Foundations of Physics, Vol. 9, Nos. 5/6, 1979

The Coordinate Transformations of the Absolute Space–Time Theory

Stefan Marinov[1, 2]

Received April 26, 1978

In the light of our recently performed experiments, revealing the anisotropy of light velocity in any frame moving with respect to absolute space, we show that the Lorentz transformation, where the relativity of light velocity is given implicitly through the relativity of the time coordinates, must be treated from an absolute point of view if one seeks to preserve its adequacy to physical reality. Then we propose a new transformation (which is to be considered as a legitimate companion of the Lorentz transformation) wherein the relativity of light velocity is given explicitly and the time coordinates are absolute.

1. INTRODUCTION

After the performance of our "coupled-mirrors" experiment(1) and especially after its repetition in the so-called interferometric variant(2) no doubts can remain that the velocity of light is direction dependent (see also Refs. 3 and 4) and that absolute space is a reality practically detectable in a laboratory.

Thus, just at this very moment when mankind, after a heavy battle lasting several decades, has finally and definitely rejected the Newtonian absolute space–time conceptions and the aether model for light propagation, perfidious experiment produces a new puzzle which cannot be explained within the framework of modern high-velocity physics.

Are we on the threshold of a new dramatic crisis? Have we to revise once more our space–time conceptions? Have physicists of different orientations and erudition, philosophers, thinkers, and fiction writers to give birth to thousands of new papers and books?

Our definite answer is: No! Mankind has simply to return to the old,

[1] Laboratory for Fundamental Physical Problems, Sofia, Bulgaria.
[2] Present address: 83, rue Stéphanie, 1020 Bruxelles, Belgium.

0015-9018/79/0600-0445$03.00/0

natural, simple, and clear Newtonian and nineteenth century conceptions. However, as the dialectical laws require, certain elements of the unsuccessful revolution always remain inscribed on the banners of the counter revolution which comes to replace the former. In a series of papers which are now in the press, we show which elements of modern high-velocity physics are to be introduced in the old Newtonian mathematical apparatus with the aim of obtaining a theory adequate to physical reality, which we have called the *absolute space–time theory*.

In the present paper we shall consider the problem of coordinate transformations in high-velocity physics, which, for historical reasons, we shall also call relativistic.

Before broaching this problem we must state that in absolute space–time theory we work only with three undefinable physical notions: (a) space, (b) time, and (c) energy (matter).

These three physical quantities cannot be defined at all and, appealing to the intuitive ideas of the reader, we can say only: (a) *Space* is that which extends. (b) *Time* is that which endures. (c) *Energy* is that which exists.

The points in space are called *material* (if their energy is different from zero) or *immaterial* (if their energy is equal to zero). The material points (i.e., the lumps of energy) can move in space. The space in which the energy of the whole world is at rest is called *absolute*. The space attached to a material system (i.e., a combination of material points) which moves with respect to absolute space is called *relative*. When all points of a material system move with the same velocity in absolute space this system is called *inertial* and the relative space attached to it is also called inertial.

Material points of an important class, called photons, propagate always with velocity c in absolute space. This assertion is hypothetical and represents the axiomatical basis of the so-called *aether model* for light propagation. We call this aether conception *Newtonian*, emphasizing in such a way that it has nothing in common with the wave model for light propagation. More details about our conception for light propagation can be found in Ref. 5.

Space intervals can be measured by rigid rods (i.e., material systems the distances between whose points do not change) and time intervals can be measured by so-called light clocks. Since the velocity of light in absolute space is a universal constant, the light clock represents the most accurate, exact, and *theoretically the most simple clock*.

2. THE LIGHT CLOCK

The light clock represents a light source and a mirror placed at a certain distance in front of it, called the "arm" of the clock. If this "arm" has d length units, then any photon (or short enough package of photons) will return to the light source, being reflected by the mirror, after

$$T = 2d/c \tag{1}$$

time units. The time interval T is called the period of the light clock.

A clock that rests in absolute space is called an *absolute clock* and a clock that moves with a certain velocity V is called a *proper clock*. Let us now establish the period of a proper light clock with "arm" d.

First we shall suppose that the "arm" is perpendicular to V and such a light clock will be called *transverse*. Denoting by $T_\perp'$ and $T_\perp''$ the times in which light covers the "arm" d of the transverse light clock "there" and "back," we have

$$c^2(T_\perp')^2 = d^2 + V^2(T_\perp')^2, \qquad c^2(T_\perp'')^2 = d^2 + V^2(T_\perp'')^2 \tag{2}$$

from which

$$T_\perp = T_\perp' + T_\perp'' = \frac{2d}{c(1 - V^2/c^2)^{1/2}} = \frac{T}{(1 - V^2/c^2)^{1/2}} \tag{3}$$

Then we shall suppose that the "arm" is parallel to V and such a light clock will be called *longitudinal*. Denoting by $T_\parallel'$ and $T_\parallel''$ the times in which light covers the "arm" d of the longitudinal light clock "there" and "back," we have (for the case where the source–mirror vector points along the same direction as the clock's velocity)

$$cT_\parallel' = d + VT_\parallel', \qquad cT_\parallel'' = d - VT_\parallel'' \tag{4}$$

from which

$$T_\parallel = T_\parallel' + T_\parallel'' = \frac{2d}{c(1 - V^2/c^2)} = \frac{T}{1 - V^2/c^2} \tag{5}$$

Hence we have the following conclusions:

(i) The rate of a proper light clock is different than the rate of an absolute clock.

(ii) The rate of a proper light clock depends on the orientation of its "arm" with respect to its velocity.

3. THE HIGH-VELOCITY AXIOM

The historic experiment of Michelson and Morley showed that the rate of a proper light clock does not depend on the orientation of its "arm."

Two hypotheses have been proposed for the explanation of this experimental fact, which contradicts the Newtonian aether conception:

(a) The Lorentz Hypothesis. Every rigid body contracts those of its dimensions that are parallel to its velocity by the factor $(1 - V^2/c^2)^{1/2}$. Hence the "arm" of the longitudinal light clock becomes $d_\parallel = d(1 - V^2/c^2)^{1/2}$, while the "arm" of the transverse clock remains $d_\perp = d$, and one obtains

$$T_\perp = T_\parallel = T/(1 - V^2/c^2)^{1/2} \tag{6}$$

(b) The Einstein Hypothesis. In every inertial relative space the velocity of light is isotropic and equal to c. Thus the period of any proper light clock will be given by formula (1).

Einstein rejected the Newtonian aether hypothesis *more radically than was demanded* by the Michelson–Morley experiment. This experiment only showed that the "there-and-back," i.e., *bidirectional*, light velocity is isotropic in any relative space, but it gives no information whether the "there" and "back," i.e., *unidirectional*, light velocities are also isotropic.

Einstein made the radical assumption about the unidirectional light velocity constancy, proceeding from the general principle of relativity, which asserts that there is no physical possibility for registering the motion of an inertial material system.

Before the performance of our "coupled-mirrors" experiment[1,2] there was no experiment contradicting the general (Einstein) principle of relativity and the hypothesis for the unidirectional light velocity constancy. But following its performance we have to revise Einstein's hypothesis, reject the general principle of relativity, and make it clear that from the Michelson–Morley experiment no such radical conclusion is to be drawn.

The axiomatical grounds of high-velocity (relativistic) physics is given by the tenth axiom of our absolute space–time theory,[6] which reads:

The material points called photons move with velocity c along all directions in absolute space and their velocity does not depend on their history. Light clocks with equal "arms" have the same rate in any frame, independent of the orientation of their "arms." At any point of any frame the time unit is to be defined by the period of light clocks with equal "arms," independent of the velocity of the frame and the local concentration of matter.

Now proceeding from this axiom, we shall show which coordinate transformations we must have in high-velocity physics.

4. THE GALILEAN TRANSFORMATION

All transformations of the space and time coordinates which we consider are between a frame K attached to absolute space (called *absolute frame*) and a frame K' moving inertially with a velocity V (called *relative frame*). To avoid trivial constants we shall consider the so-called homogeneous transformation, i.e., we shall suppose that at the initial zero moment the origins of both frames coincide (see Fig. 1, where for simplicity's sake a two-dimensional case is presented).

Let us have a point P whose radius vector in K is $\mathbf{r}$ (called the *absolute radius vector*) and whose radius vector in K' is $\mathbf{r}'$ (called the *relative radius vector*). The radius vector of the origin of frame K' in frame K is $\mathbf{R}$ (called the *transient radius vector*). It is

$$\mathbf{R} = \mathbf{V}t = \mathbf{V}_0 t_0 \tag{7}$$

where t is the time read on a clock at rest in frame K (an absolute clock) and $\mathbf{V}$ is the velocity of frame K' measured on this clock, while t_0 is the time read on a clock at rest in K' (a proper clock) and $\mathbf{V}_0$ is the velocity of frame K' measured on this clock.

According to the traditional Newtonian conceptions we shall have

$$\mathbf{r}' = \mathbf{r} - \mathbf{V}t, \qquad \mathbf{r} = \mathbf{r}' + \mathbf{V}_0 t_0 \tag{8}$$

Adding these two equations, we obtain (7). If we assume that the clocks attached to K and K' read the same time, we have

$$t = t_0\,, \qquad \mathbf{V} = \mathbf{V}_0 \tag{9}$$

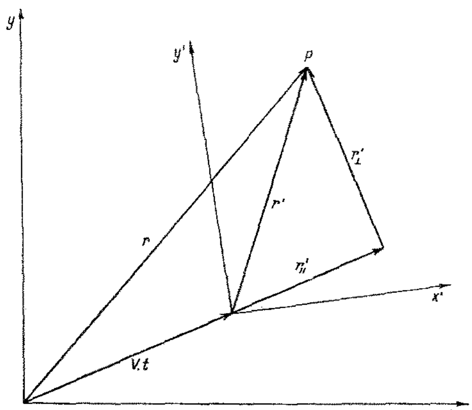

Fig. 1. A homogeneous transformation between two inertial frames of reference.

The first formula (8) represents the direct and the second formula (8) the inverse homogeneous *Galilean transformation* where the relations (9) are to be taken into account.

5. THE LORENTZ TRANSFORMATION

Now we shall search for a transformation of the space and time coordinates which will lead to the relation $T_\perp = T_\parallel$ between the periods of transverse and longitudinal light clocks, as required by our tenth axiom.

Let us decompose (Fig. 1) the radius vectors $\mathbf{r}$ and $\mathbf{r}'$ into components $\mathbf{r}_\perp$, $\mathbf{r}_\perp'$ and $\mathbf{r}_\parallel$, $\mathbf{r}_\parallel'$, respectively, perpendicular and parallel to the direction of propagation of K'.

According to the traditional Newtonian conceptions we have

$$\mathbf{r}' = \mathbf{r}_\perp' + \mathbf{r}_\parallel' = \mathbf{r}_\perp + (\mathbf{r}_\parallel - \mathbf{V}t) = \mathbf{r} - \mathbf{V}t \tag{10}$$

We can meet the requirement $T_\perp = T_\parallel$ of our tenth axiom if we take the parallel component of the relative radius vector contracted by the factor $(1 - V^2/c^2)^{1/2}$ when expressed by the coordinates in frame K, i.e., if we *axiomatically* assume as valid instead of the Newtonian relations

$$\mathbf{r}_\perp = \mathbf{r}_\perp', \qquad \mathbf{r}_\parallel - \mathbf{V}t = \mathbf{r}_\parallel' \tag{11}$$

the "Lorentzian" relations

$$\mathbf{r}_\perp = \mathbf{r}_\perp', \qquad \mathbf{r}_\parallel - \mathbf{V}t = \mathbf{r}_\parallel'(1 - V^2/c^2)^{1/2} \tag{12}$$

This "contraction" (when $\mathbf{r}_\parallel - \mathbf{V}t$ is expressed by $\mathbf{r}_\parallel'$) or "dilation" (when $\mathbf{r}_\parallel'$ is expressed by $\mathbf{r}_\parallel - \mathbf{V}t$) is neither a physical effect, as *supposed* by Lorentz, nor a result of measurement, as *obtained* by Einstein. According to our theory $\mathbf{r}_\parallel'$ and $\mathbf{r}_\parallel - \mathbf{V}t$ represent the *same* length (distance) between two material points which can be connected by a rigid rod or which can move with respect to one another, as well as between two non material points, taken at a given moment. (N.B. About lengths one can speak at a given moment only!) Thus $\mathbf{r}_\parallel'$ and $\mathbf{r}_\parallel - \mathbf{V}t$ are *equal* and we write the second relation (12) only because the velocity of light does *not* have an exact aether-Newtonian character. Making a transition from (11) to (12), we introduce a *blunt mathematical contradiction* into the traditional Newtonian mathematical apparatus. As we show in detail in Ref. 7, this mathematical contradiction remains in the formulas and we must state that after years of intensive mathematical speculations we have found no way to get rid of it. We ask the reader to pay due attention to this statement and not to blame our theory for mathematical imperfection. This imperfection exists in Nature itself. We must realize once and for all that light does not have an exact aether-Newtonian character of propagation, since its "there-and-back" velocity (in a frame moving in absolute space) is isotropic, while according to the *aether-Newtonian* conceptions it must be anisotropic. We have called this peculiarity in the propagation of light the *aether-Marinov* character of light propagation.

Thus, if we wish to meet the requirement $T_\perp = T_\parallel$, we have to write instead of relation (10) the following transformation of the radius vectors in frames K and K':

$$\mathbf{r}' = \mathbf{r}_\perp' + \mathbf{r}_\parallel' = \mathbf{r}_\perp + \frac{\mathbf{r}_\parallel - \mathbf{V}t}{(1 - V^2/c^2)^{1/2}} \tag{13}$$

This formula, written in such a manner that only the absolute radius vector $\mathbf{r}$ is represented, but not its transverse and longitudinal components $\mathbf{r}_\perp$, $\mathbf{r}_\parallel$, has the form

$$\mathbf{r}' = \mathbf{r} + \left\{\left[\frac{1}{(1 - V^2/c^2)^{1/2}} - 1\right]\frac{\mathbf{r}\cdot\mathbf{V}}{V^2} - \frac{t}{(1 - V^2/c^2)^{1/2}}\right\}\mathbf{V} \tag{14}$$

Let us now find the formula for the inverse transformation, i.e., from $\mathbf{r}'$ to $\mathbf{r}$. Here we have two possibilities:

(a) To assume that also in frame K' the velocity of light is isotropic and equal to c (the Lorentz way).

(b) To assume that the velocity of light is isotropic and equal to c only in frame K which is attached to absolute space (the Marinov way).

The Lorentz way leads to transformation of the time coordinates where the radius vectors should appear, i.e., to relative time coordinates, while the Marinov way leads to transformation of the time coordinates where the radius vectors should not appear, i.e., to absolute time coordinates.

Now we shall follow the first way and in Section 6 the second.

If the velocity of light in frame K' is *assumed* to be isotropic and equal to c, then assuming further that the velocity with which frame K moves with respect to K' (and measured on a clock attached to K') is equal and with opposite sign to the velocity V with which frame K' moves with respect to K (and measured on a clock attached to K), we can write (let us note that both these assumptions follow from the principle of relativity)

$$\mathbf{r} = \mathbf{r}' + \left\{\left[\frac{1}{(1 - V^2/c^2)^{1/2}} - 1\right]\frac{\mathbf{r}'\cdot\mathbf{V}}{V^2} + \frac{t'}{(1 - V^2/c^2)^{1/2}}\right\}\mathbf{V} \tag{15}$$

Adding formulas (14) and (15), we obtain

$$-\left[\frac{1}{(1-V^2/c^2)^{1/2}}-1\right]\frac{\mathbf{r}\cdot\mathbf{V}}{V^2}+\frac{t}{(1-V^2/c^2)^{1/2}}$$
$$=\left[\frac{1}{(1-V^2/c^2)^{1/2}}-1\right]\frac{\mathbf{r}'\cdot\mathbf{V}}{V^2}+\frac{t'}{(1-V^2/c^2)^{1/2}} \tag{16}$$

If in this formula we substitute $\mathbf{r}'$ from (14), we obtain the transformation formula for time in which t' is expressed through t and $\mathbf{r}$,

$$t'=\frac{t-\mathbf{r}\cdot\mathbf{V}/c^2}{(1-V^2/c^2)^{1/2}} \tag{17}$$

On the other hand, if in formula (16) we substitute $\mathbf{r}$ from (15), we obtain the transformation formula for time in which t is expressed through t' and $\mathbf{r}'$,

$$t=\frac{t'+\mathbf{r}'\cdot\mathbf{V}/c^2}{(1-V^2/c^2)^{1/2}} \tag{18}$$

Formulas (14) and (17) represent the direct, and formulas (15) and (18) the inverse homogeneous *Lorentz transformation*. These formulas show that not only are the radius vectors $\mathbf{r}$ and $\mathbf{r}'$ two different quantities, but also the time coordinates t and t' are two different quantities and are to be called the *absolute time coordinate* and the *relative time coordinate*.

Thus, as the time coordinates in the Lorentz transformation are relative quantities, the light velocity constancy in this transformation is only *apparent*. In Ref. 7 [see formulas (4.33) and (4.34) there] we show how, proceeding from the Lorentz transformation, one can obtain the expressions for the light velocity in any inertial frame which are adequate to physical reality. Hence, according to absolute space–time theory, the Einstein general principle of relativity is invalid and the Lorentz transformation is adequate to physical reality only if it is treated from our absolute point of view. Since Einstein treats the light velocity constancy as a physical fact and the general principle of relativity as a law of Nature, we consider the Lorentz transformation in the context of special relativity as inadequate to physical reality.

Note that we consider the Galilei limited principle of relativity as adequate to physical reality. This principle asserts that there is no mechanical physical phenomenon by whose help one can establish the inertial motion of a given material system. Hence for the mechanical phenomena any inertial relative space is isotropic.

For electromagnetic phenomena the principle of relativity does not hold good. Thus for the electromagnetic phenomena the inertial relative spaces are not isotropic.

However, as Minkowski has shown, if we consider a 4-space in which the three space coordinates in any inertial frame are unified with the corresponding time coordinate multiplied by c (and by the imaginary unit), then this 4-space turns out to be isotropic and homogeneous. As the Galilean transformations make a group in the 3-space, so the Lorentz transformations make a group in the 4-space. This is a great mathematical advantage and the four-dimensional mathematical apparatus developed by Minkowski has been an enormous help in the investigation of high-velocity physical phenomena.

In our absolute space–time theory we work intensively with the four-dimensional mathematical formalism of Minkowski, keeping always in mind that the fourth dimension is not a time axis, but a length axis along which the time coordinates are multiplied by the velocity of light, and here the apparent absoluteness of the light velocity is always connected with the relativity of the time coordinates. As a matter of fact, the time coordinates are absolute and light velocity relative, as in the Marinov transformation and as we have shown by the help of numerous experiments.[8]

We must note and emphasize that if experiments are set up where only electromagnetic phenomena are involved, then the principle of relativity apparently holds because of the mutual cancellation of the absolute effects that appear. This principle breaks down only for experiments where combined electromagnetic and mechanical phenomena are involved, as is the case with our "coupled-mirrors" experiment[1,2] and Briscoe's ultrasonic "coupled-transmitters" experiment.[9]

6. THE MARINOV TRANSFORMATION

To obtain a transformation of the space and time coordinates adequate to physical reality we shall proceed from our tenth axiom, noting that now we shall not take into account the influence of the gravitating masses on the rate of the light clocks, which problem was considered in Ref. 6.

Thus according to the tenth axiom:

(a) Light clocks with equal "arms" have the same rate, independent of the orientation of their "arms."

(b) In any frame the time unit is to be defined by the period of light clocks with equal "arms," independent of the velocity of the frame.

As we have shown in Section 2, the first assertion drastically contradicts the traditional Newtonian conceptions. The second assertion represents no such drastic contradiction, because in the framework of the traditional Newtonian space–time conceptions one can also define the time unit in any inertial frame by the period of light clocks with equal "arms." However, in the traditional Newtonian framework, the inconvenience exists that one has further to define that the "arms" of the light clocks must always make the same angle with the velocity of the inertial frame used—for example, their "arms" must be perpendicular to this velocity. In such a manner the absolute time dilation phenomenon will be introduced also into the traditional Newtonian theory. Thus, at first glance, it seems that the second assertion has not such a "natural" character as the first one and represents only a stipulation. However, it turns out that not only do the periods of light clocks become greater when they move with greater velocity in absolute space (we repeat, a phenomenon which exists also in the traditional Newtonian theory), but so do the periods of many other physical processes (the periods of atomic clocks, the mean lives of decaying elementary particles). So far there is no experimental evidence permitting one to assert that the period of any system (say, the period of a spring clock, the pulse of a man) becomes greater with the increase of its absolute velocity. This problem needs additional theoretical and experimental investigation. At any rate, we think the statement about the time dilation is to be considered not as a stipulation but as an axiomatical assertion alien to the traditional Newtonian theory.

Let us find first how the Galilean transformation formulas are to be written if one assumes that in any inertial frame the time unit is to be defined by the period of light clocks with equal "arms," supposing for definiteness that the "arms" of the light clocks must be always perpendicular to the absolute velocities of the frames.

The period of an absolute light clock with "arm" equal to d is given by formula (1). The period T_0 of a proper light clock with the same "arm" and which moves at velocity V (we repeat, V is assumed to be perpendicular to the "arm") will be given by formula (3), where we have to write $T_\perp = T_0$.

If (at an appropriate choice of d) we choose T as a time unit in frame K (called an *absolute second*) and T_0 as a time unit in frame K' (called a *proper second*), then it is clear that when between two events, t absolute seconds and t_0 proper seconds have elapsed, the relation between them will be

$$t_0/t = T/T_0 = (1 - V^2/c^2)^{1/2} \tag{19}$$

where T and T_0 are measured in the *same* time units (absolute or proper). Under this stipulation we shall obtain from (7) and (19)

$$\mathbf{V}_0 = \frac{\mathbf{V}}{(1 - V^2/c^2)^{1/2}}, \qquad \mathbf{V} = \frac{\mathbf{V}_0}{(1 - V_0^2/c^2)^{1/2}} \tag{20}$$

Formulas (8), to which we attach the relations (19) and (20), represent the direct and inverse homogeneous *relativistic Galilean transformation.*

In these formulas, $\mathbf{V}$ is the velocity of frame K' with respect to absolute space (i.e., to frame K) measured in absolute seconds (called the *absolute* *transient velocity*), $\mathbf{V}_0$ is the same velocity measured in proper seconds (called the *proper transient* velocity), and c is the velocity of light along the "arm" of the absolute clock measured in absolute seconds, as well as along the "arm" of the proper clock measured in proper seconds.

If, on proceeding from the traditional Newtonian conceptions, one would come to the result that a transverse and a longitudinal light clock would have the same rate, then a transformation of the space and time coordinates adequate to physical reality, at the assumption of the time dilation dogma, would be given by the relativistic Galilean transformation. However, the traditional Newtonian conceptions lead to the conclusion that a transverse and a longitudinal light clock have different rates (see Section 2). On the other hand, experiments (the historic Michelson–Morley experiment was the first) have shown that the rates of a transverse and a longitudinal light clock are equal. We have assumed this empirical fact as an axiomatical assertion, *without trying to explain why Nature is made in such a manner.* The introduction of this axiomatical (empirical) assertion into the Galilean transformation leads to the Marinov transformation.

This is to be done in the following manner: Exactly in the same way as in Section 5, we come to the conclusion that if we wish to meet the requirement of our tenth axiom about the independence of the light clock's rate on the orientation of the clock's "arm," the transformation between the radius vectors $\mathbf{r}$ and $\mathbf{r}'$ is to be written in the form (14). To obtain the inverse transformation we proceed from the formula [see (12)]

$$\mathbf{r} = \mathbf{r}_\perp + \mathbf{r}_\parallel = \mathbf{r}_\perp' + \mathbf{r}_\parallel'(1 - V^2/c^2)^{1/2} + \mathbf{V}t \tag{21}$$

This formula, written in such a manner that only the relative radius vector $\mathbf{r}'$ is represented, but not its perpendicular and parallel components $\mathbf{r}_\perp'$ and $\mathbf{r}_\parallel'$, has the form

$$\mathbf{r} = \mathbf{r}' + \{[(1 - V^2/c^2)^{1/2} - 1]\mathbf{r}' \cdot \mathbf{V}/V^2 + t\}\mathbf{V} \tag{22}$$

From formulas (14) and (22), in a manner similar to that used in Section 5, we obtain formula (19).

Let us combine formulas (14) and (19), and then formulas (22) and (19), expressing in both last formulas $\mathbf{V}$ through $\mathbf{V}_0$ according to the second relation (20):

$$\mathbf{r}' = \mathbf{r} + \left\{\left[\frac{1}{(1 - V^2/c^2)^{1/2}} - 1\right]\frac{\mathbf{r} \cdot \mathbf{V}}{V^2} - \frac{t}{(1 - V^2/c^2)^{1/2}}\right\}\mathbf{V} \tag{23}$$

$$t_0 = t(1 - V^2/c^2)^{1/2}$$

$$\mathbf{r} = \mathbf{r}' + \left\{\left[\frac{1}{(1 + V_0^2/c^2)^{1/2}} - 1\right]\frac{\mathbf{r}' \cdot \mathbf{V}_0}{V_0^2} + t_0\right\}\mathbf{V}_0 \tag{24}$$

$$t = t_0(1 + V_0^2/c^2)^{1/2}$$

Formulas (23) represent the direct, and formulas (24) the inverse, homogeneous *Marinov transformation.*

Let us now obtain the Marinov transformation formulas for velocities. Writing in the first formulas (23) and (24) $d\mathbf{r}$, dt, $d\mathbf{r}'$, dt_0 instead of $\mathbf{r}$, t, $\mathbf{r}'$, t_0, dividing them by dt, and introducing the notations $\mathbf{v} = d\mathbf{r}/dt$, $\mathbf{v}' = d\mathbf{r}'/dt$, we obtain

$$\mathbf{v}' = \mathbf{v} + \left\{\left[\frac{1}{(1 - V^2/c^2)^{1/2}} - 1\right]\frac{\mathbf{v}\cdot\mathbf{V}}{V^2} - \frac{1}{(1 - V^2/c^2)^{1/2}}\right\}\mathbf{V} \tag{25}$$

$$\mathbf{v} = \mathbf{v}' + \left\{\left[\left(1 - \frac{V^2}{c^2}\right)^{1/2} - 1\right]\frac{\mathbf{v}'\cdot\mathbf{V}}{V^2} + 1\right\}\mathbf{V} \tag{26}$$

The velocities $\mathbf{v}$ and $\mathbf{v}'$ are measured in absolute time. Thus v must be called the *absolute absolute velocity* (as a rule, the first adjective "absolute" will be omitted) and v' the *absolute relative velocity* (as a rule, the adjective "absolute" will be omitted). For this reason we have written in (26) the absolute transient velocity $\mathbf{V}$ and not the proper transient velocity $\mathbf{V}_0$. Formula (25) represents the direct and formula (26) the inverse Marinov transformation for velocities written in *absolute time.*

Writing in the first formulas (23) and (24) $d\mathbf{r}$, dt, $d\mathbf{r}'$, dt_0 instead of $\mathbf{r}$, t, $\mathbf{r}'$, t_0, dividing them by dt_0, and introducing the notations $\mathbf{v}_0 = d\mathbf{r}/dt_0$ for the *proper absolute velocity* and $\mathbf{v}_0' = d\mathbf{r}'/dt_0$ for the *proper relative velocity,* we can obtain the Marinov transformation for velocities written in *proper time.*

One also can write the transformation formulas for velocities in which the relative velocity is expressed in proper time and the absolute velocity in absolute time. This will be the Marinov transformation for velocities written in *mixed time.*

Now we shall write the transformation formulas for the velocities' magnitudes. Denoting the angle between $\mathbf{v}$ and $\mathbf{V}$ by θ and the angle between $\mathbf{v}'$ and $\mathbf{V}$ by θ', we can write formulas (25) and (26) in the following form, after having squared them:

$$(v')^2 = \frac{v^2[1 - V^2(\sin^2\theta)/c^2] - 2vV\cos\theta + V^2}{1 - V^2/c^2} \tag{27}$$

$$v^2 = (v')^2\,[1 - V^2(\cos^2\theta')/c^2] + 2v'V(\cos\theta')(1 - V^2/c^2)^{1/2} + V^2 \tag{28}$$

If we suppose $v = c$ and if we write $v' = c'$, where c' is the relative light velocity measured in absolute time, i.e., the absolute relative light velocity, then these two equations (the second after a solution of a quadratic equation with respect to v') give

$$c' = c\,\frac{1 - V(\cos\theta)/c}{(1 - V^2/c^2)^{1/2}} = c\,\frac{(1 - V^2/c^2)^{1/2}}{1 + V(\cos\theta')/c} \tag{29}$$

If we denote by c_0' the proper relative light velocity, then its connection with the absolute absolute light velocity c will be

$$c_0' = c\,\frac{1 - V(\cos\theta)/c}{1 - V^2/c^2} = \frac{c}{1 + V(\cos\theta')/c} \tag{30}$$

and its connection with the proper absolute light velocity

$$c_0 = \frac{c}{(1 - V^2/c^2)^{1/2}} \tag{31}$$

will be the same as that given by formula (29).

Note that the velocities with respect to the moving frame K' are called relative, while the clocks attached to K' are called proper. On the other hand, the velocities with respect to the rest frame K are called absolute and the clocks attached to K are also called absolute. To have in the second case a terminological difference similar to that in the first case we have considered calling the absolute clock and absolute time "universal." However, finally we decided to use a single word, even though this might sometimes lead to misunderstanding, because of the confusion in using too many different terms.

We designate the relative quantities by superscripts (primes) and the proper quantities by subscripts (zeros). For this reason, in the Lorentz transformation (where time is relative), we designate the relative time coordinates by superscripts (primes) and in the Marinov transformation (where time is absolute) we designate the proper time coordinates by subscripts (zeros).

The distances are always absolute. However, the aether-Marinov character of light propagation leads to the introduction of the notion "proper distance." The problem about the eternal contradiction between proper distances and distances is considered in detail in Ref. 7. Here we must again repeat that the absolute and proper time intervals are *physically different quantities*, while the difference between proper distances and distances is only a *contradictory mathematical result* which appears because of the aether-Marinov character of light propagation engendered by the bidirectional light velocity isotropy in any inertial frame.

7. GROUP PROPERTIES OF THE MARINOV TRANSFORMATION

After a due examination of the Marinov transformations, it can easily be established that they form a group. As the mathematical analysis in the general case is too cumbersome, we shall suppose, for simplicity's sake, that the velocities of the different frames and their x axes are parallel to the x axis of the rest (absolute) frame. Since in this simple case the y and z coordinates are subjected to an identical transformation, we shall ignore them.

From formulas (23) we obtain the following direct transformation between the coordinates (x, t) in the absolute frame K and the coordinates (x_2, t_2) in a proper frame K_2 moving with a velocity V_2 $(V_2 \gtrless 0)$ along the positive direction of the x axis:

$$x_2 = (x - V_2 t)/(1 - V_2^2/c^2)^{1/2}, \qquad t_2 = t(1 - V_2^2/c^2)^{1/2} \tag{32}$$

The inverse transformation between the coordinates (x_1, t_1) in a proper frame K_1 moving with velocity V_1 $(V_1 \gtrless 0)$ along the positive direction of the x axis of the rest frame K and the coordinates (x, t) in K, according to formulas (24) [see also formulas (20)], is

$$x = x_1 \left(1 - \frac{V_1^2}{c^2}\right)^{1/2} + \frac{V_1 t_1}{(1 - V_1^2/c^2)^{1/2}}, \qquad t = \frac{t_1}{(1 - V_1^2/c^2)^{1/2}} \tag{33}$$

where the velocities V_1 and V_2 are measured in absolute time.

Substituting formulas (33) into formulas (32), we can express the coordinates in frame K_2 through the coordinates in frame K_1:

$$\begin{aligned} x_2 &= x_1 \left(\frac{1 - V_1^2/c^2}{1 - V_2^2/c^2}\right)^{1/2} + t_1 \frac{V_1 - V_2}{(1 - V_1^2/c^2)^{1/2}(1 - V_2^2/c^2)^{1/2}} \\ t_2 &= t_1 \left(\frac{1 - V_2^2/c^2}{1 - V_1^2/c^2}\right)^{1/2} \end{aligned} \tag{34}$$

These formulas are absolutely symmetric with respect to the coordinates in both frames. Now we shall prove that these transformations form a group.

A set of transformations T_{12}, T_{23}, T_{34},... form a group if it has the following properties:

1. *Transitive property*: The product of two transformations of the set is equivalent to a member of the set, the product

$$T_{13} = T_{12} T_{23} \tag{35}$$

being defined as performing T_{12} and T_{23} successively.

If formulas (34) give a transformation T_{12}, a transformation T_{23} will have the same form in which the number 1 is replaced by 2 and the number 2 by 3. Substituting formulas (34) for the transformation T_{12} into the corresponding formulas for the transformation T_{23}, we obtain a transformation T_{13} which has the same form as (34) in which the number 2 is replaced by 3.

Thus the transitive property is proved. Let us mention here that the transitive property for the Lorentz and Galilean transformations can be proved only if one takes into account the corresponding transformation for velocities. The transitive property for the Marinov transformation is proved *directly*, i.e., without taking into account the transformation for velocities.

2. *Identity property*: The set includes one "identity" transformation T_{ii} whose product with any other member of the set leaves the latter unchanged. Thus

$$T_{12}T_{22} = T_{11}T_{12} = T_{12} \tag{36}$$

The identity form of the transformation (34) occurs for $V_1 = V_2$.

3. *Reciprocal property*: Every member of the set has a unique reciprocal (or inverse) which is also a member of the set. Thus the inverse of T_{12} is T_{21}, where T_{21} is a member of the set and

$$T_{12}T_{21} = T_{11} \tag{37}$$

The reciprocal of the transformation (34) can be obtained by writing the number 2 instead of 1 and vice versa.

4. *Associative property*: If three succeeding transformations are performed, then

$$T_{12}(T_{23}T_{34}) = (T_{12}T_{23})T_{34} \tag{38}$$

The associative property can easily be proved.

8. CONCLUSIONS

In the light of the experimental demonstration of the anisotropy of the unidirectional light velocity performed recently by us,[1–4] we have shown how the Lorentz transformation is to be treated from an absolute point of view, if one seeks to preserve its adequacy to physical reality. The seeming constancy of light velocity appearing in the Lorentz transformation is due to the introduction of space coordinates in the transformation formulas for time. In the Lorentz transformation the space as well as the time coordinates are relative quantities, while light velocity is an absolute quantity. We propose the Marinov transformation where the time coordinates are absolute quantities and light velocity is a relative quantity and we assert that this transformation is adequate to physical reality.

In Ref. 7 we have shown that the Einstein time synchronization leads to the Lorentz transformation, while the Newtonian time synchronization leads to the Galilean transformation. The second assertion is true only within an accuracy of first order in V/c. Within an accuracy of second order in V/c the Newtonian time synchronization leads to the Marinov transformation, and this is due to the aether-Marinov character of light propagation.

We have found difficulties in considering the Marinov transformation in a 4-space. In our opinion the Lorentz transformation is much more convenient and productive, so that the Marinov transformation only helps us when treating the Lorentz tiansformation from an absolute point of view, i.e., adequately to physical reality. We hope that future investigations will throw more light on the essence of the Lorentz and Marinov transformations, which are simply two companions.

REFERENCES

1. S. Marinov, *Czech. J. Phys.* **B24**, 965 (1974).
2. S. Marinov, *Int. J. Paraphys.* **11**, 26 (1977).
3. S. Marinov, *Phys. Lett.* **54A**, 19 (1975).
4. S. Marinov, *Found. Phys.* **8**, 137 (1978).
5. S. Marinov, *Int. J. Theor. Phys.* **9**, 139 (1974).
6. S. Marinov, *Found. Phys.* **6**, 571 (1976).
7. S. Marinov, *Int. J. Theor. Phys.* **13**, 189 (1975).
8. S. Marinov, *Eppur si muove* Centre Belge de Documentation Scientifique Bruxelles (1977).
9. J. A. Briscoe, British patent, London, No. 15089/58-884830, Application date 12 May 1958.