NEW TRANSFORMATION EQUATION WHICH REPLACES LORENTZ TRANSFORMATION TO BE APPLIED IN AN ATOM

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Abstract

K. Suto has derived that, between the total energy and momentum of an electron in a hydrogen atom, the following relationship is obtained: $E_{ab}{}^2 + c^2p^2 = E_0{}^2$

From this relationship it is easily derived that the mass of an electron in an atom decreases as the velocity increases.

Consequently, we reach the recognition that, in the space in an atom, we need a new transformation equation which replaces Lorentz transformation.

In this paper we are going to derive the new transformation equation.

As a result, we can predict that a particle moving in an atom or passing through an atom will expand in the moving direction and that the time which passes in the coordinate system of the particle will pass earlier.

Furthermore, we will find that, in an atom, light velocity doesn't function as the upper velocity in the nature. From this, we can predict the existence of a tachyon moving at superluminal velocity.

I. Introduction

K. Suto has derived that, in a hydrogen atom, the relationship of special relativity $E^2 = c^2p^2 + E_0{}^2$ can't be applied. Instead the following relationship can be applied:[1)]

$$E_{ab}{}^2 + c^2p^2 = E_0{}^2 \tag{I.1}$$

Here, E_{ab} is the total energy of an electron expresses by absolute standard, and p is the momentum of an electron.

By the way, in special relativity, we can obtain:

$$m = E/c^2 \tag{I.2}$$

In classical mechanics, we can obtain:

$$m = p/v \tag{I.3}$$

From the two equations above, we can obtain:

$$cp = Ev/c \tag{I.4}$$

Suppose Eq. (I.4), which holds true in the macro space, also holds true when we replace E with E_{ab} .

When we substitute cp in Eq. (I.4) into Eq. (I.1), we obtain:

$$E_{ab} = E_0/(1 + v^2/c^2)^{1/2} \tag{I.5}$$

Considering (I.2), we obtain:

$$m = m_0/(1 + v^2/c^2)^{1/2} \tag{I.6}$$

It is clear that the mass of a particle moving in a hydrogen atom decreases when its velocity increases.

This result is different from the prediction of special relativity.

From the relation in Eq. (Ⅰ.6), we can predict the particle moving in or passing through an atom will expand in the moving direction and that the time passing by the clock in the coordinate system of the particle will gain.

Therefore, we can't apply Lorentz transformation to the two coordinate systems moving at uniform speed to each other in the space of an atom. We need to introduce a new transformation equation.

II. Introduction of a new transformation equation that replaces Lorentz transformation

In quantum mechanics we can't draw a picture as to the movement of an electron in an atom. So we are going to derive a new transformation equation by using the picture of classical quantum theory.

Let us refer to the famous thought experiment of "the twin paradox." It is known that the accelerated movement of the rocket, which one of the twins traveling in the space experiences, can be described by using special relativity, if we consider the movement of limiting time for $t \to 0$.

For the same reason, let us suppose the new transformation equation we are going to obtain can be applied to an electron in an atom even if an electron changes its velocity moment by moment.

Let us now consider the coordinate system (S′) of an electron moving along the elliptic orbit in an atom and the coordinate system (S) of a nucleus.

In quantum mechanics a complex number plays an essential role.

Therefore, let us suppose a complex number also plays an important role in deriving a new transformation equation.

In addition, we are going to derive the unknown transformation equation referring to the process of obtaining Lorentz transformation.[2)]

First of all, the new transformation equation we are going to obtain has to be linear.

Furthermore, considering the symmetry coming from the principle of relativity, let us suppose the relationships below:

$$x = ax' + ibt' \ , \ \ x' = ax - ibt \tag{II.1}$$

The movement of the origin of S coordinates seen from S′coordinates can be obtained if x=0 in the first equation in Eq. (II.1).

The movement of the origin of S′coordinates seen from S coordinates can be obtained if x'=0 in the second equation in Eq. (II.1). Now suppose the speed of the other coordinate system seen from one coordinate system is v. Differentiating the second equation in Eq. (II.1), we can obtain the following condition:

$$ib/a = v \tag{II.2}$$

Next let us consider the case where the light signal moving in the plus direction on the x-axis is seen from S coordinates and S′coordinates. When the origins of the x-axis of the two coordinate systems agree, the light signal is emitted from the origin O. Let us suppose that the light signal seen from S coordinates and S′ coordinates can be described by the following equations:

$$x = ict \ , \ x' = ict' \tag{II.3}$$

Substituting x and $x'$of these equations into Eq. (II.1), we have

$$ct = (ac + b)\, t' \ , \ ct' = (ac - b)\, t \tag{II.4}$$

Eliminating t and $t'$of these two equations and using the relation of Eq. (II.2), we have:

$$c^2 = a^2(c^2 + v^2) \qquad (\mathrm{II}.5)$$

From this,

$$a = 1/(1 + v^2/c^2)^{1/2} \qquad (\mathrm{II}.6)$$

Now rewriting the coefficient a as γ_a, Eq. (II . 1) will be

$$x = (x' + vt') / (1 + v^2 / c^2)^{1/2}$$
$$= \gamma_a(x' + vt')$$
$$x' = (x - vt) / (1 + v^2 / c^2)^{1/2}$$
$$= \gamma_a(x - vt) \qquad (\mathrm{II}.7)$$

Note that

$$\gamma_a(v) = (1 + v^2 / c^2)^{-1/2} \qquad (\mathrm{II}.8)$$

Meanwhile, the coefficient $\gamma_a(v)$ in Lorentz transformation was given in the following expression:

$$\gamma(v) = (1 - v^2 / c^2)^{-1/2} \qquad (\mathrm{II}.9)$$

The coefficient of Eq. (II . 7) obtained in this paper is $\gamma_a(v)(<1)$, whereas the coefficient in Lorentz transformation is $\gamma(v)(>1)$.

If we can obtain (II . 7), it is a matter of elementary algebra to obtain the following expressions for t and t':

$$t = \gamma_a(t' + vx' / c^2)$$
$$t' = \gamma_a(t - vx/c^2) \qquad (\mathrm{II}.10)$$

Here, we give the complete set of transformations below, expressed both ways, i.e., S′ coordinates in terms of S and vice versa:

$$x' = \gamma_a(x - vt) \quad , \quad x = \gamma_a(x' + vt')$$
$$y' = y \quad , \quad y = y'$$
$$z' = z \quad , \quad z = z'$$
$$t' = \gamma_a(t - vx/c^2) \quad , \quad t = \gamma_a(t' + vx'/c^2) \qquad (\mathrm{II}.11)$$

with $\gamma_a = (1 + v^2/c^2)^{-1/2}$, where v is the velocity of S′ as measured in S

The only difference between the new transformation equation (II . 11) and Lorentz transformation is coefficients, i.e., γ_a and γ.

Therefore, the new transformation equation is, as Lorenz transformation, covariant concerning transformation of coordinate systems.

Then, what about the length of an object moving in an atom?

Let us consider the situation where a particle with the length l_0 at rest moves at velocity v in an atom. Suppose that an observer in S coordinates measures the length of the particle in the moving direction and gets the value l.

According to the new transformation equation, we can get the relationships between l_0 and l as follows:

$$l = l_0/\gamma_a = l_0(1 + v^2/c^2)^{1/2} \qquad (\mathrm{II}.12)$$

From this equation, we can find that a particle moving in an atom at velocity v expands in the moving direction.

Furthermore, let us suppose that, when time t_0 passes by the clock in S coordinates, the time t passes by the clock in S′coordinates. The relationships between t_0 and t becomes

$$t = t_0/\gamma_a = t_0(1 + v^2/c^2)^{1/2} \tag{II.13}$$

From this equation, we can find that, in the coordinate system of a moving particle, the time passes earlier.

III. Conclusion

1. So far, we have found that, as its velocity increases, the total energy and mass of an electron moving in an atom decrease. This gives a different result from the one predicted in special relativity.

We have also found that different expression can be applied as to whether the movement of a particle occurs in the macro space or in the micro space in an atom.

However, this paper can't express the clear standpoint as to whether an electron really expands and whether the time in an electron's coordinate system really passes earlier.

That is because the physical meaning of the expansion of an electron is unclear, since an electron is considered a particle without extent.

As to the passage of time, too, the meaning of the fact that time passes earlier is unclear, since an electron is considered a particle without lifetime.

However, when a particle moving in from outside an atom passes through an atom, it is possible that Eqs. (II . 12) and (II . 13) can be applied.

Now, when we obtain the value of ml and mt from Eqs. (I . 6), (II . 12) and (II . 13), we have:

$$ml = m_0 l_0 = const \qquad \text{(III . 1)}$$

$$mt = m_0 t_0 = const \qquad \text{(III . 2)}$$

From the equations above, it follows that, whether a particle is moving in or outside an atom, when its mass or total energy becomes n times larger its length in the moving direction and the time passing in its coordinate system become $1/n$.

If Eqs. (III . 1) and (III . 2) can be obtained in every case, we can't exclude the possibility that an electron may be a particle with extent and lifetime.

Special relativity insists that the contraction of the length of an object and the time dilation passing in the coordinate system of the object depend on the velocity of the object. However, this paper concludes it is more essential to think that the length of an object and the time passing in the coordinate system depend on the mass or total energy of the object.

2. When the velocity of an electron in an atom increases, its mass decreases. Therefore in an atom, light velocity doesn't function as the upper velocity in the nature.

Here, let us obtain the velocity of an electron when its total energy E_{ab} is the minimum value $m_0c^2/2$.[3] Substitute $m_0c^2/2$ in E_{ab} in Eq. (I . 1):

$$(m_0c^2/2)^2 + c^2p^2 = (m_0c^2)^2 \qquad \text{(III . 3)}$$

Also, from Eq. (I . 3):

$$p^2 = m^2v^2 \qquad \text{(III . 4)}$$

Substitute p^2 of Eq. (III . 4) and m_0 of Eq. (I . 6) into Eq. (III . 3). Adopting the plus value, we have:

$$v = 3^{1/2}\, c \qquad \text{(III . 5)}$$

We can predict that, when an electron gets closer to an atomic nucleus, the velocity of an electron surpasses light velocity. Then an electron behaves as a tachyon, a particle moving at superluminal velocity. A tachyon is not an unknown particle but an existing particle behaves as one under a certain condition.

When describing the state of an electron in an atom by means of wave function, the probability of detecting an electron is not zero even in the area where an electron behaves as a tachyon. Therefore, we can predict the existence of a tachyon.

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References

1) K.SUTO, "REVISION OF THE RELATIONAL EXPRESSION OF SPECIAL RELATIVITY IN A HYDROGEN ATOM AND BOHR RADIUS"

2) A.P.FRENCH, "Special Relativity"(THE M.I.T INTRODUCTORY PHYSICS SERIES) W・W・NORTON&COMPANY,New York・London,1968.

3) K.SUTO, "REVISION OF THE RELATIONAL EXPRESSION OF SPECIAL RELATIVITY IN A HYDROGEN ATOM AND BOHR RADIUS"