Special relativity
without time dilatation and length contraction

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This paper is an extract of [7] listed in section Bibliography.

Abstract

This paper presents a new interpretation of special relativity based on Lorenz transformations build on equations with speed variables instead of space-time variables as done by Einstein. The transformation rules between inertial frames are free of time dilatation and length contraction and all the transformation equations already existent for the electric and magnetic fields, deduced on the base of the invariance of the Maxwell wave equations are still valid for the present approach.

1 Introduction.

Space and time are variables of our physical world that are intrinsically linked together. Laws that are mathematically described as independent of time, like the Coulomb and gravitation laws, are the result of repetitive actions of the time variations of linear momentum [7].

To arrive to the transformation equations Einstein made abstraction of the physical cause that makes that light speed is the same in all inertial frames. The transformation rules show time dilation and length contraction.

The Lorenz transformation applied on speed variables, as shown in the proposed approach, is formulated with absolute time and space for all frames and takes account of the physical cause of constancy of light speed in all inertial frames.

2 Lorenz transformation based on speed variables.

The general Lorentz Transformation (LT) in orthogonal coordinates is described by the following equation and conditions for the coefficients [2]:

$$\sum_{i=1}^{4}(\theta^i)^2 = \sum_{i=1}^{4}(\bar{\theta}^i)^2 \qquad \sum_{i=1}^{4} \bar{a}_k^i \bar{a}_l^i = \delta_{kl} \qquad \sum_{i=1}^{4} \bar{a}_i^k \bar{a}_i^l = \delta^{kl} \tag{1}$$

with

$$\bar{\Theta}^i = \bar{a}^i_k \Theta^k \ + \ \bar{b}^i \tag{2}$$

The transformation represents a relative displacement $\bar{b}^i$ and a rotation of the frames and conserves the distances $\Delta\Theta$ between two points in the frames.

Before we introduce the LT based on speed variables we have a look at Einstein's formulation of the Lorentz equation with space-time variables as shown in Fig. 1.

$$x^2 + y^2 + z^2 + (ic_o\, t)^2 = \bar{x}^2 + \bar{y}^2 + \bar{z}^2 + (ic_o\, \bar{t})^2 \tag{3}$$

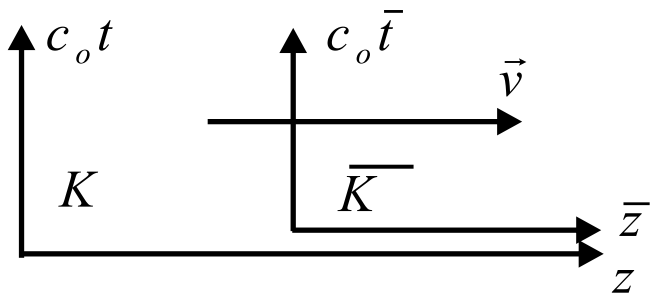

Figure 1: Transformation frames for **space-time** variables

For distances between two points eq. (3) writes now

$$(\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 + (ic_o\, \Delta t)^2 = (\Delta \bar{x})^2 + (\Delta \bar{y})^2 + (\Delta \bar{z})^2 + (ic_o\, \Delta \bar{t})^2 \tag{4}$$

The fact of equal light speed in all inertial frames is basically a speed problem and not a space-time problem. Therefor, in the proposed approach, the Lorentz equation is formulated with speed variables and absolut time and space.

$$v_x^2 + v_y^2 + v_z^2 + (iv_c)^2 = \bar{v}_x^2 + \bar{v}_y^2 + \bar{v}_z^2 + (i\bar{v}_c)^2 \tag{5}$$

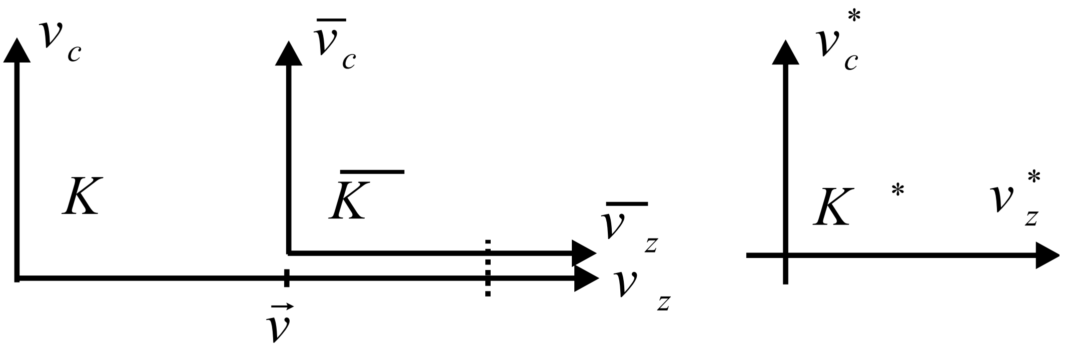

Figure 2: Transformation frames for **speed** variables

For the special Lorentz transformation with speed variables we get the following transformation rules between the frames K and $\bar{K}$:

a) $\bar{v}_x = v_x \qquad v_x = \bar{v}_x$

b) $\bar{v}_y = v_y \qquad v_y = \bar{v}_y$

c) $$\bar{v}_z = \frac{v_z - v}{\sqrt{1 - v^2/v_c^2}} \qquad v_z = \frac{\bar{v}_z + v}{\sqrt{1 - v^2/\bar{v}_c^2}}$$

d) $$\bar{v}_c = \frac{v_c - \dfrac{v}{v_c}\, v_z}{\sqrt{1 - v^2/v_c^2}} \qquad v_c = \frac{\bar{v}_c + \dfrac{v}{\bar{v}_c}\, \bar{v}_z}{\sqrt{1 - v^2/\bar{v}_c^2}}$$

According to the approach "Emission & Regeneration" Field Theory [7] from the author, electromagnetic waves that arrive from moving frames with speeds different than light speed to measuring instruments like optical lenses or electric antennas, are absorbed by their atoms and subsequently emitted with light speed c_o in their own frames. To take account of the behaviour of light in measuring instruments an additional transformation is necessary.

In Fig 2 the instruments are placed in the frame K^* which is linked rigidly to the *virtual* frame $\bar{K}$ and electromagnetic waves arrive from the frame K with the speed $\bar{v}_z$ in the *virtual* frame $\bar{K}$. The potentiality of the virtual frame $\bar{K}$ consists in that electromagnetic waves can move with all possible speeds in that frame. The frequencies of electromagnetic waves that pass from the virtual frame $\bar{K}$ to the frame K^* are invariant resulting the following transformation rules between the two frames:

$$v^*_x = \bar{v}_x \qquad v^*_y = \bar{v}_y$$
$$v^*_z = \bar{v}_z \qquad f^*_z = \bar{f}_z$$

The link between the frames K and $\bar{K}$ is given by the wavelengths $\lambda = \bar{\lambda}$ which are invariant because there is **no length contraction**.

The links between the frames are:

$$K \to \bar{K} \qquad\qquad \bar{K} \to K^*$$
$$\lambda = \bar{\lambda} \qquad\qquad \bar{f} = f^*$$

The factor

$$\gamma = \left(1 - \frac{v^2}{v_c^2}\right)^{-1/2} = 1 + \frac{1}{2}\,\frac{v^2}{v_c^2} + \frac{1\cdot 3}{2\cdot 4}\,\left(\frac{v^2}{v_c^2}\right)^2 + \frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\,\left(\frac{v^2}{v_c^2}\right)^3 + \cdots \qquad (6)$$

gives the non-linearity of the variables (linear momentum, energy, etc.) with the relative speed v of the frames, as will be shown for each case.

Note: All information about events in frame K are passed to the frames $\bar{K}$ and K^* exclusively through the electromagnetic fields E and B that come from frame K. Therefore all transformations between the frames must be described as transformations of these fields, what is achieved through the invariance of the Maxwell wave equations.

3 Linear momentum.

To calculate the linear momentum in the virtual frame $\bar{K}$ of a particle placed at the origin of frame K with $v_x = v_y = v_z = 0$ we use the equation c) of sec 1, with $v_c = c_o$ because K is not a virtual frame. The speed $v_c = c_o$ describes the speed of the Fundamental Particles (FP) [7] emitted continuously by electrons and positrons and which continuously regenerate them, also when they are in rest in the frame K ($v_x = v_y = v_z = 0$).

$$\bar{v}_z = \frac{v_z - v}{\sqrt{1 - v^2/v_c^2}} = (v_z - v)\gamma \qquad \textit{and get} \qquad \bar{v}_z = \frac{-v}{\sqrt{1 - v^2/c_o^2}} \qquad (7)$$

The negative sign of $\bar{v}_z$ is because for the frame $\bar{K}$ the particle in the frame K moves in $-\bar{z}$ direction.

The linear momentum $\bar{p}_z$ we get multiplying $\bar{v}_z$ with the rest mass m of the particle.

$$\bar{p}_z = m\,\bar{v}_z = m\,\frac{-v}{\sqrt{1 - v^2/c_o^2}} \qquad (8)$$

Because of momentum conservation the momentum we measure in K^* is equal to the calculated momentum for $\bar{K}$, expressed mathematically as $p_z^* = \bar{p}_z$.

With eq. (6) we can write the linear momentum as

$$m\,v\,\gamma = m\,v + m\,v\,\left\{\frac{1}{2}\,\frac{v^2}{v_c^2} + \frac{1\cdot 3}{2\cdot 4}\,\left(\frac{v^2}{v_c^2}\right)^2 + \frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\,\left(\frac{v^2}{v_c^2}\right)^3 + \cdots\right\} \qquad (9)$$

where the first term of the right side gives the linear momentum due to the relative speed v between the frames, and the second term in {} brackets the contribution due to the non-linearity with v of the linear momentum.

Note: The mass is simply a proportionality factor which is not a function of the speed and is invariant for all frames. The quotient $v/\sqrt{1-v^2/v_o^2}$ describes the dynamic of the particle.

4 Acceleration.

To calculate the acceleration in the virtual frame $\bar{K}$ we start with

$$\bar{a}_z = \frac{d\bar{v}_z}{dt} \qquad with \qquad \bar{v}_z = \frac{v_z - v}{\sqrt{1-v^2/c_o^2}} \tag{10}$$

what gives

$$\bar{a}_z = \frac{d\bar{v}_z}{dt} = \frac{dv_z/dt}{\sqrt{1-v^2/c_o^2}} = \frac{a_z}{\sqrt{1-v^2/c_o^2}} \tag{11}$$

As $v_z^* = \bar{v}_z$ we get

$$a_z^* = \frac{a_z}{\sqrt{1-v^2/c_o^2}} \tag{12}$$

5 Energy.

To calculate the energy in the virtual frame $\bar{K}$ for a particle that is placed in the origin of frame K we use the equation d) of sec 1, with $v_z = 0$ and $v_c = c_o$ because K is not a virtual frame. The speed $v_c = c_o$ describes the speed of the Fundamental Particles (FP) [7] emitted continuously by electrons and positrons and which continuously regenerate them, also when they are in rest in frame K ($v_x = v_y = v_z = 0$).

$$\bar{v}_c = \frac{v_c - \dfrac{v}{v_c}\, v_z}{\sqrt{1-v^2/v_c^2}} = (v_c - \frac{v}{v_c}\, v_z)\gamma \qquad and\ \ get \qquad \bar{v}_c = \frac{c_o}{\sqrt{1-v^2/c_o^2}} \tag{13}$$

We multiply now $\bar{v}_c$ with $m\, c_o$ and get

$$\bar{E} = m\, c_o\, \bar{v}_c = \frac{m\, c_o^2}{\sqrt{1-v^2/c_o^2}} = \sqrt{E_o^2\ +\ \bar{E}_p^2} \tag{14}$$

with

$$\bar{E}_p = \bar{p}_z\, c_o \qquad and \qquad E_o = m\, c_o^2 \tag{15}$$

The energy E_o is part of the energy in the frame $\bar{K}$ and invariant, because if we make $v = 0$ we get E_o as the energy of the particle in the frame K.

Because of energy conservation between frames without speed difference the energy E^* in the frame K^* is equal to the energy $\bar{E}$ in the frame $\bar{K}$.

To calculate the energy $\bar{E}_p = m\,\bar{v}_z\,c_o$ we must calculate $\bar{v}_z$ as explained in sec. 3.

With eq. (6) we can write the energy as

$$m\,c_o^2\,\gamma = m\,c_o^2 + \frac{1}{2}\,m\,v^2 + m\,c_o^2\,\left\{\frac{1\cdot 3}{2\cdot 4}\,\left(\frac{v^2}{c_o^2}\right)^2 + \frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\,\left(\frac{v^2}{c_o^2}\right)^3 + \cdots\right\} \tag{16}$$

where the first term of the right side gives the rest energy in frame K and the following terms the kinetic energy which is not linear with the speed v.

6 Relativistic Doppler effect.

To calculate the speed $\bar{v}_z$ in the frame $\bar{K}$ for an electromagnetic wave which is generated in frame K we use equation c) of sec 1, with $v_z = c_o$ and $v_c = c_o$.

$$\bar{v}_z = \frac{v_z - v}{\sqrt{1 - v^2/v_c^2}} \qquad \textit{and get} \qquad \bar{v}_z = \frac{c_o - v}{\sqrt{1 - v^2/c_o^2}} \tag{17}$$

Because of **no length contraction** the wavelengths of waves that go from frame K to frame $\bar{K}$ are equal $\lambda = \bar{\lambda}$. We have that

$$f = \frac{c_o}{\lambda} \qquad \bar{f} = \frac{\bar{v}_z}{\bar{\lambda}} = \frac{\bar{v}_z}{\lambda} = f^* \qquad f^* = \frac{v_z^*}{\lambda^*} = \frac{c_o}{\lambda^*} \tag{18}$$

With eq. 17 we get the known equations for the relativistic Doppler effect

$$\frac{f}{f^*} = \frac{\sqrt{1 + v/c_o}}{\sqrt{1 - v/c_o}} \qquad \textit{and} \qquad \frac{\lambda}{\lambda^*} = \frac{\sqrt{1 - v/c_o}}{\sqrt{1 + v/c_o}} \tag{19}$$

For $v > 0$ the distance between the frames K and $\bar{K}$ increases with time and we have that:

$$\frac{f}{f^*} > 1 \qquad \textit{or} \qquad f^* < f \qquad\qquad \frac{\lambda}{\lambda^*} < 1 \qquad \textit{or} \qquad \lambda^* > \lambda \tag{20}$$

For $v > 0$ we measure at the frame K^* a frequency $f^* < f$ and a wavelength $\lambda^* > \lambda$ which is equivalent to a red shift.

7 Charge and current densities.

From the LT based on space-time variables [2] with its rules for time dilatation and length contraction the following equations were derived for the charge and current densities:

$$\bar{\rho} = \frac{\rho - \dfrac{v}{c_o^2}\, J_z}{\sqrt{1 - v^2/c_o^2}} \qquad and \qquad \bar{J}_z = \frac{J_z - v\,\rho}{\sqrt{1 - v^2/c_o^2}} \tag{21}$$

To get the corresponding equations for a LT based on speed variables, it is necessary to compensates the length contraction present in the volume and area respectively of the above density equations. This compensation we get if we multiply the equations with the length contraction $\Delta z = \Delta \bar{z}\ \sqrt{1 - v^2/c_o^2}$. To get expressions for the charge density and the current density we make $J_z = 0$ in the first equation and $\rho = 0$ in the second. We get

$$\bar{\rho} = \frac{\rho}{\sqrt{1 - v^2/c_o^2}}\,\frac{\Delta z}{\Delta \bar{z}} = \rho \qquad and \qquad \bar{J}_z = \frac{J_z}{\sqrt{1 - v^2/c_o^2}}\,\frac{\Delta z}{\Delta \bar{z}} = J_z \tag{22}$$

As $\bar{\rho} = \rho^*$ and $\bar{J}_z = J_z^*$ we conclude that the charge density and the current density are invariant in all three frames.

8 Findings.

The special Lorentz transformation formulated by Einstein is based on space-time variables and the definition of different times for inertial frames, what leads to transformation rules between frames with time dilatation and space contraction.

Based on the findings of the authors "Emission & Regeneration" Field Theory [7], where electrons and positrons continuously emit and are regenerated by Fundamental Particles (FP), the following conclusions about *special relativity based on* ***speed variables*** were deduced:

- The situation of equal light speed in all inertial frames is basically a speed problem and not a space-time problem. Time and space are absolute variables and equal for all frames.

- Electromagnetic waves that arrive at the atoms of measuring instruments like optical lenses or electric antennae are absorbed and subsequently emitted with light speed c_o relative to the measuring instruments, independent of the speed they have when arriving to the atoms of the measuring instruments. That explains why always light speed c_o is measured in the frame of the instruments.

- Electromagnetic waves are emitted with light speed c_o relative to the frame of the emitting source.

- The transformation rules of *special relativity based on space-time variables* as done by Einstein describe the macroscopic results between frames making abstraction of the physical cause of constant light speed in all frames and require therefore space and time distortions. The transformation rules of *special relativity based on speed variables* take into consideration the physical cause of the constant light speed in all frames and therefore don't require space and time distortions.

- All relevant relativistic equations can be deduced with the proposed approach. The transformation rules have no transversal components, nor for the speeds neider for the Doppler effect.

- The speed v_c of the fourth orthogonal coordinate gives the speed of the FPs emitted continuously by electrons and positrons and which continuously regenerate them.

- Particles with rest mass are more stable when moving because of the interactions of their Fundamental Particles (FPs) with the FPS of the masses of the real reference frames as explained in [7], and not because of time dilatation .

The transformation equations based on speed variables are free of time dilatation and length contraction and all the transformation rules already existent for the electric and magnetic fields, deduced on the base of the invariance of the Maxwell wave equations are still valid for the present approach.

The electric and magnetic fields have to pass two transformations on the way from the emitter to the receiver. The first transformation is between the relative moving frames while the second is the transformation that takes into account that measuring instruments that convert the speed of the arriving electromagnetic waves to the speed of light c_o in their frames.

9 Bibliography.

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