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 intrinsically the result of repetitive actions of the time variations of linear momentum [7].

The Lorenz transformation applied on space variables, as done by Einstein, requires the introduction of independent times for the frames and arrives to transformation rules with time dilation and length contraction.

The Lorenz transformation applied on speed variables, as shown in the present approach, is formulated with an absolute time for all frames and has no time dilation and length contractions in its transformation rules.

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.

To introduce the LT based on speed variables we start with Einsteins formulation with space variables as shown in Fig. 1.

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

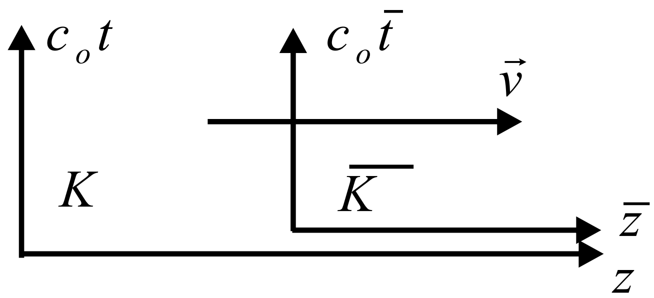

Figure 1: Transformation frames for **space-time** variables

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

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

Defining that the time is equal in all frames (**no time dilatation**) we divide both sides of the equation by $(\Delta t)^2$ and get

$$v_x^2 + v_y^2 + v_z^2 + (ic_o)^2 = \bar{v}_x^2 + \bar{v}_y^2 + \bar{v}_z^2 + (ic_o\, \frac{\Delta \bar{t}}{\Delta t})^2 \tag{5}$$

We define now

$$\xi = \frac{\Delta \bar{t}}{\Delta t} \qquad\qquad c_o = v_c \qquad\qquad \xi\, c_o = \bar{v}_c \tag{6}$$

where ξ is a dimensionless factor. We get

$$v_x^2 + v_y^2 + v_z^2 + (iv_c)^2 = \bar{v}_x^2 + \bar{v}_y^2 + \bar{v}_z^2 + (i\bar{v}_c)^2 \tag{7}$$

which is the speed formulation of the LT as shown in Fig. 2 .

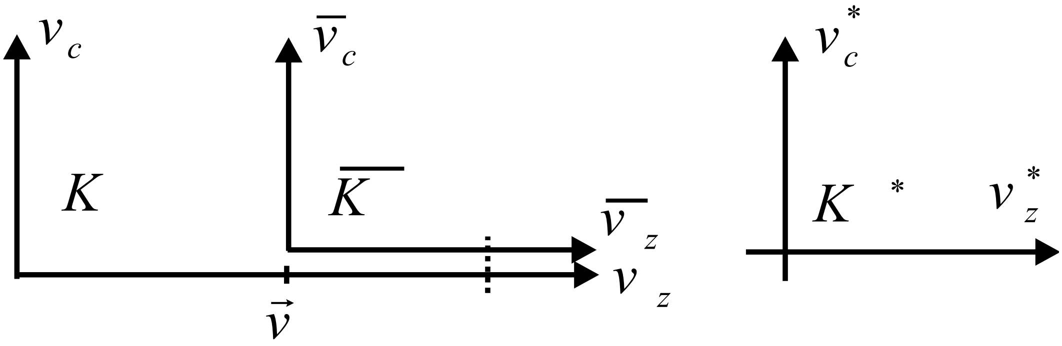

Figure 2: Transformation frames for **speed** variables

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

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. 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:

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

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:

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

The factor

$$\gamma = \left(1 - \frac{v^2}{v_c^2}\right)^{-1/2} = 1 + \frac{1}{2}\,\frac{v^2}{v_c^2} + \frac{1\cdot 3}{2\cdot 4}\,\left(\frac{v^2}{v_c^2}\right)^2 + \frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\,\left(\frac{v^2}{v_c^2}\right)^3 + \cdots \tag{8}$$

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 $(v_x = v_y = v_z = 0)$.

$$\bar{v}_z = \frac{v_z - v}{\sqrt{1 - v^2/v_c^2}} = (v_z - v)\gamma \qquad \textit{and get} \qquad \bar{v}_z = \frac{-v}{\sqrt{1 - v^2/c_o^2}} \tag{9}$$

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.

$$\bar{p}_z = m\,\bar{v}_z = m\,\frac{-v}{\sqrt{1 - v^2/c_o^2}} \tag{10}$$

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

As the measuring instruments are in the frame K^* we measure f^* and λ^*. To calculate $\bar{v}_z = \bar{f}\,\bar{\lambda} = f^*\,\lambda$ we need to know the wavelength λ of the source.

With eq. (8) we can write the linear momentum as

$$m\,v\,\gamma = m\,v + m\,v\,\left\{\frac{1}{2}\,\frac{v^2}{v_c^2} + \frac{1\cdot 3}{2\cdot 4}\,\left(\frac{v^2}{v_c^2}\right)^2 + \frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\,\left(\frac{v^2}{v_c^2}\right)^3 + \cdots\right\} \tag{11}$$

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 constant proportionality factor which is not a function of the speed and is invariant for all frames. The denominator $\sqrt{1 - v^2/v_o^2}$ is part of the numerator v which together describe the dynamic of the particle.

4 Acceleration.

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

$$\bar{a}_z = \frac{d\bar{v}_z}{dt} \qquad with \qquad \bar{v}_z = \frac{v_z - v}{\sqrt{1 - v^2/c_o^2}} \tag{12}$$

what gives

$$\bar{a}_z = \frac{d\bar{v}_z}{dt} = \frac{dv_z/dt}{\sqrt{1 - v^2/c_o^2}} = \frac{a_z}{\sqrt{1 - v^2/c_o^2}} \tag{13}$$

As the measuring instruments are in the frame K^* we measure f^* and λ^*. To calculate

$$\frac{d\bar{v}_z}{dt} = \lambda\, \frac{df^*}{dt} + f^*\, \frac{d\lambda}{dt} \tag{14}$$

we must know λ and $d\lambda/dt$ of the source.

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 $(v_x = v_y = v_z = 0)$.

$$\bar{v}_c = \frac{v_c - \frac{v}{v_c^2}\, v_z}{\sqrt{1 - v^2/v_c^2}} = (v_c - \frac{v}{v_c^2}\, v_z)\gamma \qquad and\;\; get \qquad \bar{v}_c = \frac{c_o}{\sqrt{1 - v^2/c_o^2}} \tag{15}$$

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

$$\bar{E} = m\, c_o\, \bar{v}_c = \frac{m\, c_o^2}{\sqrt{1 - v^2/c_o^2}} = \sqrt{E_o^2 \;+\; \bar{E}_p^2} \tag{16}$$

with

$$\bar{E}_p = \bar{p}_z \, c_o \qquad and \qquad E_o = m \, c_o^2 \tag{17}$$

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. (8) we can write the energy as

$$m \, c_o^2 \, \gamma = m \, c_o^2 + \frac{1}{2} \, m \, v^2 + m \, c_o^2 \left\{ \frac{1 \cdot 3}{2 \cdot 4} \left(\frac{v^2}{c_o^2} \right)^2 + \frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6} \left(\frac{v^2}{c_o^2} \right)^3 + \cdots \right\} \tag{18}$$

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 Red and blue shift.

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 $v_c = c_o$.

$$\bar{v}_z = \frac{v_z - v}{\sqrt{1 - v^2/v_c^2}} \qquad and \;\; get \qquad \bar{v}_z = \frac{c_o - v}{\sqrt{1 - v^2/c_o^2}} \tag{19}$$

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

$$f = \frac{c_o}{\lambda} \qquad \bar{f} = \frac{\bar{v}_z}{\bar{\lambda}} = \frac{\bar{v}_z}{\lambda} = f^* \qquad f^* = \frac{v_z^*}{\lambda^*} = \frac{c_o}{\lambda^*} \tag{20}$$

With eq. 19 we get the known equations for the relativistic Doppler effect

$$\frac{f}{f^*} = \frac{\sqrt{1 + v/c_o}}{\sqrt{1 - v/c_o}} \qquad and \qquad \frac{\lambda}{\lambda^*} = \frac{\sqrt{1 - v/c_o}}{\sqrt{1 + v/c_o}} \tag{21}$$

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

$$\frac{f}{f^*} > 1 \qquad or \qquad f^* < f \qquad\qquad \frac{\lambda}{\lambda^*} < 1 \qquad or \qquad \lambda^* > \lambda \tag{22}$$

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 variables with its rules for time dilatation and length contraction the following equations were derived for the charge and current densities:

$$\bar{\rho} = \frac{\rho - \dfrac{v}{c_o^2}\, J_z}{\sqrt{1 - v^2/c_o^2}} \qquad and \qquad \bar{J}_z = \frac{J_z - v\,\rho}{\sqrt{1 - v^2/c_o^2}} \tag{23}$$

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

$$\bar{\rho} = \frac{\rho}{\sqrt{1 - v^2/c_o^2}}\,\frac{\Delta z}{\Delta \bar{z}} = \rho \qquad and \qquad \bar{J}_z = \frac{J_z}{\sqrt{1 - v^2/c_o^2}}\,\frac{\Delta z}{\Delta \bar{z}} = J_z \tag{24}$$

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 Resume.

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 were deduced:

- The transformation rules of special relativity describe the macroscopic results of the interactions of FPs emitted by electrons and positrons.
- The special Lorentz transformation is intrinsically a transformation of speed variables. Time and space are absolute variables and equal for all frames.
- Electromagnetic waves are emitted with light speed c_o relative to the frame of the emitting source.

- 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.

- 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.

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 convert the speed of the arriving electromagnetic waves to the speed of light c_o in their frames.

There is no transversal relativistic Doppler effect, only the longitudinal relativistic Doppler effect exists.

Life time of radioactive particles (muons, etc.) increase when moving relative to other particles because of the interactions of their FPs as explained in [7], and not because of time dilatation .

9 Bibliography.

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