COORDINATE SYSTEM AT ABSOLUTE REST IN EINSTEIN'S SPECIAL RELATIVITY THEORY

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Against the general belief, a coordinate system at absolute rest is doubtlessly identified in Einstein's original paper on relativity. The special relativity theory appears to be a theory of absolute rather than one of relativity.

Among other goals of Einstein's original paper on relativity [1], there was a derivation of the Lorentz transformation (LT) which physical grounds were less investigated. It is the purpose of this paper to identify the true diagram of the experiment that Einstein thought in that aim, and to show that this diagram assumes the existence of the coordinate system (CS) at absolute rest in the special relativity theory (SRT).

We suppose, in accordance with Einstein, that the sets of coordinates ξ,η,ζ,τ and x,y,z,t determine completely the place and time of an event in relation with the parallel inertial CS's k and K, respectively, that k moves relative to K with constant velocity v along the common x',x axis, that at an instant of time k and K superpose, then k is continuing its motion relative to K. Also in accordance with Einstein, we choose the point P(x',y,z) at rest in k, define the time τ of k as function of x',y,z,t, and proceed to calculate τ in terms of the time t of K by inserting its values $\tau_O=\tau(0,0,0,t)$ associated to the emission of a light signal at O'_i, $\tau_P=\tau[x',0,0,t+x'/(c-v)]$ associated to its reflection at P, and $\tau'_O=\tau[0,0,0,t+x'/(c-v)+x'/(c+v)]$ associated to its arrival at O'_f (O'_i and O'_f are successive positions of the origin of k along the *x* axis) in the equation

$$\tau_O+\tau'_O=2\tau_P \qquad (1)$$

which Einstein claimed to define clocks running in synchrony at the origin of k and P, after he initially defined (1) (also in [1]) for clocks located at fixed points of space. For x' infinitely small, Einstein obtained the differential equation

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

and, on its integration,

$$\tau=\phi(v)[t-vx'/(c^2-v^2)]. \qquad (2)$$

By this result, and taking some mathematical decisions (which physical grounds are provided in [2, 3], Einstein further deduced the quantities ξ,η,ζ in terms of x,y,z,t (for calculation details see Sect I.2 of [1]) establishing the LT.

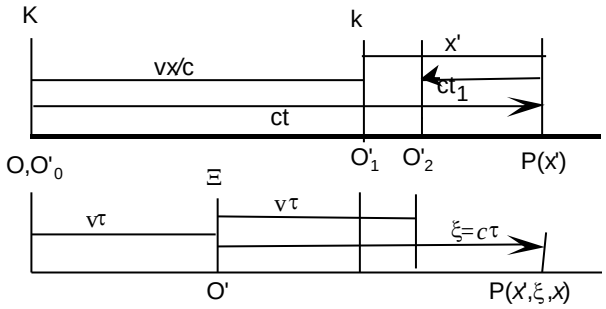

Figure 1

Figure caption. Upper diagram: P(x') is a fixed point in k. At time t=0, the origin of k and a light signal leave the origin O of the CS K at absolute rest, reaching at time t, respectively, O'_1 and P(x'). In the time t_1, the reflected light signal covers PO'_2, while the origin of k covers $O'_1O'_2$. Bottom diagram: O' is the origin of Ξ at absolute rest associated by $OO'=O'O'_2$. ξ is the coordinate of P(x') relative to Ξ. ξ is traced by a light signal in the time of Ξ, τ.

Since Einstein supposed that 'at the origin of k, t=0 when τ=0', by equation

$$x'=x-vt \qquad (3)$$

(that he also assumed to be valid for the coordinates of P), we have x=0 at $t=\tau=0$, and thus the evident proof that the true diagram of his thought experiment to deduce the LT (which he did not draw, however!) was the upper diagram in Fig. 1.

Focusing our attention on this diagram, we see that it joins together the two diagrams in Fig. 1 in [4], where K is the CS at absolute rest. This remark requires two comments. The first one concerns eventual consequences of the upper diagram in Fig. 1. Inserting (3) in (2), then putting, in accordance with Einstein,

$\phi(v)=1$ (value determined further in [1]) and

$\xi=c\tau$, (4)

this diagram predicts

$O'_oP=x=ct=\xi+v\tau$. (5')

It also predicts the line segments $O'_oO'_1=vx'/(c-v)$, $O'_1O'_2=vx'/(c+v)$, which added give

$O'_oO'_2/2=v\tau$. (5")

So that, in view of the upper diagram in Fig. 1, Eqs. (5) predict the existence of a fixed point O' situated at the mid-distance $v\tau$ between O and O'_2, relative to which ξ is defined as a coordinate of P(x'). Thus, as shown in the bottom diagram in Fig. 1, O' is the origin of a CS Ξ at absolute rest associated to the inertial CS k. Ξ is parallel to both k and K, having the common x',ξ,x axis. There results that set of coordinates ξ, η, ζ is actually defined in relation to Ξ, not relative to k as it was initially assumed. ξ is traced by a light signal emitted by a source located at O', that reaches P, as well as by the reflected signal reaching O'. So that, by (1), τ is the time of Ξ.

The second comment concerns the emergence of Ξ. Eq. (1) is true for clocks at rest in a reference frame at absolute rest. Then the path of the light signal traveling from O to P is equal to that of the light signal traveling from P to O. Otherwise, as it is evident from the upper diagram in Fig. 1, the path of the light signal traveling from O'_o to P differs from that of the light signal traveling from P to O'_2. The reason is that the ends of the line segment O'_oP moves with velocity v along the x',x axis simultaneously with, and independently of the light signal. Einstein's extension of (1) to inertial CS's was just the price paid to those anachronical inertial observers who -as pointed out in [4]- are supposed to perform measurements and interpret correctly their results without having any a priori training in physics, particularly as concerns the relative motion. Since Einstein obtained Eq. (2), and, finally, the LT, we also must search for the true meaning of Eq. (1).

Since Eqs. (5) are consequences of a calculation based on Eq. (1), and 2ξ is the path of a light signal traveling from O' to P and back to O' in the bottom diagram in Fig. 1, in a time 2τ equal to the time $t+t_1$ in which the initial signal travels from O'_o to P and back to O'_2, Ξ emerged from Eq. (1). Also, the true meaning of Eq. (1) -which was deduced for clocks located at fixed points of space in [1]- is that to define synchronous clocks attached to O' and P of Ξ, not to the origin of k and P (which are moving points), as it was initially assumed.

Therefore, there is a doubtless presence of the CS at absolute rest in Einstein's SRT by Ξ. This is in accordance with the results obtained in [2, 4], as well as with the mathematical description by Eq. (3) of both, the motion of an inertial CS, having imparted an additional constant velocity v relative to another inertial CS, and the motion with velocity v of the same CS relative to a CS at absolute rest [2, 3], being essential for a correct understanding of the LT and SRT, with major consequences on modern physics. This way, Einstein's SRT results to be the theory of absolute rather than of relativity.

References

[1] A. Einstein, "Zur Electrodynamik Bewegter Korper", Ann. der Phys. **17** (1905) 891.
[2] A.C.V. Ceapa, "Reconsidering Einstein's 1905 Derivation of Lorentz Transformation: A Need" (PIRT-VII).
[3] A.C.V. Ceapa, Physical Grounds of Einstein's Theory of Relativity (3rd Ed., Bucharest, 1998).
[4] A.C.V. Ceapa, "Measurement of Absolute Velocities by Inertial Observers" (PIRT-VII).