Einstein's variable speed of light and his enforced wrong synchronization method

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Abstract

This article describes two of the major errors of Einstein's reasoning in his 1905 document which founded the Special Theory of Relativity (STR)[1]. Einstein contradicted himself by using both the principle of Constancy of Speed of Light (CSL) and a variable speed of light, along with a wrong synchronization method. A 3D animated simulation accompanies and demonstrates the statements of this article, as part of the development of the Neo-Classical Theory of Relativity (NCTR).

Introduction: A description of the purpose of Einstein's theory of relativity

The errors in Einstein's relativity theory can be grouped by several criteria, as mentioned in the main document of NCTR [6]. The two main errors considered here are errors in Einstein's reasoning of STR. However, in order to understand such errors of reasoning, it is important to understand first the purpose of that reasoning, and the context in which that purpose appeared (see Fig. 1).

By the end of the XIXth century, Classical Physics had discovered and defined to a great extent physical phenomena of the macroscopic Universe which can be today grouped in disciplines such as Classical Mechanics (including Newton's Gravitation Theory), Classical Optics, and Classical Electromagnetism. However, the various relations between those disciplines were not well defined yet.

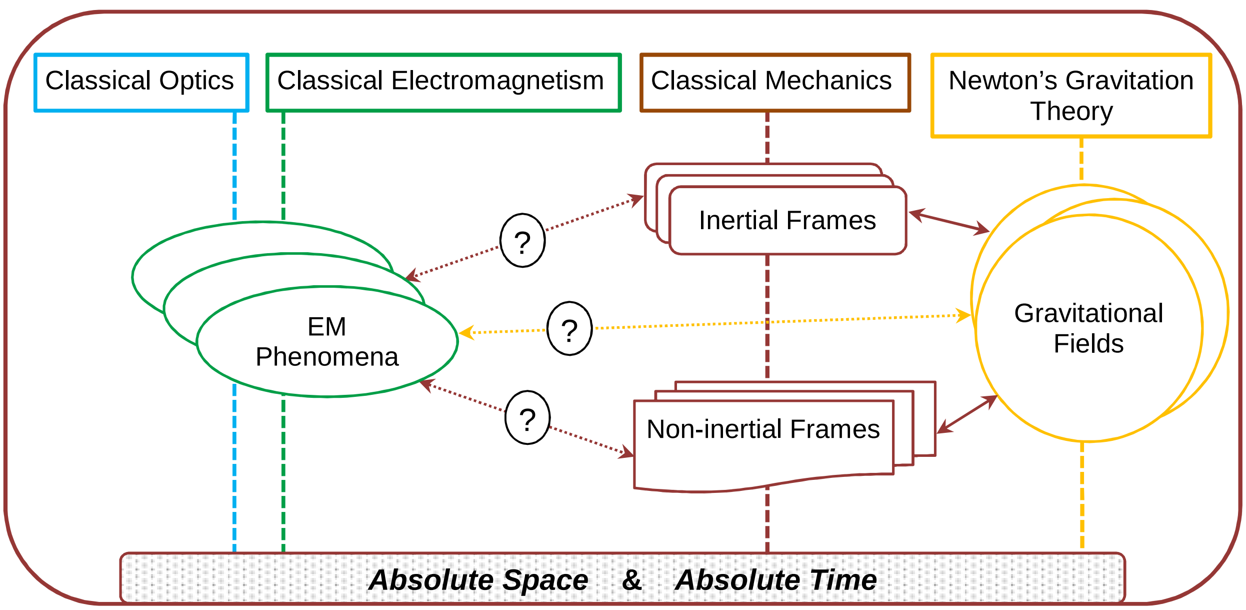

Fig. 1 - Relations between systems (frames) and phenomena described in Classical Physics.

Einstein's STR was conceived mainly with the purpose of defining new relations of space and time between moving systems, in such a way that the electromagnetic (EM) phenomena observed by those systems can be described within those systems in the simplest and the most common form possible.

A few physicists, notably Voigt (1887)[2], Lorentz (1892)[3], Larmor (1897)[4], Poincaré (1904)[5], and Einstein (1905)[1], have considered that the simplest way to describe the EM phenomena in different moving systems is to preserve the form of the Maxwell's equations for the EM fields, across those different moving systems. Voigt, in particular, considered an equivalent way: to keep the form of the EM wave equation the same across different systems, which implied to keep the velocity of light ***c*** as a constant across systems (by systems here we mean "inertial reference frames", IRFs).

Although such a preservation of Maxwell's equations might be convenient from a mathematical perspective, the way it has been obtained raises doubts from a physical perspective, in most of the works of the authors mentioned above, because at that time there was not enough evidence (and still there is not enough evidence) that either: two observers in different frames would observe an EM phenomenon identically, or, that ***c*** is strictly a constant when measured one-way in any inertial reference frame (IRF).

The Doppler effect and the aberration of light suggest that, on the contrary, the EM phenomena is observed differently by different observers in different frames. Also, the <u>independence</u> of the EM phenomena from any inertial object suggests that the propagation of light through space cannot be <u>constant with</u> different inertial frames. (Logically speaking, "*independence from*" is the opposite of "*constancy with*", as the latter implies "*connection with*", and "*dependency on*").

That means, the <u>presumption</u> of Voigt, Lorentz and Larmor, and also Einstein's <u>purpose, conclusion, and demonstration</u> (that Maxwell's equations have the same form in different IRFs), are all logically incorrect, since they are not based on a truth value - a value which needed to be firmly validated experimentally before such presumptions were made, and before such a purpose was followed up.

Even if we assume by *reductio ad absurdum* that Einstein's <u>purpose of reasoning</u> (in his 1905 paper) was valid, we can now still demonstrate that his <u>actual reasoning</u> had many errors. Although the two errors detailed here have already been presented in the main document of NCTR, more details and a special 3D animation simulation (which accompanies this article) are needed to be described here, to clarify them and to support the further development of NCTR.

<u>1. From synchronizing clocks to the invariance of Maxwell's equations</u>

Let us describe Einstein's reasoning by a simplified diagram, as seen in Fig. 2, in order to present the points of interest of this article.

Although we affirm by our research that most of the parts of Einstein's reasoning present major errors, for the sake of brevity we will not treat all of those parts in this article. The 1st block of the diagram, containing the definitions 1a, 1b, and 1c of the fundamental ideas of STR, will be treated in a separate article named "*Determinations of an Absolute Reference Frame and a Common Time for all frames of reference*" which will be published very soon. Some of the errors of this block have also been addressed in the main document of NCTR [6].

The 2nd block (the definition of simultaneity), the 3rd block (the declaration of a singular synchronization method), and the 4th block (the imaginary experiment) will be discussed in details in the next sections, as well as the decisional (question-answer) blocks leading to the 5th block.

The 5th and the 6th blocks will be treated separately in an upcoming article regarding the physical and mathematical implications of the Lorentz transformations.

Fig. 2 - The main parts of Einstein's reasoning in his 1905 presentation of the Special Relativity Theory:

1a. Ambiguously suggest that Maxwell's electrodynamics have a different behaviour seen from the moving bodies when compared to the form of actual EM phenomena (defined by Maxwell in a stationary frame!). Further suggest that phenomena of electrodynamics and mechanics do not possess properties corresponding to the idea of the existence of an absolute rest.

1b. Declare the First Postulate of the Special Theory of Relativity (STR):
The principle of relativity (PR).

1c. Declare the Second Postulate of STR:
The principle of constancy of speed (|velocity|) *of light* (CSL).

2. Define Simultaneity of Events.

3. Declare a singular Method of Synchronizing Clocks.

4. Perform a ***particular*** imaginary experiment with the clocks of an inertial reference frame (IRF) moving away from a "stationary" frame.

Q1.: Are the moving clocks still synchronized to each other ?

A1.: **Yes**, but unfortunately Einstein ignored this question and its answer.

Q2.: Can the moving clocks be re-synchronized by using (**3**.) ?

A2.: **No**

Q3.: Can the moving clocks be re-synchronized by using **another method** ?

A3.: **Yes**, but unfortunately Einstein ignored this question and its answer.

5. The events are **incorrectly** deemed as no longer observed as simultaneous in both stationary and moving system. Einstein assumed the **need** of **new** time and space relations between systems.

6. The Lorentz Transformations (LT) were reobtained by Einstein's foggy mathematical manipulation.
- In the end, Maxwell's equations for EM fields were showed to be invariant with LT.

2. Einstein's definition of simultaneity

It is important first to understand that Einstein needed a method of synchronization of clocks in order to extend his definition of simultaneity across space. Fig. 3 represents his definition of "local" simultaneity:

> "*If at the point A of space there is a clock, an observer at A can determine the time values of events in the immediate proximity of A by finding the positions of the hands which are simultaneous with these events.*"

> "*If there is at the point B of space another clock in all respects resembling the one at A, it is possible for an observer at B to determine the time values of events in the immediate neighbourhood of B.*"[1]

Fig. 3 - Different time values associated with events happening in the points A and B of space.

> "***But it is not possible without further assumption to compare, in respect of time, an event at A with an event at B.***"..."*We have not defined a common "time" for A and B, for the latter cannot be defined at all unless we establish by definition that the "time" required by light to travel from A to B equals the "time" it requires to travel from B to A.*"[1]

There are multiple errors in Einstein's definition of simultaneity of remote events:

I.) He claimed it was not possible to compare the time of an event at A to the time of an event at B, unless another assumption was further made. The error is that he did not explain his claim, neither he explored any practical possibilities of comparing times. We will show here that such possibilities do exist:

I.1.) As Einstein's definition states, the indication of a clock located in the proximity of an event is simultaneous with that event, and that implies that the indications of two identical clocks next to each other are also simultaneous. If we fill the distance between A and B with identical clocks, then each pair of adjacent clocks will show simultaneous indications, which means the clocks in A and B will be synchronized (their indications will be simultaneous).

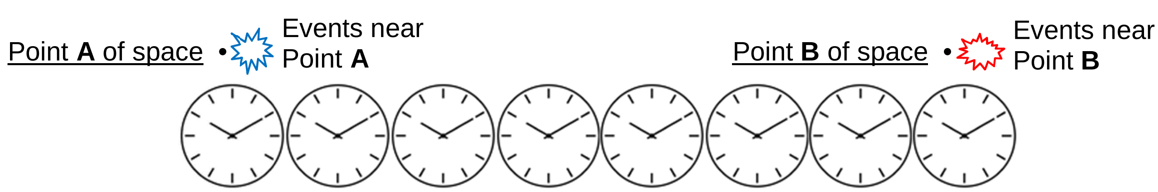

Fig. 4 - The distance between points A and B can be filled with identical synchronized clocks next to each other, and thus the time indicated in A will be the same as the time indicated in B.

I.2.) Einstein did not take in consideration the transportation of a clock from A to B. Assuming the two clocks are identical and synchronized when they are built, and initially together at point A, there is no physical reason to claim that an ideal slow transportation of a clock from A to B will make the clocks show different indications when they are finally apart as one clock at A and the other clock at B.

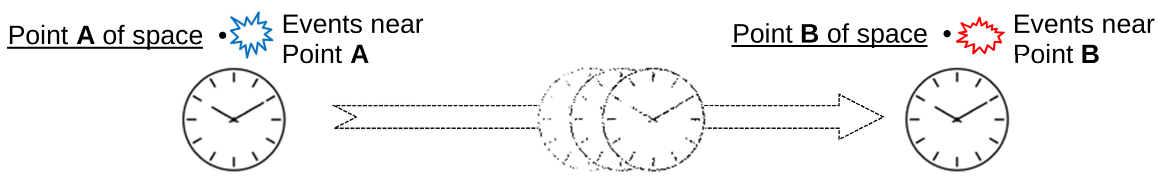

Fig. 5 - The transportation of an ideal clock away from another identical clock should keep both clocks synchronized (i.e. their indications should be simultaneous and identical in count).

That means, Einstein's claim (that it is impossible to consider a common time for the points A and B without employing his assumption and definitions) is invalid and useless, from a scientific point of view.

II.) His assumption of a "*common time*" was bound to his one and only definition, invented by himself but not explained scientifically. His assumption was, in fact, a 3rd postulate added to his theory.

III.) There is a circular logic between the 2nd postulate of STR and his definition of "*common time*":

- The measured velocity of light traveling from A to B, or from B to A, is a constant $\mathbf{c} = \mathbf{r}_{AB} / \mathbf{t}_{AB}$, where $\mathbf{r}_{AB}$ is the distance between A and B, and $\mathbf{t}_{AB}$ is the time taken to travel from A to B, or from B to A.
- However, $\mathbf{t}_{AB}$ can be considered into the measurement only if it is a "*common time*" of A and B.
- The "*common time*" T can be considered by Einstein only if his theory *defines* that the time T taken by light to travel from A to B equals the time T taken by light to travel from B to A. That is equivalent to requiring the velocity of light be the same constant between A and B, as well as between B and A.

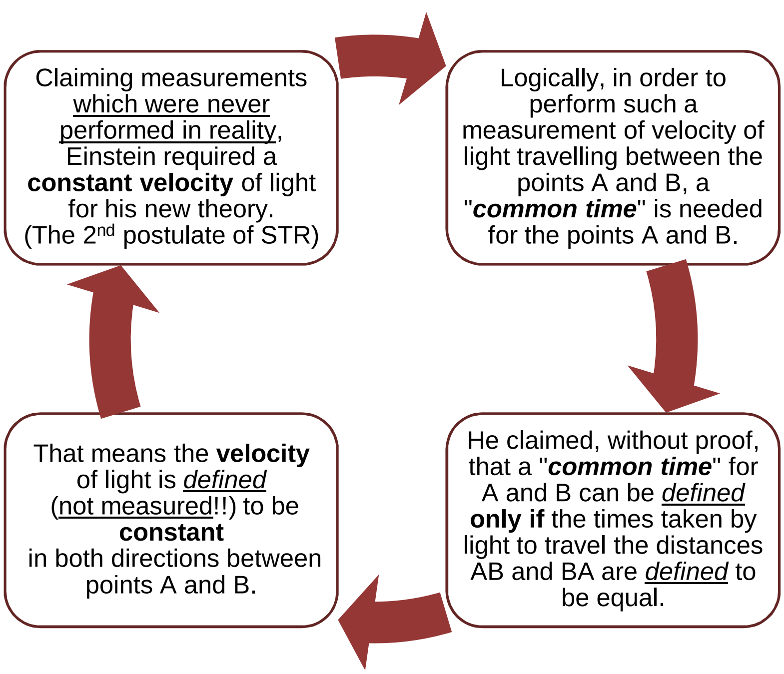

Fig. 6 - The circular logic between the 2nd postulate of STR and the definition of "*common time*" (which is actually a hidden 3rd postulate of STR).

IV.) Einstein crafted his own definition (of equal times taken by light to travel from A to B and viceversa) to match his second postulate (of the constancy of speed of light). He assumed that between an arbitrary system and an EM phenomenon (light) there is <u>a constant universal relation which suited his reasoning</u>.
However, <u>such a relation does not exist in reality</u>, because light, as any other EM phenomena, is independent from any object which is in inertial motion. That means, light is not part of any coordinate system (IRF) attached to an object in motion. There are at least two consequences of that:

IV.1.) A photon sent from a source A to a target B may miss the target due to the velocity-aberration of light from the system which contains A and B. For details on this aspect please see [6], the Fig. 7 here, and the 3D animation simulation at: youtu.be/0ed5CCP0eMg

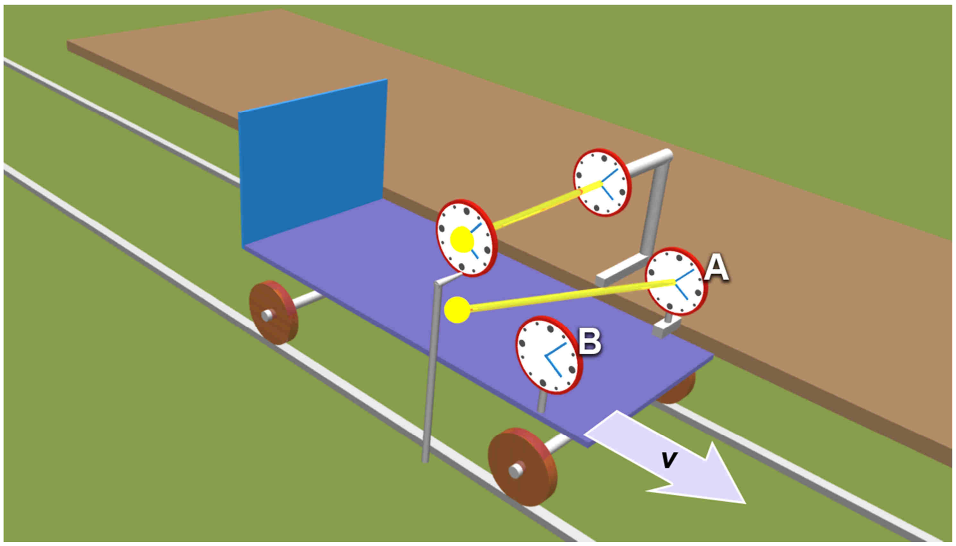

Fig. 7 - A photon of light sent from A to B may miss the target due to the velocity-aberration of light in the moving frame. An identical photon sent on the same direction will reach the target in the stationary frame.

IV.2.) Einstein's assumption cannot be considered valid if there is any <u>situation</u> in which the velocity of light can be found by measurements to be variable between two distant synchronized clocks (i.e. two clocks showing the same *common time*) at rest with each other.
In other words: it has not been proven either theoretically or experimentally, prior to Einstein's assumption, that in any system, light takes equal intervals of time to travel between two synchronized clocks.

As we will show in the next sections, Einstein himself found twice in his further reasoning that such a situation can actually occur, however he did not realize that such a fact invalidated his own assumption. Also, we will show further that there was at least one experiment performed which successfully measured a variable velocity of light.

To be fair in our reasoning, we have to propose here better definitions for the concept of simultaneity, as it is a basic concept of the Neo-Classical Theory of Relativity. In NCTR, the simultaneity of two different events, occurring respectively in two points of space remote from each other, can be decided ultimately by employing multiple observers in various states of inertial motion, which observers must use various methods of observation. Such methods will be detailed soon in an upcoming article, as part of the development of NCTR, however, the definition of simultaneity will be complete by the end of this article.

3. Einstein's declaration of a singular method of synchronization of clocks

It is important now to distinguish between the two related notions: simultaneity and synchronization:

- **Simultaneity** means the mindful association of two or more events (or changes) together. The set of events being associated may contain a reference event (or a reference change). That association gives us a sense of *co-existence* or *co-manifestation* into existence of those events (or changes), regardless of where those events happen in space. The events in such association are considered to be then *simultaneous*.

- **Synchronization** means an act of making two or more recurring reference changes (i.e. clocks) happen in reality in such a way that they can further be associated, and thus considered to be *simultaneous*.

As the synchronization has also the purpose of **verifying** the simultaneity (the association) of the events observed, it is logical that the method of synchronization should not use the same criterion of association used in the definition of simultaneity, otherwise a circular reasoning might occur, and thus it might lead to erroneous conclusions or erroneous results.

Unfortunately Einstein chose an only method of synchronization of clocks which was derived from his only chosen criterion of simultaneity, which criterion was given by his definition of a common time:

> "*Let a ray of light start at the "A time"* t_A *from A towards B, let it at the "B time"* t_B *be reflected at B in the direction of A, and arrive again at A at the "A time"* t'_A .
> *In accordance with definition the two clocks synchronize if* $t_B - t_A = t'_A - t_B$."[1]

It is also worth mentioning here that Einstein did not give details on what he actually meant by "*the two clocks synchronize*". We may guess from the context that he meant that the clocks would show the same indications (or the same "time values"). Unfortunately it is not clear from his text, nor from ulterior texts of the relativity theory:

- how and when the clocks establish the initial same indications,
- how the interval-unit of time, occurring between any two consecutive indications, is established,
- how the interval-unit of time, occurring between any two consecutive indications, is maintained.

As already showed in NCTR [6], even if we consider the clocks to be ideal, there are at least two errors in Einstein's choice of a synchronization method:

Error #1: The ideal clocks would actually not need to be re-synchronized after being transported to the two remote points A and respectively B:

In a reasoning similar to the one at point I.2. above, if M is the midpoint between A and B, then the two ideal clocks can be initially placed together in M, then synchronized to each other (i.e. set for the initial indications to match, and set to use the same internal time unit), then each can be transported to one of the points A, and respectively B, as in Fig. 8:

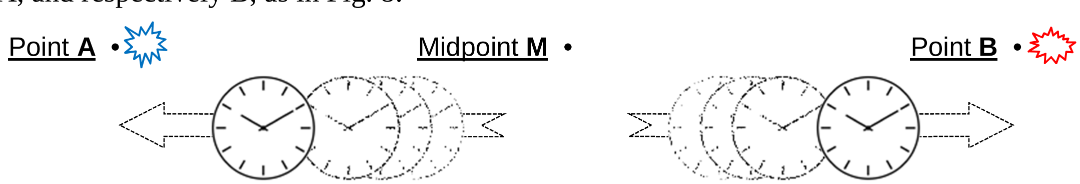

Fig. 8 - Two ideal clocks transported to two remote points would undergo identical changes in their indications and their time unit, therefore would not need to be re-synchronized with each other.

Error #2: Due to the independence of light as an EM phenomenon, the method of synchronization would not work in many cases, as the motion relation between the system (in which the clocks are at rest) and light is unknown or incorrectly defined. Therefore the method may result in errors due to the velocity-aberration of light, or errors of calculation due to an actual different velocity of light, as mentioned already in the error IV. described in the section 2. here, as well as in the main document of NCTR (see [6] - section 1.2.2.)

As we can see, the errors of the synchronization method are similar to the errors described in the previous section about the definition of simultaneity. That confirms our recommendation already mentioned, that the method of synchronization should be different and unrelated to the criterion used for the association of events which defines simultaneity.

4. Einstein's imaginary experiment with a moving rod and two clocks, and the enforced use of his wrong synchronization method in two different IRFs

We arrive now at the part of Einstein's reasoning which contains the two major errors mentioned in the beginning of this article. In the diagram of the Fig. 2, the fourth block describes this part: an imaginary experiment is performed by him, by applying his own concepts of simultaneity and synchronization to two IRFs in motion from each other. To understand better Einstein's imaginary experiment, we created a 3D animated simulation named "*Einstein's errors: the variable speed of light and his wrong synchronization method*", available on the NCTR channel at: youtu.be/ZOjNwuQUOAM
In Fig. 9, a still image from that 3D simulation shows the setting of the experiment:

A rigid rod with two clocks placed at its ends (A and B) is set in inertial motion from a stationary frame. Clock-A emits a photon to Clock-B, and then another photon will be emitted from Clock-B to Clock-A.

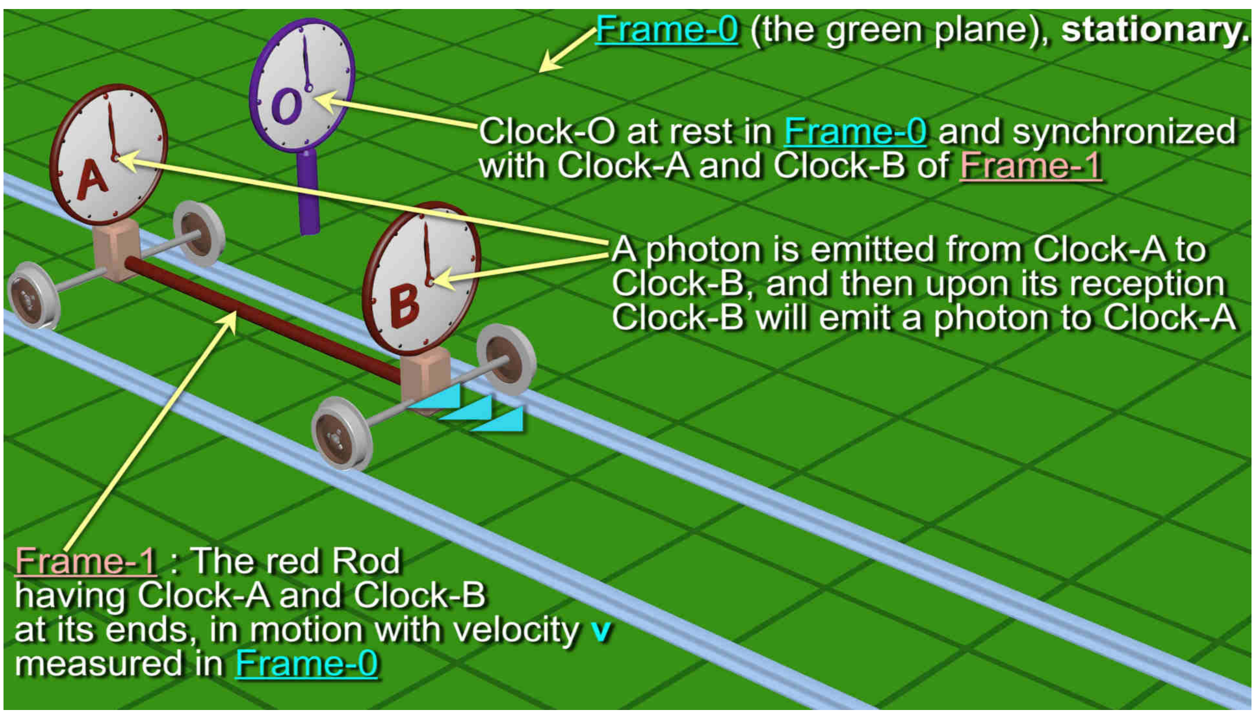

Fig. 9 - Still image of a 3D animated simulation of Einstein's imaginary experiment, showing the paths of the photons as seen from the stationary frame and respectively from the moving frame.

Initially, when the rod is at rest in Frame-0, both clocks are synchronized with each other and with a reference Clock-O of the Frame-0. We note and remark:

- Einstein's definition of velocity of light was: $$\textbf{Velocity} = \frac{\textbf{Light path}}{\textbf{Time interval}} \qquad \textbf{(1)}$$

- We consider only one photon traveling between the clocks from A and B, and then another photon traveling between B and A, instead of Einstein's ray of light sent from A and reflected at B back to A.
- c the velocity of light in any direction, measured in the stationary Frame-0.
- $\mathbf{v}$ the velocity of the rod, measured in the stationary Frame-0.
- $\mathbf{r_{AB}}$ the length of the rigid rod.
- $\mathbf{t_{AB} = t_B - t_A}$, where $\mathbf{t_{AB}}$ is the time interval between the moment $\mathbf{t_A}$ when the photon is emitted by Clock-A, and the moment $\mathbf{t_B}$ of the reception of the photon by Clock-B.
- $\mathbf{t_{BA} = t'_A - t_B}$, where $\mathbf{t_{BA}}$ is the time interval between the moment $\mathbf{t_B}$ when the photon is emitted by Clock-B, and the moment $\mathbf{t'_A}$ of the reception of the photon by Clock-A.

At the end of the experiment, Einstein found out that the times taken respectively by light to travel between the clocks in each direction are not equal:

$$\mathbf{t_{AB} = t_B - t_A = \frac{r_{AB}}{\boldsymbol{c} - v}} \quad , \quad \mathbf{t_{BA} = t'_A - t_B = \frac{r_{AB}}{\boldsymbol{c} + v}} \qquad \textbf{(2)}$$

From which he concluded:

> "*Observers moving with the moving rod would thus find that the two clocks were not synchronous, while observers in the stationary system would declare the clocks to be synchronous. So we see that we cannot attach any absolute signification to the concept of simultaneity*"

Einstein's errors in this case are, again, multiple:

E.1.) The clocks are ideal, and as they were already synchronized while being at rest in the stationary Frame-0, there is no reason to assume that they will become unsynchronized once they are set in motion. That means, the clocks in motion will still be synchronized to each other, and synchronized to the clocks in the Frame-0.
Otherwise the calculations which Einstein himself made would not have any physical sense, because, by his own previous claims (while defining simultaneity), there would not be a "*common time*" to allow an expression such as $\mathbf{t_B - t_A}$ to be calculated (!).

E.2.) He did not realize that the validation of the simultaneity is actually the coincidence of the values indicated by those two ideal clocks, not the ulterior use of a method of synchronization. In other words, if he considers the moving clocks to still be synchronized from the perspective of the stationary Frame-0, that means there is already a "*common time*" which allows simultaneous indications of the moving clocks.

His attempt to find another "*common time*", indicates his **preconception** about measuring different times in different inertial frames. Such preconception, and such attempt to prove it, are illogical.

E.3.) Einstein omitted to mention the fact that the observers attached to the moving clocks are measuring a **variable speed of light**, i.e. a variable magnitude of the velocity of light measured respectively in both directions: AB and respectively BA.

To prove our statement, first we notice in Fig. 10 (taken from the 3D simulation) that the paths of light observed in Frame-1 (the moving rod) are different from the paths of light observed in Frame-0 (the stationary frame). The calculation of the lengths of those paths is showed in Fig. 11.

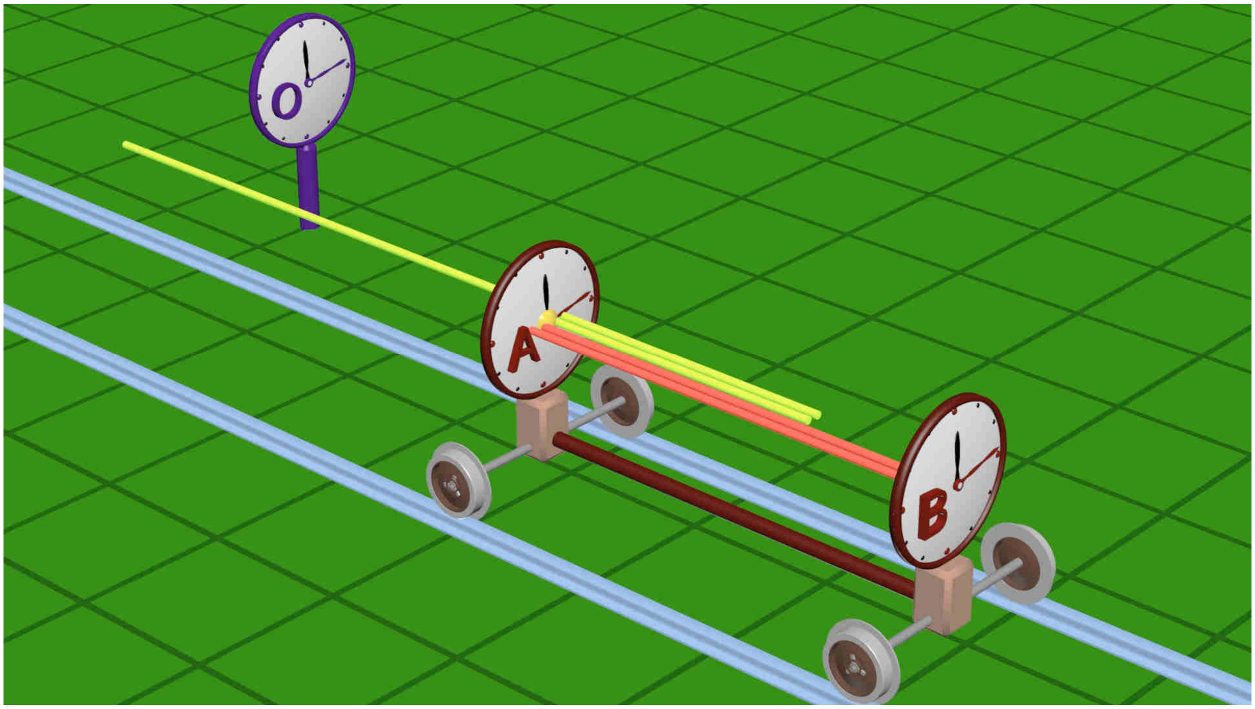

Fig. 10 - Still image of a 3D animated simulation of Einstein's imaginary experiment, showing the paths of the photons as seen in the stationary frame and respectively in the moving frame.

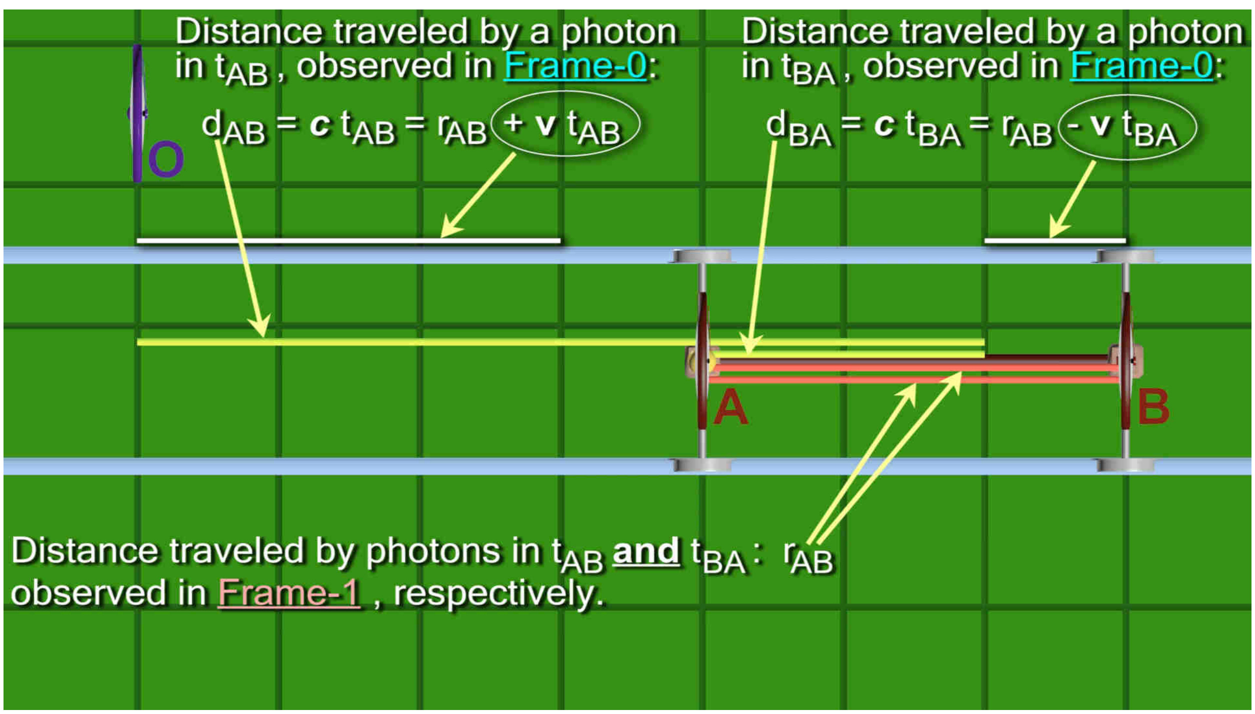

Fig. 11 - Still image of a 3D animated simulation of Einstein's imaginary experiment, showing the paths of the photons <u>measured</u> in the stationary frame and respectively in the moving frame.

We have to stress again that the observers moving with the clocks, and calculating $\mathbf{t_{AB}}$ and $\mathbf{t_{BA}}$ according to (2) used by Einstein, could not and should not do such a calculation if they would not have the clocks physically ticking at the same rate simultaneously, i.e. if they would not have already a "*common time*".

That means we have a valid reason to consider the observers of the moving clocks as already having a "*common time*", being synchronized, and being entitled to claim that their time calculations are correct.
Also contrary to the requirement of Einstein, it is natural that no other re-synchronization method is necessary, and there is no need to enforce the clocks to use "another" "*common time*".

That means the moving observers will calculate the velocity of light in their own Frame-1 using the formulas (2) as follows:

$$\boxed{\mathbf{c_{AB}} = \frac{\mathbf{r_{AB}}}{\mathbf{t_{AB}}} = c - \mathbf{v}} \quad , \quad \boxed{\mathbf{c_{BA}} = \frac{\mathbf{r_{AB}}}{\mathbf{t_{BA}}} = c + \mathbf{v}} \qquad \textbf{(3)}$$

Einstein's formulas reveal the hidden fact that the observers within a moving frame, using clocks synchronized to each other, can measure variable values for the speed of light. In other words:
Einstein's formulas resulted from his imaginary experiment show a variable speed of light and contradict his own postulate which claimed a constant speed of light.

E.4.) Instead of noticing that a "*common time*" is already determined in the moving frame, and instead of searching for other synchronization methods which would validate that "*common time*" across multiple frames, Einstein preferred to enforce his own synchronization method upon the moving frame, and to claim that there is **another** "*common time*" in the moving frame, **different** from the "*common time*" which the moving frame already had together with the stationary frame.

As the NCTR has already showed, there are other synchronization methods which can be used across multiple inertial frames, and which preserve the synchronization of the clocks internal to each frame.
The **inertial method of synchronization**, proposed by NCTR, is using inertial objects sent between clocks with a velocity **w** which is always constant when measured internally within the frame which uses the method. From the perspective of any other IRF moving with a velocity **v** from the first frame, the velocity with which the inertial object will travel between clocks will be a vectorial resultant **v + w**, and that will guarantee equal times on both legs of a roundtrip between any two clocks (Fig. 12).

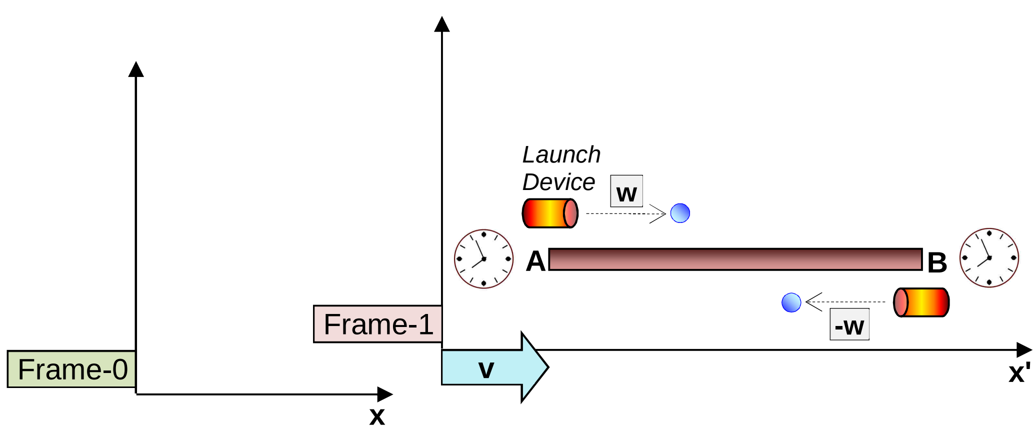

Fig. 12 - The inertial method of synchronization guarantees equal times taken by the inertial objects to travel between clocks, even when the times are measured from any other inertial frame.

Another advantage of the inertial synchronization method is that it is not affected by a velocity-aberration effect. Indeed, the means of synchronization (the inertial objects sent between clocks) is carried along with the frame which employs the method of synchronization, as noticed in Fig. 13, in comparison to the case showed in Fig.7.

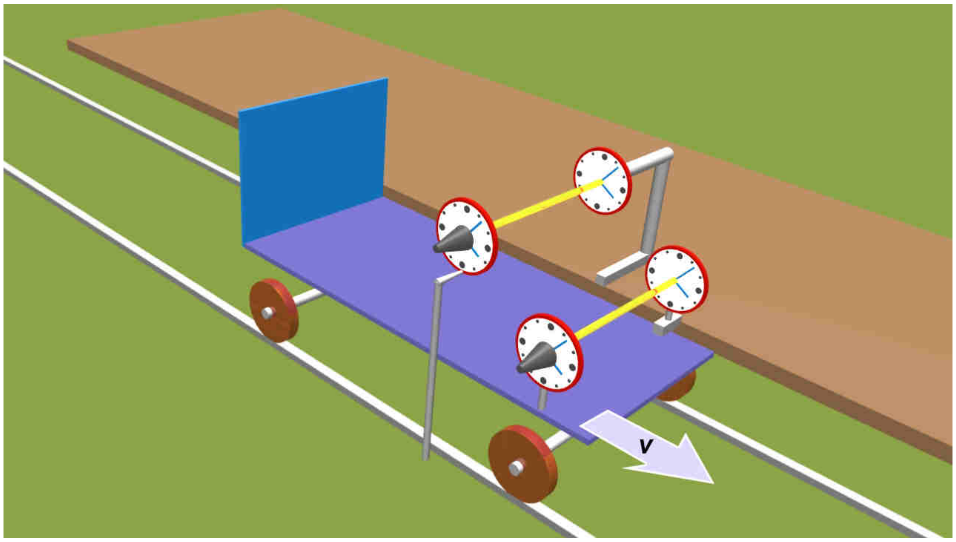

Fig. 13 - The inertial method of synchronization is not affected by a velocity-aberration effect.

Numerical examples:

To show the difference between the synchronization methods, our 3D simulation is following these numerical values and calculations:

- the magnitude of the velocity of light (i.e. speed of light):	c = 300000 km/s
- the magnitude of the velocity of the rod measured in Frame-0:	$\mathbf{v} = 0.5c$
- the magnitude of the velocity of the inertial objects, in Frame-1:	$\mathbf{w} = 0.5c$
- the length of the rod:	$\mathbf{r}_{AB}$ = 1500000 km
- the length unit of the grid in the 3D simulation and the related figures:	1 segment = 500000 km
- the time unit of the clocks in the 3D simulation:	1 tick = 1 second

Example-1: The case of Einstein's "*light synchronization method*" (Fig.11):

The distance traveled by a photon in $\mathbf{t}_{AB}$, observed in Frame-0:

$$\mathbf{d}_{AB} = c\, \mathbf{t}_{AB} = \mathbf{r}_{AB} + \mathbf{v}\, \mathbf{t}_{AB} \tag{4}$$

The distance traveled by a photon in $\mathbf{t}_{BA}$, observed in Frame-0:

$$\mathbf{d}_{BA} = c\, \mathbf{t}_{BA} = \mathbf{r}_{AB} - \mathbf{v}\, \mathbf{t}_{BA} \tag{5}$$

Applying the (2), (3), (4), (5) we obtain:

$\mathbf{t}_{AB}$ = 10 s	$\mathbf{t}_{BA}$ = 3.33333333 s
$\mathbf{c}_{AB} = 0.5c$	$\mathbf{c}_{BA} = 1.5c$
$\mathbf{d}_{AB}$ = 300000 km	$\mathbf{d}_{AB}$ = 100000 km

Example-2: The case of NCTR's "*inertial synchronization method*" (Fig.14):

The distance traveled by the inertial object in $\mathbf{t_{AB}}$, observed in Frame-1 is obviously $\mathbf{r_{AB}}$.

The times taken by the inertial object to travel between A and B, and respectively between B and A:

$$\mathbf{t_{iAB}} = \mathbf{t_{iBA}} = \frac{\mathbf{r_{AB}}}{\mathbf{w}} \qquad\qquad \mathbf{t_{iAB}} = \mathbf{t_{iBA}} = 10 \text{ s} \qquad\qquad \textbf{(6)}$$

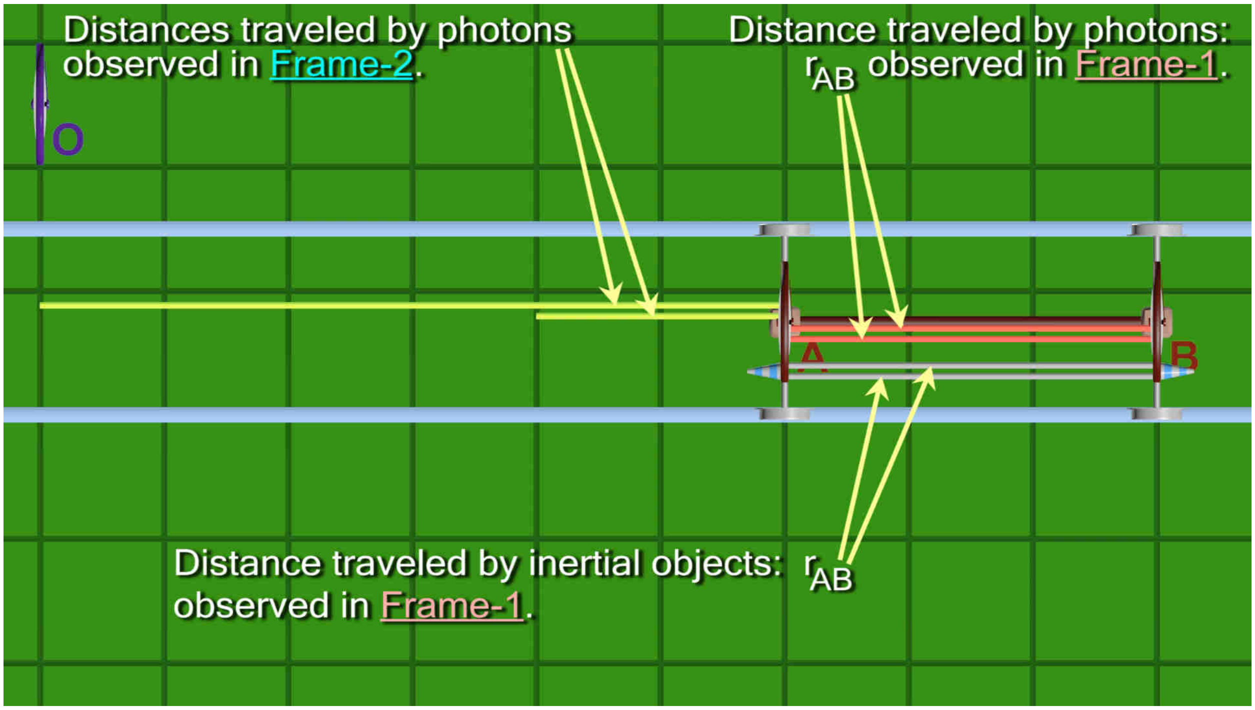

Fig. 14 - The inertial objects' paths (the gray lines) used in the inertial method of synchronization, as observed in Frame-1 (the moving rod).

The point of the calculations and the numerical examples above is that the times (of travel between clocks) obtained by the *inertial synchronization method* **do not depend** on the velocity **v** between Frame-1 and Frame-0, while the times obtained by Einstein's light synchronization method **depend** on the velocity **v**.

In other words, the fault of Einstein's method is that it was conceived to depend on the relative motion between frames, while the theory ignored other methods which do not depend on the relative motion.

5. To the Lorentz Transformations, via fudged mathematics

Upon finding that his imaginary experiment showed the failure of simultaneity (by his definition), Einstein concluded that there is no "*absolute signification to the concept of simultaneity, but that two events which, viewed from a system of co-ordinates, are simultaneous, can no longer be looked upon as simultaneous events when envisaged from a system which is in motion relatively to that system*".[1]

As the "common time" is no longer common to two different inertial reference frames, he proceeds further to find out mathematical relations which would connect the times (and coordinates) of two such IRFs, in his next section "*§ 3. Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former*".

He starts by defining one stationary frame **K**, and one moving frame **k**, and gives each of both frames identical clocks for measuring time respectively (i.e. separately in each frame), and identical rods for measuring distances respectively.

> "*To any system of values x, y, z, t, which completely defines the place and time of an event in the stationary system, there belongs a system of values ξ,η,ζ,τ, determining that event relatively to the system k, and* ***our task is now to find the system of equations connecting these quantities****.*"[1]

Then he makes an invalid assumption about the form of the said equations:

> "*In the first place it is clear that the equations must be linear on account of the properties of homogeneity which we attribute to space and time.*"[1]

The question which we need to raise here is this:
How is time homogenous, since, by Einstein's method, it was not even found to have common values measured in two different frames?
The moment Einstein claimed that the "*common time*" is no longer one and only across all frames, the idea of homogeneity of time was falsified. Time became multi-versioned, with each "version-time" being attributed to a frame and isolated from the "version-times" of other frames. Therefore the relations between "version-times" needed to be guessed, based on the laws of Physics. Unfortunately, all the laws of Physics had been expressed by that moment in a universal absolute "*common time*", already dismissed.

Einstein's assumption of linearity of the equations connecting different frames has no physical and no mathematical basis, in the context of his own definitions of simultaneity and synchronization.

Moreover, it was mathematically and physically incorrect of him to assume that between a system of values **(x, y, z, t)** and a system of values **(ξ, η, ζ, τ)** there is only one relation, only one function. Once the systems (the frames) are considered separated, there could be many functions between subsets of values from both systems. Mathematically there is no way to demonstrate that there is only one function which relates (applies) any point from one system to any other point from the other system, or - on the contrary - to demonstrate that there is a different function for each pair of points respective from both systems.

For example, Einstein considers only one function **τ(t)** which would describe any pair of time values between the systems, and from his relation (in the frame **k**, about the equal time intervals taken by light from its start at the origin and at time $\boldsymbol{\tau_0}$, to the moment of reflection at $\boldsymbol{\tau}_1$, and then back to the origin at which arrives at time $\boldsymbol{\tau}_2$):

$$\frac{1}{2}[\tau_0 + \tau_2] = \tau_1 \tag{7}$$

He founds a correspondence of the form:

$$\frac{1}{2}\left[\tau(0, 0, 0, t) + \tau\left(0, 0, 0, t + \frac{x'}{c - v} + \frac{x'}{c + v}\right)\right] = \tau\left(x', 0, 0, t + \frac{x'}{c - v}\right) \tag{8}$$

However, we can affirm that in Einstein's conditions (of having separate sets of time values for separate frames) there is nothing mathematically or physically that would prevent us to hypothesize that there are **multiple** <u>different</u> **functions** which can describe relations between such sets. Therefore, Einstein's correspondence using **$\tau(t)$** can be re-written by using multiple different functions **$\tau_{f0}(t)$**, **$\tau_{f1}(t)$**, **$\tau_{f2}(t)$**:

$$\frac{1}{2}[\tau_0 + \tau_2] = \tau_1$$

$$\frac{1}{2}\left[\tau_{f0}(0, 0, 0, t) + \tau_{f2}\left(0, 0, 0, t + \frac{x'}{c - v} + \frac{x'}{c + v}\right)\right] = \tau_{f1}\left(x', 0, 0, t + \frac{x'}{c - v}\right) \qquad (9)$$

The problem in either case is that, in Einstein's setting of his theory, <u>neither hypothesis can be proven physically</u>: neither Einstein's assumption that there is only one function **$\tau(t)$** which relates any two systems, nor our assumption here that there are multiple functions which would relate any two systems.

Einstein failed to realize that, before his own new theory, the only physical aspect which made two IRFs be **uniquely** related (by the Galilean transformations of the Classical Mechanics) was the **unicity** of the absolute time across all the IRFs.

Another point of failure in Einstein's mathematical reasoning was the absence of any demonstration regarding the use of the same length values by two different systems.
<u>Einstein should have proposed a method of comparison of lengths measured in the two different IRFs respectively, in a similar way he proposed a method of comparison of times measured in the two IRFs</u>.

We consider now that a comparison of the length values between the two IRFs should have been done by Einstein even in 1905 when he wrote his article, considering the **hypothesis of the length contraction** was already proposed by FitzGerald in 1889 and then considered mathematically by Lorentz in 1992.

If we summarize the time and space quantities used by Einstein in his imaginary experiment, in his attempt to find the transformations between two IRFs, we notice a few bizarre omissions which have been replaced only by assumptions, not by physical proofs (see Fig. 15):

	The case of a photon traveling from point **A** to point **B**, being measured respectively from two systems (IRFs)	
Physical quantity	Stationary IRF (Frame-0)	Moving IRF (Frame-1)
Velocity of light	***c* − v** (measured)	***c*** (postulated, <u>not measured</u>)
Velocity between IRFs	**v** (measured)	**v** (assumed, <u>not measured</u>)
Time of travel	**t_{AB}** (measured)	**ignored** (by a <u>faulty reasoning</u>)
Length traveled	**r_{AB}** (measured)	**r_{AB}** (assumed, <u>not measured</u>)

Fig. 15 - The measurements, from two systems, of a photon traveling from point A to point B.

We can notice, a few times throughout Einstein's text, the use of the $c-\mathbf{v}$ and $\mathbf{c+v}$ expressions, along with Einstein's remark:

> "*the ray moves relatively to the initial point of k, when measured in the stationary system, with the velocity* $c - \mathbf{v}$"

It is puzzling how Einstein or any other physicist would conceive that the relation between light and Frame-1 would be $c-\mathbf{v}$ when measured from Frame-0, yet the same relation between light and Frame-1 would be c when measured from within Frame-1 itself (!).

That means light would seem **independent** from any frame (like Frame-1) when the observation is done from Frame-0, yet at the same time light would seem **connected** (as it would be a constant phenomenon) to any frame (like Frame-1), when the observation is done within that any frame (like Frame-1). Such a **duality** contradicts the reality of the **independence** of light from any frame.

6. Are there other relativistic derivations of the Lorentz transformations which can be considered logically correct?

As far as the author has researched, other *relativistic* derivations of the LT, obtained after 1905, have some flaws similar to, and some flaws different from those present in Einstein's original derivation. Among the works considered by the author, the ones of Einstein (1916)[7], Pauli (1921-1958)[8], Löwdin (1939-1998)[9], Robertson(1949)[10], and Logunov (2005)[11], will be briefly discussed here.
Although a thorough analysis of the mentioned derivations is beyond the purpose of this article, it is worth describing briefly how they are distinguished from the original, and what are their weak points from a reasoning perspective:

6.1. • **Einstein's simpler derivation** [7] uses a certain type of equations of the propagation of light to start his calculations. For two systems K and K', with a ray of light propagating parallel to the X axes on the positive direction, the equations are respectively:

$$\mathbf{x - ct = 0} \quad , \quad \mathbf{x' - ct' = 0} \qquad \mathbf{(10)}$$

from which he considered that the space-time points, which satisfy one equation, must satisfy the other equation as well, and then he states that that is possible only if:

$$\mathbf{(x' - ct') = \lambda(x - ct)} \quad \text{where } \lambda \text{ is a constant.} \qquad \mathbf{(11)}$$

Even if we pretend that we don't notice the ambiguity of such assumption, as it is not backed by any experimental validation, the biggest mistake of such reasoning is that Einstein at that point ignored his own first postulate, the principle of relativity. In other words, if he had applied the principle of relativity then, he would have found that at the same time there is another relation which must be considered in the calculations, from the perspective of the other frame:

$$\mathbf{(x - ct) = \alpha\,(x' - ct')} \text{ where } \alpha \text{ is another constant.} \qquad \mathbf{(12)}$$

(The irony is that, later at some point in the reasoning, he invoked the principle of relativity to show something else: that the way in which frame K sees the length of the unit-rod of K' must be the same with the way in which frame K' sees the length of the unit-rod of K.)

If the calculations had been performed on both perspectives showed by the (11) and respectively (12) then Einstein would have eventually reached a contradiction: his result from the perspective of (11) was:

$$\mathbf{x' = a\,x} \qquad \text{at } \mathbf{t = 0}, \text{ where } \quad \mathbf{a} = \frac{\mathbf{1}}{\sqrt{\mathbf{1} - \frac{\mathbf{v}^2}{c^2}}} \tag{13}$$

On the other hand, following (12) he would have obtained:

$$\mathbf{x = f\,x'} \qquad \text{at } \mathbf{t' = 0}, \text{ where } \quad \mathbf{f} = \frac{\mathbf{1}}{\sqrt{\mathbf{1} - \frac{\mathbf{v}^2}{c^2}}} \tag{14}$$

Obviously $0 < \mathbf{v} < c$ implies that $\mathbf{a = f} > 1$, and that means that at $\mathbf{t = t' = 0}$ we have:

$\mathbf{x' = a\,x}$ <u>and</u> $\mathbf{x = a\,x'}$ <u>which is a mathematical contradiction!</u> **(15)**

In fact, this mathematical contradiction can be found in most of the relativistic derivations of the Lorentz transformations, at different stages of the respective reasoning, including in the application of LT.

Indeed, according to principle of relativity, as two physical systems are identical and observing the laws of nature in the same form, the LT should have exactly the same form when applied from each system to the other system, respectively. Such equivalent applications from both systems lead to contradictory results, whether in algebraical forms or in numerical examples.

Those contradictory results have been expressed by numerous researchers in the last century in the definitions of various clocks paradoxes and lengths paradoxes, as their criticism to Einstein's theory of relativity. Unfortunately, nowadays most of the mainstream Physics obeys the relativistic culture and ignores or refuses to treat the reasoning from both perspectives, of both frames, seen from each other.

<u>**6.2.**</u> • <u>**Pauli's derivation**</u> [8] considered first the Lorentz transformations, in this form:

$$x' = \varkappa \frac{x - vt}{\sqrt{1-\beta^2}} \quad , \quad y' = \varkappa\, y \quad , \quad z' = \varkappa\, z \quad , \quad t' = \varkappa \frac{t - \frac{v}{c^2}x}{\sqrt{1-\beta^2}} \qquad \text{where } \beta = \frac{v}{c} \tag{16}$$

Then Pauli made extensive considerations about the two postulates of the theory of relativity. It is worth it discussing those considerations, as there are some interesting points along with some rather ambiguous arguments which he brought in favour of the adoption of the two postulates of STR together.
Unfortunately an entire discussion on those matters would be too different in purpose from this article, and so it should be left for a future article.

A few aspects from those considerations need to be included here though:

- <u>His mentioning of other possible methods of synchronization of clocks</u>: "*Naturally, one could think of other ways of comparing clocks, such as transporting them, or using mechanical or elastic couplings, etc.*" Unfortunately, he did not explore such other ways, and he even ruined his own observation about them by stating this illogical requirement which sounds like another postulate: "*Only it must be stipulated that no such method should lead to a contradiction with the optical regulation method*".

- His apparent justification for the linearity of the transformation between two IRFs. In his words: "*All writers start with the requirement that the transformation formulae should be linear. This can be justified by the statement that a uniform rectilinear motion in K must also be uniform and rectilinear in K'* ".

The issue with this attempt of justification is that Pauli was ambiguous about the subject of the linear motion. Such a statement, referring to "*motion **in** K* " should be clearly about the motion of inertial objects, or the motion of other systems with which K is **in** an inertial relation. We stressed again the word "in" because it signifies only something which is part of an inertial reference system such as K.

Such a statement cannot and should not refer to an EM phenomenon such as the propagation of light through empty space, because the EM phenomena are **independent** from K and from any other IRFs. Therefore, a requirement of linearity, arisen from the linearity of the inertial motion observed in different IRFs, cannot be blindly applied to the propagation of EM phenomena observed in those IRFs.

Our point is that such careless requirement (which in fact is just a guess) serves to nothing than to fudge the mathematics towards a pre-conceived purpose of a theory.
A correct assessment of the linearity should consider and seek the correct forms of all three **separate linear relations among the three entities involved in such a case: system K, system K', and a particular EM phenomenon observed from K and respectively from K'.**

That being said (and left as a subject for future developments of NCTR), it is no surprise that Pauli's derivation continued on the same path as Einstein's derivation. He used these equations of the propagation of a spherical wave front of light, as observed from K and respectively from K':

$$\mathbf{x^2 + y^2 + z^2 - c^2t^2 = 0} \qquad \text{and} \qquad \mathbf{x'^2 + y'^2 + z'^2 - c^2t'^2 = 0} \qquad \mathbf{(17)}$$

Then based on his assumed linearity of a transformation between the two systems, he required that:

$$\mathbf{x'^2 + y'^2 + z'^2 - c^2t'^2 = \varkappa\,(x^2 + y^2 + z^2 - c^2t^2)} \qquad \mathbf{(18)}$$

Where $\varkappa$ is presumed a constant which depends on v, as a function $\boldsymbol{\varkappa(v)}$, where **v** is the constant velocity of the systems moving from each other. Pauli simply stated that the Lorentz transformations in the form mentioned at (16) will "*follow immediately*" (from (18)). Our counterargument to that is identical to the one presented here in the section 5 above.

6.3. • **Löwdin's derivation** [9] was an attempt to derive the Lorentz transformations "*without reference to electrodynamics and the properties of light[...], without reference to the velocity of light or group theoretical assumptions*".

First Löwdin identified four axioms from Pauli's work discussed above [8]:

~~(P1.) The velocity of light is the same in all privileged systems.~~
(L1.) Space and time are homogenous
(L2.) Space is isotropic
(L3.) Space is symmetric with respect to velocities.

We intentionally struck-through the text of the first axiom above, to show that Löwdin did not want to use that axiom in his derivation. Instead, he added a forth axiom which he conceived:

(L4.) The superposition of two positive velocities will again be a positive velocity

The derivation of Löwdin proceeded then algebraically, based on the four axioms (L1.)...(L4.), reaching in the end formulas similar to the Lorentz transformations, and respectively to Einstein's relativistic composition of velocities, with the notable difference that instead of ***c*** (which he chose not to use throughout his whole reasoning) his formulas show a constant ***a*** which he interprets as a *limit velocity*. In his notations:

$$x_1 = \frac{x - vt}{\sqrt{1 - v^2 / a^2}} \quad , \quad y_1 = y \quad , \quad z_1 = z \quad , \quad t_1 = \frac{t - vx / a^2}{\sqrt{1 - v^2 / a^2}} \qquad \textbf{(19)}$$

and the condition: $-a < v < +a$ **(20)**

While Löwdin's derivation is a remarkable example of a deductive theory (and he also explains very well what this type of theory means), there are a few reproaches which we would bring to his reasoning.

First, the assumed homogeneity and isotropy of space is a concept insufficiently explained, and it is so even in the works of his predecessors such as Pauli or Einstein:
- On one hand, there are two universal unique entities named "space", and "time", either of them without a clear definition, however invested with undefined properties which are supposed to be the same in each point of the unclearly defined "space" and "time". That is just circular reasoning and ambiguity.
- On the other hand, there is the abstract statement of Pauli (whose views on these aspects were not questioned by Löwdin) about "*a **triply infinite set** of reference systems moving rectilinearly and uniformly relative to one another*"[8].

The fact (claimed by the relativity theory) that there would be an infinity of systems which do not agree with each other on the measurements of those universal concepts (space and time) shows that there are no grounds to claim the homogeneity and isotropy of space, because if one system is proving the homogeneity and isotropy by its own measurements, an infinity of other systems will disprove those measurements, hence they will disprove those particular claims of homogeneity and isotropy.

Hence, the linearity of the relations between systems, claimed by Einstein, Pauli, Löwdin, et al. cannot be logically proven. It might be taken as a postulate, but that would place the theory of relativity outside the science of Physics, since it would be just a pseudo-physical abstract mathematical construction.

The second reproach we bring to Löwdin's derivation is that the orientation of the axes of the systems considered, together with his 4th axiom about the superposition of two positive velocities, seem crafted so the signs of the terms in the calculation lead to the desired results: a set of transformations similar to LT.

This is a more general reproach to various other derivations, a reproach related to the one we brought above, discussing Einstein's derivation: if the systems are equivalent, then the systems would observe each other in the same way, which means the signs of their relative velocity should be identical. The relations obtained by those derivations depend on that sign, and the reasoning of the derivations always preferred one system over the other, when it was about the signs, or about the expression of the linear relation: which system is given the "+" sign, and which the "–"? Which side (corresponding to a system) of the equation of a linear relation should remain the same, and which should be multiplied by a constant, and why? There is a preference given to one system only, and the final relations (LT or similar) depend on that preference - which was never justified in the relativistic expositions.

The third reproach to be brought to Löwdin's derivation is about his result of a *limit velocity* ***a***.
Practically such result leaves the door open to disproving the whole theory of relativity, first because

there is no experimental nor theoretical way to decide that ***c*** or other velocity is the real **final** physical limit for the ***a*** velocity of any possible physical phenomena.

Second, if Löwdin's transformations would be true and a velocity ***a* = d** > ***c*** is discovered by experiments, then all the relations, models and all the previous relativistic calculations based on ***c*** (the velocity of light) would be revealed as being wrong since their conception.

6.4. • **Robertson's derivation** [10] was done for a stated purpose of showing that the Lorentz transformations can be obtained without using Einstein's postulates. In itself, such an attempt would be praised, because it seems that it was done in the investigative and practical character of the science of Physics, as different from the speculative ways which appear to have taken over the fundamentals of this science more and more in the last century.

Robertson started by defining two systems, one system **Σ** which he names Einstein's "rest-system", and a moving system **S** in motion from **Σ** with a velocity of magnitude v < ***c*** . He postulated that in the rest system **Σ** "*light is propagated rectilinearly and isotropically in free space with constant speed* ***c***". Also, both systems use the measuring rods and clocks of the same physical constitution.

Unfortunately Robertson made a mistake in his reasoning, by adopting Einstein's procedure for setting the clocks in system **S**. In a brief description: in a moving system **S**, a light signal is sent at the time $t = 0$ from the origin O to a position $x^a = p^a$ of an event E from which it is reflected, and then it will reach back the origin O at the moment t_0. The mistake of Robertson comes next, in his assumption:

> "*We **agree** to set the auxiliary clock situated at $x^a = p^a$ in such a way that it records the time* $\boldsymbol{t_0/2}$ *for the event E of reflection*"

That means he required that the time taken by the light signal to travel from O to E **must** be equal to the time taken by it to travel from E to O. Thus, the velocity of light **must** have equal magnitudes on the paths OE and EO.
It is clear that different velocities of the forms ***c*−v** and ***c*+v** were **prohibited**, by a **requirement** stated as an **agreement** in Robertson's assumption above, which was unfounded logically and physically.

Therefore, the measurements of the light signal on those paths were prohibited, and instead Robertson used his own imagination. After a couple of pages of tensorial calculus done to find the transformation T from **S** to **Σ**, he inserted another assumption in the reasoning, this time under the form of his interpretation of the Kennedy-Thorndike experiment:

> "*We accept this interpretation of their results, and conclude from it that:*
> K-T: *The total time required for light to traverse a closed path in S is independent of the velocity v of* ***S*** *relative to* ***Σ*.**"

That fitted well Robertson's first assumption of the equal times on the paths OE and EO, as further he chose the case of v=0 (as if **S** and **Σ** would coincide) from which the time necessary for light to travel OE and EO, with ***c***, will be the same time for light to travel those paths when v > 0 (as if **S** would move from **Σ**). As the lengths of OE-EO are measured by identical rods in both systems, from that and the equality of the times mentioned, it resulted clearly that the velocity of the light signal in **S** could only be ***c***.

Therefore, we consider that Robertson's reasoning was crafted towards achieving a pre-conceived goal, and unfortunately he just replaced Einstein's second postulate with his own postulate-agreement, which he later combined with his interpretation of the Kennedy-Thorndike experiment.

To be even more clear, it is known that the Kennedy-Thorndike experiment can be interpreted by other theories as well, not only by Einstein's STR. For example, it can be interpreted by the Lorentz Ether Theory very well [17], with a concept of "local time" (inherent to the original Lorentz transformations) different in meaning from the concept of "time dilation" or failed simultaneity given by Einstein in STR.

6.5. • **Logunov's derivation** [11] should enjoy a special attention in a broader context, as Logunov did an impressive work to restore the image and the credits which Henri Poincaré deserves in the history of Physics, in particular for his contributions to electrodynamics and the theory of relativity.

In the beginning, Logunov quoted Poincaré and showed that both the principle of relativity and the principle of constancy of velocity of light **were formulated by Poincaré in 1902 and 1904**, before Einstein mentioned them in the beginning of his 1905 article (!).

Then Logunov proceeded in discussing simultaneity, around Poincaré's article [13] published in 1900. He presented the setting of Lorentz, with a "motionless" reference system related to the ether, the coordinates X, Y, Z as **absolute**, and the time T as **true time**. Also in the setting, there is a reference system moving along the X axis with a velocity *v* relative to a reference system "at rest". The coordinates with respect to the axes moving together with the reference system have the values:

$$x = X - vT \quad , \quad y = Y \quad , \quad z = Z \tag{21}$$

while the time in the moving reference system was termed by Lorentz as "local time" (1895) and defined as follows:

$$\tau = T - \frac{v}{\boldsymbol{c}^2} X \tag{22}$$

Although Lorentz deemed the "local time" as "**a mathematical trick**", Poincaré defined "local time" as the time of reading from the clocks when the clocks are controlled by light signals sent from A to B and, then, from B to A. Poincaré also gave an important aspect about the observers:

> "*situated at different points, to compare their clocks with the aid of light signals; they correct these signals for the transmission time, but, without knowing the relative motion they are undergoing and, consequently, considering the signals to propagate with the same velocity in both directions*"

This was a major error of Poincaré, to state that the observers should guess an equality of the velocity of the signals. The velocity can never be guessed, nor assumed to have a pre-conceived value. **The velocity is a quantity which needs precise determination by measurements of its magnitude (speed) and (orientation) direction**. We can now observe that Poincaré's wrong assumption was later transformed into a postulate by Einstein.

Despite this major weak point which indicates that Poincaré's derivation of the LT was a clear model or anticipation of Einstein's derivation, further in Logunov's presentation we actually notice a confirmation of our main statement in this article: **the measured velocity of light is variable in the moving frame**.

From (21) used in (22) he obtains:

$$\tau = T\left(1 - \frac{\boldsymbol{v}^2}{\boldsymbol{c}^2}\right) - \frac{v}{\boldsymbol{c}^2} X \tag{23}$$

"*As the the velocity of light in a reference system "at rest" is, in all directions, equal to* ***c****, i. e.*"

$$\boldsymbol{c}^2 = \left(\frac{dX}{dT}\right)^2 + \left(\frac{dY}{dT}\right)^2 + \left(\frac{dZ}{dT}\right)^2 \tag{24}$$

"*In a moving reference system x = X −vT the upper expression assumes, in the variables x, T, the form*"

$$\boldsymbol{c}^2 = \left(\frac{dx}{dT} + v\right)^2 + \left(\frac{dY}{dT}\right)^2 + \left(\frac{dZ}{dT}\right)^2 \tag{25}$$

"*Hence it is evident that* ***<u>in a moving reference system, the coordinate velocity of a light signal</u>*** *parallel to the X axis dx/dT is given as follows*"

$$\frac{dx}{dT} = \boldsymbol{c} - v \quad \text{in the positive direction,} \qquad \frac{dx}{dT} = \boldsymbol{c} + v \quad \text{in the negative direction.} \tag{26}$$

We have to stress this conclusion of Logunov, as it matches our demonstration about the variable velocity of light measured in the moving system:

"***The velocity of light in a reference system "at rest" is c. In a moving reference system, in the variables x, T, it will be equal, in the direction parallel to the X axis, to***

$\boxed{c - v}$ ***in the positive, and*** $\boxed{c + v}$ ***in the negative direction***." **(27)**

<u>That means the moving frame is able to use correctly its own space coordinates x and the true time T which is measured in the rest frame</u>.
It is simple to apply Logunov's calculations to Einstein's imaginary experiment which we simulated and we discussed above, in the section 4.:

The variable T expressing the time measured in the rest frame (Frame-0) takes the values given by the moving clocks (Clock-A and Clock-B placed at the ends of the moving rod). As the clocks are still synchronized to each other and to the clocks in the rest frame (see Clock-O in the 3D simulation), they both indicate the same time T, with the particular values $\mathbf{t_A}$, $\mathbf{t_B}$ and $\mathbf{t'_A}$ (in Einstein's notation).
<u>That means the time measured in the moving frame is the same as the time measured in the rest frame</u>.

Despite that, unfortunately Logunov proceeded to prove Poincaré's claim that the observers in the moving frame would be right to guess equal times of the signals traveling between clocks in both directions. He used the expression (23) of the <u>local time</u> conceived by Lorentz, and calculated that the <u>local times would be equal</u> for the said signals, "*to have the velocity of light equal to* ***c*** *in any direction in the moving reference system*". This differed though from Einstein's reasoning, as Einstein poorly justified the equation (7) only by the constancy of the velocity of light postulated by himself.

To summarize the above, Logunov started from the idea of <u>equal local times</u>, and based on that he calculated that the velocity of light is equal to ***c*** in both directions between clocks. What he unfortunately forgot is that prior to his calculations he already mentioned that Lorentz' idea of <u>local time</u> was conceived as a **mathematical trick**. That trick was only **proposed** by Lorentz, **not postulated**, as there was not any known aspect of the physical reality to imply that trick needed to be a postulate (!).
It is concerning that since then, Modern Physics has searched for various ways to prove intellectually the need of postulating the consequences of such a trick, without having first any slightest experimental indications which would naturally require a postulate in a case when all their explanations had failed.

Despite Logunov's admirable work in explaining the importance of Poincaré's works for the foundation of the special relativity, we found that his derivation of the Lorentz transformations is more a verification of the LT through Poincaré's concepts about: simultaneity, the principle of relativity, and the invariance of the electrodynamics with LT. Nevertheless, it is a great read for anyone interested in relativity theories.

6.6. • **Derivations based on the space-time geometry, or based on the group theory**: such types of demonstrations are overstated as "derivations", when in fact they are only mathematical re-presentations of the initial algebraic relations derived by Einstein since 1905. Due to the multiple layers of abstraction in such formalisms, the errors in Einstein's theory seem harder to prove. However, an analysis of the details of such abstract constructions, reveal the artificial mathematical assumptions introduced to save the apparent consistency of those constructions. For example, Minkowski's 4-dimensional model of space-time would not have any relativistic sense if the fourth dimension would simply have the values of t (just time), instead of the artificial ***c***t (or i***c***t).
It is however concerning that certain theoretical physicists present nowadays such constructions as "natural" derivations of the LT, or even as the best explanations of the concepts and relations of STR.

7. Experiments which attempted to determine a variable speed of light

As mentioned in the section 6.4. above, Robertson's derivation [10] referred to the results of the Kennedy-Thorndike (K-T) experiment [14], and interpreted them as a proof of the relativistic effect known as "time dilation". Robertson's reasoning refers also to other two experiments which, together with the K-T experiment, are considered by today's mainstream Physics a test of Einstein's relativity theory: the Michelson-Morley (M-M) experiment [15], and the Ives-Stilwell (I-S) experiment [16].

There is a clear discrepancy between the purposes of those three experiments - on one side, and the interpretations of their results - on the other side, with their consequences, as showed in Fig. 16.:

	Purpose of the experiment		Interpretation of the results	
Experiment	Definition	Quantity to determine	Conclusions	Quantities affected
Michelson-Morley (1887)	Relative velocity between Earth and ether.	**v** [m/s]	**- Length contraction** - assumed, not measured	**L'** [m] assumed, not measured
Kennedy-Thorndike (1932)	Relative velocity between Earth and ether.	**v** [m/s]	**- Length contraction, and** **- Time dilation** - assumed, not measured	**L'** [m] **T'** [s] assumed, not measured
Ives-Stilwell (1938)	Anomalous frequency shift of EM radiation in a Doppler effect case.	**f** [1/s]	**- Frequency shift** **-** measured **- Time Dilation** - assumed, not measured	**f '** [1/s] measured **T'** [s] assumed, not measured
Sagnac (1913)	Relative velocity between a rotating device and ether.	***c* ± v** [m/s]	**- Relative velocity** **-** measured	***c* ± v** [m/s] measured

Fig. 16 - The discrepancy between the purposes of the "test" experiments, and their interpretations and the consequences upon quantities which measure fundamental concepts of Physics. (The L', T', f ' quantities are attributed to a moving frame).

Let us explain the discrepancy, and why those experiments cannot prove the theory of relativity:

a.)- The M-M experiment apparently failed to put in evidence the motion of Earth relative to ether. Although the criticism of the experiment was extensive in the last century, and even NCTR [6] presents a hypothesis to explain that failure, we will ignore here all that criticism, and instead we will consider what the mainstream Physics has considered: an **assumption** made by FitzGerald and Lorentz that the lengths are contracting in the system (Earth) which is moving relative to the stationary ether.
However, <u>the experiment itself did not **measure** that assumption in any way</u>.

b.)- The K-T experiment also apparently failed to put in evidence the motion of Earth relative to ether.
Another **assumption** was made by the authors of the experiment themselves, that time would be relative to the system in which it is measured, specifically that time would "dilate" in that system.
However, again, <u>the experiment itself did not **measure** that assumption in any way</u>.

c.)- To verify the assumption that time would be relative, Ives and Stilwell performed an experiment meant to show a frequency shift of the EM radiation of a moving source, which shift apparently could not be explained by the classical formula of the Doppler effect.

Grouping those three experiments and considering them together as a test of the relativity theory (in the way Robertson et al. did) is logically invalid, because an assumption about a quantity can be verified only when that quantity is measured. Here we have three quantities improperly measured:

1.) For the length contraction, a method which compares the lengths in both systems is needed. NCTR has proposed a method of transversal sharing of length units between two different IRFs. That method can be used for comparing lengths of specific objects between IRFs. However, no such method has been employed yet experimentally.

2.) For the time dilation, a method which compares time intervals in both systems is needed, because time cannot be given only by one periodic recurring change (i.e. by only one clock). **Time is given by multiple comparisons between various recurring changes** observed in the two systems. Just a shift in the frequency showed by an "atomic" clock of any kind indicates nothing about the time within that system, as <u>time means all the changes occurring in that system</u>, not only the recurring change measured by the frequency of an EM radiation.

All three experiments, M-M, K-T, and I-S, can also be explained by theories which preceded Einstein's STR. For example, the Lorentz Ether Theory (LET) can explain very well those three experiments and many other experiments considered by some authors as tests of STR [17].

3.) None of the three mentioned experiments provided any indication about the relative motion between the moving system and the EM phenomena involved. They did not measure either a variable velocity of light, nor a certain velocity of a system relative to the frame in which light is generated and propagated through empty space (the unique stationary frame implied by Maxwell's equations).

An experiment which has proved a **variable velocity of light** as measured in a moving system was performed by George Sagnac in 1913 [18]. His results were ignored by Einstein, and obviously this experiment is also not considered a test for STR, as it actually disproves STR.

Wolfgang Engelhardt showed mathematically that the classical theory calculates correctly the results of the Sagnac effect, while <u>the theory of relativity does not calculate correctly those results</u> [19].

8. Conclusions

C.1.) The concept of **simultaneity** is derived from the concept of **time**. As the meaning of time is given to us by multiple countings and comparisons between the changes which we observe, the association of those events in certain sets gives us the meaning of simultaneity. Hence, multiple observations and multiple criteria are needed in order to validate that specific events belong to the same set, as their belonging to that set makes us think that they are *simultaneous* with each other.

The determinations of simultaneity (i.e. the evidence of simultaneity, the establishment of the set of events), are subjective - they depend on observations. Such observations, made to put in evidence the concept of simultaneity, may succeed or may fail. The failure of some observations does not mean that the simultaneity itself fails. Simultaneity does not fail until all the possible methods of its observation are exhausted, under the chosen purposes. Therefore we can conclude that:
Einstein and most of the relativists have confused simultaneity **with the** observation of simultaneity.

The article also showed a circular logic between the 2nd postulate of STR (the principle of the constancy of speed of light) and Einstein's definition of "*common time*" (which definition can actually be considered as a hidden 3rd postulate of STR).

C.2.) Synchronization means an act of making (or verifying that) two or more recurring reference changes (i.e. clocks) happen in reality in such a way that they can further be associated as *simultaneous*. Such an act, or procedure, or method, might happen once or it might happen in a recurring manner. For ideal clocks functioning in identical conditions, a synchronization method is needed to be performed only once. However, if such a method fails, it does not mean that the clocks are no longer synchronized, nor that they are no longer *synchronizable*.
As the synchronization has the goal of determining the simultaneity of the indications of the clocks, then the multiple criteria necessary do define simultaneity should require multiple methods of synchronizing clocks. Thus, if one synchronization method fails, other methods can still perform well, i.e. they can achieve the simultaneity of the indications of the clocks.

C.3.) The **velocity of light is a variable** which takes different values when it is measured from different inertial reference frames, and it depends on the motion of such IRFs from the stationary frame in which light is generated sequentially in its propagation through space (the generative frame of the EM phenomena, i.e. the unique frame for which, and by which, the Maxwell's equations were originally written).

The velocity of light measured in an IRF represents the unique motion relation between light, as an EM phenomenon, and that IRF. The value of its magnitude, i.e. its speed, as well as its direction in that IRF, is unique and particular only to that IRF, because light -as an EM phenomenon- is independent from any and all IRFs, which means it does not have a only constant relation with all the IRFs.
As light is independent from any IRFs, the relations between light and different IRFs will be different, and the differences are given by what differentiate those IRFs in reference to light: their different motions from light's generative frame, given by their different inertial velocities measured in reference to light's generative frame. If an IRF moves from light's generative frame with a velocity $\mathbf{v}$, then within that IRF light will be measured as having a speed (magnitude of its velocity) in the interval $[\, c - \mathbf{v},\ c + \mathbf{v}\,]$.

In a bizarre logic, Einstein has used a variable velocity of the $c \pm \mathbf{v}$ forms in his calculations, and he even mentioned that one frame sees that expression as a relation between the other frame and the light ray, however he considered that the other frame measures only c, as enforced by his own 2nd postulate.

C.4.) A variable velocity of light was put experimentally in evidence by George Sagnac in 1913. The Sagnac effect has been either overlooked or misinterpreted by the Physics of the last century. Instead, the paradigm constructed upon Einstein's theory of relativity chose a set of failed experiments: M-M, K-T, I-S, to test its assumptions. The discrepancy between the purpose of those experiments and the assumptions arisen from their failed results should make any physicist be cautious in considering them as validations of Einstein's relativity, especially when knowing that other theories can explain the said experiments as well, or better **-** considering also STR's damaging impact on the fundamental concepts.

C.5.) Referring to the diagram of Einstein's reasoning in Fig 2., we can now conclude that his theory of special relativity should have asked the questions:

Q.1.− "Are the clocks still synchronized to each other?", and then
Q.3.− "Can the clocks be synchronized by other methods?".

The obvious answer to both questions is "Yes" and it should have been a sufficient logical justification to exit the faulty reasoning of the theory of relativity, or to change its course accordingly, in search for the unknown relations between the inertial systems and the electromagnetic phenomena.

Historically it is hard to find if, or why, Einstein and other relativists have ignored such questions. What is clear is that he crafted his reasoning in order to demonstrate a desired agreement between his postulated assumptions and his preconceived purpose of the reasoning (the invariance of the form of Maxwell's equations in different inertial systems).

C.6.) The article here showed how Einstein's mathematical derivation of the Lorentz transformation has been fudged by him to serve the final purpose of making Maxwell's equations apparently fit any inertial frame. Various attempts of other physicists to derive the LT in a more logical manner have brought either more assumptions without physical experimental grounds, or less assumptions (a case which would be actually beneficial for the science of Physics) and more experimental results; however, the latter case has used several failed experiments, which unfortunately have brought up other assumptions meant to explain the failed results of those experiments.

C.7.) The development of the Neo-Classical Theory of Relativity will continue in the future by more articles to:

- express better definitions, examples, 3D simulations and clarifications about the fundamental concepts of time, simultaneity, synchronization, space, and absolute reference frame.
- determine more accurate relations between the main classes of physical phenomena.
- research the validity, the applicability of the Lorentz transformations, and research the possible corrections or possible replacements of the LT.
- consider more examples of theories which are different from Einstein's Special and General Theory of Relativity, yet which theories bring better explanations than Einstein's STR-GTR, and consider their common views and conclusions, and/or their differences with/from NCTR.

General notes

N.1.) **-** As this article addressed the issue of the magnitude of the velocity of light, it was preferred here to use the term "*speed of light*", in the title of the article, and in the label used for Einstein's second postulate: the principle of the constancy of "*speed of light*" (CSL).

N.2.) - The subject of the FitzGerald-Lorentz length contraction was not fully considered in this article, as it is the subject of another entire article dedicated to it, which article will hopefully be published in a few months from now.

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