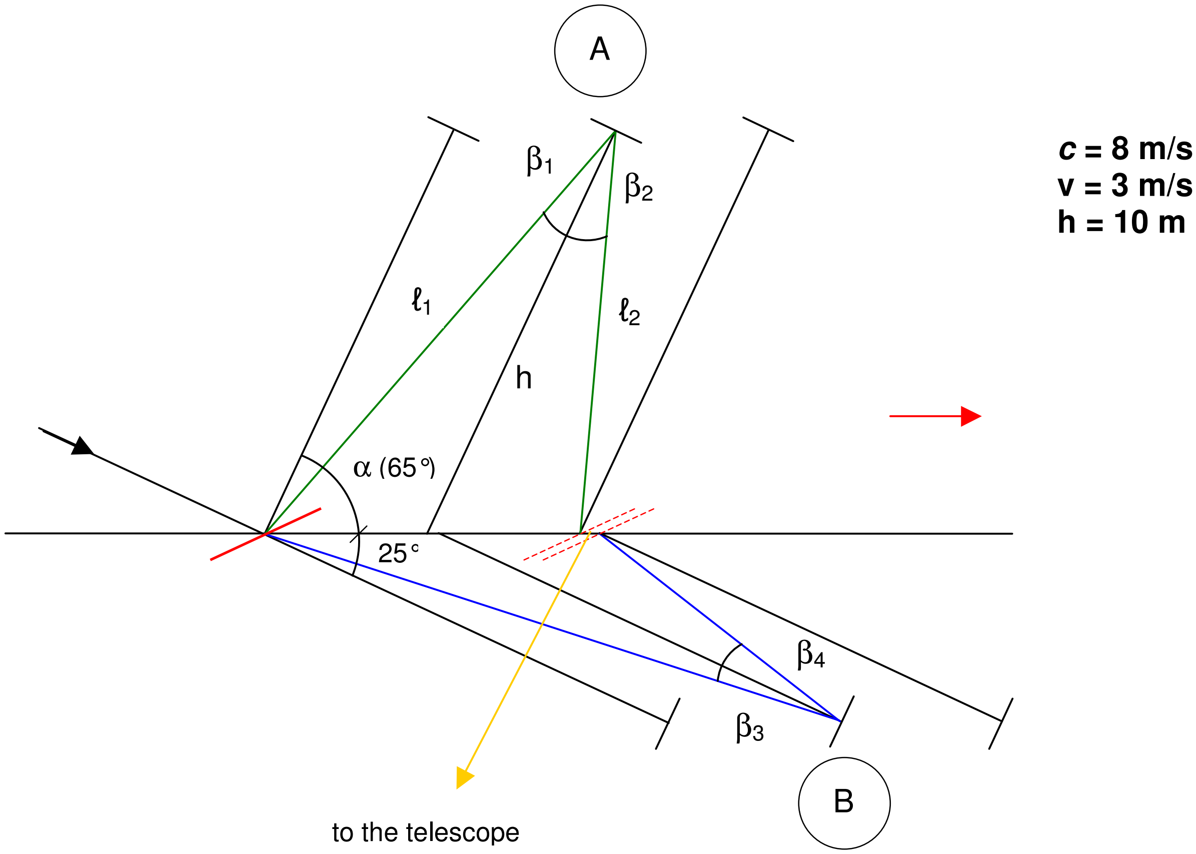
CAPITULATE TO COMPLETE
(For energy see formulas of [2] page 120 and 121)

13 *Proposal for "to explain" the experiment of Michelson-Morley*

Electromagnetic waves, and therefore light, is propagated in empty space with the speed *c* that is independent of the speed of the source. In the case of reflection or refraction in empty space, an electromagnetic wave assumes the speed:

$$c' = c + v.\cos\alpha$$

where: v is the speed of the object that produces the reflection or the refraction
and α is the angle among the vectors of the speed of light and the speed of the object that produces reflection or refraction. The speeds *c*, v and c' are measured in comparison to the "fixed" stars. For refraction in empty space it is assumed that the light ray passes from a dense transparent body to the vacuum.



$$\ell_1 = \sqrt{h^2 + v^2 t_1^2 - 2hvt_1.\cos(180° - \alpha)} = \sqrt{h^2 + v^2 t_1^2 + 2hvt_1.\cos\alpha}$$

$$t_1 = \frac{\ell_1}{c + v.\cos\varphi_1}$$

$$\varphi_1 = \arctan\frac{h.\sin\alpha}{h.\cos\alpha + vt_1} = \arccos\frac{1}{\sqrt{1 + \frac{h^2.\sin\alpha}{(h.\cos\alpha + vt_1)^2}}} = \arccos\frac{h.\cos\alpha + vt_1}{\sqrt{h^2.\cos^2\alpha + v^2 t_1^2 + 2hvt_1.\cos\alpha + h^2.\sin\alpha}}$$

$$= \arccos\frac{h.\cos\alpha + vt_1}{\sqrt{h^2 + v^2 t_1^2 + 2hvt_1.\cos\alpha}}$$

$$t_1 = \frac{\ell_1}{c + v.\cos\varphi_1} = \frac{\sqrt{h^2 + v^2 t_1^2 + 2hvt_1.\cos\alpha}}{c + v\frac{h.\cos\alpha + vt_1}{\sqrt{h^2 + v^2 t_1^2 + 2hvt_1.\cos\alpha}}} = \frac{h^2 + v^2 t_1^2 + 2hvt_1.\cos\alpha}{c\sqrt{h^2 + v^2 t_1^2 + 2hvt_1.\cos\alpha} + v(h.\cos\alpha + vt_1)}$$

$$t_1 c\sqrt{h^2+v^2t_1^2+2hvt_1.\cos\alpha}+hvt_1.\cos\alpha+v^2t_1^2=h^2+v^2t_1^2+2hvt_1.\cos\alpha$$

$$t_1 c\sqrt{h^2+v^2t_1^2+2hvt_1.\cos\alpha}=h^2+hvt_1.\cos\alpha$$

$$t_1^2c^2\left(h^2+v^2t_1^2+2hvt_1.\cos\alpha\right)=h^4+h^2v^2t_1^2.\cos^2\alpha+2h^3vt_1.\cos\alpha$$

$$t_1^2c^2h^2+t_1^4c^2v^2+2hvc^2t_1^3.\cos\alpha=h^4+h^2v^2t_1^2.\cos^2\alpha+2h^3vt_1.\cos\alpha$$

$$\underline{c^2v^2t_1^4+(2hc^2v.\cos\alpha)t_1^3+h^2(c^2-v^2.\cos^2\alpha)t_1^2-(2h^3v.\cos\alpha)t_1-h^4=0}$$

for $t_2=\dfrac{\ell_2}{c-v.\cos\varphi_2}$ **;** $\ell_2=\sqrt{h^2+v^2t_2^2-2hvt_2.\cos\alpha}$ and $\varphi_2=\arctan\dfrac{h.\sin\alpha}{h.\cos\alpha-vt_2}$

is derived:

$$\underline{c^2v^2t_1^4-(2hc^2v.\cos\alpha)t_1^3+h^2(c^2-v^2.\cos^2\alpha)t_1^2+(2h^3v.\cos\alpha)t_1-h^4=0}$$

$\beta_1=|\alpha|-|\varphi_1|$ and $\beta_2=|\varphi_2|-|\alpha|$

taking, some examples, c = 8 m/s, v = 3 m/s and h = 10 m
(performed on a Hewlett Packard 48GX calculator)

with α = 65°	t_1 = 1,20254 s	φ_1 = 49,161°	β_1 = 15,839°
	t_2 = 1,17086 s	φ_2 = 85,498°	β_2 = 20,498
with α = -25°	t_3 = 1,24143 s	φ_3 = -18,289°	β_3 = 6,712°
(65° - 90°)	t_4 = 1,21796 s	φ_4 = -38,000°	β_4 = 13,000°

The time that the ray employs that is reflected by A is:
$t_1 + t_2$ = 1,20254 + 1,17086 = 2,37340 s

The time that the ray employs that is reflected by B is:
$t_3 + t_4$ = 1,24143 + 1,21796 = 2,45939 s

or

with α = 90°	t_1 = 1,17851 s	φ_1 = 70,529°	β_1 = 19,471°
	t_2 = 1,17851 s	φ_2 = 109,471°	β_2 = 19,471°

with α = 0°	t_3 = 1,25000 s	φ_3 = 0,0°	β_3 = 0,0°
(90° - 90°)	t_4 = 1,25000 s	φ_4 = 0,0°	β_4 = 0,0°

The time that the ray employs that is reflected by A is:
$t_1 + t_2 = 1{,}17851 + 1{,}17851 = 2{,}35702$ s

The time that the ray employs that is reflected by B is:
$t_3 + t_4 = 1{,}25000 + 1{,}25000 = 2{,}5000$ s

Noticed that despite v both are about the same order of magnitude as *c,* the time employed for the two trips doesn't differ greatly. The difference is that at the angles of β that for reflection should be equal, but in the first example have a noticeable difference. Explanation: the "rays" of light are not perfectly thin, but have a spatial extension. That is the "ray" spreads from the point of reflection and "it opens" to a cone with a small angle. You will see in the example using the true value of *c* and the speed of the earth's orbit that the angles of incidence and reflection are practically equal (up to 10^{-5}).

Taking the real values of the Michelson-Morley experiment:
$c = 3.10^8$ m/s, $v = 3.10^4$ m/s e h = 11 m
(performed with a Hewlett Packard 48GX calculator)

with $\alpha = 90°$, the equation results in
$8{,}1.10^{25}\, t^4 \pm 0\, t^3 + 1{,}089.10^{19}\, t^2 \pm 0\, t - 14641 = 0$

$t_1 = 3{,}6666666483.10^{-8}$ s $\quad \varphi_1 = 89{,}99427°$ $\quad \beta_1 = 0{,}00573°$
$t_2 = 3{,}6666666483.10^{-8}$ s $\quad \varphi_2 = 90{,}00573°$ $\quad \beta_2 = 0{,}00573°$

with $\alpha = 0°$ the equation gives
$8{,}1.10^{25}\, t^4 \pm 5{,}94.10^{22}\, t^3 + 1{,}089.10^{19}\, t^2 \pm 7{,}986.10^7\, t - 14641 = 0$

$t_3 = 3{,}6666666483.10^{-8}$ s $\quad \varphi_3 = 89{,}99427°$ $\quad \beta_3 = 0{,}00573°$
$t_4 = 3{,}6666666483.10^{-8}$ s $\quad \varphi_4 = 90{,}00573°$ $\quad \beta_4 = 0{,}00573°$

and therefore the two times are equal.

With this supposition, the speed of measured light on the earth will depend on the direction travelled in comparison to the speed of the earth around the sun. We see it can vary:

data $\quad c = 300'000'000$ m/s $\quad$ and $\quad v = 30'000$ m/s

with $\alpha = 0° \quad c' = c = 300'000'000\ m/s$

with $\alpha = 90° + \arccos\frac{-vt}{h} \quad c' = \sqrt{c^2 + v^2} = 300'000'001{,}5\ m/s$

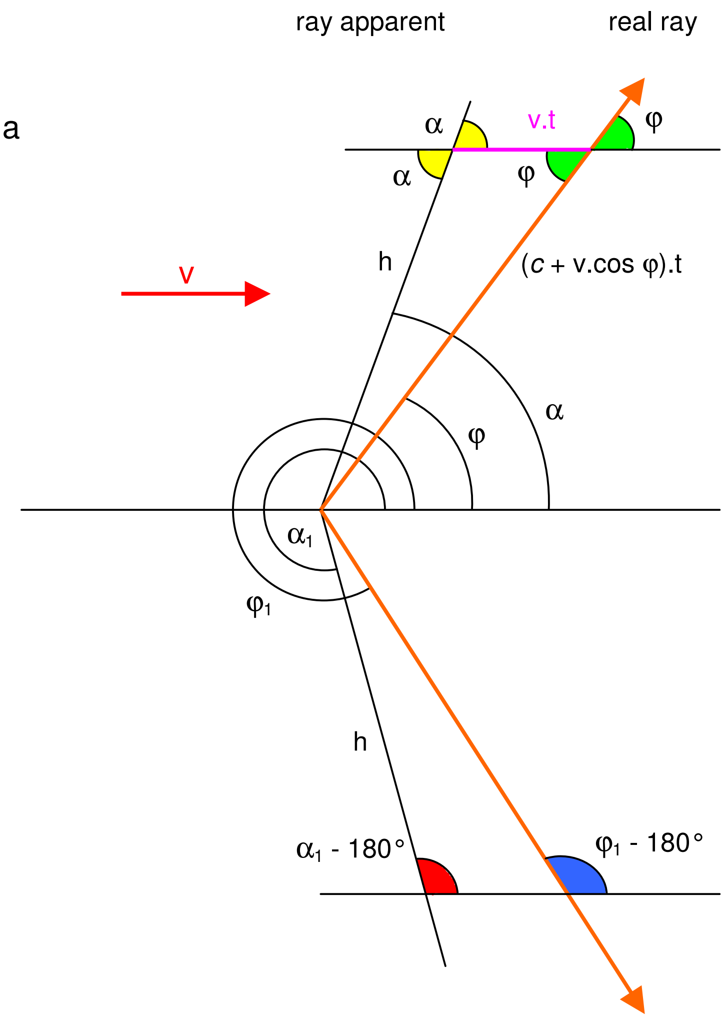
in [3] on page 397 we find that the speed of light is 299'792'457,4 ±s 1,2 m/s, therefore the maximum difference that results from the proposed formula is of the same order of the magnitude of the uncertainty. Currently the speed of light is established at 299'792'458 m/s (without uncertainty) and it serves for determining unity in SI for the length of the meter.

<u>Experiment of Kennedy -Thorndike with uneven interferometer arms</u>

This experiment is explained in the same way as that of Michelson-Morley.

14 *Aberration*

Development of a general formula



$$\frac{\sin(180° - \alpha)}{(c + \cos\varphi)t} = \frac{\sin(\alpha - \varphi)}{vt}$$ (sine theorem)

$$v.\sin\alpha = (c + v.\cos\varphi).\sin(\alpha - \varphi)$$
$$v.\sin\alpha = (c + v.\cos\varphi)(\sin\alpha.\cos\varphi - \cos\alpha.\sin\varphi)$$
$$v.\sin\alpha = c.\sin\alpha.\cos\varphi - c.\cos\alpha.\sin\varphi + v.\sin\alpha.\cos^2\varphi - v.\cos\alpha.\cos\varphi.\sin\varphi \qquad *)$$
$$(v - c.\cos\varphi - v.\cos^2\varphi).\sin\alpha = -(c.\sin\varphi + v.\cos\varphi.\sin\varphi).\cos\alpha$$
$$(v - c.\cos\varphi - v + v.\sin^2\varphi).\sin\alpha = -(c.\sin\varphi + v.\cos\varphi.\sin\varphi).\cos\alpha$$

$$\frac{\sin\alpha}{\cos\alpha} = \qquad \tan\alpha = \frac{\sin\varphi(c + v.\cos\varphi)}{c.\cos\varphi - v.\sin^2\varphi}$$

and *) $v.\sin\alpha = c.\sin\alpha.\cos\varphi - c.\cos\alpha.\sin\varphi + v.\sin\alpha.\cos^2\varphi - v.\cos\alpha.\cos\varphi.\sin\varphi$

$$v.\sin\alpha = c.\sin\alpha.\cos\varphi - c.\cos\alpha.\sin\varphi + v.\sin\alpha - v.\sin\alpha.\sin^2\varphi - v.\cos\alpha.\cos\varphi.\sin\varphi$$
$$c.\sin\alpha.\cos\varphi - c.\cos\alpha.\sin\varphi - v.\sin\alpha.\sin^2\varphi - v.\cos\alpha.\cos\varphi.\sin\varphi = 0$$
$$v.\sin\alpha.\sin^2\varphi + c.\cos\alpha.\sin\varphi + \sqrt{1 - \sin^2\varphi}(v.\cos\alpha.\sin\varphi - c.\sin\alpha) = 0$$

$$v^2.\sin^2\alpha.\sin^4\varphi + c^2\cos^2\alpha.\sin^2\varphi + 2cv.\sin\alpha.\cos\alpha.\sin^3\varphi =$$
$$v^2.\cos^2\alpha.\sin^2\varphi + c^2.\sin^2\alpha - 2cv.\sin\alpha.\cos\alpha.\sin\varphi - v^2.\cos^2\alpha.\sin^4\varphi - c^2.\sin^2\alpha.\sin^2\varphi + 2cv.\sin\alpha.\cos\alpha.\sin^3\varphi$$

$$v^2.\sin^4\varphi + c^2.\sin^2\varphi - v^2.\cos^2\alpha.\sin^2\varphi + 2cv.\sin\alpha.\cos\alpha.\sin\varphi - c^2.\sin^2\alpha = 0$$

and the equation is finally determined for calculating φ:

$$\underline{v^2.\sin^4\varphi + (c^2 - v^2.\cos^2\alpha).\sin^2\varphi + 2cv.\sin\alpha.\cos\alpha.\sin\varphi - c^2.\sin^2\alpha = 0}$$

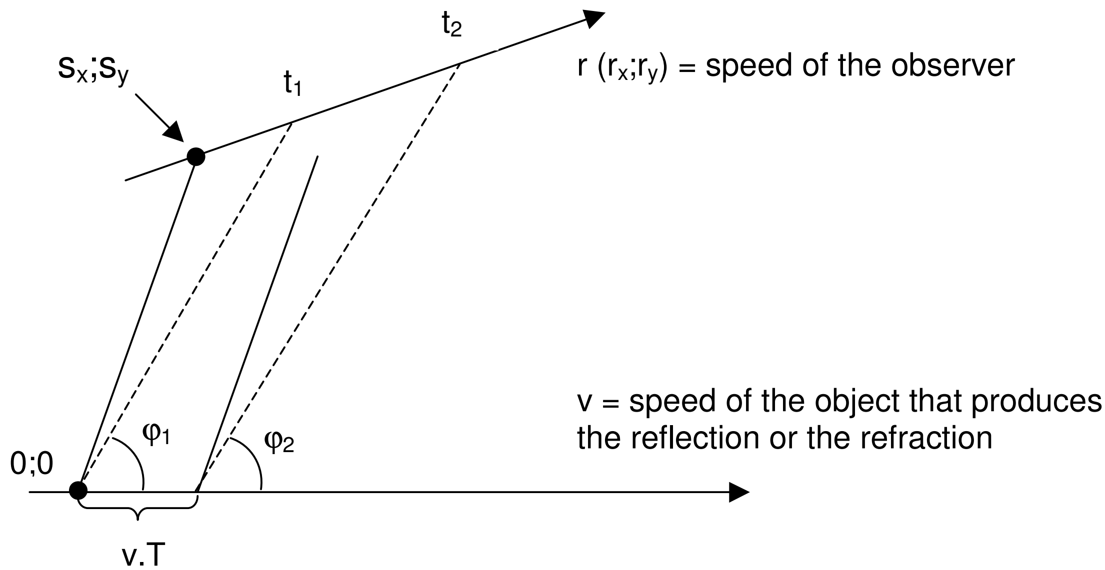
Normally when aberration occurs, the beam of light, "to arrive" on the axis of the abscissas requires replacing *c* with -*c*, in the formula to get

$$\tan\alpha = \frac{\sin\varphi(c - v.\cos\varphi)}{c.\cos\varphi + v.\sin^2\varphi}$$

Comparing this formula with formula 2-27a of [1] it is seen that the difference for $c = 3.10^8$ m/s and $v = 3.10^4$ m/s it is negligible.

φ		$\alpha = \arctan\dfrac{\sin\varphi\sqrt{1-v^2/c^2}}{\cos\varphi + v/c}$	$\alpha = \arctan\dfrac{\sin\varphi(c - v.\cos\varphi)}{c.\cos\varphi + v.\sin^2\varphi}$
0		00.0000	00.0000
30		29.9971	29.9971
45		44.9959	44.9959
60		59.9950	59.9950
90		89.9942704220	89.9942704221
90		$= \arctan\dfrac{\sqrt{1-v^2/c^2}}{v/c}$	$= \arctan\dfrac{c}{v}$
210		30.0029	30.0029

15 *Doppler Effect*



$$t_1 = \frac{\sqrt{(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2}}{c + v\cos\varphi_1} \qquad \textbf{(15.1)}$$

$$t_1 = \frac{(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2}{c\sqrt{(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2} + v(s_x + r_x t_1)}$$

$$t_1 c\sqrt{(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2} + t_1 v(s_x + r_x t_1) = \left(\sqrt{(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2}\right)^2$$

$$t_1^2 c^2 (s_x + r_x t_1)^2 + t_1^2 c^2 (s_y + r_y t_1)^2 = \left[(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2\right]^2 + t_1^2 v^2 (s_x + r_x t_1)^2 - 2(s_x + r_x t_1)^2 t_1 v (s_x + r_x t_1)$$
$$- 2(s_y + r_y t_1)^2 t_1 v (s_x + r_x t_1)$$

$$t_1^4\left(c^2 r_x^2 + c^2 r_y^2 - r_x^4 - r_y^4 - 2r_x^2 r_y^2 - v^2 r_x^2 + 2v r_x^3 + 2v r_x r_y^2\right) +$$
$$t_1^3\left(2c^2 r_x s_x + 2c^2 r_y s_y - 4r_x^3 s_x - 4r_y^3 s_y - 4r_x r_y^2 s_x - 4r_x^2 r_y s_y - 2v^2 r_x s_x + 6v r_x^2 s_x + 2v r_y^2 s_x + 4v r_x r_y s_y\right) +$$
$$t_1^2\left(c^2 s_x^2 + c^2 s_y^2 - 6r_x^2 s_x^2 - 6r_y^2 s_y^2 - 2r_y^2 s_x^2 - 8r_x r_y s_x s_y - 2r_x^2 s_y^2 - v^2 s_x^2 + 6v r_x s_x^2 + 4v r_y s_x s_y + 2v r_x s_y^2\right) -$$
$$t_1\left(4r_x s_x^3 + 4r_y s_y^3 + 4r_y s_x^2 s_y + 4r_x s_x s_y^2 - 2v s_x^3 - 2v s_x s_y^2\right) - s_x^4 - d_y^4 - 2s_x^2 s_y^4 = 0$$

Calculation of t_2

$$(t_2 - T)(c + v\cos\varphi_2) = \sqrt{(s_x + r_x t_2 - vT)^2 + (s_y + r_y t_2)^2}$$

$$(t_2 - T) = \frac{\sqrt{\left[s_x + r_x(t_2 - T) + r_x T - vT\right]^2 + \left[s_y + r_y(t_2 - T) + r_y T\right]^2}}{c + v\cos\varphi_2}$$

$$(t_2 - T) = \frac{\sqrt{[s_x + (r_x - v)T + r_x(t_2 - T)]^2 + [s_y + r_y T + r_y(t_2 - T)]^2}}{c + v\cos\varphi_2}$$

Compared with 1)

$$t_1 = \frac{\sqrt{[s_x + r_x t_1]^2 + [s_y + r_y t_1]^2}}{c + v\cos\varphi_1}$$

Then to calculate t_2, the formula can be used for t_1, replacing for s_x → $[s_x + (r_y - v)T]$ and for s_y → $[s_y + r_y T]$. The result is $(t_2 - T)$, therefore adding T, t_2 is found.

A simple case with v and r_x in the same direction, gives $s_y = 0$; $r_y = 0$; $\cos\varphi_1$ e $\cos\varphi_2 = 1$

$$t_1(c + v\cos\varphi_1) = \sqrt{(s_x + r_x t_1)^2 + (s_y + r_y t_1)^2}$$ with the condition set above

$$t_1(c + v) = s_x + r_x t_1 \qquad t_1[c + (v - r_x)] = s_x \qquad t_1 = \frac{s_x}{c + (v - r_x)}$$

$$(t_2 - T)(c + v\cos\varphi_2) = \sqrt{(s_x + r_x t_2 - vT)^2 + (s_y + r_y t_2)^2}$$ with the condition set above:

$$(t_2 - T)(c + v) = s_x + r_x t_2 - vT = s_x + r_x t_2 - r_x T + r_x T - vT = s_x + (t_2 - T)r_x - (v - r_x)T$$

$$(t_2 - T)[c + (v - r_x)] = s_x - (v - r_x)T$$

$$t_2 = \frac{s_x - (v - r_x)T + cT + (v - r_x)T}{c + (v - r_x)} = \frac{s_x + cT}{c + (v - r_x)}$$

$$T' = t_2 - t_1 = \frac{s_x + cT - s_x}{c + (v - r_x)} = T\frac{c}{c + (v - r_x)}$$ it is seen therefore that the Doppler effect depends on the difference of v and r_x , That is, for the motion of the “source” (object that produces the reflection or the refraction) and that of the observer they have the same effect. For sound it is not the same thing. Inserting *c* in the development of the formula above instead of *c*+v.cosφ then: $T' = T\frac{c - v}{c - r_x}$ is derived.

16 *Conclusions*

I have introduced quite a number points whose interpretation doesn't hold. Even if certain phenomena seemingly can be explained with the special theory of relativity, it is not excluded that they also can be explained by another theory that is not in conflict with common sense and that doesn’t introduce the incongruities found in the preceding.

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