Inconsistency of Lorentz Transformation and Maxwell Equations

Zhihao Geng

Department of Physics, Beijing University of Chemical Technology, Beijing 100029, China

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Abstract

We show the Lorentz transformation and the electromagnetic field transformation will give inconsistent results under the sequential space-time transformation with direction changed. We indicate the self-consistency demands the matrixes of space-time transformation should not only form a group but also meet the commutative law of multiplication, while the Lorentz transformation does not fully meet this requirement. It is proved the inconsistency comes from that the postulate of the constancy of the speed of light is incompatible with the postulate that the space and time are homogeneous and isotropic. We propose a self-consistent 6-dimensional space-time model to solve this problem. This model shows time should have properties and the relativistic effects of both space and time only happen in the direction of relative movement. The 4-dimensional space-time can be regarded as one time scale approximation of the 6-dimensional space-time. Based on this, the 6-dimensional electromagnetic field equations are proposed. We imply no previous experiment has yet been able to reveal the failing, and more direct experimental verifications are needed.

I. INTRODUCTION

Due to the birth of special relativity [1], the inertial reference system transformation of Maxwell equations has solid theoretical description [1–3]. The electromagnetic fields can be defined by the 4-dimensional potential, which also meets the Lorentz transformation [4, 5]. So the basic formula is the Lorentz transformation based on the 4-dimensional Minkowski space. As a theory with a history of over one hundred years, the special relativity is believed to have incontrovertible logical consistency, especially it is known the Lorentz transformation can form the Lorentz group with $\det L = 1$, L represents the transformation matrix. One rarely discussed feature of the Lorentz transformation is the Lorentz matrixes in different relative directions do not meet the commutative law of multiplication. It may be believed this is just a doubtless natural feature which needs not to be investigated. However, the multiplication of Lorentz matrixes in different relative directions corresponds to the sequential space-time transformation with direction changed. Since they are not commutative, we conjecture the non-commutative characteristic may lead to the path dependence for the continuous rotation in the 4-dimensional Minkowski space, this may cause some unusual results which needs to be verified.

Although many experimental evidences have supported the special relativity [6–15], rarely corresponding experiments have ever thoroughly revealed the non-commutative behavior. A similar example can be found about the early analysis of anomalous Zeeman effects [16, 17]. It is discussed the relativistic effects of the sequential space-time transformation of three reference systems with direction changed will cause the Thomas precession [16–18]. The Thomas precession is usually explained as, supposing there are three inertial reference systems K, K' and K'', if the relative velocity between K and K' is perpendicular to the relative velocity between K' and K'', meanwhile the axes of K are parallel to the axes of K' and the axes of K' are parallel to the axes of K'', then the axes of K'' will not be parallel to the axes of K, but have a rotation. The rotation seems weird as we can recall how the Lorentz transformation is derived. The initial state presumption about the derivation of Lorentz transformation is the axes of two inertial reference systems coincide with each other and the times are all set to zero. So how could it be possible that if the axes of K coincide with the axes of K' and the axes of K' coincide with the axes of K'', while the axes of K'' do not coincide with the axes of K, but have an inclination. The seemly confliction indicates whether the non-commutative behavior could really cause some inconsistent results.

II. SEQUENTIAL LORENTZ TRANSFORMATION AND ELECTROMAGNETIC FIELDS TRANSFORMATION WITH DIRECTION CHANGED

Motivated by this, we need to calculate concrete examples to investigate the behavior of sequential transformation with direction changed. It is easy to calculate the following cases. First, we assume there are two inertial reference systems named K and K', and K' moves along the x axis of K with relative velocity v measured in K, as shown in Fig.1(a).

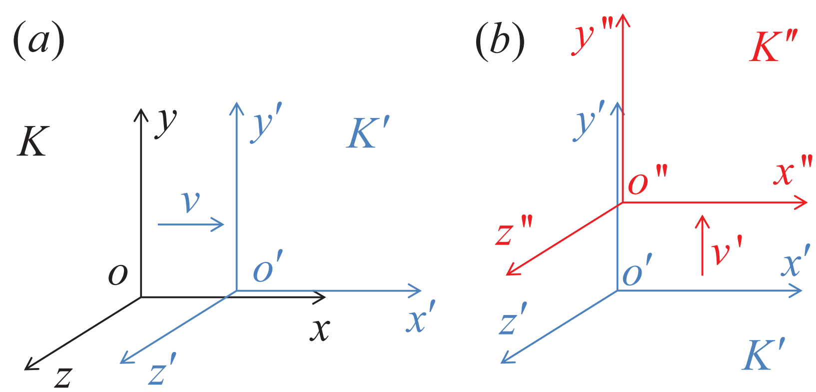

FIG. 1. (a)Inertial reference system K' moves along the x axis of inertial reference system K with relative velocity v measured in K. (b)Inertial reference system K'' moves along the y' axis of inertial reference system K' with relative velocity v' measured in K'.

The space-time transformation between K and K' can be written with $\beta = v/c$ and $\gamma = 1/\sqrt{1-\beta^2}$ as

$$\begin{pmatrix} x' \\ y' \\ z' \\ ct' \end{pmatrix} = L_x(v) \begin{pmatrix} x \\ y \\ z \\ ct \end{pmatrix}, \quad L_x(v) = \begin{pmatrix} \gamma & 0 & 0 & -\gamma\beta \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\gamma\beta & 0 & 0 & \gamma \end{pmatrix} \tag{1}$$

Regardless of K, we can further assume there is a third inertial reference system named K'', and K'' moves along the y' axis of K' with relative velocity $v' = \gamma v$ measured in K', as shown in Fig.1(b). Then, the space-time transformation between K' and K'' can be obtained with $\beta' = v'/c$ and $\gamma' = 1/\sqrt{1-\beta'^2}$ as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ ct'' \end{pmatrix} = L_y(v') \begin{pmatrix} x' \\ y' \\ z' \\ ct' \end{pmatrix}, \quad L_y(v') = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \gamma' & 0 & -\gamma'\beta' \\ 0 & 0 & 1 & 0 \\ 0 & -\gamma'\beta' & 0 & \gamma' \end{pmatrix} \tag{2}$$

According to the Lorentz velocity transformation between K and K', K'' 's velocity $(0, v', 0)$ measured in K' can be transformed into the velocity $(v, v, 0)$ measured in K. This ensures every point of the reference frame K'' has the same velocity $(v, v, 0)$ in K, there is no additional velocity, so no rotational motion exists between K and K''. Besides, the initial state is the axes of K, K' and K'' are all coincident and the times are all taken as $t = t' = t'' = 0$. This means at the starting point K'' coincide with K, then K'' moves straight forward in the diagonal direction of $x - y$ plane in K. Following the sequential transformation $K'' \to K' \to K$, the space-time transformation between K'' and K can be obtained by the multiplication $L_y(v')L_x(v)$ as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ ct'' \end{pmatrix} = \begin{pmatrix} \gamma & 0 & 0 & -\gamma\beta \\ \gamma\gamma'\beta\beta' & \gamma' & 0 & -\gamma\gamma'\beta' \\ 0 & 0 & 1 & 0 \\ -\gamma\gamma'\beta & -\gamma'\beta' & 0 & \gamma\gamma' \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ ct \end{pmatrix} \tag{3}$$

The final transformation matrix in Eq.(3) has no symmetry. This seems unreasonable, as K'' moves in the diagonal direction of $x - y$ plane in K, at least, the matrix should be symmetric by exchanging x and y components. However, the example is so simple that no mistake can be found in the derivation. It can be noticed that the above calculation refers to the multiplication of Lorentz matrixes in different directions. Considering the non-commutative behavior of Lorentz matrixes, we can do the mirror symmetry operation of the Fig.1 along the diagonal direction of $x - y$ plane in K, and calculate the second case for comparison, which corresponds to the result of exchanging matrixes. So for the second case, the relative moving directions between K, K' and K'' are arranged as in Fig.2.

The initial state is also the axes of three systems are all coincident and the times are taken as zero. Obviously, the velocity $(v', 0, 0)$ of K'' measured in K' can ensure K'' still moves with velocity $(v, v, 0)$ in the diagonal direction of $x - y$ plane in K. So the only difference between Fig.1 and Fig.2 is the different intermediate reference K'. Now following

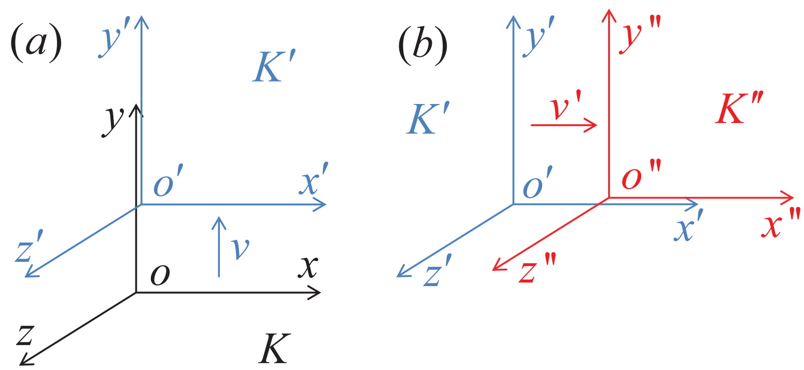

FIG. 2. (a)Inertial reference system K' moves along the y axis of inertial reference system K with relative velocity v measured in K. (b)Inertial reference system K'' moves along the x' axis of inertial reference system K' with relative velocity v' measured in K'.

the same process $K'' \rightarrow K' \rightarrow K$, the space-time transformation between K'' and K in this case can be obtained by the multiplication $L_x(v')L_y(v)$ as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ ct'' \end{pmatrix} = \begin{pmatrix} \gamma' & \gamma\gamma'\beta\beta' & 0 & -\gamma\gamma'\beta' \\ 0 & \gamma & 0 & -\gamma\beta \\ 0 & 0 & 1 & 0 \\ -\gamma'\beta' & -\gamma\gamma'\beta & 0 & \gamma\gamma' \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ ct \end{pmatrix} \tag{4}$$

The strange conclusion comes by comparing Eq.(3) and Eq.(4), the space-time transformation matrixes for the two cases are not equal. However, the K and K'' in the two cases are the same, they have the same initial state and the same relative velocity $(v, v, 0)$, the same K and K'' should have a unique transformation matrix. The results indicates the non-commutative characteristic of Lorentz matrixes can cause inconsistent results. This inconsistency is different from the previous alleged paradoxes [19–22]. The previous paradoxes are just the discrepancy of misunderstandings of space-time, while in the above derivations we only rely on the Lorentz transformation and did not introduce any additional assumption that may cause the misleading judgment. The transformation between K and K' regardless of K'' and the transformation between K' and K'' regardless of K all satisfy the condition of Lorentz transformation. We cannot find an appropriate reason to deny the derivation.

As we known, the Lorentz transformation comes from the study of inertial reference system transformation of Maxwell equations [2, 3]. So to verify the existence of contradiction, we can further check whether the transformation of electromagnetic fields can lead to the same inconsistency. In the following discussions, we take the Heaviside-Lorentz units for the convenient expression of transformation. It can be found if K' moves along the x-axes of K with velocity v as shown in Fig.1(a), the transformation of electromagnetic fields between K and K' can be written in the matrix form as [5, 23]

$$\begin{pmatrix} B'_x \\ B'_y \\ B'_z \\ E'_x \\ E'_y \\ E'_z \end{pmatrix} = M_x(v) \begin{pmatrix} B_x \\ B_y \\ B_z \\ E_x \\ E_y \\ E_z \end{pmatrix}, \quad M_x(v) = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & \gamma & 0 & 0 & 0 & \gamma\beta \\ 0 & 0 & \gamma & 0 & -\gamma\beta & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & -\gamma\beta & 0 & \gamma & 0 \\ 0 & \gamma\beta & 0 & 0 & 0 & \gamma \end{pmatrix} \tag{5}$$

If K'' moves along the y-axes of K' with velocity v' as shown in Fig.1(b), the electromagnetic field transformation between K'' and K' is

$$\begin{pmatrix} B''_x \\ B''_y \\ B''_z \\ E''_x \\ E''_y \\ E''_z \end{pmatrix} = M_y(v') \begin{pmatrix} B'_x \\ B'_y \\ B'_z \\ E'_x \\ E'_y \\ E'_z \end{pmatrix}, \quad M_y(v') = \begin{pmatrix} \gamma' & 0 & 0 & 0 & 0 & -\gamma'\beta' \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & \gamma' & \gamma'\beta' & 0 & 0 \\ 0 & 0 & \gamma'\beta' & \gamma' & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ -\gamma'\beta' & 0 & 0 & 0 & 0 & \gamma' \end{pmatrix} \tag{6}$$

So for the first case that the three systems are arranged as in Fig.1, we follow the sequence $K'' \to K' \to K$, the final transformation of electromagnetic fields between K'' and K can be obtained by the multiplication $M_y(v')M_x(v)$ as

$$\begin{pmatrix} B''_x \\ B''_y \\ B''_z \\ E''_x \\ E''_y \\ E''_z \end{pmatrix} = \begin{pmatrix} \gamma' & -\gamma\gamma'\beta\beta' & 0 & 0 & 0 & -\gamma\gamma'\beta' \\ 0 & \gamma & 0 & 0 & 0 & \gamma\beta \\ 0 & 0 & \gamma\gamma' & \gamma'\beta' & -\gamma\gamma'\beta & 0 \\ 0 & 0 & \gamma\gamma'\beta' & \gamma' & -\gamma\gamma'\beta\beta' & 0 \\ 0 & 0 & -\gamma\beta & 0 & \gamma & 0 \\ -\gamma'\beta' & \gamma\gamma'\beta & 0 & 0 & 0 & \gamma\gamma' \end{pmatrix} \begin{pmatrix} B_x \\ B_y \\ B_z \\ E_x \\ E_y \\ E_z \end{pmatrix} \tag{7}$$

For the second case shown in Fig.2, based on the process $K'' \to K' \to K$, the final transformation of electromagnetic fields between K'' and K can be obtained by the multiplication

$M_x(v')M_y(v)$ as

$$\begin{pmatrix} B''_x \\ B''_y \\ B''_z \\ E''_x \\ E''_y \\ E''_z \end{pmatrix} = \begin{pmatrix} \gamma & 0 & 0 & 0 & 0 & -\gamma\beta \\ -\gamma\gamma'\beta\beta' & \gamma' & 0 & 0 & 0 & \gamma\gamma'\beta' \\ 0 & 0 & \gamma\gamma' & \gamma\gamma'\beta & -\gamma'\beta' & 0 \\ 0 & 0 & \gamma\beta & \gamma & 0 & 0 \\ 0 & 0 & -\gamma\gamma'\beta' & -\gamma\gamma'\beta\beta' & \gamma' & 0 \\ -\gamma\gamma'\beta & \gamma'\beta' & 0 & 0 & 0 & \gamma\gamma' \end{pmatrix} \begin{pmatrix} B_x \\ B_y \\ B_z \\ E_x \\ E_y \\ E_z \end{pmatrix} \tag{8}$$

Comparing Eq.(7) and Eq.(8), the final transformation matrixes for the two cases are also contradictory. This is predictable as the electromagnetic fields can be defined by the 4-dimensional potential $(A_x, A_y, A_z, i\varphi)$. We know the potential meets the same Lorentz transformation as space-time, so they will show the same inconsistent or self-consistent behavior. However, this contradiction is not about the understanding of space-time but about the regarded experimental measurable electric field and magnetic field. The verifiable discrepancy about the measurable quantities is completely unacceptable.

The question is no one can deny the derivation of Lorentz transformation, but why the Lorentz transformation could finally fall into the inconsistent situation. We speculate this may only happen if there is some defect about the postulates of special relativity which we have not realized. It is believed the special relativity is only based on two postulates [1], the first postulate is the principle of relativity, and the second postulate is the constancy of the speed of light. From the perspective of the derivation of Lorentz transformation, if two inertial reference systems move along the x axes with relative velocity v, the space-time transformation can be derived by the rotation of $x-t$ plane in the 4-dimensional Minkowski space [5, 26, 27]. However, we think the two postulates do not restrict the space-time must be 4-dimensional. As expressed by Pauli "This also implies the validity of Euclidean geometry and the homogeneous nature of space and time" [Ref [4], Part I, section 4], so we think the derivation of Lorentz transformation actually introduces a third postulate, that is space and time are homogeneous and isotropic. Since the two postulates have solid experimental basis [7, 15], so logically, the inconsistency may arise from the employment of the 4-dimensional Minkowski space. This means the defect may come from whether the third postulate is really compatible with the two postulates.

III. INCOMPATIBILITY BETWEEN THE SECOND POSTULATE AND THE THIRD POSTULATE

Next, we prove the the third postulate is incompatible with the second postulate. In order to demonstrate the incompatibility, we can suppose we only have the first postulate and the third postulate, and do not know the second postulate. If we can determine the space-time transformation only based on the first postulate and the third postulate, and the derived space-time transformation finally violates the second postulate, then the incompatibility can be confirmed.

First, we assume the inertial reference system K' moves along the x axis of the inertial reference system K with relative velocity v as shown in Fig.3(a).

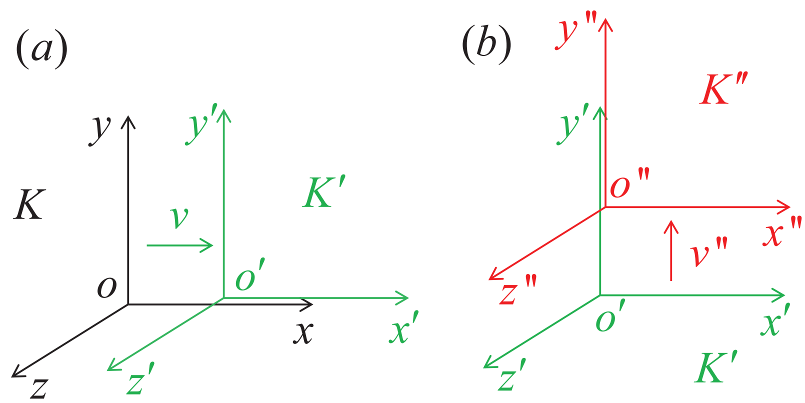

FIG. 3. (a)Inertial reference system K' moves along the x axis of inertial reference system K with relative velocity v measured in K. (b)Inertial reference system K'' moves along the y' axis of inertial reference system K' with relative velocity v'' measured in K'.

Since the third postulate states space and time are homogeneous and isotropic, then the space-time is 4-dimensional. As the relative movement between K and K' is along the x axes, so the space-time transformation can be written as

$$x' = \lambda x - \eta t, \qquad y' = y, \qquad z' = z, \qquad t' = \theta x - \phi t \tag{9}$$

where the coefficient $\lambda, \eta, \theta, \phi$ depend only on the value of the relative velocity v, while their specific forms are unknown yet, as we only have the first postulate and the third postulate, and have no other postulates. Based on this space-time transformation, we can get the velocity transformation between K and K' as

$$v'_x = \frac{\lambda v_x - \eta}{\theta v_x - \phi}, \qquad v'_y = \frac{\lambda v_y}{\theta v_x - \phi}, \qquad v'_z = \frac{\lambda v_z}{\theta v_x - \phi} \tag{10}$$

and also the equivalent expression in reverse as

$$v_x = \frac{\phi v'_x - \eta}{\theta v'_x - \lambda}, \quad v_y = v'_y(\theta \frac{\phi v'_x - \eta}{\theta v'_x - \lambda} - \phi), \quad v_z = v'_z(\theta \frac{\phi v'_x - \eta}{\theta v'_x - \lambda} - \phi) \tag{11}$$

Since the velocity of K' measured in K is v, therefore $v'_x = 0$ corresponds to $v_x = v$. We substitute this in Eq.(11), and find $\eta = \lambda v$. In reverse, the velocity of K measured in K' is $-v$, therefore $v_x = 0$ corresponds to $v'_x = -v$, We substitute this in Eq.(10), and find $\eta = -\phi v$. So $\theta = -\lambda$, thus the space-time transformation can now be written as

$$x' = \lambda(x - vt), \qquad y' = y, \qquad z' = z, \qquad t' = \theta x + \lambda t \tag{12}$$

or in the matrix form as

$$\begin{pmatrix} x' \\ y' \\ z' \\ t' \end{pmatrix} = \begin{pmatrix} \lambda & 0 & 0 & -\lambda v \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \theta & 0 & 0 & \lambda \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ t \end{pmatrix} \tag{13}$$

Besides, we suppose the third inertial reference system K'' moves along the y' axis of K' with relative velocity $v'' = \frac{v}{\theta v + \lambda}$ as shown in Fig.3(b). According to the velocity transformation shown in Eq.(11), the velocity $(0, v'', 0)$ of K'' measured in K' can be transformed into the velocity $(v, v, 0)$ measured in K, so K'' moves in the diagonal direction of $x - y$ plane in K. The space-time transformation between K' and K'' is

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ t'' \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \lambda' & 0 & \lambda' v'' \\ 0 & 0 & 1 & 0 \\ 0 & \theta' & 0 & \lambda' \end{pmatrix} \begin{pmatrix} x' \\ y' \\ z' \\ t' \end{pmatrix} \tag{14}$$

where the coefficient λ', θ' depend only on the value of the relative velocity v''. Then following the process $K'' \to K' \to K$, the space-time transformation between K'' and K in this case can be obtained by combining Eq.(13) and Eq.(14) as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ t'' \end{pmatrix} = \begin{pmatrix} \lambda & 0 & 0 & -\lambda v \\ -\lambda'\theta v'' & \lambda' & 0 & -\lambda\lambda' v'' \\ 0 & 0 & 1 & 0 \\ \lambda'\theta & \theta' & 0 & \lambda\lambda' \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ t \end{pmatrix} \tag{15}$$

In the above case, K'' moves in the diagonal direction of $x-y$ plane in K, then we can do the mirror symmetry operation along the diagonal direction of $x-y$ plane in K, and calculate the second case as shown in Fig.4

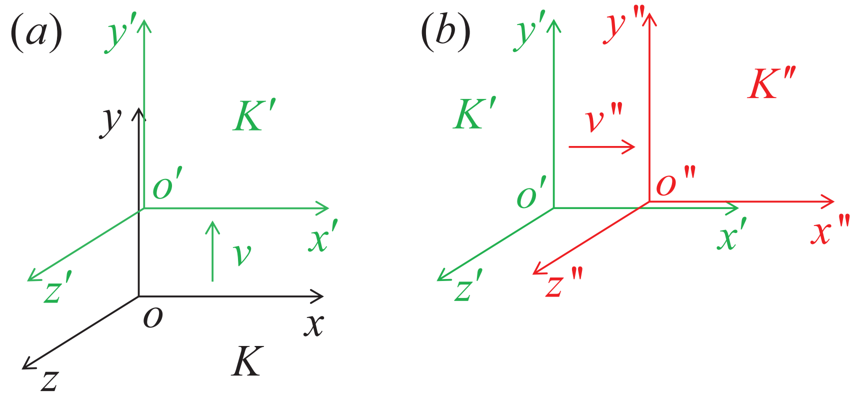

FIG. 4. (a)Inertial reference system K' moves along the y axis of inertial reference system K with relative velocity v measured in K. (b)Inertial reference system K'' moves along the x' axis of inertial reference system K' with relative velocity v'' measured in K'.

So the K'' in Fig4 is the same as the K'' in Fig3. Obviously, the space-time transformation between K' and K in this case can be expressed as

$$\begin{pmatrix} x' \\ y' \\ z' \\ t' \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \lambda & 0 & \lambda v \\ 0 & 0 & 1 & 0 \\ 0 & \theta & 0 & \lambda \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ t \end{pmatrix} \tag{16}$$

The space-time transformation between K'' and K' is

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ t'' \end{pmatrix} = \begin{pmatrix} \lambda' & 0 & 0 & -\lambda' v'' \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \theta' & 0 & 0 & \lambda' \end{pmatrix} \begin{pmatrix} x' \\ y' \\ z' \\ t' \end{pmatrix} \tag{17}$$

Then the space-time transformation between K'' and K now can be given by combining

Eq.(16) and Eq.(17) as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ t'' \end{pmatrix} = \begin{pmatrix} \lambda' & -\lambda'\theta v'' & 0 & -\lambda\lambda' v'' \\ 0 & \lambda & 0 & -\lambda v \\ 0 & 0 & 1 & 0 \\ \theta' & \lambda'\theta & 0 & \lambda\lambda' \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ t \end{pmatrix} \tag{18}$$

Since K and K'' in Fig4 and Fig3 are the same, the self-consistency demands the final transformation matrixes in Eq.(15) and Eq.(18) should be identical. By comparison, we find

$$\theta = \theta' = 0, \qquad \lambda = \lambda' \tag{19}$$

Substituting in Eq.(12), we have $t' = \lambda t$. However in reverse, we should have $t = \lambda t'$ according to the first postulate, so $\lambda = 1$. As a result, we finally find the concrete form of the space-time transformation in Eq.(12) is

$$x' = x - vt, \qquad y' = y, \qquad z' = z, \qquad t' = t \tag{20}$$

This is the Galilean transformation. During the whole derivation, we only rely on the first postulate and the third postulate, the resulting the Galilean transformation violates the second postulate. This means the third postulate is indeed incompatible with the second postulate. Thus, based on the first and second postulates of special relativity, it should be regarded illegal to perform derivations under the third postulate.

IV. 6-DIMENSIONAL SPACE-TIME MODEL

In the above discussions, the key point we could reveal the inconsistency is the process with direction changed. This implies the direction really works and there should be some crucial information about direction lost in the Lorentz transformation. In the Lorentz transformation, only the spatial coordinate axes parallel to the direction of relative movement have relativistic effects, the other spatial axes keep unchanged. However, in the Lorentz velocity transformation, the velocities both perpendicular and parallel to the direction of relative movement all have relativistic effects, because the derivation of velocity needs the time and time is always believed to be changed relatively. Why time must be believed to have the ubiquitous isotropic ability to neglect the direction. Time describes the continuity of movement, suppose the continuity of movement on different directions is independent of each other, we may ask what if time has independent scales on different directions. This means we may doubt why there is always only one time scale except space even though it is relative, or why the space-time is really 4-dimensional rather than other dimensional, especially the 4-dimensional can cause the logical inconsistency here.

So we could propose a possible method to figure out this inconsistency. Since the direction is so important, and the third postulate is incompatible with the second postulate, thus the third postulate should be not obeyed. We could hypothesize time has independent scales on different directions. Then the space-time should be described as the 6-dimensional space-time. In the Cartesian coordinate system, the time scales can be denoted as t_x, t_y and t_z corresponding to directions x, y and z separately. We assume the three time scales can be identical for a static object, that is $t_x = t_y = t_z = t$, hence it seems like there is only one time parameter for the static experimental observer. However, for the transformation of inertial reference systems, the three time scales will behave differently depending on the direction of relative movement. Considering the special Lorentz transformation is regarded as the rotation of $x - t$ plane in the 4-dimensional space-time, which could guarantee the the constancy of the speed of light in the x direction, thus the new space-time transformation under the condition that K' moves along the x axes of K with relative velocity v can be written as

$$\begin{pmatrix} x' \\ y' \\ z' \\ ct'_x \\ ct'_y \\ ct'_z \end{pmatrix} = G_x(v) \begin{pmatrix} x \\ y \\ z \\ ct_x \\ ct_y \\ ct_z \end{pmatrix}, \quad G_x(v) = \begin{pmatrix} \gamma & 0 & 0 & -\gamma\beta & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ -\gamma\beta & 0 & 0 & \gamma & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \tag{21}$$

This can be regarded as the rotation of $x - t_x$ plane in the 6-dimensional space. It can be verified that if the light is propagating in the x direction, the new transformation still keeps the constancy of the speed of light. The new model shows only the time scale t_x along the direction of relative movement is changed relatively, and the time scales t_y and t_z perpendicular to the direction of relative movement remain unchanged like the spatial coordinates y and z. So the effects of relativity on space and time only happen in the direction of relative movement. It can be imagined there are three series of clocks t_x, t_y and t_z along the axes x, y and z separately in each reference system. If we describe some event in K and the three series of clocks of K show simultaneously, while if we describe the same event using clocks t'_x, t'_y and t'_z of K' as how they behave in K, the clocks t'_x, t'_y and t'_z will not look like simultaneously in K, and vice versa. The relationship between the 4-dimensional space-time and the 6-dimensional space-time is the 4×4 matrix in the upper left corner of $G_x(v)$ corresponds to the special Lorentz matrix. So if there are only two inertial reference systems, we only need to consider the transformation in one direction, then $G_x(v)$ can degenerate to the Lorentz matrix. This means the 4-dimensional space-time are just one time scale approximation of the 6-dimensional space-time. Generally, the difference between the two models can only be revealed by the process of the continuous space-time transformation with direction changed, at least three inertial reference systems are needed. The previous experiments which support the special relativity rarely focus on the case about three reference systems [6–15], and only two reference systems are involved. Hence, they can be hold by both of the two models and we have not been able to reveal which model is failing.

We can check further whether the 6-dimensional space-time model is self-consistent for the sequential transformation. First, we should redefine the velocity transformation as

$$v_x = \frac{dx}{dt_x} = \frac{v'_x + v}{1 + \frac{v}{c^2} v'_x}, \quad v_y = \frac{dy}{dt_y} = \frac{dy'}{dt'_y} = v'_y, \quad v_z = \frac{dz}{dt_z} = \frac{dz'}{dt'_z} = v'_z \tag{22}$$

The identities show the velocities v_y and v_z perpendicular to the direction of relative movement keep unchanged, and the transformation of velocity v_x which is along the direction of relative movement is the same as in the Lorentz velocity transformation. Although they are a little different from the previous formulas, they can still be used to explain the experiment by Fizeau [6], as only the transformation of v_x is needed for the explanation. Since no experiment about the sequential transformation with direction changed has ever been made, we have not find definite evidence to deny the new transformation about v_y and v_z. Based on the new velocity transformation, in order to assure K'' still moves in the diagonal direction of $x - y$ plane with velocity $(v, v, 0)$ measured in K, the relative velocities between the three inertial reference systems K, K' and K'' should be reset. For the first case, the three systems are arranged as in Fig.5

The relative velocity between K' and K shown in Fig.5(a) and the relative velocity between K'' and K' shown in Fig.5(b) are both set to v. The space-time transformation between K' and K has been given in Eq.(21), and the transformation between K'' and K'

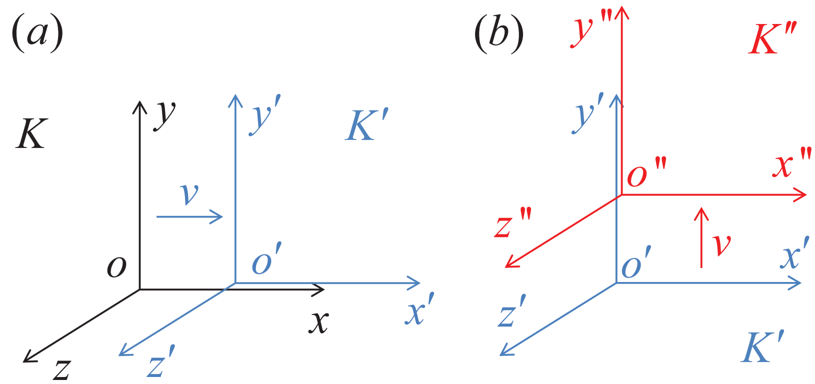

FIG. 5. (a)Inertial reference system K' moves along the x axis of inertial reference system K with relative velocity v measured in K. (b)Inertial reference system K'' moves along the y' axis of inertial reference system K' with relative velocity v measured in K'.

can be found by exchanging x and y components in $G_x(v)$ as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ ct''_x \\ ct''_y \\ ct''_z \end{pmatrix} = G_y(v) \begin{pmatrix} x' \\ y' \\ z' \\ ct'_x \\ ct'_y \\ ct'_z \end{pmatrix}, \quad G_y(v) = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & \gamma & 0 & 0 & -\gamma\beta & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & -\gamma\beta & 0 & 0 & \gamma & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \tag{23}$$

Following the process $K'' \to K' \to K$, the space-time transformation between K'' and K can be given by the multiplication $G_y(v)G_x(v)$ as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ ct''_x \\ ct''_y \\ ct''_z \end{pmatrix} = \begin{pmatrix} \gamma & 0 & 0 & -\gamma\beta & 0 & 0 \\ 0 & \gamma & 0 & 0 & -\gamma\beta & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ -\gamma\beta & 0 & 0 & \gamma & 0 & 0 \\ 0 & -\gamma\beta & 0 & 0 & \gamma & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ ct_x \\ ct_y \\ ct_z \end{pmatrix} \tag{24}$$

For the second case, we just need to change the moving direction of K' as shown in Fig. 6.

This arrangement in Fig. 6 still guarantees K'' moves in the diagonal direction of $x-y$ plane with relative velocity $(v, v, 0)$ measured in K. Then following the process $K'' \to K' \to$

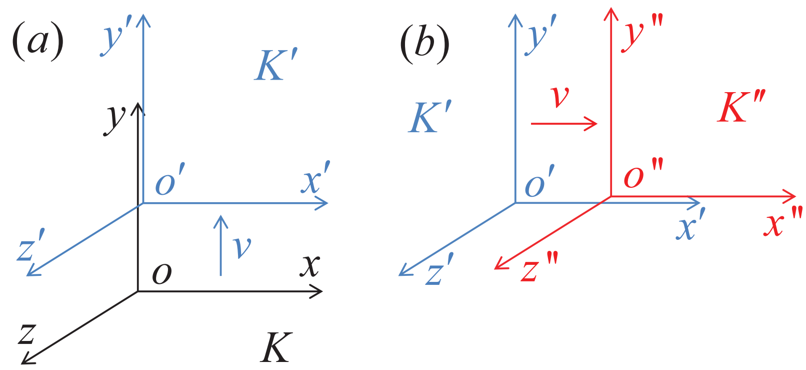

FIG. 6. (a)Inertial reference system K' moves along the y axis of inertial reference system K with relative velocity v measured in K. (b)Inertial reference system K'' moves along the x' axis of inertial reference system K' with relative velocity v measured in K'.

K, the space-time transformation between K'' and K in this case can be obtained by the multiplication $G_x(v)G_y(v)$ as

$$\begin{pmatrix} x'' \\ y'' \\ z'' \\ ct''_x \\ ct''_y \\ ct''_z \end{pmatrix} = \begin{pmatrix} \gamma & 0 & 0 & -\gamma\beta & 0 & 0 \\ 0 & \gamma & 0 & 0 & -\gamma\beta & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ -\gamma\beta & 0 & 0 & \gamma & 0 & 0 \\ 0 & -\gamma\beta & 0 & 0 & \gamma & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ ct_x \\ ct_y \\ ct_z \end{pmatrix} \tag{25}$$

Comparing the Eq.(24) and Eq.(25), the final results are the same, so the inconsistency disappears. The final matrix seems more reasonable as it is symmetric by exchanging x and y components. Surely the same K'' and K should have a unique space-time transformation matrix, the cost is time has independent scales on different directions. A significant feature can be noticed that the new space-time transformation matrices in different directions meet the commutative law of multiplication, such as $G_x(v)G_y(v) = G_y(v)G_x(v)$, which is completely different from the Lorentz transformation. This confirms our conjecture that the non-commutative characteristic will lead to inconsistency, here the commutative characteristic lead to self-consistency, as it ensures the space-time transformation for two inertial reference systems is irrelevant to the different choice of the intermediate reference system and has a unique solution. Generally, if K' has relative velocity (v_1, v_2, v_3) measured in K, the space-time transformation between K' and K can be given with $\beta_1 = v_1/c$, $\beta_2 = v_2/c$,

$\beta_3 = v_3/c$, $\gamma_1 = 1/\sqrt{1-\beta_1^2}$, $\gamma_2 = 1/\sqrt{1-\beta_2^2}$ and $\gamma_3 = 1/\sqrt{1-\beta_3^2}$ as

$$\begin{pmatrix} x' \\ y' \\ z' \\ ct'_x \\ ct'_y \\ ct'_z \end{pmatrix} = \begin{pmatrix} \gamma_1 & 0 & 0 & -\gamma_1\beta_1 & 0 & 0 \\ 0 & \gamma_2 & 0 & 0 & -\gamma_2\beta_2 & 0 \\ 0 & 0 & \gamma_3 & 0 & 0 & -\gamma_3\beta_3 \\ -\gamma_1\beta_1 & 0 & 0 & \gamma_1 & 0 & 0 \\ 0 & -\gamma_2\beta_2 & 0 & 0 & \gamma_2 & 0 \\ 0 & 0 & -\gamma_3\beta_3 & 0 & 0 & \gamma_3 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ ct_x \\ ct_y \\ ct_z \end{pmatrix} \tag{26}$$

It can be checked that the general matrix in Eq.(26) guarantees all the transformation matrixes meet the commutative law of multiplication, their multiplication is closed, and they can form a group. We hold that the reasonable matrices of space-time transformation should not only form a group but also meet the commutative law of multiplication. However, the Lorentz transformation does not fully satisfy the demand.

An interesting result deduced by the new transformation is the 6-dimensional space-time model will lead to an uncertainty principle. For example, suppose an object is static in K', then we can measure the three spatial coordinates of the object simultaneously in K', here the simultaneity in K' means the time coordinates satisfy $t'_x = t'_y = t'_z$. This indicates we can operate the accurate measurement of position using only one time parameter in K'. However, if we try to measure the status of the object in K, it can be found that the three time coordinates will not be identical to each other according to the new transformation, which means $t_x \neq t_y \neq t_z$ in K. Then if we finally operate the position measurement using only one time parameter in K, the obtained three spatial coordinates measured simultaneously in K actually correspond to different status of the object at different times in K', so the measurement will be the failing action to obtain the true spatial coordinates of the object. It means the spatial coordinates measured simultaneously in K actually have no relation to each other as they correspond to different status in K'. As a consequence, we cannot determine the state of movement at the same time in K, this lead to the velocities will be completely uncertain. Similarly, the precise measurement of velocities of the object simultaneously in K will cause the spatial coordinates of the object completely uncertain. We could notice that the full measurement of the six coordinates of an object can be done only in its own stationary reference system in which the object is absolutely static, while for the moving object, the full measurement is unavailable. The uncertainty principle comes from the relativistic effects of the time on directions. We think the underlying reason is time should not be independent of the description of the continuity of movement, and the continuity on different directions has its own time scale. We are not sure whether there is some relationship with the Heisenberg's uncertainty principle in quantum mechanics. At least, this can be addressed as the macro-uncertainty principle.

V. ELECTROMAGNETIC FIELD EQUATIONS BASED ON THE 6-DIMENSIONAL SPACE-TIME

Even though we have obtained the self-consistent space-time transformation, it may be still less convincing as we know the Lorentz transformation comes from the Maxwell equations, unless we could find out the corresponding self-consistent electromagnetic field equations, and the new equations can approximate to the Maxwell equations. However, we should be alerted whether it is feasible to do the amendment to Maxwell equations from the experimental view. The fact is Maxwell equations give the constancy of the speed of light and have many experimental evidences [7, 15, 28–34], while we think the logical sequence should be stated clear, as in reverse, we cannot get the concrete formulas for the electromagnetic field equations from the constancy of the speed of light. As it is known, owing to Maxwell's hypothesis of displacement current, Maxwell could finally write down his equations[23–25]. However, the hypothesis of displacement current actually extends the applicable range of Coulomb's Law. Coulomb's Law is derived from steady-state observation, and Gauss's Law is derived from Coulomb's Law, while the speculation over displacement current reflects the relationship between the changing charge and electric field. Up to now, there is still no direct and independent experiment has proved that the Gauss's Law is also valid for changing electric field. From the experimental view, this may be the vital defect which causes the inconsistency of the transformation of electromagnetic fields. Thus we may not be absolutely sure that the Maxwell equations must be the unique electromagnetic field equations.

Inspired by our solutions to the inconsistency of Lorentz transformation, we think the possible self-consistent amendment to Maxwell equations is to extend those 4-dimensional quantities to 6-dimensional quantities, and assume they meet the same transformation as the 6-dimensional space-time coordinate $x_i = (x, y, z, ict_x, ict_y, ict_z)$, then the relationship between these quantities can give the self-consistent new equations. Hence, we employ the relativistic covariant expression of the Maxwell equations [5, 23], where the 4-dimensional quantities are the 4-dimensional potential $(A_x, A_y, A_z, i\varphi)$, the 4-dimensional current $(J_x, J_y, J_z, ic\rho)$ and 4×4 electromagnetic field tensor. Thus we try to define the new 6-dimensional potential $A_i = (A_x, A_y, A_z, i\varphi_{t_x}, i\varphi_{t_y}, i\varphi_{t_z})$ and the new 6-dimensional current $j_i = (J_x, J_y, J_z, ic\rho_{t_x}, ic\rho_{t_y}, ic\rho_{t_z})$, and assume they meet the same transformation matrix $G_x(v)$. Since we have verified the self-consistency of $G_x(v)$, consequently, any equation defined by these 6-dimensional quantities will also be self-consistent and covariant for the reference system transformation. Meanwhile, the new equations should not deviate too far from the Maxwell equations. By analogy, we think the field equations can be written with the new 6×6 electromagnetic field tensor $F_{ik} = \frac{\partial A_k}{\partial x_i} - \frac{\partial A_i}{\partial x_k}$ as

$$\frac{\partial F_{ik}}{\partial x_k} = \frac{1}{c} j_i \tag{27}$$

$$\frac{\partial F_{ik}}{\partial x_l} + \frac{\partial F_{kl}}{\partial x_i} + \frac{\partial F_{ji}}{\partial x_k} = 0 \tag{28}$$

The only difference between the above equations and the covariant expression of Maxwell equations is the dimension. However, the 6-dimensional expression will cause a serious problem that the known relationship between the potential and electromagnetic fields is no longer valid, and they all need to be redefined. Ensuring the new relationship can degenerate to the 4-dimensional case, we define the new field quantities as

$$F_{ik} = \begin{pmatrix} 0 & B_z & -B_y & -iE_{t_x x} & -iE_{t_y x} & -iE_{t_z x} \\ -B_z & 0 & B_x & -iE_{t_x y} & -iE_{t_y y} & -iE_{t_z y} \\ B_y & -B_x & 0 & -iE_{t_x z} & -iE_{t_y z} & -iE_{t_z z} \\ iE_{t_x x} & iE_{t_x y} & iE_{t_x z} & 0 & \frac{1}{c}N_{t_z} & -\frac{1}{c}N_{t_y} \\ iE_{t_y x} & iE_{t_y y} & iE_{t_y z} & -\frac{1}{c}N_{t_z} & 0 & \frac{1}{c}N_{t_x} \\ iE_{t_z x} & iE_{t_z y} & iE_{t_z z} & \frac{1}{c}N_{t_y} & -\frac{1}{c}N_{t_x} & 0 \end{pmatrix} \tag{29}$$

Here $B_i (i = x, y, z)$ describes the magnetic field, it still reflects the spatial rotation of vector potential $\vec{A} = (A_x, A_y, A_z)$. $E_{t_i j} (i, j = x, y, z)$ describes the electric field, which is redefined and has 9 independent components, such as $E_{t_x y} = -\frac{\partial \varphi_{t_x}}{\partial y} - \frac{1}{c}\frac{\partial A_y}{\partial t_x}$. This is because the scalar potential has been extended to three scalar potentials corresponding to different directions now, and the gradient of each scalar potential has three components. This makes no strange, as we could assume the summation of the gradient component in the same direction for three scalar potentials, such as $E_{t_x x} + E_{t_y x} + E_{t_z x}$, corresponds to the component of the usual electric field in this direction, such as E_x. Besides, the 6-dimensional definition leads to a new field quantity $N_i (i = x, y, z)$. It reflects the temporal rotation of scalar potential, for example $N_{t_x} = \frac{\partial \varphi_{t_z}}{\partial t_y} - \frac{\partial \varphi_{t_y}}{\partial t_z}$. If we introduce three auxiliary temporal unit vectors $\hat{i}_t, \hat{j}_t, \hat{k}_t$ to label those quantities corresponding to the time components, such as $\varphi_{t_x}\hat{i}_t$, $\varphi_{t_y}\hat{j}_t$ and $\varphi_{t_z}\hat{k}_t$, and make the convention that the temporal unit vectors can perform vector operations with each other like the usual spatial unit vectors $\hat{i}, \hat{j}, \hat{k}$, but they cannot do hybrid vector operations with the spatial vectors. Then we can define some abbreviated expression, such as $\vec{\varphi} = \varphi_{t_x}\hat{i}_t + \varphi_{t_y}\hat{j}_t + \varphi_{t_z}\hat{k}_t$ and $\nabla_t = \frac{\partial}{\partial t_x}\hat{i}_t + \frac{\partial}{\partial t_y}\hat{j}_t + \frac{\partial}{\partial t_z}\hat{k}_t$. The three field quantities can be denoted as

$$\vec{B} = \nabla \times \vec{A} \tag{30}$$

$$\vec{E} = -\nabla\vec{\varphi} - \frac{1}{c}\nabla_t \vec{A} \tag{31}$$

$$\vec{N} = \nabla_t \times \vec{\varphi} \tag{32}$$

$\vec{E}$ is expressed by the dyadic expression with $\nabla = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$. The three field quantities have 15 independent components, which are $\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$, $\vec{E} = (E_{t_x x}\hat{i}_t + E_{t_y x}\hat{j}_t + E_{t_z x}\hat{k}_t)\hat{i} + (E_{t_x y}\hat{i}_t + E_{t_y y}\hat{j}_t + E_{t_z y}\hat{k}_t)\hat{j} + (E_{t_x z}\hat{i}_t + E_{t_y z}\hat{j}_t + E_{t_z z}\hat{k}_t)\hat{k}$, and $\vec{N} = N_{t_x}\hat{i}_t + N_{t_y}\hat{j}_t + N_{t_z}\hat{k}_t$. The inertial reference system transformation for the 15 components is defined by their relationship with the 6-dimensional potential. If K' moves along the x-axis of K

with relative velocity v, we have the transformation

$$\begin{pmatrix} B'_x \\ B'_y \\ B'_z \\ E'_{t_x x} \\ E'_{t_x y} \\ E'_{t_x z} \\ E'_{t_y x} \\ E'_{t_y y} \\ E'_{t_y z} \\ E'_{t_z x} \\ E'_{t_z y} \\ E'_{t_z z} \\ \frac{N'_{t_x}}{c} \\ \frac{N'_{t_y}}{c} \\ \frac{N'_{t_z}}{c} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \gamma & 0 & 0 & 0 & \gamma\beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \gamma & 0 & -\gamma\beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\gamma\beta & 0 & \gamma & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \gamma\beta & 0 & 0 & 0 & \gamma & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \gamma & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\gamma\beta \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \gamma & 0 & 0 & 0 & \gamma\beta & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \gamma\beta & 0 & 0 & 0 & \gamma & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -\gamma\beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \gamma \end{pmatrix} \begin{pmatrix} B_x \\ B_y \\ B_z \\ E_{t_x x} \\ E_{t_x y} \\ E_{t_x z} \\ E_{t_y x} \\ E_{t_y y} \\ E_{t_y z} \\ E_{t_z x} \\ E_{t_z y} \\ E_{t_z z} \\ \frac{N_{t_x}}{c} \\ \frac{N_{t_y}}{c} \\ \frac{N_{t_z}}{c} \end{pmatrix}$$

Following the same procedure as how we check the self-consistency in Fig. 5 and Fig. 6, it is easy to confirm the transformation of the 15 field components are self-consistent, no matter how we choose the intermediate K'. The problem of inconsistency can be solved. We can further define $\vec{J} = J_x\hat{i} + J_y\hat{j} + J_z\hat{k}$ and $\vec{\rho} = \rho_{t_x}\hat{i}_t + \rho_{t_y}\hat{j}_t + \rho_{t_z}\hat{k}_t$, thus the Eqs.(27) and (28) can be expressed by the three field quantities as

$$\nabla \times \vec{B} = \frac{1}{c}\nabla_t \cdot \vec{E} + \frac{1}{c}\vec{J} \tag{33}$$

$$\nabla \cdot \vec{B} = 0 \tag{34}$$

$$\nabla_t \times \vec{N} = c^2\nabla \cdot \vec{E} - c^2\vec{\rho} \tag{35}$$

$$\nabla_t \cdot \vec{N} = 0 \tag{36}$$

$$\nabla \times \vec{E} = -\frac{1}{c}\nabla_t\vec{B} \tag{37}$$

$$\nabla_t \times \vec{E} = -\nabla\vec{N} \tag{38}$$

(39)

Eq.(27)gives Eq.(33)(35), and Eq.(28)gives Eq.(34)(36)(37)(38). The six equations can degenerate to the Maxwell equations, as $\vec{N}$ will vanish in the 4-dimensional approximation.

We know the Maxwell equations have suspicious asymmetry for the spatial divergence of electric and magnetic fields, hence it is conjectured the monopole may be exist. However, the new equations shows the satisfactory symmetry for $\vec{B}$ and $\vec{N}$, the spatial divergence of $\vec{B}$ is zero corresponds to the temporal divergence of $\vec{N}$ is zero, not $\vec{E}$. So the monopole should not be existent, as it will break the symmetry of equations, A striking contrast to the Maxwell equations can be found in Eq.(35), where the Gauss's Law is no longer valid for varying electromagnetic field. As we have assumed, the times scales relative to a static object should be identical on different directions. If we choose the steady state $t_x = t_y = t_z$, that is the 4-dimensional approximation, the new equations can still give the Ampère's Law corresponding to Eq.(33) and the Coulomb's Law corresponding to Eq.(35). Faraday's Law is given by Eq.(37) and it contains 9 equations with more detailed components. From the logical point of view, we think we have find out the self-consistent electromagnetic field equations, which is based on the 6-dimensional space-time model.

In summary, we investigate the process of the sequential space-time transformation with direction changed, which shows the inconsistency of the space-time transformation as well as the electromagnetic fields transformation. Based on the two postulates of special relativity, the self-consistent transformation should be $G_x(v)$, and time should have relativistic effects on directions. If we strict space-time must be 4-dimensional and do not consider the constancy of speed of light, only the Galilean transformation will give the self-consistent results regardless of the different choice for K', while it violates the constancy of speed of light. So the additional statement of 4-dimensional space-time in the derivation of Lorentz transformation should be alleged incompatible with the usual two postulates. In order to solve the inconsistency of Lorentz transformation, we propose a 6-dimensional space-time model. This also lead to the new electromagnetic field quantities and equations. Nevertheless, more direct experiments are needed to testify them. We think the crucial direct experiment is whether the Gauss's Laws is really valid for varying electric field, as we have denied this in Eq.(35), even though the experiment is hard to handle. We could propose a possible experiment to test the 6-dimensional space-time model. As the new velocity transformation is different from the Lorentz velocity transformation, the experiment can be done by comparing the maximum speed of radiated particles in the direction y from a static radioactive atom with the maximum speed of radiated particles in the direction y from a highly accelerated radioactive atom moving in the direction x. If the speeds are the same, the 6-dimensional space-time can be verified.

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