Faster than Light: Again on the Lorentz Transformations

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Abstract

The Lorentz transformations can be considered, without any doubt whatsoever, as the backbone of the theory of Special Relativity. Nonetheless, both the conventional derivation of the transformations and the meaning commonly assigned to them have been often savagely criticized, to the extent that, despite an alleged empirical evidence, the whole Special Relativity, in several occasions, has been brought into question. This paper is finalized to more thoroughly discuss a line of reasoning, elsewhere used in order to carry out an alternative deduction of the mass – energy equivalence, that may lead, amongst other things, towards the assignment of a new meaning to the Lorentz transformations, without any loss of formal validity. The transformations can be alternatively deduced once assumed some noteworthy hypotheses concerning our Universe, among which the existence of at least a further spatial dimension stands out. It is fundamental to underline that time is supposed as being absolute.

Keywords: Lorentz Transformations, Special Relativity, extra dimensions

1. Introduction

Firstly, it is worth underlining how, as Lorentz himself was forced to admit at a later time (Lorentz, 1909), the transformations had been already conceived, several years before the publication of the famous paper (Lorentz, 1904), by someone else (Voigt, 1887). Secondly, the work of Lorentz was anything but concretely linked to relativistic issues, at least in the Einsteinian sense of the term (Einstein, 1916). Very simply, Lorentz's aim fundamentally lay in finding some transformations able to formally make the well known Maxwell equations (Maxwell, 1873) invariant. On this subject, moreover, it can be even proved how the Lorentz transformations are not the only ones able to preserve the formal validity of the Maxwell equations (Di Mauro et al., 1997).

The so called direct transformations are usually written, with obvious meaning of symbols and signs, as follows:

$$x = \frac{x' + vt'}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{1}$$

$$t = \frac{t' + \frac{vx'}{c^2}}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{2}$$

The so called inverse transformation are usually written in the following form:

$$x' = \frac{x - vt}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{3}$$

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{4}$$

It is commonly said that, when the speed assumed by the mobile frame of reference is far less than that of light, the Lorentz transformations tend to the Galilean ones. In other terms, according to the previous assertion, Galilean Relativity should be interpreted as a particular case of the Einsteinian one. This is an erroneous conviction (Ghosal et al., 1991). In fact, referring to the ratio that appears in the numerator of (2) and (4), it is easy to understand how no limitation turns out to be imposed, respectively, on the variables x and x'. Therefore, since the above mentioned variables should be able to evidently assume arbitrarily large values, the ratio we have taken into consideration could even not tend to zero, as such making de facto impossible a real identification of the Lorentz transformations with the Galilean ones (Di Mauro et al., 1995). As we are about to see, however, this misleading problem can be easily overcome by means of an alternative deduction of the transformations.

2. Discussion

The discussion is carried out by postulating a cyclic Universe (Harrison, 1967), that oscillates with a simple harmonic motion (Cataldo, 2016a). The oscillations are not to be considered as a real phenomenon, since the variations of the cosmological distances are supposed as being exclusively metric (Cataldo, 2016b). The existence of a further spatial dimension is hypothesized: very roughly, what we perceived as being a point may actually be a straight line segment. The segment crosses the center of the four-dimensional ball that represents the Universe in its entirety: its endpoints are what we are able to perceive. Due to the symmetry that evidently arises from the hypothesized scenario, we could even state that, in a certain sense and measure, each point and its antipode are actually the same thing. As elsewhere expounded (Cataldo, 2016c), thanks to an opportune rewriting of the conservation of energy, we are able to hypothesize that, as a consequence of a possible motion, each segment undergoes a radial contraction whose entity depends on the value of the tangential speed of its endpoints. The motion can be imagined as nothing but a rotation around the center of the four-dimensional ball that represents our Universe. The endpoints, that we perceive as being a unique entity, are like dragged towards an inner hyper surface characterized, obviously, by a smaller radius of curvature. If we denote with R the radius of curvature of the Universe, with R' the radius of curvature of the surface on which the motion of the endpoints actually takes place, with v the tangential speed, hypothesized as being constant, that characterizes the motion of the endpoints, with c, as usual, the speed of light, and with γ the relativistic factor, we can write the following:

$$\frac{R}{R'} = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} = \gamma \tag{5}$$

To deduce the direct transformations, let's consider the scenario portrayed in the following figure (Figure 1).

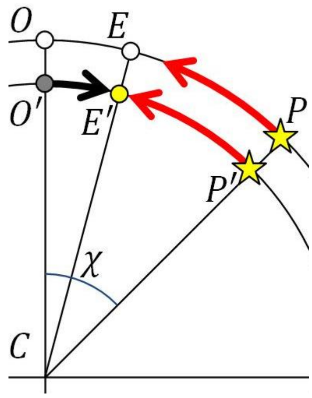

Figure 1. Direct Transformations

The procedure will be carried out without considering the symmetry. We have denoted with O the origin of the frame of reference at rest, and with O' the origin of the frame of reference in motion. At the beginning, the above mentioned points, obviously, coincide. We have to hypothesize that when O' starts moving, with a constant speed equal to v, a signal is simultaneously sent from a source, that both the observer at rest and the one in motion will perceive as being punctual. The initial angular distance between the origins and the source is denoted by χ. The signal is actually sent from each of the points that belong to the straight line segment bordered by the center of curvature, denoted by C, and P. The latter represents the source as perceived by an observer at rest. Net of the symmetry, ignoring possible gravitational effects (Cataldo, 2016d), the radial extension of any point at rest is evidently equal to the radius of curvature of the Universe, denoted with R. As soon as O' starts moving, its radial extension, denoted by R', assumes the value provided by (5). If we denote with S_{OP} the arc bordered by O and P, representing the distance at rest from the source, and with $s_{O'P'}$ the arc bordered by O' and P', which represents the distance between O' and the source not as soon as the motion takes place, we can write the following:

$$\overline{CO} = \overline{CP} = R \tag{6}$$

$$\overline{CO'} = \overline{CP'} = R' \tag{7}$$

$$s_{OP} = R\chi \tag{8}$$

$$s_{O'P'} = R'\chi \tag{9}$$

$$\frac{s_{OP}}{s_{O'P'}} = \frac{R}{R'} = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{10}$$

$$s_{OP} = \frac{s_{O'P'}}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{11}$$

The coordinate of the light source as measured by the observer at rest, up until now denoted by s_{OP}, can be replaced by x. After a certain time, denoted by t', the observer in motion intercepts the signal. Let's denote with E' the rendezvous point. Obviously, the time elapsed is equal to the time taken by light to cover the distance $s_{E'P'}$. The above mentioned distance coincides with the coordinate of the light source, denoted by x', as measured by the observer in motion as soon as the signal is received. We can now write the following:

$$s_{OP} = x \tag{12}$$

$$s_{E'P'} = x' \tag{13}$$

$$t' = \frac{s_{E'P'}}{c} = \frac{x'}{c} \tag{14}$$

$$s_{O'E'} = vt' \tag{15}$$

$$s_{O'P'} = s_{E'P'} + s_{O'E'} = x' + vt' \tag{16}$$

From (11) and (16) we can immediately deduce (1), that represents the first direct Lorentz Transformation. If we divide the first and second member of (1) by c, we obtain:

$$\frac{x}{c} = \frac{\frac{x'}{c} + \frac{vt'}{c}}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{17}$$

The first member of the previous equation, that can be denoted by t, represents the time elapsed between the light signal emission and the moment in which the observer at rest succeeds in seeing it. From (14) and (17) we can immediately obtain (2), that represents the second direct Lorentz Transformation.

To deduce the inverse transformations, let's consider the scenario portrayed in the following figure (Figure 2).

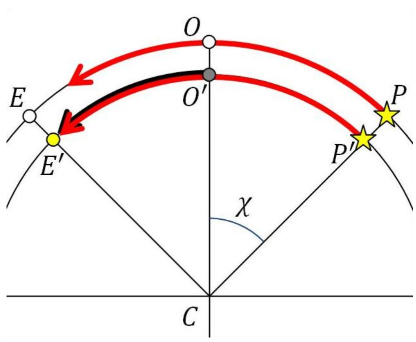

Figure 2. Inverse Transformations

This time, however, referring to the bi-dimensional representation provided by the previous figure, we have to suppose that the motion takes place counterclockwise, with a constant speed equal to *v*. Obviously, the equations from (6) to (11) are still valid. The line of reasoning previously followed in deriving the direct transformations can be exploited, being careful to switch the superscripts: from the point of view of the observer actually in motion, in fact, the one at rest, placed in *O*, seems to approach the light source. We can now write the following:

$$s_{OP} = x' \tag{18}$$

$$s_{E'P'} = x \tag{19}$$

$$t = \frac{s_{E'P'}}{c} = \frac{x}{c} \tag{20}$$

$$s_{E'O'} = vt \tag{21}$$

$$s_{O'P'} = s_{E'P'} - s_{E'O'} = x - vt \tag{22}$$

From (11) and (22) we can immediately deduce (3), that represents the first inverse Lorentz Transformation. If we divide the first and second member of (3) by *c*, we obtain:

$$\frac{x'}{c} = \frac{\frac{x}{c} - \frac{vt}{c}}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{23}$$

The first member of the previous equation, that can be denoted by *t'*, represents the time elapsed between the light signal emission and the moment in which the observer placed in *O*, actually at rest but considered as being in relative motion towards the source, succeeds in seeing it. From (20) and (23) we can immediately obtain (4), that represents the second direct Lorentz Transformation.

It is fundamental to underline that, if we take into account the symmetry (Cataldo, 2016e), both the direct transformations and the inverse ones can be simultaneously applied to whatever point in motion with a constant speed equal to *v*. Referring to the following figure (Figure 3), that represents just a modified version of the one used to deduce the direct transformations, we can easily notice how, due to the symmetry, the light signals start not only from P^+ and P'^+, but also from P^- and P'^-, moving both clockwise and counterclockwise.

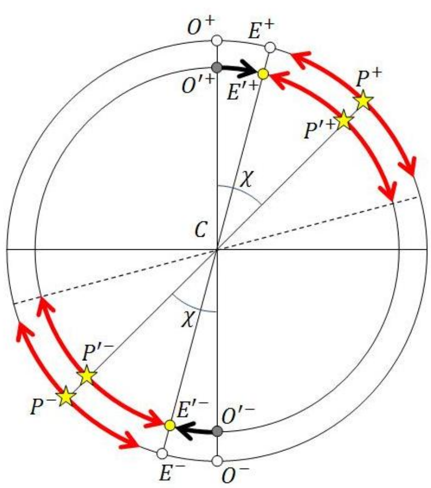

Figure 3. Symmetry

Very simply, the observer in motion travels towards the signal that propagates counterclockwise, so making possible the adoption of the direct transformations; simultaneously, the same observer moves away from the signal that propagates clockwise, so making possible the adoption of the inverse transformations.

By virtue of what up until now deduced, we can make the following noteworthy remarks.

Firstly, referring to both the previously described scenarios, we can state that if the motion were suddenly stopped in E', the traveler would be instantaneously dragged into E, and the signal, after a certain period of time, would be seen once again: in other terms, the observer would be involved in some sort of déjà-vu.

Secondly, we can state that the distance between the traveler and the light source undergoes a reduction as soon as the motion takes place: the higher the value of the speed, the higher the entity of the reduction. For example, referring to the first of the two cases previously examined, we can state that the traveler is able to cover the distance $s_{O'P'}$ by taking a time, denoted by t_m, provided by the following relation:

$$t_m = \frac{s_{O'P'}}{v} \tag{24}$$

However, once the traveler reaches the light source, the observer at rest believes that the covered distance is equal to s_{OP}. As a consequence, from the point of view of the observer at rest, the virtual speed of the traveler, denoted by v^*, is provided by the following relation:

$$v^* = \frac{s_{OP}}{t_m} = \frac{s_{OP}}{s_{O'P'}} v \tag{25}$$

From the previous equation, by taking into account (10), we can immediately write the following:

$$v^* = \frac{v}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \tag{26}$$

Coherently with the domain of the relativistic factor, the real speed, that keeps on being denoted by v, can never equate that of light. On the contrary, the virtual speed, that we have denoted with v^*, tends to infinity when the real speed tends to that of light. This result is qualitatively described by the following figure (Figure 4), in which the x-coordinate represents the ratio between the real speed and that of light, commonly denoted by β, and the y-coordinate represents the correspondent value of the virtual speed, in number of times that of light.

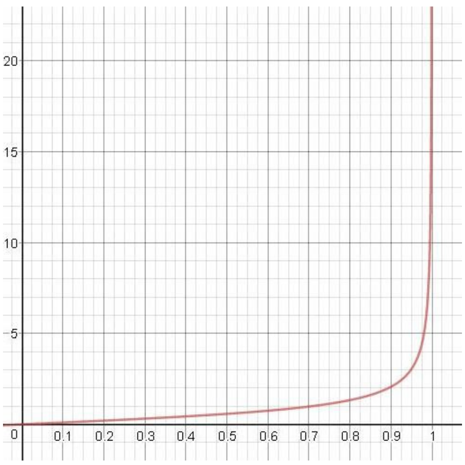

Figure 4. Virtual Speed as a function of Real Speed

As a consequence, an observer at rest will measure, in any given case, a speed greater than the real one. Obviously, from (26) it is possible to easily deduce the relation that expresses the real speed, the one measured by the observer in motion, as a function of the virtual one:

$$v = \frac{v^*}{\sqrt{1 + \left(\frac{v^*}{c}\right)^2}} \tag{27}$$

The following table (Table 1) provides some simple numerical examples that should allow to better understand the results just obtained. All the values are rounded to two decimal places.

Table 1. Real Speed and Virtual Speed

REAL SPEED (Percentage of the Speed of Light)	RELATIVISTIC FACTOR	VIRTUAL SPEED (Number of Times the Speed of Light)
70.71%	1.41	1
89.44%	2.24	2
94.87%	3.16	3
97.01%	4.12	4
98.06%	5.10	5
98.64%	6.08	6
98.90%	6.80	7
99.22%	8.02	8
99.39%	9.07	9
99.50%	10.01	10
99.56%	10.70	11
99.65%	12.00	12
99.71%	13.14	13
99.75%	14.15	14
99.78%	15.08	15
99.81%	16.23	16
99.83%	17.16	17
99.85%	18.26	18
99.86%	18.90	19
99.88%	20.42	20
99.89%	21.33	21
99.90%	22.37	22

Let's now choose a destination. Generalizing (11), if we denote with *s* the distance at rest from the point that we have to reach, and with *s*' the corresponding reduced distance, the one that a traveler, who starts moving with a speed equal to *v*, should actually cover in order to reach the destination, we can write:

$$s' = s\sqrt{1-\left(\frac{v}{c}\right)^2} \tag{28}$$

This result is qualitatively described by the following figure (Figure 5), in which the x-coordinate represents, once again, the ratio between the real speed and that of light, commonly denoted by β, and the y-coordinate represents the correspondent value of the ratio between the reduced distance and the one measured at rest.

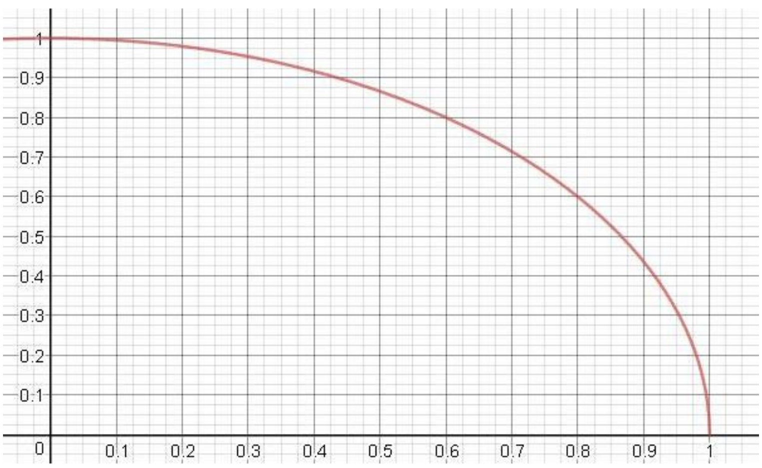

Figure 5. Reduced Distance as a function of Real Speed

Although it may not be strictly necessary, we underline how, taking into account the domain of the relativistic factor, the phenomenon cannot be so extreme as to reduce the distance to zero.

The two following tables (Table 2 and 3), finalized to synthesize the results up until now obtained, are drafted by hypothesizing a distance at rest equal to one light year. All the values are rounded to two decimal places.

Table 2. Time Reduction Examples: Real Speed less than or equal to 90% of that of Light

REAL SPEED (Percentage of the Speed of Light)	VIRTUAL SPEED (Percentage of the Speed of Light)	DISTANCE AT REST (Light Years)	REDUCED DISTANCE (Light Years)	FORECAST TIME (Years)	REAL TIME (Years)
10%	10.05%	1	0.99	10.00	9.95
20%	20.41%	1	0.98	5.00	4.90
30%	31.45%	1	0.95	3.33	3.18
40%	43.64%	1	0.92	2.50	2.30
50%	57.74%	1	0.87	2.00	1.73
60%	75.00%	1	0.80	1.67	1.33
70%	98.02%	1	0.71	1.43	1.02
80%	133.33%	1	0.60	1.25	0.75
90%	206.47%	1	0.44	1.11	0.48

Table 3. Time Reduction Examples: Real Speed greater than or equal to 91% of that of Light

REAL SPEED (Percentage of the Speed of Light)	VIRTUAL SPEED (Percentage of the Speed of Light)	DISTANCE AT REST (Light Years)	REDUCED DISTANCE (Light Years)	FORECAST TIME (Years)	REAL TIME (Years)
91%	219.48%	1	0.41	1.10	0.46
92%	234.74%	1	0.40	1.09	0.43
93%	253.02%	1	0.37	1.08	0.40
94%	275.52%	1	0.34	1.06	0.36
95%	304.24%	1	0.31	1.05	0.33
96%	342.86%	1	0.28	1.04	0.29
97%	399.00%	1	0.24	1.03	0.25
98%	492.47%	1	0.20	1.02	0.20
99%	701.80%	1	0.14	1.01	0.14

3. Conclusions

A new meaning has been assigned to the Lorentz transformations. The procedure we have followed to alternatively deduce the above mentioned transformations is founded on several noteworthy hypotheses concerning the Universe we live in, among which the existence of at least a further spatial dimension and the absoluteness of time stand up. As an answer to the problem, raised in the introduction, that would not allow to formally define Galilean Relativity, when the speed is far less than that of light, as a particular case of the Einsteinian one, we underline how the so called time transformations, although characterized by a different meaning, have been herein banally deduced from the spatial ones. The consequences related to the existence of a further spatial dimension would allow to tremendously reduce the distances between us and, for example, other star systems. The absoluteness of time would prevent us from stumbling against paradoxes that could represent an obstacle to travelling with speeds even far higher, from the point of view of an observer at rest, than that of light. It is fundamental to highlight how the value of the real speed of a material point cannot exceed, in any case, that of light. During the motion, in fact, there is no mass on the external hyper surface, as well as on the ones characterized by a radius of curvature whose value is greater than the radial extension of the material segment that, net of the symmetry, represents what we perceive as a material point. Once considered a light source, both the direct transformations and the inverse ones can be simultaneously applied to whatever point in motion with a constant speed. Coherently with the Universe we have hypothesized, in fact, any point in motion, at the same time, approaches the source and moves away from it.

References

Cataldo, C. (2016a). A simplified model of Oscillating Universe: alternative deduction of Friedmann–Lemaître equations with a negative cosmological constant. *Research & Reviews: J. of Pure and App. Phys., 4*(2), 1-3. Retrieved from http://www.rroij.com/open-access/a-simplified-model-of-oscillating-universe-alternative-deduction-of-friedmannlematre-equations-with-a-negative-cosmological-consta-.pdf

Cataldo, C. (2016b). Further Remarks on the Oscillating Universe: an Explicative Approach. *Research & Reviews: Journal of Pure and Applied Physics, 4*(3), 3-37. Retrieved from http://www.rroij.com/open-access/further-remarks-on-the-oscillating-universe-an-explicative-approach-.pdf

Cataldo, C. (2016c). Towards a New Relativity: how to Travel Faster than Light. *Research & Reviews: Journal of Pure and Applied Physics, 4*(1), 7-14. Retrieved from http://www.rroij.com/open-access/towards-a-new-relativity-how-to-travel-faster-than-light-.pdf

Cataldo, C. (2016d). Beyond the Metrics: qualitative introduction to the Modified Gravitation. *Research & Reviews: Journal of Pure and Applied Physics, 4*(2). Retrieved from http://www.rroij.com/open-access/beyond-the-metrics-qualitative-introduction-to-the-modified-gravitation-.pdf

Cataldo, C. (2016e). Effects of a Global Symmetry on the Observation of Astronomical Objects. *Applied Physics Research, 8*(5), 75-80. http://dx.doi.org/10.5539/apr.v8n5p75

Di Mauro, P., & Notarrigo S. (1997). Sull'Invarianza delle Equazioni di Maxwell. *Atti del XVI Congresso Naz. di Storia della Fisica e dell'Astronomia,* 355-360. Retrieved from http://www.lascuolaitalica.it/pubbl5.htm

Di Mauro, P., & Notarrigo S. (1995). Critica delle usuali derivazioni delle trasformazioni di Lorentz. *Com. al LXXXI Congr. Naz. SIF*, 4 Ott. 1995, Perugia. Retrieved from http://www.lascuolaitalica.it/pubbl12.htm

Einstein, A. (1916). Relativity: The Special and General Theory (translated by R. W. Lawson, 1920). Henry Holt and Company, New York. Retrieved from https://archive.org/details/cu31924011804774

Ghosal, S. K., Nandi, K. K., & Chakraborty, P. (1991). Passage from Einsteinian to Galilean Relativity and Clock Synchrony. *Zeitschrift für Naturforschung, 46*a, 256-258. Retrieved from http://www.degruyter.com/downloadpdf/j/zna.1991.46.issue-3/zna-1991-0307/zna-1991-0307.xml

Harrison, E. R. (1967). Classification of uniform cosmological models. *Monthly Notices of the Royal Astronomical Society, 137*, 69-79. Retrieved from http://paperity.org/p/39522229/classification-of-uniform-cosmological-models

Lorentz, H. A. (1904) Electromagnetic phenomena in a system moving with any velocity smaller than that of light. *Proceedings of the Royal Netherlands Academy of Arts and Sciences, 6*, 809-831. Retrieved from http://www.orgonelab.org/EtherDrift/Lorentz1904.pdf

Lorentz, H. A. (1909) *The theory of electrons and its applications to the phenomena of light and radiant heat*. Teubner, Leipzig. Retrieved from https://archive.org/details/electronstheory00lorerich

Maxwell, J. C. (1873). A Treatise on Electricity and Magnetism. Clarendon Press, Oxford. Retrieved from https://archive.org/details/electricandmagne01maxwrich

Voigt, W. (1887). Ueber das Doppler'sche Princip. *Nachrichten von der Königlichen Gesellschaft der Wissenschaften und der Georg – Augusts – Universität zu Göttingen, 2*(10), 41-51. Retrieved from http://www.digizeitschriften.de/dms/img/?PPN=PPN252457072_1887&DMDID=dmdlog12

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