Space Axis of Time-Space Frame of Reference for Special Relativity Theory and The Core of the Theory

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Abstract

It may be hard to understand Lorentz transformation intuitively because it is derived inductively from the light speed constancy for every inertia systems. Specially the definition of space-axis (time zero line) is unclear although time-axis definition may be reasonable if the Lorentz transformation is recognized as a rotation of frame of reference on the Minkowski space. On such situation, Lorentz transformation may become understandable if the logic of space-axis definition becomes clear. And light speed constancy may not be an axiom, it should be what to be derived.

1. Introduction

Here we try to understand Lorentz Transformation from more basic definition. For it, following two systems are considered.

S system(two dimensions(ct, x)) and S' system(two dimensions(ct', x')). [1]

Here both are moving relatively with velocity v.

As we consider Lorentz transformation is rotation of frame of reference on the Minkowski space, detail investigation of space axis definition is required. And the result of the process makes clear the meaning of special relativity theory.

2. Category of Systems

Lorentz transformation expresses a time-space point using two categories of frame of reference. These two categories are following.

Base System: This is static independent system

Secondary System: This is moving relatively to the Basic System and dependent system

We can also say that Lorentz transformation express Secondary System's frame of reference on Base System's frame of reference.

These categories are interchangeable, not be a unique feature to a system.

3. Move of time

Here exact definition of words is required.

Space distance : space dimension difference of two points

Time : For any space point, something passing. Its dimension is called time dimension.

   And time is time dimension difference of two points

Time distance : space compatible distance time moves on (1)

Following has been assumed. [1][2]

  Time moves toward time direction also toward space direction with speed c.   (1)

  Origin of moving time in space recognizes passed time distance at the moving time
  reached point by moved distance.   (2)

4. Requirement for time-space graph rotation

Followings are required so that time-space graph can be rotated.

-   Time axis and space axis should be same unit or same dimension.

About this, time axis have time distance value ct in order that time axis have same
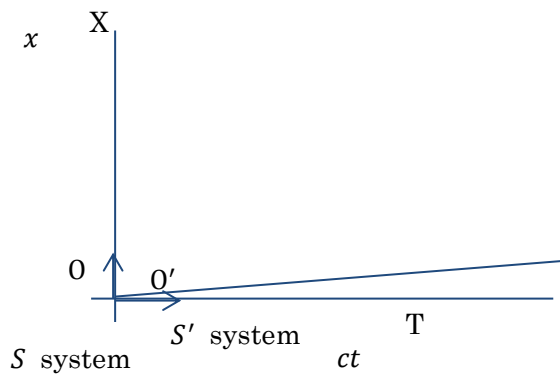dimension as space.[1]

5. Space axis definition

Fig. 1

About Fig. 1, origin of S system is O, origin of S' system is O'. Space point X is away x
from origin O and O'. Time point T is away ct from origin O and O'.

Regarding to time axis, as describe in [1], it takes time distance ct for time to move
from origin to point T.

While the timing, origin O' moves vt toward space direction.

This relation is $x = \frac{v}{c}ct$. This is space zero line or time axis for S' system.

When moving time reached at point X from origin, moved time distance is x in space. While this timing, S' system origin moves $\frac{v}{c}x$ in space. Then moved distance of moving time for S' system is
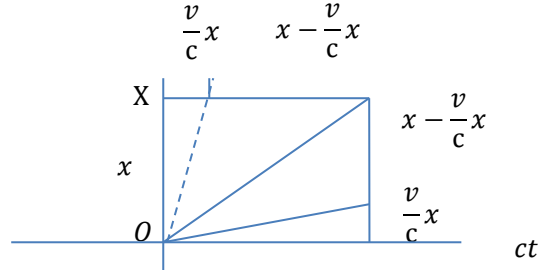
$x - \frac{v}{c}x$ (Fig.3)

Fig.3

Then S' system origin recognizes passed time distance $x - \frac{v}{c}x$ at point X based on (2), So S' system frame of reference is advanced $\frac{v}{c}x$ about time dimension than S system frame of reference

So S' system time zero is on the following line

$$ct = \frac{v}{c}x$$
$$x = \frac{c}{v}ct \tag{6}$$

This is time zero line and space axis of S' system.

6.   Light speed constancy

When light moves from space 0 to x for t on Base System,

For Base System

  Moved distance of light; $x = ct$ $\tag{4}$

For Secondary system

  Moved distance of light; $ct - vt = (c - v)t = (c - v)\frac{x}{c}$ $\tag{5}$

  Passed time: $(c - v)\frac{x}{c^2}$ $\tag{6}$

Light speed of S system is

$$\frac{ct}{t} = c \tag{7}$$

Light speed of S' system is from (5)(6)

$$\frac{(c-v)\frac{x}{c}}{\frac{c-v}{c^2}x} = c \tag{8}$$

Here moved distance depends on each system. Elapsed time also depends on each system. Then light speed which is ratio of space distance and time distance is constant or doesn't depend on system.

3

7. Relativity

Lorentz transformation expresses relation of two systems on Base System.

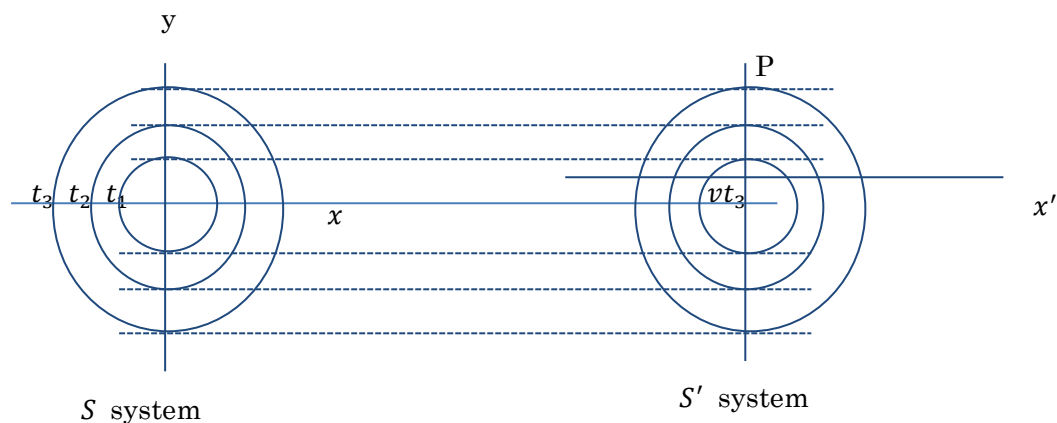But actually each system observes own system as it is Base System.

Fig. 3

On Fig.3, light flushes at the origin of S system. It moves according to time t_1, t_2, t_3 ....

If S' system moves with speed v relatively to S system, S' system seems to observe the light as on Fig.3.

But actually time moves same as light do. At point P for S' system

  light moved $(c - v)t_3$.

  elapsed time is $\frac{c-v}{c}t_3$.

Then when time become t_3 for S' system, distance light moves is

$$(c - v)t_3 \times \frac{t_3}{\frac{c-v}{c}t_3} = ct_3 \tag{9}$$

This is same distance light moves for t_3 on S system.
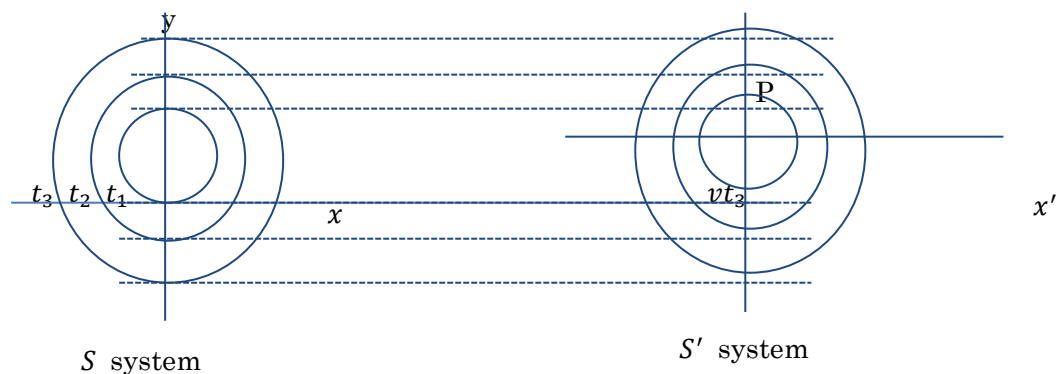
Fig.4 reflects this result.

Fig. 4

For S' system, light flushes at the origin and moves to all directions with speed c. This is just same scene as S system views. This means relatively moving two systems observe same scene regarding to light propagation.

Here the assumption that S' system is moving to S system, is disappeared. We cannot say S' system is moving nor S system is moving. We can say only these are moving relatively.

8. Conclusion

On the assumption (1)(2), following are derived.

 -space axis definition for Lorentz transformation on the Minkowski space

 -light speed constancy

 -meaning of relativity for inertia systems

  Reference

    [1] Tsuneaki Takahashi, viXra:1611.0077,(http://vixra.org/abs/1611.0077)

    [2] Tsuneaki Takahashi, viXra:1908.0534,(http://vixra.org/abs/1908.0534)