RECONSIDERING EINSTEIN'S 1905 DERIVATION OF THE LORENTZ TRANSFORMATION: A NEED FOR RECONSTRUCTING MODERN PHYSICS

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Disclosing the physical grounds of the manipulations of equations that Einstein strangely used to deduce the Lorentz transformation (LT) in his original paper on relativity, we prove the correctness of that derivation of the LT, as well as its operational nature. Main consequences of this result are pointed out.

1. Introduction

In his original paper on relativity [1], Einstein deduced the Lorentz transformation by three strange manipulations of equations. They seemed wrong to him, that derivation of the LT was soon ignored, and no later comment on them was/is admitted in order…to 'save' the relativistic modern physics and Einstein's fame. Disclosing the physical grounds of each of the three manipulations, we reveal the correctness of Einstein's 1905 derivation of the LT, its operational nature, and so the fact that there was/is no need of measures to 'save' the relativistic physics, implicitly his fame. Moreover, by that Einstein decided those manipulations of equations but failed in explaining them rationally (since 1907 wholly ignoring his 1905 derivation of the LT), our result also illustrates that a superhuman objectivity manifests through the subconscious of a genius (what Einstein has repeatedly assumed!), often the resulting information being only partly rationally decoded during all his life. This way a large amount of essential physical (scientific) information was and is still lost.

The three manipulations of equations consisted in i)using the equation defining clocks running in synchrony at two points 'of space' [1] to clocks in uniform rectilinear motion which are at rest with respect to each other, ii)dropping the square of β [$\beta=(1-v^2/c^2)^{-1/2}$] in order to obtain a set of equations analogous to those constituting the LT, iii)putting x=wt in the equations from point ii) in order to make them into the LT. Point i) was approached in [2], points ii), iii) are approached, respectively, in Sects. 2 and 3 of this paper. The obtained results are in accordance with those obtained in [3]. Main conclusions are drawn in Sect. 4.

2. Addition of Travel Times of Non-collinear Light Signals as Scalar Quantities

What Einstein never pointed out explicitly was that in his special relativity theory (SRT) the light signals trace radius vectors of moving geometrical points with respect to the coordinate system (CS) which he considered 'at rest'. This happened because Einstein always laid these signals along the common x',x axis. Also due to this choice, by adding paths of light signals as collinear line segments, and dividing the resulting equations by c, Einstein added by diagrams the light travel times as scalar quantities. An addition of travel times of non-collinear light signals as scalar quantities could be merely ignored. Let us approach this last issue.

Consider the diagram in Fig. 1. In accordance with the diagram of Einstein's thought experiment drawn in [2], at time t=0, the origin of the CS k leaves the origin O of the CS K at absolute rest (any uniform rectilinear motion relative to an inertial reference frame conceived by Einstein being mathematically described relative to a CS at absolute rest [4]), moving with constant velocity v along the common x',x axis, simultaneously with the light signal tracing the radius vector of the point Q(X,y,z), which is at rest relative to k. At time t* the origin of k reaches the point O'.

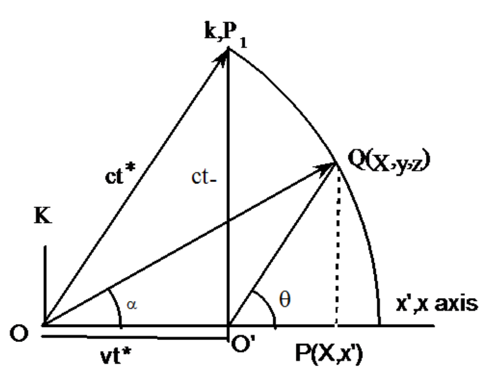

Figure 1

Light signals of path ct* are emitted isotropically by a source situated at O when the tridimensional CS's k, K coincide, at time t=0. At time t*, one of them reaches the point Q, while the origin of k reaches O'. Define O'P_1 as the time-axis. By the Pythagorean theorem, t_- is associated to t* on the time-axis.

Since the collinear line segments OO’ and O’P depend, respectively, on travel times elapsed along the non-collinear line segments OQ and O’Q, we must convert these travel times to travel times of light signals propagating along one and the same direction -we name *time-axis*- in order to get a linear time-equation from this diagram. This because the line segments OO' and O'P are covered by the projections onto the x’,x axis of the tips of the light signals tracing the radius vectors of the geometrical point Q relative to K (OQ) and k (O'Q) at the differing velocities $c\times\cos\alpha$ and $c\times\cos\theta$, respectively, which makes impossible a passage from OO'+O'P=OP to the time-equivalent OO'/c+O'P/c=OP/c, as in the case of the collinear light signals. Only this way light travel times like OO'/c and O'P/c can be graphically added as scalar quantities in a theory joining CS’s in uniform rectilinear motion by light signals tracing radius vectors. The geometry of Fig. 1 shows that a time-axis is always orthogonal to **v**. From the right triangle OP_1O', we get

$$t^*=\beta t\_. \tag{1}$$

Laying OP and O’O on the time-axis is straightforward by (1). Laying O’P requires for the diagram in Fig. 2. P(X) and P(βX) are fixed points relative to k. At time t=0, the origin of k and a light signal leave the origin O of K, moving with velocities v and c, respectively, along the positive, common x’, x axis. At time $T(=t^*\cos\alpha)$, they reach, respectively, O'_o and P(X). We lay the bottom diagram in Fig. 1 of [2] at O'_0 on the time-axis. In other words, we lay the CS Ξ at absolute rest along the time-axis. By the reasoning leading to (1), from the right triangle $OP'_1O'_o$, we have

$$T=\beta t,\ X=cT=\beta ct=\beta x,\ OO'_o=vT=v\beta t. \tag{2}$$

To remove the dependence of $O'_oP(X)$ (O'P in Fig. 1) on the time in which light travels O'_oQ, by Eqs. (4) and (5’) in [2] and the above Eq. (2), we determine ξ and τ in terms of X and T as

$$\xi=\beta(X-vT),\ \tau=\beta(T-vX/c^2). \tag{3}$$

βX in Eq. (3) is the abscissa OP(βX) of another geometrical point Q(β**r**), located β times far from O, and βT the travel time of the light signal tracing it. This way we get a geometrical point P(βX) which x’=ξ by (3) is traveled by a light signal in the time τ of Ξ, which is independent of the travel time elapsed along O’Q(β**r**). Since X=βx by (2), Eqs. (3) (to which we add y’=βy, z’=βz) identify with the set of equations linear in β^2,viz.

$$\xi=\beta^2(x-vt),\ \eta=\beta y,\ \zeta=\beta z,\ \tau=\beta^2(t-vx/c^2), \tag{4}$$

that Einstein should obtain in [1] by inserting Eq. (3) in [2] in Eq. (2) in [2], and computing ξ by Eq. (4) in [2] before writing the set of equations linear in β.

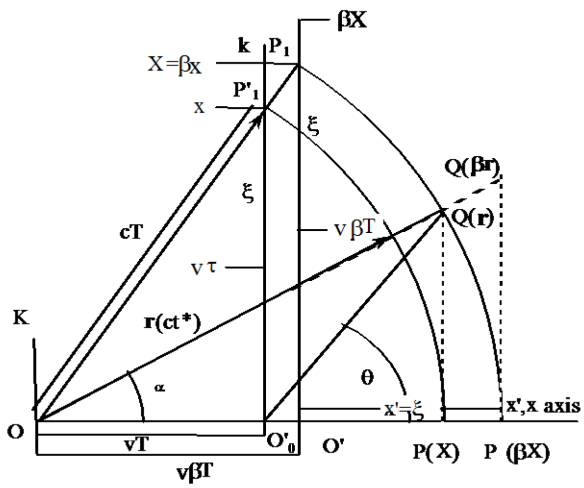

Figure 2

A light signal leaves the origin O of K, accompanied by the origin of k, tracing the radius vector of Q(**r**) (at rest relative to k). At time t*, OP(X) is divided in two line segments, depending on t* and the light travel time elapsed along the radius vector of Q(**r**) relative to k. The simultaneous motions in time $T=t^*\cos\alpha$ of both the light signal tracing OP(X) and the origin of k remove this dependence at time βT, when are reached the points P(βX) and O’, respectively, because the x’=ξ of P(βX) implies x’/c=τ, which is independent of O’Q(β**r**)/c.

Therefore, Einstein’s removal of the square of β in Eqs. (4) in [1] -that seemed to be an arbitrary decision- actually originates in the change of Q(**r**) to Q(β**r**), implicitly of the pair of geometrical points P(X), O'_o(vT) initially taken into account to the points P(βX), O’(vβT) in Fig. 2, *imposed* by the scalar addition of travel times of non-collinear light signals. Clearly, the terms βx and vβt of the equations linear in β stand, respectively, for the coordinates of the imposed geometrical points, not for the points of coordinates x and vt, as it is customarily believed.

3. The Lorentz Transformation

Let us consider the Q’s (implicitly their projections P) in Fig. 2 to move relative to the CS k also in translatory motion relative to the CS K at absolute rest. Identifying projection P of Q with the origin of a CS k_B, we are in the last case considered in [4]. Therefore, we pass from a description of the motion of Q relative to the 'stationary' CS k to one with respect to a CS K'_A at absolute rest associated to k just as it was associated to k_A in [4]. By a diagram analogous to the last one in Fig. 2 in [4], we have, analogously to Eqs. (3) in [4],

$$\xi=\beta(x-vt),\ \eta=y,\ \zeta=z,\ \tau=\beta(t-vx/c^2), \qquad (5)$$

with w=vt and u defined by (2) in [4]. Thus, Einstein's third manipulation of equations in [1] is also physically well-founded, the additional equation making Eqs. (5) into the LT. Unlike the fourth of the equations linear in β which result from Eqs. (4), the fourth of the LT equations (5) is not the time equivalent of the equation in ξ and x. βx and βvt keep further the meaning of coordinates disclosed in Sect. 2 above. Thus, LT just relates mathematically, by absolute quantities, 'stationary' observers in a theory joining them by light signals as SRT is.

As concerns Einstein's 1905 method to deduce the LT, it is an operational one: Consisting in tracing radius vectors of geometrical points in 'stationary' spaces by light signals, it was founded on measuring procedures. The tracing of such a radius vector by one of the light signals emitted isotropically by a source is required by its change in length and direction with time.

4. Conclusions

1°. The LT belongs to the class of complementary time-dependent coordinate transformations defined in [5]. Unlike the ordinary time-dependent coordinate transformations, LT can be written *only when* the radius vector of a geometrical point in a 'stationary' space is physically traced by a light signal emitted by an observer 'at rest' relative to that space. The mixture of spatial and temporal coordinates in the LT originates just in this fact. Since the invariant metric of the Minkowski four-dimensional space is assured by the LT, the nature of this space is also operational, what makes the Minkowski metric into a relationship by which any 'inertial' observer can read a time interval measured by any observer moving rectilinearly and uniformly relative to him (to this end, the moving observer must associate to this time interval a light signal traveling along his time-axis).

2°. Rigorously applied, the operational method raises the vector LT, and proves that the *non-collinear LT's form a group* without requiring rotations of inertial CS's in this aim. The resulting relativistic law for the composition of non-parallel velocities does not support the Thomas precession, what is in accordance with the experimental facts [6].

3°. Consistent with the corpus of classical physics by that βx and $v\beta t$ are coordinates of geometrical points, LT predicts no true Fitzgerald-Lorentz contraction and no true time dilation, keeping further unaltered the meaning of the Newtonian concepts of space and time, in deep agreement with the everyday common sense experience. This result is in accordance with the analysis of the airborne clocks tests [7]. The larger life-times of faster moving particles -the only predicted doubtlessly by experiments- originates in the relativistic mass, which -as shown in [6]- is a coupling 'constant' between clouds of subquantum particles that spin tangentially, in opposite directions within them.

4°. Also by turning the 'blind' and 'innocent' inertial observers to professionals, as it is required by the results obtained in [3], both the paradoxical interpretations in Einstein's SRT and main criticism of the LT and SRT seem to loose any grounds, what strengthens the accuracy of SRT.

5°. The operational identification of the CS Ξ at absolute rest in SRT, and of the terms in the LT as coordinates and Newtonian times validate the classical principle of the physical determination of equations in SRT, promoting its physical understanding. This result is essential for a true advancement of physics.

6°. All the inertial observers are equal to one another in SRT, but, by enabling them to refer the physical quantities measured in their reference frames to quantities defined in relation with the CS at absolute rest, the SRT is a theory of absolute rather than one of relativity, having nothing in common with the almighty misleading relativism governing the 20th and now 21st century. Consequently, the endeavor of the philosophers to relate SRT to this relativism, as well as to remove the newtonian concepts of time and space from the human conscious, imposing the minkowskian space as a physical entity, are baseless and should be abandoned.

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