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Abstract Coordinate Systems at Absolute Rest Associated to Inertial Coordinate Systems Meaning of the Relativistic Addition Law for the Parallel Velocities

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Abstract: It will be proved that the uniform rectilinear motion of any object relative to an inertial coordinate system (CS) is always mathematically and graphically described relative to a CS at absolute rest. The uniform rectilinear motion of an object with respect to two parallel CSs moving collinearly is reduced to one with respect to the CSs at absolute rest associated to the last. The velocities of this object relative to the two CSs at absolute rest are related by the relativistic law for the composition of parallel velocities. Traced by physical signals (in particular light signals) with respect to these CSs at absolute rest, the radius vectors of moving geometrical points predict time-dependent coordinate transformations complementary to spatial translations and rotations. Lorentz transformation (LT) is one of them. The special relativity theory (SRT) appears to be a theory of absolute.

Keywords: theory of relativity, theory of absolute, inertial coordinate system, coordinate system at absolute rest, relative motion, absolute motion, relativistic law of the addition of parallel velocities, Lorentz transformation.

This is the last of a series of three papers concerning the CSs[1] with respect to which relative motion is trully described graphically and mathematically by inertial observers in Einstein's SRT [1], [2]. Consider the diagrams shown in Figure 1, with marked arrows ignored. The CS k moves with constant velocity v along the positive common x',x axis relative to the CS K at absolute rest and to the inertial CS K_1, respectively. At time t=0, the origin of k leaves the origins of the CSs K and K_1. k and K_1 are at rest in an inertial space[2] of velocity w in the mid-diagram. At time t the mid-diagram differs from the upper one in that everything is shifted right for a distance wt, including the point P(x,' x) to P(x,' x_1). By removing the line segment OO(t) covered in common by both the origin of k and K_1, is obtained the Galilean transformation

$$x'=x-vt, \tag{1}$$

which associates the abstract CS at absolute rest K in the bottom diagram to the inertial CS K_1. Also predicted by the first diagram, equation (1) proves that the very mathematical description of the uniform rectilinear motion of any object relative to an inertial observer is done with respect to the abstract CS at absolute rest associated to his inertial CS, not to the

[1] CS is an assembly of three straight lines crossing orthogonally at a point, its origin. Inertial CS is one aimed by a uniform rectilinear motion. CS at absolute rest is one aimed by no motion at all.

[2] Space (empty space) is the assembly of geometrical points at rest with respect to each other, as well as as a whole. Inertial physical space is an assembly of geometrical points at rest with respect to each other, and in uniform rectilinear motion as a whole.

last (an abstract CS is one which axes are not defined by the bodies of a reference frame). The result is valid for both absolute and relative w velocities (absolute quantities are defined with respect to CSs at absolute rest).

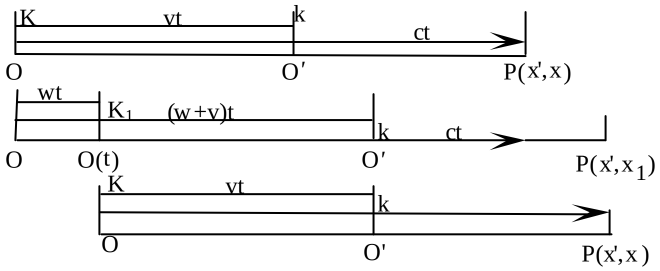

Figure 1.

Consider now the diagrams in Figure 1, with the arrows standing for the light signal tracing the radius vector of P(x') fixed in k. At time t=0, a light signal leaves (together with the origin of k) the origin of K, K_1, respectively, moving along the x',x axis with velocity c. At time t they reach, respectively, P and O' in the first diagram. We get Eq. (1) with x=ct. Also at time t, the path of the signal in the mid-diagram is ct, but both the origin of K_1 and P are sifted right to O(t) and P(x',x_1) for the distance wt. At time t_1=t+wt/c the light signal will reach P(x',x_1), but, in the time wt/c, P(x') changed its position by (w+v)wt/c. At time $t_2=t_1+(w+v)wt/c^2$, the light signal will reach that position of P(x'), while K_1 and k, P(x') moved further to right by $(w+v)w^2t/c^2$, and $(w+v)^2wt/c^2$, respectively. And all that until the time

$$t_f=t+wt/c+(w+v)wt/c^2+(w+v)^2wt/c^3+...=t+wt/c+(w+v)wt/c(c-w-v),$$

when the light signal will reach P(x'), tracing its radius vector relative to O. Since the radius vector of P(x'), and that of the origin of k at time t_f are

$$x_f=ct_f=ct+wt+(w+v)wt/(c-w-v)$$

and

$$x_{O'}=(v+w)t_f=vt+wt+(w+v)wt/(c-w-v),$$

respectively, x_f-$x_{O'}$ reduces to (1) by removing the line segments wt and (w+v)wt/(c-w-v), covered by the light signal in common with the origin of k, in accord with the second diagram shown in Figure 1. Thus, any inertial observer who traces the radius vector of a geometrical point P in an inertial space by a light signal obtains a mathematical relationship which connects P, the origin of the CS in that space, that of his CS, and the fixed origin of the signal in space. It is the reduced form (1) of this mathematical relationship that which associates an abstract CS at absolute rest to the observer's inertial CS by the third diagram. It is with respect to this CS at absolute rest that the radius vector of the moving geometrical point is actually traced (hence defined as direction and magnitude) by the light signal.

Therefore, whenever an object (let it be k) is moving uniformly and rectilinearly with velocity v relative to an inertial CS (let it be K_1), by geometry identical to that describing its absolute motion with constant velocity v, its motion is described in relation to a CS (let it be K) at absolute rest, and expressed mathematically by (1) (reason for which we will refer the motion of k to K in the next diagrams). So that, what we named relative motion and relative velocity (e.g., v) is true absolute motion and absolute velocity. We point out that the passage from K_1 to K is not the same with saying that, for the observer to which K_1 is attached, K_1

appears to be at absolute rest (see also [2]) (a particle at rest relative to K_1 will never have the energy m_0c^2). It becomes evident that the removal of the CS at absolute rest from SRT (e.g., the CS Ξ in [3]) was baseless and misleading for understanding the physical foundations of the last.

As a consequence, an inertial observer a priori trained to represent graphically real and fictitiuous relative motions can trace the radius vector of P(x') fixed in k (first diagram in Figure 2) by a light signal reflected at P(x'). By taking into account the hypothetical motion of k with constant velocity v relative to a parallel CS at absolute rest K (associated to an inertial CS K_1 by the bottom diagram of Figure 1), he associates a CS Ξ at absolute rest to k by the second diagram in Figure 2, and determine experimentally the absolute velocities v and c (the light velocity in empty space) [2].

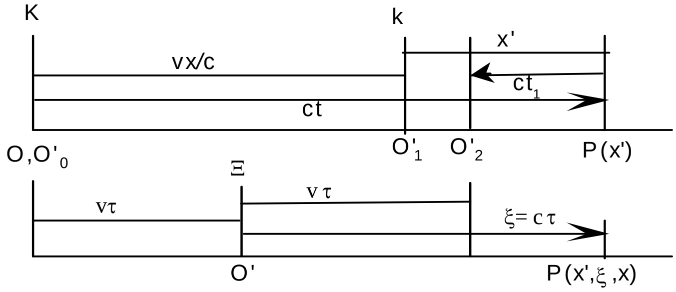

Figure 2.

The points O'_1 and O'_2 in the first diagram are positions reached successively by the origin of k at times t and $t+t_1$, respectively. The resulting equations

$$x=x'+vt, \quad x'=vt_1+ct_1, \tag{2}$$

where x=ct and t, t_1 are, respectively, the light travel times from O to P, and back from P to O'_2, predict, by the defining equations

$$(t+t_1)/2=\beta^2x'/c=\tau, \quad \xi=c\tau, \tag{3}$$

with $\beta=(1-v^2/c^2)^{-1/2}$, the geometrical point O', of abscissa $OO'_2/2=v(t+t_1)/2=v\tau$. Since P(x') is a fixed point in k, x' is constant. Hence, O' is a fixed point in K. Thus O' defines the origin of the CS at absolute rest Ξ in the second diagram in Figure 2, associated to the observer's inertial CS k, and parallel to it. The quantity $\xi=c\tau$ defines the abscissa of P(x') with respect to Ξ, while τ the time of Ξ. The absolute velocities v and c are, as solution of Eqs. (1), experimentally determinable [2]. The maximum measured value of v corresponds to the observer's true choice of the direction of motion of k relative to K. It is easily provable that Einstein formulated his controversed principle of the constancy of light velocity with respect to Ξ in [3].

Further consider the diagrams in Figure 3. They describe the uniform rectilinear motions at time t of the CSs k_A, k_B relative to the parallel CS K_1. K is that associated to K_1 in Figure 1. The CS k_A, k_B and K coincide at time t=0. By the operational method, just at t=0, k_A, k_B and a light signal, tracing the radius vector of the point Q fixed in k_B, leave the origin O of K moving uniformly along the common x',x",x axis at absolute velocities v, w and c, respectively. At time t, their origins and the tip of the signal reach, respectively, the points $O'_A(vt)$, $O'_B(wt)$ and Q(ct) in the upper diagram. Hence the motion of k_B is simultaneously referred to a CS (k_A), which in its turn moves relative to K. By diagrams like the last two shown in Figure 1, with K_1, K changed to k_A, K_A, we turn the motion of k_B relative to k_A to one relative to the CS at absolute rest K_A associated to the inertial k_A. To this end, the upper diagram in Figure 3 must lead to a diagram like the bottom diagram in Figure 1. This means that the light signal and the origin of k_B must continue their motion an additional time vt/c, until reaching P and $O'_B[w(t+vt/c)]$, respectively, as depicted in the upper diagram in Figure 3. We obtain the mid-diagram, where P, $O'_B(t)$ and $O'_B(t')$ are reached by the light signal (leaving O'_A simultaneously with the origin of k_B at time t=0) and the origin of k_B at times t, t', respectively.

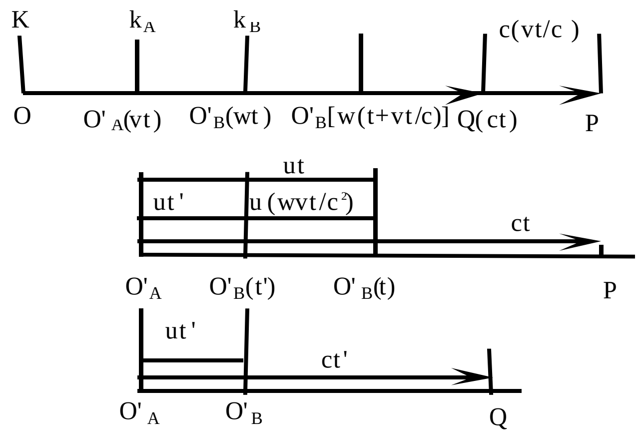

Figure 3.

Since the bottom diagram in Figure 1 is true for any value of t, the mid-diagram in Figure 3 predicts at the time $t'=t-wvt/c^2$ the relationship $ut'=(w-v)t$, where u is the velocity of k_B relative to K_A, and thus the bottom diagram in Figure 3. This last diagram describes the motion of the light signal and of the origin of k_B which (leaving O'_A at time t=0) will reach simultaneously the points Q and O'_B, respectively.

By simplifying the resulting equation $u(t-wvt/c^2)=(w-v)t$, we obtain for u the expression

$$u=(w-v)/(1-wv/c^2) \qquad (4)$$

which is just the relativistic law for the composition of parallel velocities. u, v and w are absolute velocities that comply with the Newtonian definition of velocity and inertial observers measure as such experimentally [2]. The velocity u given by (4) is specific to a theory in which the radius vectors of the moving geometrical points are traced by light signals.

In addition, by identifying Q with the origin O'_B of k_B in the first two diagrams in Figure 3, we get the equations

$$x'=x-vt,\ y'=y=0,\ z'=z=0,\ t'=t-vx/c^2 \qquad (5)$$

with x=wt, relating the translatory motion of constant velocity u of an object (the origin of k_B) relative to a CS K' at absolute rest, associated to an inertial ('stationary' in [3]) CS k_A, to the translatory motion of constant velocity w of that object relative to another CS K at absolute rest. By the additional equation x=wt, Eqs. (5) are independent from each other. Eqs. (5) give a particular form of a new class of time-dependent coordinate transformations, complementary to those already known as spatial translations and rotations. Obtaining the standard Lorentz transformation (LT) as one of these transformations [4], we assured the independence of the equations defining LT in [3] by the additional equation x=wt, and disclosed the physics warranting Einstein's mathematical decisions of genius (without justification) that led him to the LT in [3]. So we validated that ignored derivation of the LT, the LT itself, and substantially enriched the physical grounds of his SRT, implicitly its range of applications. All these results could not be obtained believing for a century now in a false graphical and mathematical description of the relative motion, with respect to inertial CSs, deliberately ignoring the CSs at absolute rest.

Concluding, since the diagram of the thought experiment by which Einstein has deduced the LT in [3] differs from the first diagram in Figure 2 only by that the light signal was emitted from the origin of k after k and K_1 coincided at time t=0, an identical CS Ξ at absolute rest is associated to any inertial observer in SRT by a diagram like the bottom diagram in Figure 2 [1]. The quantities τ, ξ, defined by Eqs. (3), were obtained in [3] by extending the validity of the equation defining clocks working in synchrony at points 'of space' (i.e., at absolute rest) to inertial clocks. So that, the essential role played by the abstract CSs at absolute rest in graphically and mathematically describing relative motion, which we disclosed in this paper, is deeply connected to SRT by [3].

Thus any relative motion is reduced graphically and mathematically to an absolute motion. Absolute velocities can be experimentally determined by inertial observers [2]. The name "theory of relativity", connected by Einstein "with the fact that motion from point of view of possible experience appears as the relative motion of one object with respect to another" [5], was supported just by the inertial observers who baselessly treated their CSs like CSs at absolute rest. Thus SRT is "theory of absolute": LT connects absolute quantities. The almighty relativism of the last century, succesfully continued now, unfairly claims support from Einstein's SRT, as long as it has nothing in common with this theory.

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