Article

Lorentz Transformation & the Meaning of Einstein's 1905 Special Theory of Relativity

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ABSTRACT

When the Lorentz transformation as a complementary time-dependent coordinate transformation is applied to special relativity theory [1], we get the objective reality warranting Einstein's decisions to manipulate some equations that led to the standard Lorentz transformation in [1]. It turns out that the terms βx and βt in the standard Lorentz transformation are, respectively, the abscissa of a geometrical point and the Newtonian time in which a light signal travels that abscissa.

Key Words: Lorentz transformation, Einstein, 1905, special theory of relativity, sbscissa, geometrical point, Newtonian time.

12. APPLYING THE DERIVATION OF THE LORENTZ TRANSFORMATION AS A COMPLEMENTARY TIME-DEPENDENT COORDINATE TRANSFORMATION TO EINSTEIN'S SPECIAL RELATIVITY THEORY

We here apply to special relativity theory our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation[2]. We get i) the objective reality warranting Einstein's decisions to manipulate some equations that led to the standard Lorentz transformation in [1] -which proves the correctness of that derivation of the Lorentz transformation, ii) that the terms βx and βt in the standard Lorentz transformation are, respectively, the abscissa of a geometrical point and the Newtonian time in which a light signal travels that abscissa -which, by removing the mysterious origin of β, validates the principle of the physical determination of equations in Einstein's special relativity theory, and iii) the essential role played by revelation in the act of science. All these issues should be deeply joined together for a true foundation and development of modern physics. Ignoring subjective incongruence in understanding and interconnecting these issues gave rise to, and maintained the crisis of modern physics, which strongly altered the progress of the mankind.

13. OUTLINE OF EINSTEIN'S 1905 DERIVATION OF THE STANDARD LORENTZ TRANSFORMATION

In his 1905 paper on relativity ([1], Sect. I.1) Einstein deduced the Lorentz transformation in view of the Gedanken experiment depicted in the upper diagram in Fig. 10[3], by manipulating three equations

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[1] Our derivation of the Lorentz transformation followed a way independent of special relativity theory. We searched for a class of coordinate transformations which to prove if the weak gravitational waves are physical entities or not [10-14] (see also Sec. 22 (Sect. 3)). An application of our results to special relativity theory became evident examining the understanding of Einstein's derivation of the Lorentz transformation [15-27].

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[3] The upper diagram in Fig. 10 needs some details. For Einstein, K and k were inertial coordinate systems and v was a relative speed. For us, by virtue of the result in Sec. 6 (Sect. 1) that any uniform rectilinear motion

with no physical justification. So he defined identical clocks working in synchrony at points O', P "of space", *i.e.* at absolute rest, by the equation

$$\tau_0 + \tau'_0 = 2\tau_P, \qquad (22)$$

where τ_0, τ'_0 and τ_P are, respectively, times associated to the emission/arrival of a light signal at O', and its reflection at P. Then, disregarding that both the light signals and the reference frames travel through empty space independently, extrapolated the the validity of Eq. (22) to define inertial synchronous clocks attached to O' and P in the "stationary" coordinate system k (the first manipulation). From the upper diagram in Fig. 10 (with k and K in Sec. 6 (Sect. 1)), which differs from the upper one in Fig. 4 in that the signal was emitted at time t when k and K didnot coincide, he defined and calculated τ (like time of k) in terms of the time t of K, and the coordinates of a point having P as projection. He inserted the times $\tau_0 = \tau(0,0,0,t)$ associated to the emission of a light signal at O'_o, $\tau_P=\tau[x',0,0,t+x'/(c-v)]$ associated to reflection at P, and $\tau'_0 = \tau[0,0,0,t + x'/(c-v) + x'/(c+v)]$ associated to its arrival at O'_2, where O'_o to O'_2 are successive positions of the origin O' of k along the common x', x axis, in Eq. (22) and obtained for infinitesimally small x' the differential equation

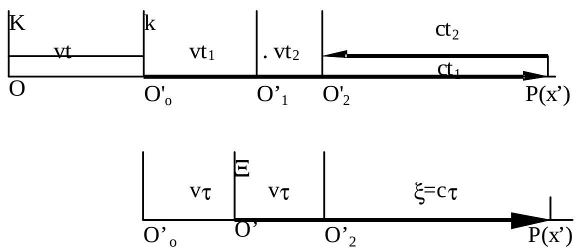

Figure 10.

$$\partial\tau / \partial x' + [v/(c^2 - v^2)]\partial\tau / \partial t = 0.$$

Integrating this equation, he obtained

$$\tau = a[t - vx'/(c^2 - v^2)], \qquad (23)$$

with $a = \phi(v) = 1$ ([1] , Sect. I.3 for calculation details), and put

$$\zeta = c\tau. \qquad (24)$$

Accepting Eq. (1), Eqs. (23), (24) predicted a set of equations linear in β^2 identical with Eqs. (8) (which Einstein didnot write down explicitly). The dropping of the square of β in Eqs. (8) with no justification[4] was the second manipulation. It is true of Eqs. (8), as well as of their counterparts linear

relative to an inertial observer is graphically described with respect to an 'abstract' coordinate system at absolute rest (Sec. 4 (Sect. 1.1)), K is an 'abstract' coordinate system at absolute rest and v is an absolute quantity (as defined in Sec. 6 (Sect. 1)). k and the light signals perform independent motions in empty space. As origins of light signals, O'_o and O'_P are points of space, hence at absolute rest. The part of the diagram to the right of O'_o is just the upper diagram in Fig. 4.

[4] Prokhovnik claimed in [28] that Einstein had included a β factor in Eqs. (8) in the function $\Psi(v) = \beta\phi(v)$. However, there is no function $\Psi(v)$ in [1]. Moreover, it is evident that Einstein did not include a β factor in $\phi(v)$, given that the $\phi(v)$ appearing in the equations linear in β that he finally wrote in [1] is just that which he formerly associated with Eq. (23).

in β, that the last one is the time-equivalent of the first one. Einstein did not point out this equivalence, or the way to break this equivalence for turning the linear equations in β into the Lorentz transformation. But he further added the equation $x = wt$ to the linear equations in β in order to deduce… the "addition theorem for speeds" ([1], Sect. I.5) (the third manipulation). The physical grounds of the three manipulations of equations, so their correctness, we disclose in the next Section.

14. PHYSICS WARRANTING THE MANIPULATIONS OF EQUATIONS THAT LED EINSTEIN TO THE LORENTZ TRANSFORMATION IN [1]

14. 1. Proof for Abstract Coordinate Systems at Absolute Rest in Einstein's Special Relativity Theory

Since the upper diagram in Fig. 10 is just the upper diagram in Fig. 4 shifted right by a distance vt, equations identical with Eqs. (4) to (7), with t, t_1 changed to t_1, t_2, t_1=τ_P-τ_0, t_2=τ'_0-τ_P, and τ_0, τ_P, τ'_0 in Sec. 13, follow. There becomes evident that Eq. (23) does not prove that the identical synchronous clocks attached to k and K would run at different rates and measure different times. Just like in Sec. 6 (Sect. 2), the coordinate system at absolute rest Ξ, depicted in the bottom diagram in Fig. 10 is associated by Eq. (23) to the inertial coordinate system k. What the inertial synchronous clocks attached to O' and P in the bottom diagram of Fig. 10 measure (by Eq. (22) and the equation O'P+PO'=$2c\tau$) is the time τ of Ξ (while those attached to O, O'(O'$_o$, O'$_1$, O'$_2$) and P(x') in K measure the time of K). So *nothing has supported Einstein's fundamental claim that identical clocks in inertial reference frames in relative motion would run at different rates.* This claim, (like that the inertial meter-sticks would change their length) was misleading to understand special relativity theory. Einstein failed to see that, by extrapolating Eq. (22), has actually associated both 'abstract' coordinate systems at absolute rest and professionals to the inertial coordinate systems in the special relativity theory. He also failed to see that (as we pointed out in Sec. 15) his formulation of the light-speed principle in [1] (Sect. I.1) was actually done in relation to coordinate systems at absolute rest. The coordinates ξ, η, ζ in [1] were actually defined with respect to the coordinate systems at absolute rest Ξ.

14. 2. Proof of the Correctness of Einstein's 1905 Derivation of the Lorentz Transformation

Behind Einstein's dropping of the square of β in Eqs. (8) lies the graphical addition of travel times like scalar quantities for non-parallel light signals (investigated in Sec. 7), a subtlety that escaped to him (however, he traced by light signals only abscissas of geometrical points, complying with its main requirement). Without the diagram in Fig. 6 for points out of *x'* axis, Einstein failed in understanding βx and βt as Cartesian coordinate and Newtonian time, respectively. Thus βx and βt were conceived, respectively, as a coordinate and a time multiplied by a mysterious factor β , which led to the famous FitzGerald- Lorentz contraction and time dilation. The last paragraph in Sec. 5 (Sect. 1) proves that the true role of the equation $x = wt$, imposed by Einstein, was to remove the equivalence of the first and the fourth of Eqs. (15) in order to turn them into a coordinate transformation. These physical grounds for Einstein's firm mathematical decisions prove the correctness of his derivation of the Lorentz transformation in [1] and (as shown in Sec. 20) their revealed nature. Their disclosure, in view of our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation (Sec. 9), validates our working hypotheses (Sec. 3).

15. LENGTH CONTRACTION, TIME DILATION AND TWIN PARADOX

Understanding the terms *x'*, βx and *t'*, βt in the Lorentz transformation as, respectively, Cartesian coordinates and Newtonian times discloses that the FitzGerald-Lorentz contraction and the time dilation are not true physical predictions of the special relativity theory (recall that the tracing of x' and βx with light signals was required by the addition of travel times and scalar quantities (Sec. 7)). One can, of course, presume the intervals $\Delta x'$, $\Delta t'$, and associate $\Delta x'=0$, $\Delta t'=0$ with, respectively, measurements of times and lengths in a coordinate system in uniform rectilinear motion with respect to an observer but the writing of $\Delta(\beta x)$ and $\Delta(\beta t)$ as $\beta(\Delta x)$ and $\beta(\Delta t)$ (mathematically valid) is physically meaningless because

$$\Delta(\beta x)=(\beta x)_2-(\beta x)_1,$$

where $(\beta x)_1$ and $(\beta x)_2$ are abscissas of different geometrical points. As an additional remark, by involving the time τ of Ξ, Eq. (23) never supported Einstein's hypothesis that identical clocks in inertial reference frames in relative motion would run at different rates and measure different times. The FitzGerald-Lorentz contraction was never proved experimentally. The claimed experimental proof of the time dilation was not sustained [29]. What it was really proved experimentally was the increased lifetime of the relativistic particles with respect to identical rest particles. But, in view of Sec. 28, this result originates exclusively in relativistic mass as internal coupling constant: a larger speed involves a larger β, hence a larger relativistic mass, i.e., internal coupling constant, and a larger lifetime. Consequently, the twin paradox was just nonsense.

16. LIGHT-SPEED PRINCIPLE

Einstein's assertion [1] that "The totality of physical phenomena is of such a character that it gives no basis for the introduction of the concept of 'absolute motion'" is contradicted by the result we just obtained in Sec. 14 (Sect. 1). We see that the simultaneous and independent motion of the line segment O'P in Fig. 4 along the *x* axis as a part of k alters the equality of the paths of the light signal from the origin of k to P(x') (O'_oP) and back to the origin of k (PO'_2), stipulated by the light-speed principle. It does not matter that isolated inertial observers are not aware of this alteration. It is their assumed lack of knowledge on the relative motion responsible for this fact. The experiment just proposed to determine absolute speeds proves it: For O'_oP to equate PO'_2, the light signal should have been made of elastic balls rolling *on* a surface embodying the $x'x$ axis from the origin of k to P(x') and back to the origin of k, which is not the case. Therefore, the light-speed principle was stated in relation to the coordinate system at absolute rest associated to the inertial coordinate system of the observer in Sec. 6 (Sect. 1). A glance at the ratio (light path)/(time interval) -defining the "fixed speed" of light with respect to "stationary" reference frames by the light-speed principle ([1], Sect. I.2)- strengthens the conclusion because -as just explained above- the end points of the path are points of space, hence at absolute rest. The rigor of the special relativity theory was assured just by his revealed hidden formulation of the light-speed principle, which tacitly imposed abstract coordinate systems at absolute rest to the inertial observers. In view of this result, as well as of those obtained in Sec. 6 (Sect's. 1, 2) and Sec. 17, Einstein's queer aversion for 'absolute motion' and coordinate systems at absolute rest was baseless and misleading.

17. EXPERIMENTAL DETERMINATION OF ABSOLUTE SPEEDS IN EINSTEIN'S SPECIAL RELATIVITY THEORY

The absolute speeds of the bodies, sliding/rolling uniformly and rectilinearly along *the surface of a physical substratum* at rest in the reference frames of the Newtonian observers, are determined by measuring the quantities which define them ((covered distance)/(time interval)) with meter-sticks and clocks, complying with the working hypotheses in Sec. 3. Since light travels through empty space , and a universal immovable physical substratum could not be identified in nature, physicists claimed (instead of searching for an alternative experimental determination of the absolute speeds) that "*terms such as 'absolute rest' and 'absolute speed' are completely foreign and unacceptable to physics*" [2], with bandy impact.

That 'abstract' coordinate systems at absolute rest (defined in Sec. 4 (Sect. 1.1)) are proper to physics, we proved in Sec. 6. That such coordinate systems are also proper to Einstein's special relativity theory, we proved in Sec. 14 (Sect. 1). So the claim that "absolute rest is completely foreign and unacceptable to physics" is wrong. The experiment thought by Einstein to deduce the standard Lorentz transformation in [1] (Sect. I.3) also proves that the same claim is wrong when concerns the absolute speed. The upper diagram in Fig. 10 reduces to the upper diagram in Fig. 4. Eqs. (4) predict the absolute speeds

$$v = x'(t - t_1)/2tt_1 \text{ and } c = x'(t + t_1)/2tt_1. \quad (25)$$

So, unlike the innocent Newtonian observers, professionals (defined in Sec. 6) can -by means of their additional ability of representing graphically hypothetical relative motions and measuring travel times of light signals traveling to and fro *through empty space*- determine their absolute speeds and that of light, independently of any physical substratum, namely in terms of light travel times. To do it, each of them has to emit to P(x') at time $t = 0$ a light signal which origin, as a point of space (hence at absolute rest), defines the origin of an 'unseen' coordinate system at absolute rest K, coinciding with his k. When the measured times t, t_1 are equal, $v = 0$ and the light speed in empty space is just x'/t. The experiment must be repeated along other directions until v in (25) takes a maximum value. That value defines the absolute speed of k (of the observer), while the path of the suitable light signal determines its direction of motion. So the claim that the inertial observers cannot do any experiment which would distinguish being at rest from moving uniformly and rectilinearly is merely *false*.

Concerning the assertion that equation *x=ct* would express a law of physics, equally right with respect to any inertial coordinate system by the principle of relativity, it makes sense *only* by recognizing the absolute speed in physics and the observer's ability to determine *c* independently of any physical substratum (both proved). This because *'equation' x=ct is just a different writing down of the Newtonian definition of absolute speed applied to light.* So long as the absolute speed *is "completely foreign and unacceptable to physics*", 'equation' *x=ct* makes no sense (Einstein should discard the Newtonian manner to determine absolute speeds experimentally, not the concept of absolute speed). So long as the inertial observers cannot determine *c* experimentally in their reference frames, 'equation' *x=ct* also makes no sense. Consequently, 'equation' *x=ct* couldnot support Einstein's formulation of the light-speed principle in [1] (Sect. I.2), as it is usually claimed: the light speed is *c* exclusively with respect to empty space and coordinate systems at absolute rest, not with respect to inertial coordinate systems.

Concerning the relative light speeds $c \pm v$ are not true speeds, we show in view of the second diagram in Fig. 1. First presume that k is attached to an object M_2 moving rectilinearly with constant speed v_2 on the plane surface of another object M_1 (having K_1 attached), along the constant speed v_1 of M_1 or oppositely. The relative speeds $v_1 \pm v_2$ are true physical quantities: They appear as true speeds of M_2 in both its kinetic energy and linear momentum. Imagine that M_1, M_2 are moving rectilinearly, uniformly, simultaneously and independently in vacuum at speeds V_1 and $\pm V_2$, respectively. This time the relative speeds $V_1 \pm V_2$ are not true physical quantities: They do not appear as true speeds of an object. They manifest physically by transfer of linear momentum when the two bodies collide each other. The last is the case with the quantities $c \pm v$, appearing by the factorization mathematically required to resolve Eqs. (4) in terms of t, t_1, respectively: the simultaneous parallel motions, that of the light signal traveling in empty space between O'_o and P(x'), and that of k from O'_o to O'_1, are fully independent.

18. MINKOWSKI SPACE-TIME AND SPACETIME

The mixture of spatial coordinates and Newtonian times in the Lorentz transformation originated in tracing by light the radius vectors of the geometrical points in uniform rectilinear motion with respect to inertial observers. The metric ds^2=▯ dx dx , where ▯ is the metric tensor and ▯,▯=0-3, is just the result of this operational mixture of spatial coordinates and times. Defined by this metric, the Minkowski four-dimensional space-time has an operational nature, not a physical one. It means Euclidian three-dimensional space (Newtonian space) plus Newtonian time. Our derivation of βx and βt in the standard Lorentz transformation like Cartesian coordinate and Newtonian time (Sec. 9) shows that Einstein did not actually develop "a new view of space and time, now called the special theory of relativity", as it is claimed [30]: there is no true physical length contraction, no true physical time dilation, no true twin paradox, no conflict with Newton's view of space and time.

Newtonian concepts of space and time are kept unaltered in Einstein's theory, in deep agreement with everyday experience and common sense. They are independent of whether anything is in the universe or not and of what happens inside the universe. Minkowski space-time has no connection with the spacetime (sometimes also written as space-time) claimed to be a physical entity causing physical effects [31]: The spacetime is just a concept having no physical grounding and no physical effect. With this remark, the special relativity theory contributes to a unified theory of elementary particle interaction. The trend to describe the whole universe, including the microcosm, in terms of geometry of an unphysical spacetime and its 'quantum' nature dominates [31-34], against its striking failure [35].

19. THE VALIDATION OF THE PRINCIPLE OF THE PHYSICAL DETERMINATION OF EQUATIONS IN EINSTEIN'S SPECIAL RELATIVITY THEORY

Applying the complementary time-dependent coordinate transformations to special relativity theory by the derivation of the Lorentz transformation as such a transformation, we proved not only the correctness of the derivation of the Lorentz transformation in [1] (Sec. 14 (Sect. 2)), but also that the terms βx and βt of the Lorentz transformation are actually Cartesian coordinate and Newtonian time. So, after βx and βt past -for a century- for a coordinate x and a fictitious time t multiplied by the factor β of unknown origin and physical meaning, we removed by our derivation of the Lorentz transformation as a complementary time-dependent coordinate transformation the mystery on β. So all the terms of the equations constituting the Lorentz transformation get clear physical meaning now. Since these equations were the only ones in the special relativity theory with some terms without known physical meaning, our result validates the principle of the physical determination of equations in the special relativity theory: x' in the Lorentz transformation is, like x' in the Galileo transformation, a difference of Cartesian coordinates (by Sec. 9), while t' is a difference of Newtonian times. Recall that passing from a geometrical point of abscissa x to one of abscissa βx was required by the graphical addition of travel times as scalar quantities (Sec. 7).

The importance of the principle of the physical determination of equations for the advancement of physics consists in the physical information to be disclosed from the terms of the underlying equations in theories already built, or required to be in the terms of the underlying equations of the theories to be built.