MEANING OF THE RELATIVISTIC LAW FOR THE COMPOSITION OF PARALLEL VELOCITIES

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The simultaneous uniform rectilinear motion of two coordinate systems (CS's) with respect to an inertial CS is reduced to the uniform rectilinear motion of one of them relative to two CS's at absolute rest. The velocities of this CS relative to those CS's are related by the relativistic law for the composition of parallel velocities.

Although we use succesfully the relativistic law for the composition of parallel velocities, yet its meaning rested undisclosed. We propose to reveal this meaning by investigating the CS's at absolute rest associated to Einstein's inertial CS's (CS's in uniform rectilinear motion). Examine in this aim the diagrams in Figs. 1, 2.

Let us consider the diagrams in Fig. 1. P is a fixed point relative to k. Simultaneously with the light signal

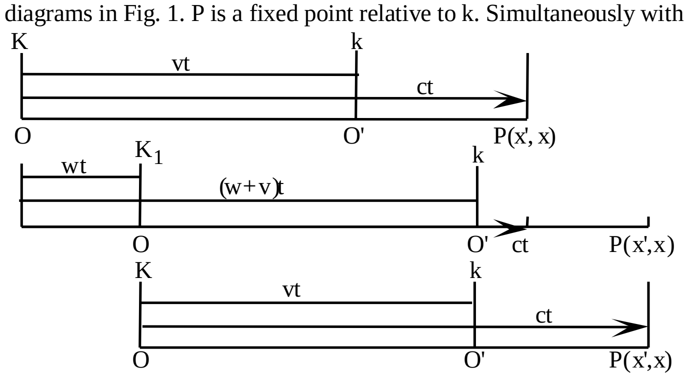

Figure 1

The CS k moves with constant velocity v relative to the CS K at absolute rest in the upper diagram, and with constant velocity v+w relative to the inertial CS K_1 in the middiagram . By the resulting bottom diagram, its motion relative to K_1 is reduced to a motion relative to K. In both cases the radius vector of P is traced by a light signal of path ct.

tracing the radius vector of P, the CS k is moving with constant velocity v along the x',x axis relative to the CS K at absolute rest in the upper diagram and to K_1 at rest in a 'stationary' (inertial) space in the middiagram. At time t the middiagram differs from the upper one in that everything is shifted right for a distance wt, including the point P. Continuing the traveling of the light signal to P(x'), simultaneously with the motion of k and K_1, we get evidence that the coordinates of any fixed P in k in the first two diagrams in Fig. 1 are connected by the Galilean transformation

$$x'=x-vt, \qquad (1)$$

the middiagram giving rise to the bottom one, which differs from the upper diagram only by that it is shifted right for a distance wt. The K in the bottom diagram is recognized as a CS at absolute rest. As the radius vector of P at time t is the same in the upper and bottom diagrams, the light signals in these diagrams have identical paths.

Therefore, whenever an object (let it be k) is moving uniformly and rectilinearly with velocity v relative to a 'stationary' CS K_1, i.e., relative to one in uniform rectilinear motion relative to the CS K at absolute rest, then -by geometry identical to that for its absolute motion with velocity **v**- the motion of k can always be described in relation to the CS K at absolute rest and expressed mathematically by (1). It becomes evident that the removal of the CS at absolute rest from SRT was just as unnecessary as it was misleading.

As an application of the result just obtained, let us consider the diagrams in Fig. 2. The K is the CS at absolute rest. The CS's k_A, k_B and K coincide at t=0. Just at t=0, k_A, k_B and a light signal, tracing the radius vector of the point P(x") 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. In view of the result just obtained, we refer the motion of k_B to the CS K'_A at absolute rest associated to k_A by the middiagram in Fig. 2. To this end, the upper diagram in Fig. 2 must lead to a diagram like the bottom diagram in Fig. 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(x") and $O'_B[w(t+vt/c)]$, respectively, as depicted in the upper diagram in Fig. 2. We obtain the middiagram, where $O'_AP(x''_1)$ and $O'_B(t')O'_B(t)$ are covered by the light signal (leaving O'_A simultaneously with the origin of k_B at time t=0) and the origin of k_B in the time intervals t and wvt/c^2, respectively.

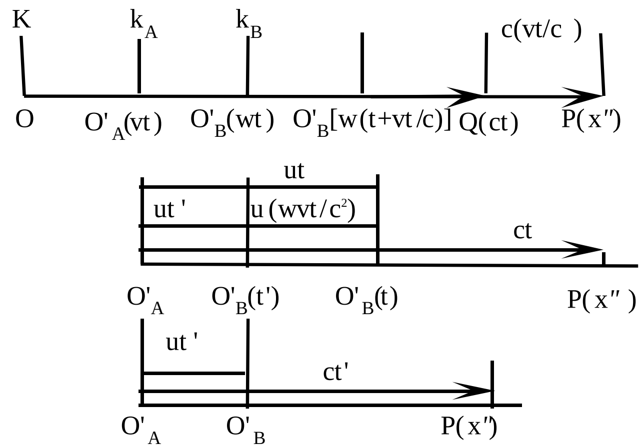

Figure 2

At time t=0, the CS's k_A, k_B and a light signal leave the origin O of K, moving uniformly along the x',x",x axis. At time t, the motion of k_B is referred to the CS K'_A at absolute rest associated to k_A by the middiagram. The simultaneous uniform motions of k_B from $O'_B(wt)$ to O'[w(t+vt/c)], and of the light signal from Q to P, required in this aim, involve u as an absolute velocity, as well as the relativistic formula for the composition of parallel velocities (2).

Since the bottom diagram in Fig. 1 is true for any value of t, the middiagram in Fig. 2 implies, for a velocity u of k_B relative to K'_A, satisfying the relationship ut'=(w-v)t at the time $t'=t-wvt/c^2$, the bottom diagram in Fig. 2, identical to the bottom diagram in Fig. 1. This bottom diagram of Fig. 2 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 P(x") and O'_B, respectively. The identity of the two diagrams becomes wholly evident by adding the line segment wvt/c to the right of P(x") in the bottom diagram in Fig. 2.

By simplifying the resulting equation

$$u(t-wvt/c^2)=(w-v)t,$$

we obtain for u the expression

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

which is just the relativistic law for the composition of parallel velocities. This result complies with the Newtonian definition of velocity. The velocity u is specific to a theory in which the radius vectors of the moving geometrical points are traced by light signals. Like the Newtonian velocities, u is an absolute velocity by its components, which are absolute quantities.

In addition, by identifying P(x") with the origin O'_B of k_B in the last diagram in Fig. 2, we get the equations

$$x'=x-vt,\ y'=y,\ z'=z,\ t'=t-vx/c^2 \qquad (3)$$

with x=wt, relating the translatory motion of constant velocity u of an object (the origin of k_B) relative to a CS K'_A at absolute rest, associated to a 'stationary' CS k_A, to the translatory motion of constant velocity w of that object relative to another CS K at absolute rest. The last of Eqs. (3) is not the time-equivalent of the first. Eqs. (1) and (3) did not assume the constancy of light speed relative to 'stationary' CS's, but relative to empty space.