The core mathematical error of Einstein's Special Relativity Theory

(The origin of the relativistic paradoxes in the pre-relativistic Electrodynamics)

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Abstract

This article shows that it is mathematically impossible for Einstein's Special Relativity Theory (SRT) to use its own Lorentz transformation (LT), and it also reveals: the origin of this error in the pre-relativistic Electrodynamics, and the main causes of misunderstandings between the advocates of SRT and the critics of SRT, regarding the relativistic paradoxes of LT.

1. Preliminary considerations:

The following features of the SRT framework will be invoked in our reasoning:

- The Principle of Relativity (PR), known also as the First Postulate of Special Relativity:

> "*All inertial frames are* ***equivalent*** *for the performance of all physical experiments*." [1]

- The standard "direct" Lorentz Transformation:

We will use here the algebraical form of the standard Lorentz transformation [1], [2], [3]. Considering two inertial frames S and S', each having a Cartesian system of coordinates of the (*x, y, z, t*) form, the velocity **v** of S' as measured from S, and the velocity ***c*** of light, the LT equations applied in S about S' are:

$$\mathbf{x' = \gamma\,(x - vt)} \quad , \quad \mathbf{y' = y} \quad , \quad \mathbf{z' = z} \quad , \quad \mathbf{t' = \gamma\,(t - vx/c^2)} \quad , \quad \gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \qquad \textbf{(1)}$$

The equations (1) assume that all the respective axes of the coordinate systems of S and S' are parallel, the X axis of S and the X' axis of S' are collinear and oriented so that the origin O' of S' is moving on the **positive** side of X of S, while the origin O of S is moving on the **negative** side of X' of S'. Fig. 1 represents the systems using only the coordinates (x, t) and respectively (x', t'):

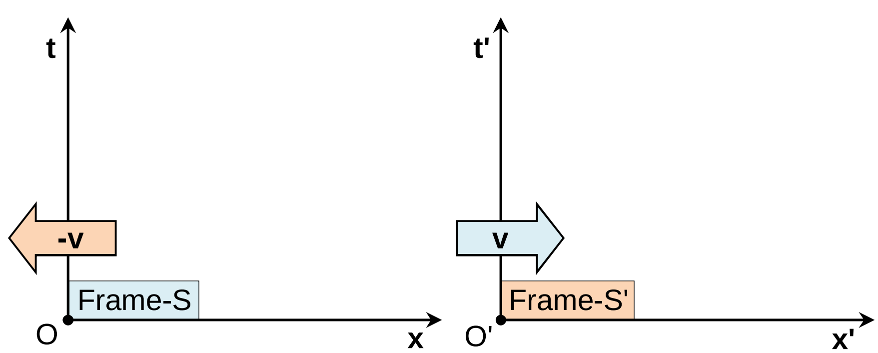


Fig. 1 - The origin O' of S' is moving on the positive side of X of S **, while the origin O of S is moving on the** negative side of X' of S'**. The velocities of each system within the other have** opposite signs**.**

2. The core mathematical error of the Special Relativity Theory

When SRT enforces the LT, the observer in S must assume that the X' axis of S' should have the same orientation as the the X axis of S. In consequence, SRT obliges the observer in S' to only use the so-called "inverse" Lorentz transformation, obtained by replacing **v** with **−v** :

$$\mathbf{x = \gamma\,(x' + vt')} \quad , \quad \mathbf{y = y'} \quad , \quad \mathbf{z = z'} \quad , \quad \mathbf{t = \gamma\,(t' + vx'/}c^2\mathbf{)} \qquad \mathbf{(2)}$$

However, **that enforcement violates the Principle of Relativity** (PR), which states that all the inertial frames are **equivalent**, and that the physical experiments should have the same performance and the same formal representation in all the inertial frames.

In this context, the physical experiment is about an inertial object/frame moving away from another inertial object/frame. The experiment's performance should be established for all frames equivalently. For example, an experiment could require the following to be performed:

> *The observer within a frame will see the other frame moving away from him/her on the positive direction of the X axis of his/her frame. That also means he/she measures a positive magnitude of the velocity* **v** *of the other frame.*

If the Special Relativity Theory would respect its own Principle of Relativity, it would require the experiment to be performed equivalently in all inertial frames, as represented in Fig. 2:

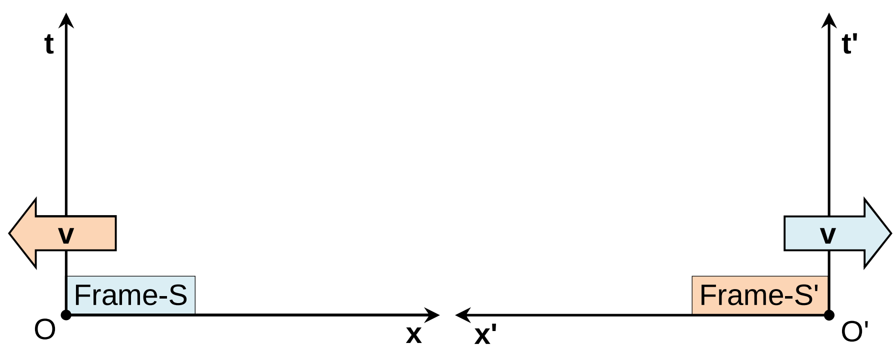


Fig. 2 - To respect the Principle of Relativity, the equivalent representation of the experiment **should** require **the origins O and O' of the systems to move** on the positive side **of respectively X and X'. As a result, the respective velocities measured in each system about the other system have the** same sign**.**

However, when PR is respected by SRT, the application of LT becomes a **mathematical error**:

The LT applied in S about S' ("direct" LT):

$$\mathbf{x' = -\,\gamma\,(x - vt)} \quad , \quad \mathbf{y' = y} \quad , \quad \mathbf{z' = z} \quad , \quad \mathbf{t' = \gamma\,(t - vx/}c^2\mathbf{)} \qquad \mathbf{(3)}$$

The LT applied in S' about S ("inverse" LT):

$$\mathbf{x = -\,\gamma\,(x' - vt')} \quad , \quad \mathbf{y = y'} \quad , \quad \mathbf{z = z'} \quad , \quad \mathbf{t = \gamma\,(t' - vx'/}c^2\mathbf{)} \qquad \mathbf{(4)}$$

where $\gamma = \dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$ for both sets of equations, (3) and (4).

For the points of the origins O', and O, we have x' = 0 and respectively x = 0 . That means:

(*from eq. 3*) $\mathbf{x = v\,t}$ => $\mathbf{t' = t\,\gamma\,(1 - v^2/c^2)}$ => $\boxed{\mathbf{t' = t / \gamma}}$ **(5)**

(*from eq. 4*) $\mathbf{x' = v\,t'}$ => $\mathbf{t = t'\gamma\,(1 - v^2/c^2)}$ => $\boxed{\mathbf{t = t'/ \gamma}}$ **(6)**

The equations (5) and (6) cannot be valid together unless $\gamma = 1$.

However, as $\gamma = \dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$, for $0 < v < c$ we always have: $\gamma > 1$.

That means the equations (5) and (6) are in a **mathematical contradiction**.

3. Eliminating one assumption does not repair the mathematical error

The contradiction in the case of Fig. 2 appears while the observers of each frame obey the PR and the performance requirements of the experiment, and apply the LT after they assume that the other frame also obeys identically the PR and the experiment.
Simply put, this type of contradiction appears when the observer within each frame has the certainty that the other frame obeys the same laws of physics and the requirements of the experiments.

Eliminating that assumption (which each frame can make about the other's obeying PR) will not solve the problem:

Another type of contradiction appears when each frame's observer is unaware about the other frame's compliance with the experiment and even with the laws of physics. In such case, the assumption about the orientation of the other frame's coordinate system is not made by an observer. Instead, it is provided by the SRT theory itself.

Since an observer in frame S can apply blindly the definition of LT from the textbooks, obtaining the setting in Fig. 1, an observer in frame S' can apply blindly the same definition, from his/her perspective of observing frame S. Thus the observer in frame S' will have the setting as in Fig. 3:

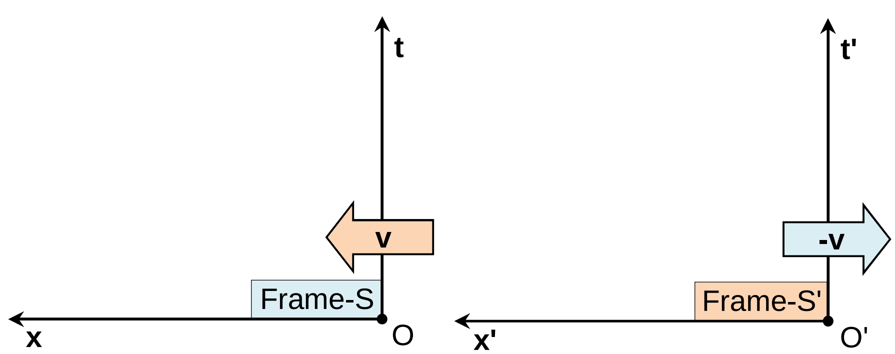


Fig. 3 - The origin O of S is moving on the positive side of X' of S'**, while the origin O' of S' is moving on the** negative side of X of S**. Note also** the opposite signs of the respective velocities **measured in each system about the other system. This representation mirrors the one in Fig. 1.**

In this case, the LT applied in S' about S ("direct" LT):

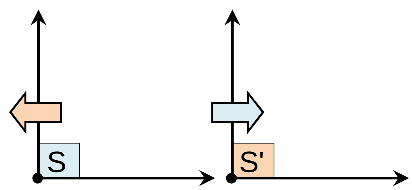
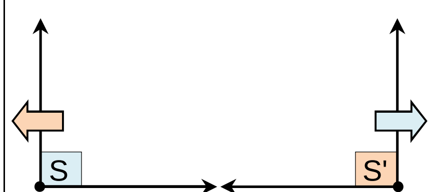
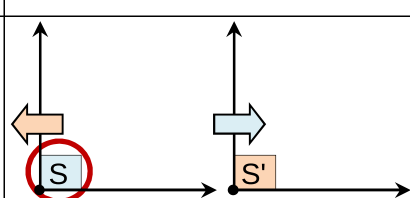
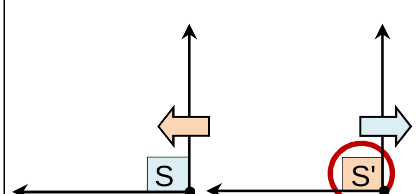
$$\mathbf{x = \gamma\,(x' - vt')} \quad , \quad \mathbf{y = y'} \quad , \quad \mathbf{z = z'} \quad , \quad \mathbf{t = \gamma\,(t' - vx'/}c^2\mathbf{)} \qquad \mathbf{(7)}$$

And then, the LT applied in S about S' ("inverse" LT):

$$\mathbf{x' = \gamma\,(x + vt)} \quad , \quad \mathbf{y' = y} \quad , \quad \mathbf{z' = z} \quad , \quad \mathbf{t' = \gamma\,(t + vx/}c^2\mathbf{)} \qquad \mathbf{(8)}$$

The contradictions are obvious between the pairs of equations [(1),(7)] and respectively [(2),(8)].

4. A synopsis of the logical and mathematical errors of SRT outlined hereby

Error Type	**Error context**	**Example of orientations of coordinate systems**	**Expressions in mathematical contradiction**
Logical error	Violation of PR of SRT: The equivalence of the inertial frames is broken by illogically enforcing the orientation of coordinate systems of two frames, when applying standard LT within one frame about the other.		Without PR in effect, the actual SRT theory is no longer a valid theory, and no longer in effect in this case. The practical use of LT in such a context is actually based on a different theory which allows the use of a preferred frame, e.g. the Lorentz Ether Theory.
Mathematical error Type I	PR of SRT is completely in effect: Any inertial frame assumes that all other frames obey PR (i.e. are equivalent) and obey the same performance requirements of a mechanics experiment(*).		(5) and (6): $t' = t / \gamma$ $t = t' / \gamma$
Mathematical error Type II	PR of SRT is superficially in effect: Any inertial frame is unaware of whether or not other inertial frames obey PR and experiment requirements(*). Hence the observer in each frame obeys individually the requirements of the experiment(*) and applies blindly the standard LT.	 *and respectively:* 	[(1), (7)] *and* [(2), (8)]

(*) By "*performance requirements of a mechanics experiment*" we mean the description of the experiment and the description of the observation of the experiment. An example of such requirements can be found above, in section 2.

5. The origin of the mathematical errors of Special Relativity Theory

As we saw in the previous sections, the aspect which generates contradictions between the calculations of LT done by observers in different frames (about each other's coordinates), is merely the orientation of the axes of the frames' coordinate systems.

However, by disregarding the equivalence required by the Principle of Relativity, hence by disregarding the Special Relativity Theory, we would remain with a working form of the Lorentz transformation (free from mathematical contradictions) which requires a special arrangement of the orientations of coordinate systems.

Mentioning again that a working form of the Lorentz transformation is no longer part of Special Relativity, we ask: what could have caused the necessity of orienting the coordinate systems in a certain way?
The answer comes from the history of the development of the Lorentz transformation:

The Lorentz transformation has been invented exclusively **for the study and research of Electrodynamics, not for some general considerations about Classical Mechanics**.

The works of Voigt [4], Lorentz [5], Larmor [6], Poincaré [7], Minkowski [8] et al. developed various forms of what we call now the *Lorentz transformation*, exclusively for describing the properties of electromagnetic (EM) fields and electromagnetic waves.

Thus, the description of an electromagnetic wave for an observer moving away from the source needed to respect the direction of propagation of that wave through the absolute space (ether), i.e. when the observer's motion was codirectional with the propagation of the wave, as in Fig. 4:

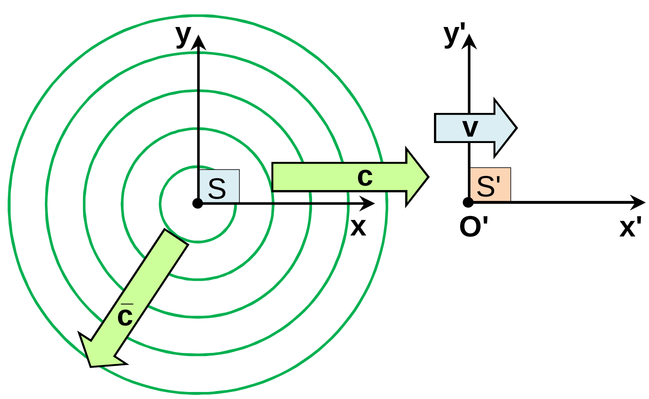


Fig. 4 - In the classical (pre-relativistic) electrodynamics, the Voigt-Lorentz transformation appeared from the necessity of describing an EM wave by an observer moving away from the static point in which the wave originated. The wavefronts also move away from their point of origin. That is why the frame S' was chosen to be moving on the positive side of X of S.

Any of the physicists mentioned above would have invented a different form of the Lorentz transformation, if they had considered the observer as moving against the direction of propagation of the EM wave (observer's motion and wave's propagation are contradirectional).

Moreover, if they had pictured the observer as moving *in the direction* of propagation of an EM wave, and at the same time that observer was also moving against the direction of propagation of **another** EM wave, then they would have been compelled to consider at the same time both a "standard" Lorentz transformation and a "different" LT, for describing the relations of the moving observer with the same stationary frame (all EM fields manifest in existence within the same stationary frame), for the two respective waves, as pictured in Fig. 5:

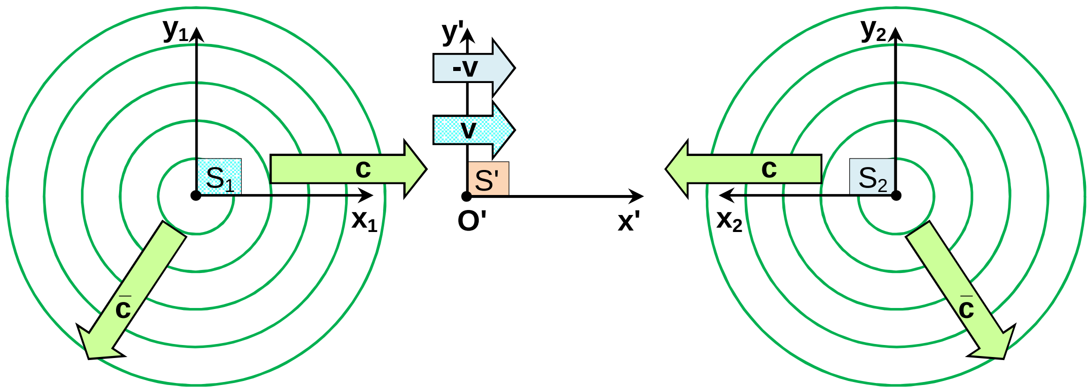


Fig. 5 - An observer S' moving between the static points S_1 and S_2 from which two opposing waves were generated. S' moves co-directionally with the wave relative to S_1, **while** it moves against the other wave's propagation relative to S_2. **As a consequence, two different contradictory LT would relate S' with the unique frame S which contains the points S_1 and S_2.**

• The unique frame S containing points S_1 and S_2 is the stationary frame for which the Maxwell's equations for electromagnetic (EM) fields were written. All the pre-relativistic physicists considered it as special medium named "ether" ("aether"), at absolute rest in space.
Even if such medium does not exist in reality, the consideration of the immovable instances of the EM fields, appearing and disappearing in space to form EM waves, can compose a unique frame which functions as an absolute reference frame (ARF) [13].

All the works of electrodynamics mentioned above referred to that ARF, including the work of Minkowski about spacetime. Even Minkowski considered the electric and magnetic fields as fixed in space, in his calculations:

> "*... keeping* $\mathfrak{e}$, $\mathfrak{m}$, $\mathfrak{w}$, *fixed in space ...*" [8]

In a different notation, Minkowski's variables would be: **e** - the electric induction, **m** - the magnetic force, and **w** - the velocity of the matter moving through ether.

• The points S_1 and S_2 do not represent the motion of the sources of the two EM waves. They are only the points where the sources were present at the moment of their respective emissions.

• The meaning of the orientation of each "X" axis, originating in S_1 and respectively S_2, is that an "X" axis indicates the propagation of the respective EM wave towards the observer.

Describing the development of LT from a historical perspective, Wolfgang Engelhardt showed in his 2013 article [9] how the Lorentz transformation would make the form of the equation of a wave (of amplitude A) appear the same for a moving observer S' in reference to the stationary ARF. First, he considered the Galilean transformation applied to the wave equation:

> *"For a wave polarized in y direction, e.g., and travelling in x-direction one may write for the y-component of A:*
>
> $$c^2 \frac{\partial^2 A}{\partial x^2} = \frac{\partial^2 A}{\partial t^2} \quad " \qquad (9)$$
>
> *"[...] If an observer travels along the x-axis, i.e. parallel to the k-vector, with velocity v, we have the obvious Galilei connection between his coordinates (x′, t′) and the wave coordinates:*
>
> $$x' = x - v\,t\,, \qquad t' = t \quad " \qquad (10)$$

After several calculations, *"the wave equation in the moving system"* has a different form:

$$" \quad c^2 \frac{\partial^2 A}{\partial x'^2} = v^2 \frac{\partial^2 A}{\partial x'^2} - 2v \frac{\partial^2 A}{\partial x' \partial t'} + \frac{\partial^2 A}{\partial t'^2} \quad " \qquad (11)$$

Then, presenting the evolution of the Lorentz transformation from Voigt, to Lorentz, to Poincaré and to Einstein, W. Engelhardt showed by calculations that the use of a final form of LT - which we mentioned in the beginning as the "standard" LT in equations (1) - leads to a wave equation for the moving observer of the same form as the equation (9) [i.e. if instead of applying Galilean transformation (10) to equation (9), we would apply standard LT (1) to equation (9)]:

$$c^2 \frac{\partial^2 A}{\partial x'^2} = \frac{\partial^2 A}{\partial t'^2} \qquad (12)$$

In our case showed in Fig. 5 above, we notice that two **different** LT should be invented at the same time to relate frame S' with frame S (for two different perspectives of S', about S_1 and S_2):

Standard LT from S to S', via $\mathbf{S_1}$ which sees S' moving with $+\mathbf{v}$:

$$\mathbf{x'_1 = \gamma\,(x_1 - vt_1)\ , \quad y'_1 = y_1\ , \quad z'_1 = z_1\ , \quad t'_1 = \gamma\,(t_1 - vx_1/c^2)} \qquad \mathbf{(13)}$$

Different LT from S to S', via $\mathbf{S_2}$ which sees S' moving with $-\mathbf{v}$:

$$\mathbf{x'_2 = -\gamma\,(x_2 + vt_2)\ , \quad y'_2 = y_2\ , \quad z'_2 = z_2\ , \quad t'_2 = \gamma\,(t_2 + vx_2/c^2)} \qquad \mathbf{(14)}$$

The standard LT in the equations (13) will be applied to the EM wave equation (9), for the electromagnetic wave emitted from $\mathbf{S_1}$, as that EM wave matches the directions of the wave and respectively the observer, as considered in W. Engelhardt's calculations.

On the other hand, the equations (14) for $\mathbf{S_2}$ are contradicting equations (13) for $\mathbf{S_1}$.

To prove the above statement, first, based on Fig. 5, we justify that equation (14) is needed because the observer in S' moves against the direction of propagation of the wave emitted from $\mathbf{S_2}$. That involves two aspects:

1.) - The velocity **v** of S', moving away from $\mathbf{S_1}$, will appear as − **v** of S' moving towards $\mathbf{S_2}$. We remember that S_1 and S_2 are in the same frame S, despite their using of opposite X axes.

2.) - The X' axis of S' will oppose the X axis of $\mathbf{S_2}$, as the idea of this exercise is to see which type of LT equations are used by the observer to represent that EM wave, by a form similar to (9).

To prove that (14) is the type of different LT equations needed for this case, we can proceed in the same manner used in the calculations of W. Engelhardt. Thus, writing (14) without indices, we prepare for the calculation of equation (9):

$$\frac{\partial}{\partial x} = \frac{\partial}{\partial x'}\frac{\partial x'}{\partial x} + \frac{\partial}{\partial t'}\frac{\partial t'}{\partial x} = \frac{\partial}{\partial x'}\frac{\partial}{\partial x}[-\gamma\,(x + vt\,)] + \frac{\partial}{\partial t'}\frac{\partial}{\partial x}\left[\gamma\left(t + \frac{vx}{c^2}\right)\right] = \gamma\left(-\frac{\partial}{\partial x'} + \frac{v}{c^2}\frac{\partial}{\partial t'}\right) \qquad (15a)$$

$$\frac{\partial}{\partial t} = \frac{\partial}{\partial x'}\frac{\partial x'}{\partial t} + \frac{\partial}{\partial t'}\frac{\partial t'}{\partial t} = \frac{\partial}{\partial x'}\frac{\partial}{\partial t}[-\gamma\,(x + vt\,)] + \frac{\partial}{\partial t'}\frac{\partial}{\partial t}\left[\gamma\left(t + \frac{vx}{c^2}\right)\right] = \gamma\left(-v\frac{\partial}{\partial x'} + \frac{\partial}{\partial t'}\right) \qquad (15b)$$

$$\frac{\partial^2}{\partial x^2} = \gamma^2\left(\frac{\partial^2}{\partial x'^2} - 2\frac{v}{c^2}\frac{\partial^2}{\partial x'\,\partial t'} + \frac{v^2}{c^4}\frac{\partial^2}{\partial t'^2}\right) \qquad (15c)$$

$$\frac{\partial^2}{\partial t^2} = \gamma^2\left(v^2\frac{\partial^2}{\partial x'^2} - 2v\frac{\partial^2}{\partial x'\,\partial t'} + \frac{\partial^2}{\partial t'^2}\right) \qquad (15d)$$

Then using (15c) and (15d) in equation (9):

$$c^2\gamma^2\left(\frac{\partial^2}{\partial x'^2} - 2\frac{v}{c^2}\frac{\partial^2}{\partial x'\,\partial t'} + \frac{v^2}{c^4}\frac{\partial^2}{\partial t'^2}\right)(A) = \gamma^2\left(v^2\frac{\partial^2}{\partial x'^2} - 2v\frac{\partial^2}{\partial x'\,\partial t'} + \frac{\partial^2}{\partial t'^2}\right)(A) \qquad (16a)$$

$$\left(c^2\frac{\partial^2}{\partial x'^2} - 2v\frac{\partial^2}{\partial x'\,\partial t'} + \frac{v^2}{c^2}\frac{\partial^2}{\partial t'^2}\right)(A) = \left(v^2\frac{\partial^2}{\partial x'^2} - 2v\frac{\partial^2}{\partial x'\,\partial t'} + \frac{\partial^2}{\partial t'^2}\right)(A) \qquad (16b)$$

$$\left(c^2\frac{\partial^2}{\partial x'^2} + \frac{v^2}{c^2}\frac{\partial^2}{\partial t'^2}\right)(A) = \left(v^2\frac{\partial^2}{\partial x'^2} + \frac{\partial^2}{\partial t'^2}\right)(A) \qquad (16c)$$

$$\left(c^2\frac{\partial^2}{\partial x'^2} - v^2\frac{\partial^2}{\partial x'^2}\right)(A) = \left(\frac{\partial^2}{\partial t'^2} - \frac{v^2}{c^2}\frac{\partial^2}{\partial t'^2}\right)(A) \qquad (16d)$$

$$c^2\left(1 - \frac{v^2}{c^2}\right)\frac{\partial^2 A}{\partial x'^2} = \left(1 - \frac{v^2}{c^2}\right)\frac{\partial^2 A}{\partial t'^2} \qquad (16e)$$

And finally we reach a form similar to the form of equation (9):

$$\boldsymbol{c^2\frac{\partial^2 A}{\partial x'^2} = \frac{\partial^2 A}{\partial t'^2}} \qquad \mathbf{(17)}$$

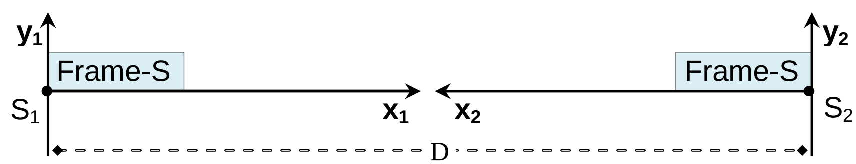
By applying the different LT (14), the form of EM wave equation (9) emitted from $\mathbf{S_2}$ was successfully preserved: the moving observer S' sees that wave as (17), i.e. in a similar form to (9) in which it exists in the stationary frame S (again, the wave being emitted from point $\mathbf{S_2}$ of S). Unfortunately, that also means:

a.) - For different directions of EM waves, the observer must apply different LT equations.
b.) - The observer's time coordinate in S' cannot be transformed to the time coordinate in S just by using only one form of **time LT**.
c.) - The two forms of time LT, which are needed to transform the two EM wave equations from the stationary frame S to the moving frame S', are contradictory. Indeed, from (13) and (14):

$$t'_1 = \gamma\,(t_1 - v x_1/c^2) \tag{18}$$

$$t'_2 = \gamma\,(t_2 + v x_2/c^2) \tag{19}$$

The relation between the coordinates x_1 and x_2 is easy to find, as $\mathbf{S_1}$ and $\mathbf{S_2}$ are at rest within S, separated by a distance D, as seen in the following Fig. 6:



$$\boxed{\mathbf{x_1 = -\ x_2 + D}} \tag{20}$$

Thus we can re-write (18) as:

$$t'_1 = \gamma\,(t_1 + v x_2/c^2 - vD/c^2) \tag{21}$$

Then, if we choose an instant $\boxed{\mathbf{t'_i = t'_1 = t'_2}}$ read by the unique observer's clock in O' of frame S':

$$t'_i = \gamma\,(t_1 + v x_2/c^2 - vD/c^2) \qquad (\textit{from eq. 21}) \tag{22}$$

$$t'_i = \gamma\,(t_2 + v x_2/c^2) \qquad (\textit{from eq. 19}) \tag{23}$$

The equations (22) and (23) are valid at t'_i only if: $\mathbf{t_1 \neq t_2}$. Otherwise, by *reductio ad absurdum*:

$t_1 = t_2$ would imply:

$$t'_i = \gamma\,(t_2 + v x_2/c^2 - vD/c^2) \tag{24}$$

$$t'_i = \gamma\,(t_2 + v x_2/c^2) \tag{25}$$

Subtracting the equations means: $0 = -\,vD/c^2$, which is absurd for D > 0 .

On the other hand, $\mathbf{t_1 \neq t_2}$ implies, by subtracting (23) from (22):

$$0 = \gamma t_1 - \gamma t_2 - \gamma vD/c^2$$

$$\boxed{\mathbf{t_1 = t_2 + vD/c^2} \quad , \quad \mathbf{t_1 \neq t_2} \quad , \quad \mathbf{t_1 > t_2}} \tag{26}$$

In the context of classical (pre-relativistic) electrodynamics, the time indications should be the same in all points of the stationary frame S. In that sense, equation (26) shows a **contradiction**, as it requires the time values for two points of S (i.e. $\mathbf{S_1}$ and $\mathbf{S_2}$) to be different (as they would be calculated by the moving observer S').

A more general mathematical error is revealed when calculating the times in S_1, and respectively S_2, from the origin O' of S'. For such calculation, we need to use the inverse LTs corresponding to (13) and (14), which we find respectively considering the sign of **v** (see also Fig. 5):

Standard "inverse" LT from S' to S, via **S'** which sees $\mathbf{S_1}$ moving with $-\mathbf{v}$:

$$\mathbf{x_1 = \gamma (x'_1 + vt'_1)} \quad , \quad \mathbf{y_1 = y'_1} \quad , \quad \mathbf{z_1 = z'_1} \quad , \quad \mathbf{t_1 = \gamma (t'_1 + vx'_1/\mathit{c}^2)} \qquad \mathbf{(27)}$$

Different "inverse" LT from S' to S, via **S'** which sees $\mathbf{S_2}$ moving with $-\mathbf{v}$:

$$\mathbf{x_2 = -\gamma (x'_2 + vt'_2)} \quad , \quad \mathbf{y_2 = y'_2} \quad , \quad \mathbf{z_2 = z'_2} \quad , \quad \mathbf{t_2 = \gamma (t'_2 + vx'_2/\mathit{c}^2)} \qquad \mathbf{(28)}$$

Then we can calculate the time relations about the origins $\mathbf{S_1}$ and $\mathbf{S_2}$, for which it is obvious that:

$\mathbf{x_1 = 0}$, and respectively $\mathbf{x_2 = 0}$ **(29)**

i.) First, the time of $\mathbf{S_1}$ as calculated from **O'**:
(*from eq. 27 and 29*) $x'_1 = -vt'_1$ => $t_1 = t'_1 \gamma (1 - v^2/c^2)$

$$=> \quad \boxed{\mathbf{t_1 = t'_1/\gamma}} \qquad \mathbf{(30)}$$

ii.) Second, the time of $\mathbf{S_2}$ as calculated from **O'**:
(*from eq. 28 and 29*) $x'_2 = -vt'_2$ => $t_2 = t'_2 \gamma (1 - v^2/c^2)$

$$=> \quad \boxed{\mathbf{t_2 = t'_2/\gamma}} \qquad \mathbf{(31)}$$

That means, at any instant $\mathbf{t'_i = t'_1 = t'_2}$ read on the clock of frame S', we have from (30) and (31):

$$t_1 = t'_i/\gamma = t'_i/\gamma = t_2$$

$$=> \quad \boxed{\mathbf{t_1 = t_2}} \qquad \mathbf{(32)}$$

The **general mathematical contradiction** between the equations (26) and (32) is obvious.

Another **mathematical contradiction** can be found by comparing (14) (the different "direct" LT) with (28) (the different "inverse" LT), for the case in which the origin **O'** of S' coincides with the point $\mathbf{S_2}$ of S. That implies:

$x_2 = 0$, $x'_2 = 0$, which replaced in (14) and (28) means:

$$\boxed{\mathbf{t'_2 = \gamma\, t_2} \quad , \quad \mathbf{t_2 = \gamma\, t'_2}} \qquad \mathbf{(33)}$$

As in the contradiction between the equations (5) and (6), this is a mathematical error because equations (33) cannot be valid together unless $\gamma = 1$. And, as $\mathbf{0 < v < \mathit{c}}$, we always have: $\boldsymbol{\gamma > 1}$.

A summary of the errors regarding the standard LT in pre-relativistic Electrodynamics:

E.1.) - A pre-existing convention was assumed implicitly (i.e. without being declared) between the ether frame (ARF) and the observer's frame in such way that the coincidence of spatial origins $x_0 = x'_0 = 0$ implies the coincidence of time origins $t_0 = t'_0 = 0$.

E.2.) - A pre-existing convention was assumed implicitly for the orientation of the coordinate systems involved in calculations, suitable to the direction of the propagation of an EM wave. Changing the orientation naturally (i.e. following the direction of different opposing EM waves) leads to different forms of LT and reveals the following errors:

E.3.) - For different instances of EM waves, two (or more) forms of LT are needed to transform from the stationary (ARF) frame S to the moving frame S' of the observer. Another convention between the frames S and S' is needed to decide which wave is considered first, and to establish then the convention of origins of coordinates (error E.1.), and the convention of orientation of coordinates (error E.2.).

The form of the other LT needed for the other EM waves will be different from the standard LT applied to the first EM wave studied, depending on the space offset (distance) between the points of emission and the convention of origins (E.1.), as well as depending on their orientation conforming or otherwise being against the convention of orientation of coordinates (E.2.).

E.4.) - Contradictory time transformations between the stationary ether frame and the moving frame of the observer who studies electromagnetic phenomena, as identified between the equations (26) and (32), and also between equations (14) and (28).

E.5.) - That the observer's **time** coordinates in S' cannot be restricted to be transformed to the time coordinates of S by only one form of LT. Thus multiple time relations might be revealed between a singular point of the moving frame S' and different points in the stationary S. Since all the points in S should indicate the same time in reference to each other, a mapping of one-to-many is contradictory and useless for the study of electrodynamics. A consistent theory should provide a **one-to-one mapping** between the times of the two different frames S and S'.

E.6.) - Last but not least, the mere discrepancy between the time values of the two frames, involved by a standard LT, was an error, from the perspective of Classical Mechanics, which had regarded time as a universal and absolute concept.

In the "defence" of the pre-relativistic Electrodynamics, we have to mention that our treatment of LT in this section went beyond the initial particular purpose of the Voigt-Lorentz-Larmor-Poincaré transformations, which was to represent only one observation about one particular EM phenomenon (i.e. LT was not meant for multiple observations on multiple EM phenomena).

As Lorentz mentioned, the transformation was initially meant to be a mathematical trick (artifice). In our approximate translation from French [10]:

"*[...] I had the idea that there is an essential difference between the systems x, y, z, t and x', y', z', t'. In one we use - that was my thought - coordinate axes with a fixed position in the ether, and what we may call the "true" time; in the other system, on the contrary, we would be dealing with simple auxiliary variables whose introduction is only a mathematical artifice. In particular, the variable* ***t'*** *could not be called "time" in the same sense that the variable* ***t****.*"

6. How the Special Relativity Theory inherited the errors of Electrodynamics

It is clear that the first intention of the physicists who used such a transformation as LT was only to simplify those calculations of the Electrodynamics based on Maxwell's equations (or, equivalently, based on the EM wave equation) for a moving observer, or for a moving object whose internal electrical interactions were studied in relation to the presumed ether.

Essentially, the Lorentz transformation went from being in Electrodynamics a relation between an inertial observer and the presumed ether, to being in the Special Relativity Theory a relation between two supposedly equivalent inertial observers.

Unfortunately, in the convoluted transition of LT from one theory to another, the possible contradictions of the multiple observations of multiple EM phenomena were not explored enough to withdraw the Voigt-Lorentz transformation from the path of becoming a false law of physics.

On the contrary, several ideas from Physics and Philosophy at the end of the XIXth century and the beginning of the XXth century made the consideration about LT from within electrodynamics to expand over the study of mechanics (and later over the study of gravitation):

• In 1887, the attempts to prove the motion of Earth relative to the ether failed by the experiments of Michelson and Morley. However, the hypothesis of FitzGerald in 1889 and the calculations of Lorentz in 1892 somehow explained that failure, by presuming certain changes in the lengths of the bodies moving through the ether. Lorentz used in his calculations his first versions of LT, and considered them as a mathematical trick intended to relate the "true" time of ether to the "local time" of the moving observer.

• Even then, in 1892, Lorentz proposed that the LT would be applicable to systems containing forces other than electric and magnetic forces.

• In 1900, Larmor considered the time in the moving system as "dilated". He referred to it as: "*the scale of time is enlarged*" [19].

• In 1900, Poincaré made considerations about the *relative simultaneity*, describing a method of synchronization of distant clocks by exchanging light signals and assuming that light travels at the same speed on both directions between clocks. *Relative simultaneity* was for him a more clear explanation of the cause of the "local time" than the explanations of Lorentz and Larmor.

• In 1902, Poincaré published a few essays which included philosophical discussions on the relativity of time and space (in the sense of impossibility of proving an absolute time and an absolute space), the possibility of non-existence of ether, and the determinations of simultaneity of distant events.

• In 1904, upon Poincaré's criticism, Lorentz made new corrections to the Voigt-Lorentz transformation, bringing them to what is today known as the standard Lorentz Transformation.

Poincaré also found that LT can be described mathematically as a group. He introduced $ct\sqrt{-1}$ as a fourth imaginary coordinate, and showed that LT is equivalent to a rotation of a coordinate system of the ether about its origin (!). Also in 1904, Poincaré generalized the Galilean relativity principle: "*The principle of relativity, according to which the laws of physical phenomena should be the same, whether to an observer fixed, or for an observer carried along in a uniform motion of translation, so that we have not and could not have any means of discovering whether or not we are carried along in such a motion.*" [20].

Finally, a radical theoretical change was proposed by Einstein in 1905, in his article [11] about the electrodynamics of moving bodies, in which he attempted to prove that LT is a relation between two inertial observers - a position which differed from Electrodynamics, where LT were a relation between one moving observer and the ether of EM phenomena.

The focus of the theoretical works mentioned above took a wrong turn (in our opinion): instead of exploring more aspects of electrodynamics (such as considering the observation/interaction of different multiple EM phenomena by the same observer at the same time) it narrowed down to the aspects of kinematics and to the fundamental concepts such as space, time, and simultaneity.

6. Accelerated motion ruins the equivalence of frames claimed by the Special Relativity Theory

Einstein constructed the Special Relativity Theory based on equivalent inertial frames.
His derivation of the Lorentz Transformation, presented in 1905, did not use accelerations at all for the frames involved in the demonstration.

Paradoxically, in the section "*Dynamics of the Slowly Accelerated Electron*" at the end of his article [11] he studied the case of an accelerated electron moving within an electromagnetic field. Einstein's reasoning on acceleration was incorrect, because he ignored these aspects:

6.1. The cause of the electromagnetic acceleration is at absolute rest.

The accelerated motion of an electron within an EM field presumes that the EM field is the cause of the acceleration. The very first change in the velocity of the electron is caused by the EM field. However, the EM field cannot be dragged through space by the inertial motion of the source which generates it. That means, the cause of acceleration at an instant is not moving through space - it is at absolute rest.

6.2. Acceleration is an absolute change.

That means acceleration, as the change dv/dt in the velocity v of an object, is observed as happening with the same value from any inertial reference frames (IRFs). That means acceleration is not relative to a particular frame; instead, it is an absolute quantity.

6.3. Acceleration applied unequally to different frames makes them non-equivalent.

If a frame A is subjected to a constant acceleration, a few aspects would make that frame incompatible with Einstein's postulates:

1.) The frame is no longer inertial. That means, it can perform mechanical experiments which can indicate: its own motion through space, and the value of its acceleration.

2.) An inertial frame B can be considered a preferred frame by an observer from A. At high speeds, B can be considered a quasi-absolute frame (i.e. almost at absolute rest), as its motion through space is negligible in comparison with the motion of the highly accelerated frame A.

A frame A which becomes inertial after it was subjected to accelerations, cannot be considered equivalent to another inertial frame B which was not subjected to identical accelerations.

To demonstrate that statement, let us consider this imaginary experiment:
Two identical spaceships, S_1 and S_2, are initially at rest with each other in a frame S_0 and separated by a significant distance in free space, in absence of gravity. They are set in motion at the same time from the S_0, with accelerations of different magnitudes, collinear, and opposite in direction: S_1 with acceleration a_1 and S_2 with acceleration a_2, and the magnitudes: $\mathbf{a_1} > \mathbf{a_2}$.

Each spaceship has a pendulum of a length L and a point-mass m, placed identically inside that respective ship at a fixed point: P_1 in S_1, and respectively P_2 in S_2 , as represented in Fig. 7:

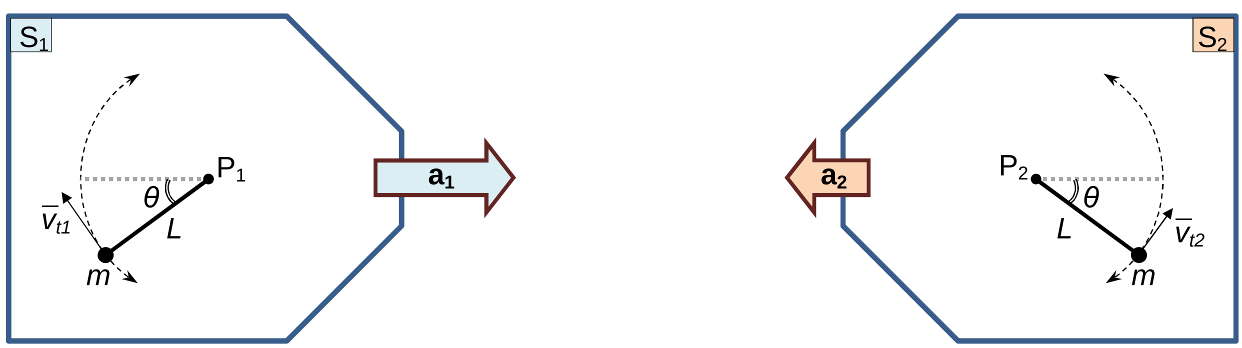


Fig. 7 - Two spaceships S_1 and S_2 are set in motion in free space with different accelerations. Each spaceship contains an identical pendulum set free from an identical angle θ_0.

Each pendulum is set free from the same angle θ_0, after the moment when its containing spaceship is set in motion. The tangential velocity of the point-mass of a pendulum is:

$$\mathbf{v_t} = \sqrt{2\mathbf{a}L(\cos\theta - \cos\theta_0)} \qquad (34)$$

The maximum magnitude of the tangential velocity of the point-mass of a pendulum happens when $\theta = 0$, which implies that $\cos\theta = 1$:

$$\mathbf{v_{tMax}} = \sqrt{2\mathbf{a}L(1 - \cos\theta_0)} \qquad (35)$$

As $\mathbf{a_1} \neq \mathbf{a_2}$, the two pendulums will have different values for the maximum velocities of their respective point-masses:

$$\mathbf{v_{t1Max}} = \sqrt{2\mathbf{a}_1 L(1 - \cos\theta_0)} \quad , \quad \mathbf{v_{t2Max}} = \sqrt{2\mathbf{a}_2 L(1 - \cos\theta_0)} \qquad \textbf{(36)}$$

$$\mathbf{a_1} > \mathbf{a_2} \quad \Rightarrow \quad \mathbf{v_{t1Max}} > \mathbf{v_{t2Max}} \qquad \textbf{(37)}$$

Let us consider the two respective moments when the acceleration of each spaceship ends (e.g. the fuel in their engines is depleted). Although the frames of the spaceships are in inertial motion after the accelerations stop, and they observe each other with velocities of equal magnitude **v** , the internal mechanical states of the frames S_1 and S_2 are not identical.

For simplicity, let us assume that each of those two moments coincides with the moment in which the tangential velocity of each pendulum has the respective maximum value $\mathbf{v_{tMax}}$.

In that case, the pendulum effect ceases, but the point-mass at the end of each cord will start moving in a full swing around the fixed point, as represented in Fig. 8:

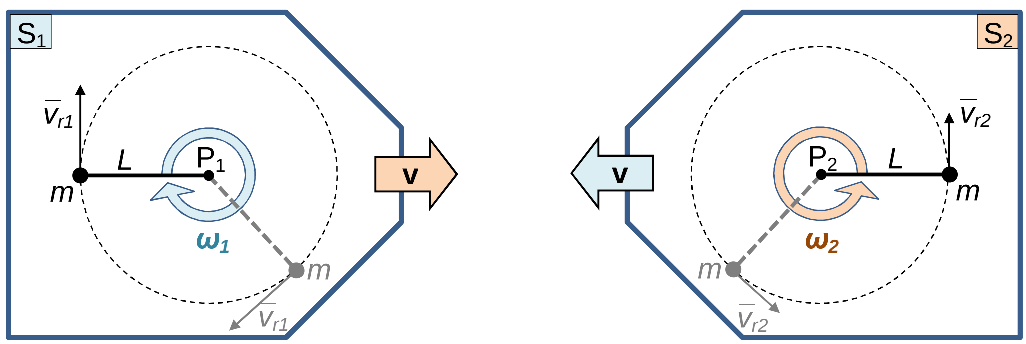


Fig. 8 - The two spaceships S_1 and S_2 are in inertial motion as soon as their accelerations stop. The pendulum effect ceases at the points of maximum tangential velocity (for simplicity), but each point-mass keeps rotating around the respective fixed point inside each ship: P_1 and respectively P_2.

If we change the notations: $\mathbf{v_{r1}} = \mathbf{v_{t1Max}}$, and: $\mathbf{v_{r2}} = \mathbf{v_{t2Max}}$ then we have:

$$\boxed{\mathbf{v_{r1}} > \mathbf{v_{r2}}} \quad , \quad \mathbf{v_{r1}} = \omega_1 L = 2\pi L/T_1 \quad , \quad \mathbf{v_{r2}} = \omega_1 L = 2\pi L/T_2 \qquad \textbf{(38)}$$

The respective periods of the rotations of the point-masses around respectively P_1 and P_2 will be:

$$T_1 = 2\pi L/\mathbf{v_{r1}} \quad , \quad T_2 = 2\pi L/\mathbf{v_{r2}} \quad , \quad \boxed{T_1 < T_2} \qquad \textbf{(39)}$$

Thus, any mechanical experiment requiring the use of the point-mass *m* will not be performed identically in the two frames.

(Note: In the imaginary experiment above, a secondary identical pendulum can be installed in each ship and set to move in the opposite direction of the first pendulum, to cancel the sideways oscillations of the center of mass of the ship relative to the direction of the applied acceleration.)

We note that since the frames are moving inertially (as the accelerations stop), a relativistic theory would claim that they observe each other as experiencing identical length contractions, in reference to each other, therefore the effects of length contraction on the cords of the pendulums would cancel each other out.

On the other hand, in a non-relativistic theory, the length contractions would happen in reference to the initial rest frame S_0. However, even in that case, it is possible to arrange the accelerations to happen for different intervals of time, respectively in the moving frames S_1 and S_2, so that in the end the velocities of those two frames relative to S_0 would be equal: $v_{10} = v_{20}$, hence equal length contractions on the *L* cords of their respective pendulums.

Also, the reader might wonder whether or not we have infringed the assumption of a rigid body which was used by Einstein in his 1905 article [11]. We would reply that Einstein did not use only a rigid body when he imagined his experiments about simultaneity and synchronization.

He used also clocks, and in 1905 most of the clocks had a mechanical construction, therefore the moving clocks involved in his experiment would have had their functionality affected differently from the clocks of the stationary frame, in case only the frame of rod & clocks was set in motion (i.e. accelerated).

The main conclusions of the imaginary experiment presented above are:

1.) Accelerated motion affects moving mechanical systems (i.e. mechanical clocks) internally.

2.) What differentiate the systems is the magnitude of the acceleration applied to them. Indeed, in the example above, both S_1 and S_2 can achieve velocities of the same magnitude $v_{10} = v_{20}$ in reference to S_0, if they were subjected to different accelerations during different time intervals. However, the system subjected to a greater acceleration will obtain a greater internal energy than the other system ($E_{iS1} > E_{iS2}$ in the example above).

3.) The imaginary experiments involved in Einstein's reasoning couldn't have been done correctly if the frames involved were subjected to different accelerations. Therefore, it is our conclusion that the notion of equivalent inertial frames applies only to the frames which were set up identically and accelerated identically.

4.) The treatment of the accelerated motion in Einstein's SRT involved non-equivalent frames, because the accelerations applied to the frames were not equal. We distinguish two cases:

4.1.) One of the frames had been accelerated, and the acceleration stopped at some moment in the past. This case refers to the Einstein's derivations or demonstrations in which a frame K' is *set in motion* and another frame K remains "*stationary*".

4.2.) A real object (e.g. an electron) was subjected to a continuous acceleration, and at some moment Einstein considered that for an infinitesimal time interval **dt** the object's frame moves at a constant velocity. At that moment Einstein tried to relate the object's frame **K** to another moving observer's frame **k**, and for that infinitesimal **dt** he incorrectly considered both frames as being inertial and equivalent and moving from each other with a velocity **v**.

Hence, the treatments of accelerated motions claimed by Special Relativity Theory are outside the actual theory of SRT, since it violates the Postulate of Relativity which demands equivalence among all inertial frames.

5.) Paradoxically, the first considerations of Einstein about simultaneity and synchronization were done by using non-equivalent frames, thus violating SRT's own Principle of Relativity.

6.4. Most of the so-called experimental proof of Special Relativity Theory was performed in non-equivalent accelerated frames.

The advocates of SRT claim nowadays that it was extensively verified in the particle accelerators, the atmospheric detection of muons, and even in GPS. Based on the findings of the previous sections, we can now argue and affirm the obvious: those tests and applications involved frames which were accelerated greater or much greater than the frame of the laboratory on Earth's ground.

Therefore, the pairs of frames considered (e.g. accelerated particle - accelerator/laboratory) were non-equivalent at the moment of ceasing the acceleration, which means the Principle of Relativity was violated, and therefore in actuality the Special Relativity Theory was neither applied, nor tested in those experiments.

For the experiments and applications which involve clocks travelling around Earth in orbit or at high altitudes, such as GPS, and respectively the Hafele-Keating experiment [12], the conditions make the frames even more non-equivalent. We bring these critical observations to the Hafele-Keating experiment, and by similarity we consider them valid for the GPS case as well:

• its original "time dilation" calculations involved not only SRT effects, but also calculations by the General Relativity Theory (GRT) for gravitational effects such as the "redshift" of the frequencies of the clocks placed at different heights in the gravitational field. Other authors provided a different set of calculations only by using GRT, considering that the "time dilation" was caused totally by the clocks' motions in the proximity of a gravitational source (Earth).

Either way, the presence of gravitation, as well as the acceleration needed to move the clocks at a higher altitude, made the moving clocks be non-equivalent against the clocks on Earth's ground. That lack of equivalence violates the Principle of Relativity, which means SRT was not actually the tested theory (despite the use of the Lorentz transformation, or formulas derived from LT).

• the original calculations involved an imaginary non-rotating inertial frame. That means, the LT expressions were used for Earth's motion in relation to a preferred imaginary frame, as well as the moving clocks' motions in relation to the same preferred imaginary frame.

As the SRT does not specify a criterion for using a preferred frame, and as it rejected the "ether" as a preferred frame, this is another argument that in fact not SRT was the theory tested in the Hafele-Keating experiment. It is very likely that the conditions of the experiment and the expressions used were similar to the ones used in the Lorentz Ether Theory.

7. Does the Minkowski spacetime solve the paradoxes of Special Relativity?

Almost all the respective textbooks of the last decades introduced the Minkowski 4-dimensional (4D) spacetime in the beginning of their presentations of SRT. Without having the intention to present here an extensive criticism of the Minkowski spacetime, we have to mention a few critical notes to it, in the same sense of the mathematical errors described in the sections above:

7.1. The Minkowski spacetime is an abstract construction.

Despite certain physicists' claims that a 4D spacetime is representing direct the physical reality, we have to note that it was constructed as an abstract mathematical object, meant to help the calculations of the Electrodynamics. In his preliminary notations, Minkowski mentioned:

> "*Let a **rectangular** system (**x**, **y**, **z**, **t**) of reference be given **in space and time**. The unit of time shall be chosen in such a manner with reference to the unit of length that the velocity of light in space becomes unity. [...] instead of operating with **t**, I shall operate with **it** [...] If now instead of (**x**, **y**, **z**, **it**) I use the method of writing with indices [...] An individual system of values of **x**, **y**, **z**, **t**, i.e., of* x_1, x_2, x_3, x_4 *shall be called a spacetime point.*"

We can observe a few traits of a construction done in abstract, not in reality:

• representing time as a geometrical axis is an abstract procedure

• representing time as a complex number (*i***t**) is an abstract decision

• representing time as a space dimension (*c***t**) is an abstract decision

• placing the abstract time axis to be orthogonal to all 3 real space axes is an abstract decision.

• choosing the scale of the representation of time as (*i***t*c***) to depend on the manifestation of a real physical phenomenon, such as the velocity of light is:
  - circular reasoning, as the manifestation of the phenomenon itself already involves time.
  - an incorrect use of both **t** and and ***c***, as their product represents a distance, not a time. The mere choice of ***c*** = 1 cannot hide that incorrect use from a careful consideration.
  - an abstract decision taken to prove a statement already made (the presumed relativity of the Lorentz transformation).

While the philosophical views of Minkowski might have asserted that there is a conceptual unity between space and time, in reality there are no experiments to confirm that the nature of time is identical to the nature of physical space. On the contrary, humanity has always conceived and represented time and space as different notions. That is why the concept of velocity contains distinctively space and time as different parts of a mathematical abstract operation: a ratio.

In different documents of the Neo-Classical Theory of Relativity (NCTR) we showed the differences between the concepts of time and space and we explained why they cannot be merged into a singular fundamental concept of Physics [13][14][15].

7.2. The Minkowski spacetime implied originally an absolute 3-dimensional space.

The abstract spacetime was constructed by Minkowski based on the frame of the electromagnetic phenomena. Extending the quote from his document [8], mentioned above in section 5:

> "... *if we take a rotation of the axes around the z-axis by an amount* φ, *keeping* **e**, **m**, **w** *fixed in space, and introduce new variables* x'_1, x'_2, x'_3, x'_4 *instead of* x_1, x_2, x_3, x_4 "[...]"*If now in the above mentioned rotation round the z-axis, we replace* φ *by* $i\psi$ ..."

where: **e** - the electric induction, **m** - the magnetic force, and **w** - the velocity of the matter.

We have to mention that although Minkowski did not indicate explicitly which frame was used as a reference for expressing the velocity **w**, his considerations were made in the context of Lorentz' Ether theory, as he presented the Maxwell's equations as "*The Fundamental Equations for Æther*", and also he mentioned Lorentz' 1904 article [16] in which for the same equations Lorentz used a different notation: **v** instead of **w**, for the velocity relative to ether ("*Geschwindigkeit relativ zum Äther*").

That means, the first consideration of a rotation in the 4-dimensional spacetime was taken in reference to a 3-dimensional space (containing the vectors **e**, **m**, **w**) which served as an absolute reference.
Unfortunately, decades later, the textbooks presenting the Special Relativity Theory (e.g. [17]) were already introducing the Minkowski spacetime by using an arbitrary system of coordinates, without any mentioning of its physical meaning as the absolute reference frame of Electrodynamics - a meaning which was still present in Minkowski's work of 1907.

Note a detail of the construction: the rotation of axes was done by an imaginary angle: $\varphi = i\psi$.

7.3. The Minkowski spacetime is considered to be an absolute 4-dimensional space.

It is also peculiar the fact that Einstein and Minkowski rejected the idea of absolute rest, and the idea of an absolute 3-dimensional space, based on their beliefs that there was no physical proof for it, while they were attempting to demonstrate the validity of an imaginary 4-dimensional absolute space (obviously built in abstract, without any experimental proof) containing an infinity of 3-dimensional spaces separated each by different time lines within that containing 4D spacetime:

> "*Hereafter we would then have in the world no more the space, but an infinite number of spaces analogously as there is an infinite number of planes in three-dimensional space. Three-dimensional geometry becomes a chapter in four-dimensional physics.*" [18]

7.4. The contradictory rotations of axes in Minkowski spacetime

There is an obvious contradiction regarding the derivation of, and respectively the representation of, the Lorentz transformation by using rotations of coordinate systems:

1.) The rotation of axes in the ***derivation*** of the Lorentz transformation:

As in the quote above (at 7.2.), Minkowski used a rotation of the 4-dimensional space to derive the Lorentz transformation [8]. It is clear that all the axes were orthogonal before the transformation, and that all the axes are orthogonal after the transformation. A simple representation of such rotation can be seen in Fig. 9 similar to a diagram of Lawden's book [17]:

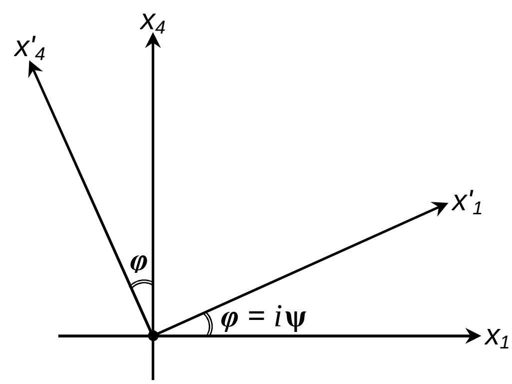


Fig. 9 - The derivation of Lorentz transformation was obtained by Minkowski by rotating the (x, t) **or** (x_1, x_4) **by the angle** $\varphi = i\psi$ **, thus obtaining the system of** (x', t') **or** (x'_1, x'_4) **, as if the Lorentz transformation would have been applied to** (x, t) **to evaluate a moving system** (x', t') **of velocity** w **.**

2.) The rotation of axes in the ***representation*** of the Lorentz transformation:

Minkowski decided to represent the Lorentz transformation differently from the way he derived them. In his 1908 paper [18] he decided that both systems (x, y, z, t), and respectively (x', y', z', t') should be able to represent the hyperbola of the equation $c^2t^2 - x^2 - y^2 - z^2 = 1$ in the same form. Fig. 10 shows a simplified diagram, drawing only the axes (x, t) and (x', t'), similar to the one in Minkowski's paper. The axes (x', t'), which were obtained by rotations, are no longer orthogonal.

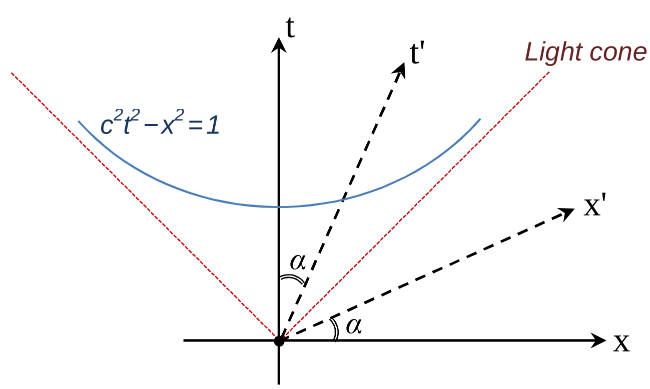


Fig. 10 - The representation of Lorentz transformation by a "*Minkowski diagram*", **aimed to relate different groups of transformations of mechanics, under the constraints of Special Relativity. As noticed, the axes** (x', t') **are no longer orthogonal as a result of such type of Lorentz transformation.**

Minkowski decided to "*take a positive parameter c and look at the structure* $c^2t^2-x^2-y^2-z^2 = 1$ " in order to relate two distinct groups of transformations: rotations and translations, as the laws of mechanics are invariant respectively to each group. Unfortunately, he also constrained a possible relation between the two groups by making relativistic assumptions, e.g. choosing $\boldsymbol{c} = 1$.

Note a detail of this representation: the rotations of the axes were done by a real angle: $\boldsymbol{\alpha}$.

Regardless of the assumptions and the reasoning behind each type of rotation mentioned at 1.) and respectively 2.), a few aspects confirm our statements in the previous sections:

- Minkowski's derivation of LT was done within **Electrodynamics**, as a relation between a moving observer and a region of ether in which an EM phenomenon manifests.

- Minkowski's application/representation of LT was done upon **Mechanics** as a relation between two moving inertial observers constrained by relativistic assumptions.

- The two types of rotations mentioned are different and they reflect the different meaning of LT in Electrodynamics and respectively in (relativistic) Mechanics.

- The same contradictions of LT revealed in the previous sections can be certainly found if the direction of the moving observer is inversed (in the Minkowski's derivation of LT), and respectively if the equivalence of the observers is invoked from the Principle of Relativity (in the Minkowski's representation of LT).
  The contradictory effects will be noticed in the contradictory angles involved by such different rotations resulted by applying a reversed velocity at 1.), or respectively resulted by applying the equivalence of the observers at 2.).

8. Can the Special Relativity Theory be fixed?

In the works of the Neo-Classical Theory of Relativity we have demonstrated that the Special Relativity Theory has errors in its entire theoretical structure, which can be detailed in:

- the purpose
- the fundamental concepts
- the experimental background
- the principles
- the logical reasoning
- the mathematical demonstrations and the derivations of LT
- the mathematical applications of LT - (the core of their errors were described in this article)
- the conclusions and consequences
- the experimental proof
- the geometrical representations

Generally speaking, the literature of criticism to the Special Theory of Relativity provides overwhelming evidence that SRT is a wrong theory from many perspectives: experimental, metrological, mathematical, logical, semantical and philosophical.

However, it is hard to fix something which is not recognized to be in need of fixing, and we have to answer the question: if Special Relativity is wrong, how come it is used by other branches of Physics, e.g. in Particle Physics?

Such a question, used as a quick counterargument by the proponents of SRT, needs to be answered by our statement here, as we demonstrated in the sections above:

> Any use of accelerated objects in the real world is actually not employing the Special Relativity Theory. Instead, unbeknown, it is using a formalism based on preferred reference frames, and the Lorentz transformations as they were originally invented in the Voigt-Lorentz-Poincaré theories.

We illustrated the logical workflow of our statements in the following diagram (Fig. 11):

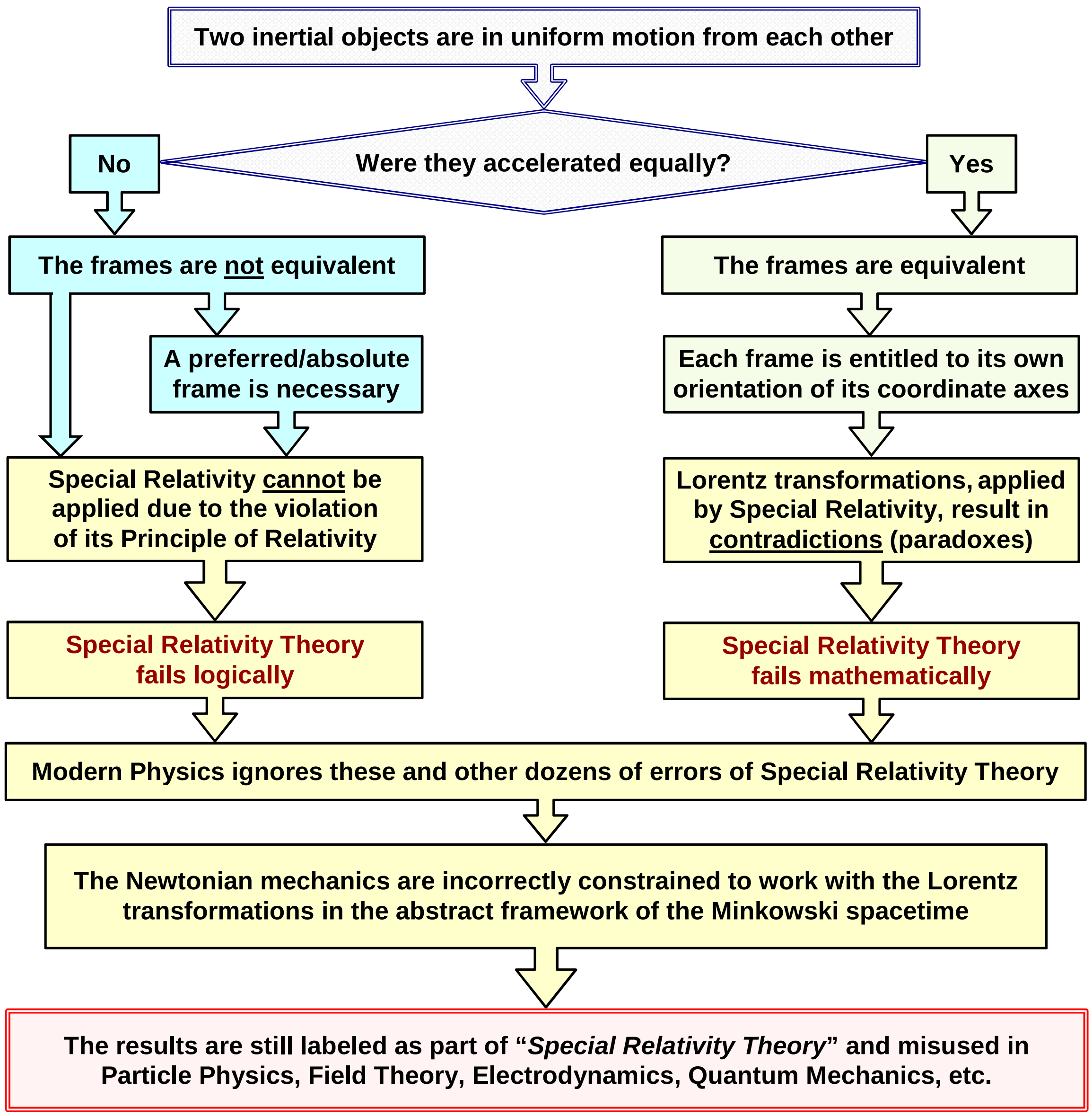


Fig. 11

Therefore we can affirm that Special Relativity Theory cannot be fixed, because it is actually not being employed correctly along with its Principle of Relativity. It is our view hereby that a new theory is needed, to describe better the relations between the various classes of phenomena. We will identify here a few general guidelines for a new theory:

• Employing a minimum possible number of fundamental concepts and axioms/principles.

• Choosing fundamental concepts which are universal, and describing them thoroughly.

• Recognizing the dependency, and/or the independence, between classes of phenomena:

- inertial
- electromagnetic
- gravitational
- others (subatomic)

• Recognizing the relationship types between classes of phenomena, such as one-to-many, many-to-many, etc.. For example, the relation between the inertial phenomena and the EM phenomena would be a many-to-one, because there are many (an infinity of) possible inertial frames, and there is only one special frame for the electromagnetic phenomena, as described above.

• Avoiding to:

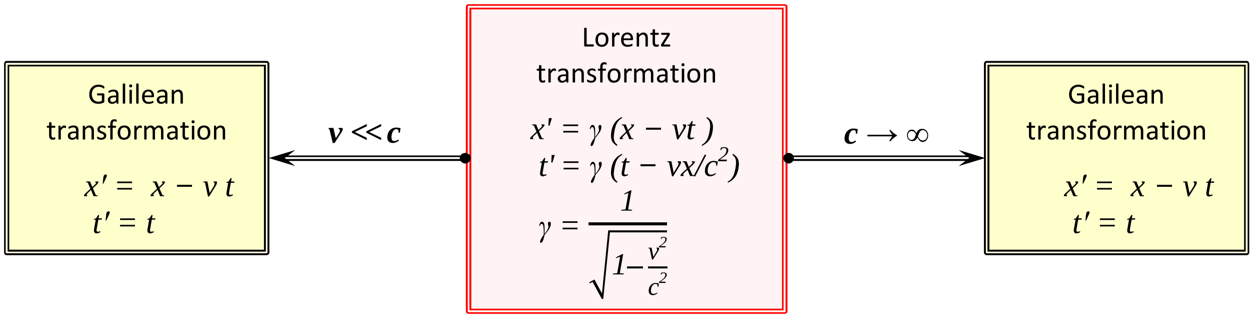
- confuse fundamental concepts of Physics such as space and time.
- confuse fundamental concepts (e.g. space, time) with composed concepts (e.g. velocity).
- confuse the laws (e.g. of Electromagnetism) with the observations of those laws.
- confuse simultaneity with the observation of simultaneity.
- confuse physical natural invariance with the wishing of invariance for practical purposes.
- confuse equivalent systems with privileged and non-equivalent systems.
- construct new concepts/relations based on the old concepts/relations with the purpose of contradicting the old concepts/relations. In short, avoiding to employ circular reasoning.
- generalize the claims of an untested theory to all the fields of Physics.
- unify for the sake of unifying.
- develop on top of new mathematics without having the new mathematics being thoroughly tested in experiments, and without clearing any logical and mathematical contradictions.
- invent fixes, artifices, assumptions, without any base in the physical reality.
- claim the truth of a theory while it depends on conventions such as the orientation of axes and on the establishing of common origins between frames.
- claim the truth of a theory while it depends on only one concept, one procedure, etc., without exploring other various ways of reaching the goal which is pursued by the theory.

One important question, for such a new theory, is about the necessity of keeping in use, or the necessity of modifying the existing Lorentz transformation. The answer to it depends on several other questions:

A.) Should the Lorentz transformation be universally applied to all interactions?

A common misconception of the relativistic discourse claims that the Newtonian (classical) mechanics is a particular case, or a limit case of the Special Theory of Relativity. Various relativistic texts consider $\boldsymbol{v} \ll \boldsymbol{c}$ as a lower limit, while other texts consider $\boldsymbol{c} \to \infty$ as an upper limit, to claim that Classical Mechanics would be “embedded” in SRT.

In fact the opposite is true: Special Relativity became a particular case of the Newtonian/Galilean mechanics by imposing on all interactions a limit which depends on one particular value of a signal: ***c*** . Considering the two limits mentioned above, from the equations (1) and (10) we realize that the Lorentz transformation is in fact a particular deviation from the Galilean transformation:



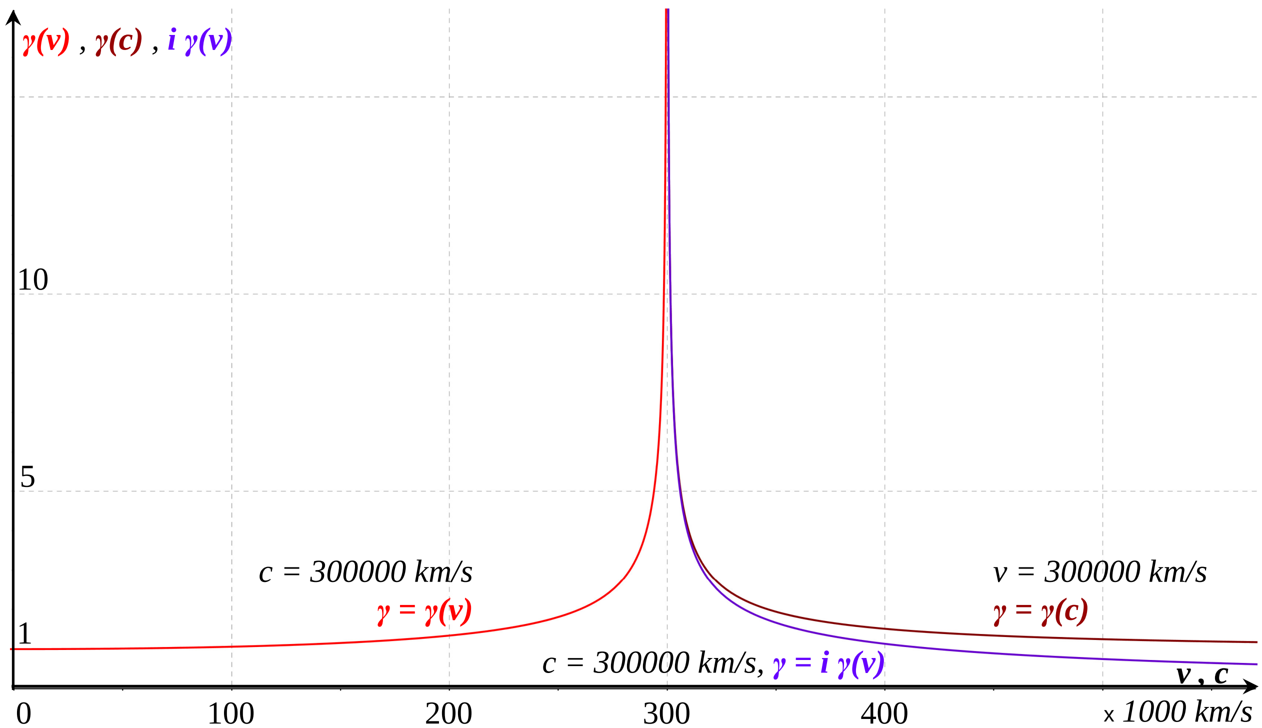


Fig. 12 - Lorentz transformation depicted as a deviation from Galilean transformation. The current upper limit for *v* **will become the lower limit for the supraluminal signals of a growing** *c* **. The graphic shows 3 different functions: 1. The regular function** $\gamma(v)$ **for** *c=constant* **and** $v < c$ **; 2. The function** $\gamma(c)$ **is a case in which the speed of the signal grows** $c \to \infty$ **while** *v = constant* **; 3. The function** $i\,\gamma(v)$ **is the imaginary solution of the regular case when** *c=constant* **while** *v* **takes values of superluminal speeds** $v > c$ **.**

As the Lorentz transformation appeared within electrodynamics to describe a particular relation between an observer and EM phenomena, that relation needs to be explored thoroughly before being generalized to other relations. The relation described by LT was purely kinematic, which means the interaction (by forces) between the EM phenomena and the observer was ignored.

Even from a kinematic perspective, as we showed, there are cases of such relations which have not been considered yet, and which become contradictory if LT is generalized.

Therefore, imposing LT on all interactions known to Physics, was and is a mistake, since LT was not even thoroughly considered, analyzed, nor tested for all the interactions between EM phenomena and inertial objects.

Furthermore, all known physical interactions were blindly limited to have the maximum propagation speed as $c \approx 300000$ km/s, based on the untested assumption of a universality of LT. Such conceptual error will only prevent the development of Physics, as the search for superluminal speeds and interactions is hindered by dogmatic attitudes rooted in the wrong belief that standard LT are always correct and universally applicable.

B.) Can Lorentz transformation be kept for particular theoretical and practical purposes?

- It might be argued that LT makes the calculations of electrodynamics overall easier. In our current view:

• A thorough study is needed to decide which fields of Physics might benefit from keeping the LT in use, provided they do not lead to contradictions, and provided they do not inhibit the development of Physics itself.

• An exact form of a physical law can be obtained only by experiments performed where and when that physical law manifests.

In case an observer is moving away from such a place where the physical law manifests, then a modified form of a physical law can be calculated for his/her frame which is in motion away from the preferred frame of the respective physical event (or phenomenon). For example a modified form of Maxwell's equations was noticed by Lorentz, but his choice of ignoring such a modified form (and instead keeping the exact form of the equations invariant to the change of coordinate systems) was never justified logically.

From a scientific point of view, such an approach (of using modified law-forms) is much more justified than the invention and blind generalization of (new) transformations such as LT. It is important to remember that the Galilean transformation has not been proposed as a hypothesis, and it was determined from direct measurements done in the real world.

From a logical point of view, since an observer moving away from an electromagnetic phenomenon sees it with definite distortions, such as changes in frequency (Doppler effect), changes in direction (aberration of light), and changes in magnitude of the speed of propagation, he/she clearly needs to describe the phenomenon differently from the way it is described by another observer which is "local" to that phenomenon.

Such an approach will also keep the fundamental concepts free from contradictions, since the newly observed (or discovered) aspects of the phenomena will not imply a need of change of the fundamental concepts.

That also means that various principles should not be generalized to classes of phenomena for which they were not tested thoroughly. For example, the Galilean Principle of Relativity which was discovered upon many tests, cannot be just extended to encompass the electrodynamics based on **no** experiments, nor just based on assumptions.

The experiments showed that the propagation of light is independent from the motion of inertial objects, which means the principles which govern respectively the two classes of phenomena do not depend on each other.

• In case the motion of the observer in reference to the EM phenomena affects the observer's internal structure from the perspective of EM fields and forces, in similar ways to those calculated by Lorentz, it is understandable that LT could be employed to express the scale distortions suffered by the observer's frame (the FitzGerald-Lorentz lengths contraction).

Thus LT would affect the Galilean transformation between inertial frames only in the sense of the scale change of one or more spatial dimensions. Also, it is possible to establish a common time between inertial frames [15], i.e. the consequences of LT upon times should have the meaning of *time delays* for certain processes happening in different inertial frames, as compared to a preferred/absolute frame in which such time delays do not happen.

9. Conclusions

C.1.) - A convention of origins and orientations of coordinate systems for inertial frames makes such frames be non-equivalent. Hence, the covert presence of a preferred frame is a violation of the Principle of Relativity, and that makes the Special Relativity Theory inapplicable in reality.

C.2.) - If the convention of origins and orientations of coordinate systems for inertial reference frames is removed, for the purpose of compliance with the Principle of Relativity, applying the Lorentz transformation between two equivalent inertial frames will result in the core mathematical contradictions of the Special Relativity Theory.

If a convention of origins and orientations of the coordinate axes is possible between two reference frames, then conventions of common time and common space are also possible between those two frames, as secured by the mutual inertial velocity between frames [15].

C.3.) - The unequal accelerations applied to different inertial frames will make those frames be non-equivalent, hence again a violation of the Principle of Relativity, and that also makes the Special Relativity Theory inapplicable in reality.

The standard Lorentz transformation cannot express correctly the kinematic relation between various inertial observers, which in reality cannot be in equivalent frames due to their different histories of motion (as caused by various accelerations).

C.4.) - The standard Lorentz transformation was invented in Electrodynamics to relate an inertial observer to an electromagnetic phenomenon. SRT misuses the LT, attempting to relate the motions of different inertial observers, while ignoring their independence from EM phenomena.

C.5.) - The standard Lorentz transformation is not the only form of a transformation needed by Electrodynamics, if in general any such need would be scientifically justified. Different forms of Lorentz transformations applied to different electromagnetic phenomena by the same inertial observer will result in contradictions regarding the local time of the observer. This is a proof that the errors of LT in Special Relativity Theory are rooted in the errors of LT in Electrodynamics.

The standard Lorentz transformations, in their current forms (direct and inverse), cannot express correctly the kinematic relations between an inertial observer and multiple electromagnetic phenomena, nor the motion relations between multiple inertial observers.

C.6.) - The core mathematical errors of the Special Relativity Theory cannot be fixed, because they are revealed by the invocation of the Principle of Relativity as a fundament of SRT.

C.7.) - A Principle of Relativity which encompasses all the laws of physics was never justified experimentally, and due to the independence of different classes of phenomena (inertial, electromagnetic, gravitational) it is likely it will never be justified experimentally.

C.8.) - Various derivations of the relativistic Lorentz transformation contain various errors [14] which do not justify the use of the Lorentz transformation in the Special Relativity Theory.

C.9.) - The geometrical representation and use of the Lorentz transformation in the abstract construction of the Minkowski spacetime is not eliminating their contradictions. On the contrary, it shows the need of artificially representing the use of the LT in an abstract absolute frame which would apparently hide their contradictions. However such a frame has never been proved by experiments as a direct representation of the physical reality.

C.10.) - The experiments in the real world which involve the use of the Lorentz transformation cannot be considered a proof of Special Relativity Theory, for the reasons mentioned above: the frames involved are subjected to accelerations of different values and thus those frames become non-equivalent, hence in need of a preferred or quasi-absolute frame of reference. In such conditions of the physical reality, the Principle of Relativity and the Special Relativity Theory are proved inapplicable and useless.

C.11.) - A new theory of Physics is needed to be developed in such a way that it relates properly different classes of physical phenomena (inertial, electromagnetic, gravitational) while it recognizes the respective independence of the laws governing those phenomena.

C.12.) - Such a new theory needs to recognize that while the laws of Physics have a definite form in the region of space where a phenomenon happens, the observed aspects of that phenomenon will vary among different moving observers. The law defining a phenomenon should not be confused with the various descriptions of various observers which have various motion states in reference or in comparison to the motion state of the phenomenon.

The laws of Physics which govern the interaction between an observer and a phenomenon can depend on the motion of the observer. They should not be confused with the laws which govern the manifestation of the phenomenon itself in the physical reality.

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