Special relativity
without time dilation and length contraction

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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 dilation 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 proposed 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 momenta [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]:

$$\sum_{i=1}^{4}(\theta^i)^2 = \sum_{i=1}^{4}(\bar{\theta}^i)^2 \qquad \sum_{i=1}^{4} \bar{a}^i_k \bar{a}^i_l = \delta_{kl} \qquad \sum_{i=1}^{4} \bar{a}^k_i \bar{a}^l_i = \delta^{kl} \tag{1}$$

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.

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

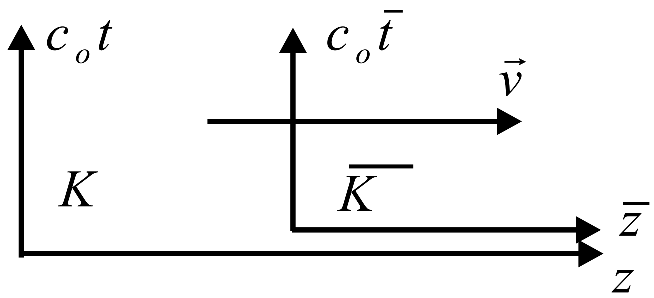

Figure 1: Transformation frames for **space-time** variables

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 dividing eq. (4) through the **absolute time** $(\Delta t)^2$ and introducing the forth speed v_c.

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

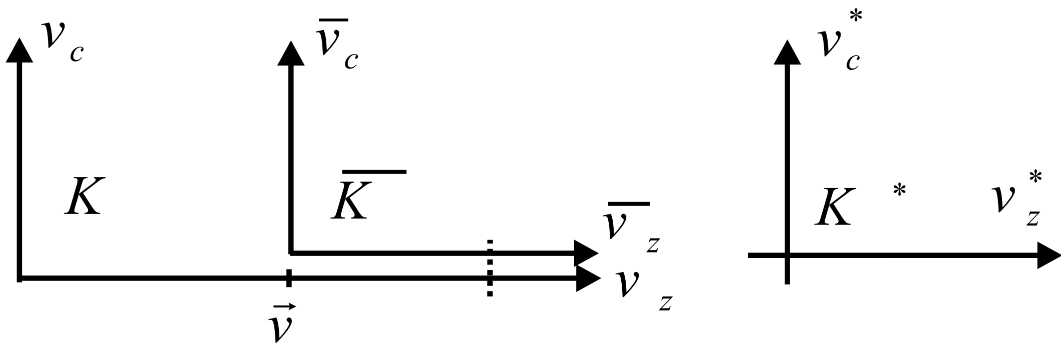

Figure 2: Transformation frames for **speed** variables

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

The factor

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

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.

The frame $\bar{K}$ is a *virtual* frame because the speeds calculated with the Lorentz transformation equations for this frame are not the real speeds of the particles, which are $v_z \pm v$. The frame $\bar{K}$ gives the velocities that allow the calculation of the momentum, acceleration, energy and current densities which are not linear functions of the real speed $v_z \pm v$. The real velocity can take values bigger than the light speed for $v_z = c$ when v_z is the speed of an emitted electromagnetic wave in the frame K.

2.1 Transformations for electromagnetic waves at measuring instruments .

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 $c \pm v$ in the *virtual* frame $\bar{K}$. 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:

$$\begin{array}{llll} \text{e)} & v_x^* = \bar{v}_x & \text{f)} & v_y^* = \bar{v}_y \\ \text{g)} & v_z^* = \bar{v}_z & \text{h)} & f_z^* = \bar{f}_z \end{array}$$

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:

$$\begin{array}{ll} K \rightarrow \bar{K} & \bar{K} \rightarrow K^* \\ \lambda = \bar{\lambda} & \bar{f} = f^* \end{array}$$

3 Equations for particles with rest mass $m \neq 0$.

Following, equations are derived for particles with rest mass $m \neq 0$ that are observed from an inertial frame that moves with constant speed v. For this case the transformation equations a), b), c) and d) from K to $\bar{K}$ are used. The transfomation from $\bar{K}$ to K^* is the **unit** transformation.

3.1 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 2, 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 $(v_x = v_y = v_z = 0)$.

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

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.

$$\bar{p}_z = m\,\bar{v}_z = m\,\frac{-v}{\sqrt{1-v^2/c_o^2}} = p_z^* \tag{8}$$

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

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

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

Note: The rest 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.

3.2 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

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

3.3 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 2, 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 ($v_x = v_y = v_z = 0$).

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

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

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

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. 3.1.

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.

3.4 Charge and current densities.

Because of charge and space invariances we get for the charge density

$$\bar{\rho}_z = \rho_z = \rho_z^* \tag{17}$$

For the current density we get

$$\bar{J}_z = \bar{\rho}_z\, \bar{v}_z = \rho_z\, \frac{v_z - v}{\sqrt{1 - v^2/c_o^2}} = \frac{J_z - \rho_z\, v}{\sqrt{1 - v^2/c_o^2}} \tag{18}$$

4 Equations for particles with rest mass $m = 0$.

Following, the equations are derived for electromagnetic waves observed from an inertial frame that moves with speed v. For this case first the transformation equations a), b), c) and d) from K to $\bar{K}$ are used. Then the transfomation equations e), f), g) and h) from $\bar{K}$ to K^*.

4.1 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 2, with $v_z = c_o$ and $v_c = c_o$.

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

Because of **no length contraction** the wavelengths of waves that go from frame K to frame $\bar{K}$ are equal $\lambda = \bar{\lambda}$. With eq. h) of section 2.1 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

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

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

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

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.

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.

4.2 Relativistic energy of FPs.

A photons is a sequences of pairs of FPs with opposed angular momenta at the distance $\lambda/2$. The potential linear moment of a pair of FPs with opposed angular momenta is perpendicular to the plane that contains the opposed angular momenta. The potential linear moment of a pair of FPs with opposed angular momenta can take every direction in space relative to the moving direction of the pair.

The concept is shown in Fig. 3

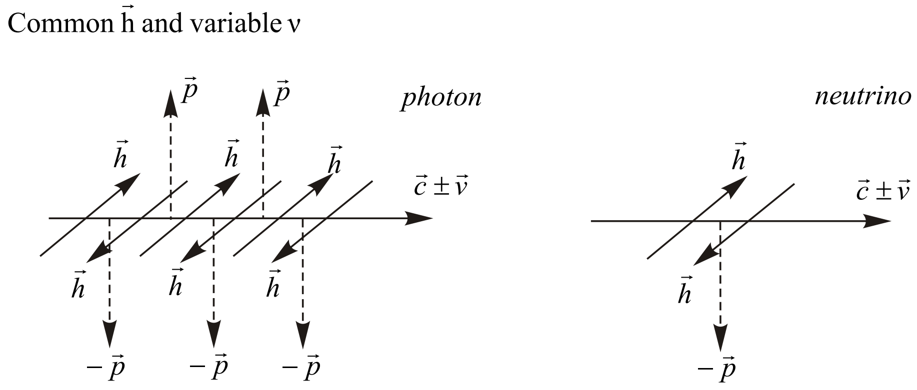

Figure 3: Photon and neutrino

The emission time of photons from **isolated** atoms is approximately $\tau = 10^{-8}\ s$ what gives a length for the wave train of $L = c\ \tau = 3\ m$. The total energy of the emitted photon is $E_t = h\ \nu_t$ and the wavelength is $\lambda_t = c/\nu_t$. We have defined that the photon is composed of a train of FPs with alternated angular momenta where the distance between two consecutive FPs is equal $\lambda_t/2$. The number of FPs that build the photon is therefore $L/(\lambda_t/2)$ and we get for the energy of one FP

$$E_{\text{FP}} = \frac{E_t\ \lambda_t}{2\ L} = \frac{h}{2\ \tau} = 3.313 \cdot 10^{-26}\ J = 2.068 \cdot 10^{-7}\ eV \tag{23}$$

and for the angular frequency of the angular momentum h

$$\nu_{\text{FP}} = \frac{E_{\text{FP}}}{h} = \frac{1}{2\ \tau} = 5 \cdot 10^7\ s^{-1} \tag{24}$$

We can define an equivalent proportionality factor m_{FP}

$$E_{\text{FP}} = m_{\text{FP}}\ c^2 \qquad with \qquad m_{\text{FP}} = 2.29777 \cdot 10^{-24}\ \ kg \tag{25}$$

The relativistic energy of a FP is

$$\bar{E}_{\text{FP}} = m_{\text{FP}}\ c_o\ \bar{v}_c = \frac{m_{\text{FP}}\ c_o^2}{\sqrt{1 - v^2/c_o^2}} = \frac{2.068 \cdot 10^{-7}}{\sqrt{1 - v^2/c_o^2}}\ \ eV \tag{26}$$

A neutrino can be seen as N_{FP} pairs of FPs with opposed angular momenta that all contribute to one potential linear momentum.

$$E_{\texttt{Neutrino}} = N_{\texttt{FP}}\ E_{\texttt{FP}} = N_{\texttt{FP}}\ 2.068 \cdot 10^{-7}\ eV \tag{27}$$

Photons can be seen as a sequence of neutrinos with opposed potential linear momenta at the distance $\lambda/2$.

5 The proposed approach and the Standard Model.

The proposed approach represents a photon as a package of a sequence of FPs with opposed angular momenta. Packages are emitted with the speed c relative to its source. A monochromatic source emitts packages with equal distances λ between FPs.

A package emitted with the speed c, the frequency ν and the vawelength λ in the frame K will arrive to the virtual frame $\bar{K}$ with the speed $\bar{v} = c \pm v$, the same vawelength $\bar{\lambda} = \lambda$ and a frequency $\bar{\nu} = (c \pm v)/\lambda$. In the frame K^* the package is absorbed by the atoms of the measuring instruments and immediately reemitted with the speed c relative to K^*. The frequency in the frame K^* is the same as in $\bar{K}$ resulting a wavelength $\lambda^* = c/\nu^* = c/\bar{\nu}$ or

$$\lambda^* = \frac{c}{c \pm v}\,\lambda \qquad\qquad \nu^* = \frac{c \pm v}{\lambda} \tag{28}$$

The proposed approach unifies the frames $\bar{K}$ and K^* defining that the packages move from their source in frame K through space with the speed $c \pm v$ relative to the frame K^* of the instruments.

The Standard Model unifies the frames K and $\bar{K}$ to one frame defining that the packages (photons) move already from their source through space with speed c relative to the frame K^* where the measuring instruments are located. This gives the impression that an absolute frame (aether) must exist for the photons to move always with ligth speed c independent of their sources. The SM arrives to the same equations (28).

For the Standard Model the length of a package in space (length of the wave train or coherence length) is $l = (c \pm v)\tau$ while for the present approach it is $l = c\ \tau$ (τ is the time needed for traversing the coherence length l), which is independent of the relative speed v .

In the proposed approach packages with equal distances between their FPs (equal λ) but with different speeds $c \pm v$ from a star rotating around a neutron star (Astrometric binaries) may arrive simultaneously and produce two spectroscopic lines at the same time corresponding to the two speeds.

The theories normally known as "Emission Theories" analysed by Willem de Sitter and Daniel Frost Camstock are theories that are a mixture of the Standard Model and the proposed approach and don't see light as a train of independent packages (photons).

6 Findings.

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

Based on the findings of the authors "Emission & Regeneration" Unified 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 fact 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.
- 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* as done in the proposed approach, 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 real reference frames as explained in [7], and not because of time dilation .
- 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 equations based on speed variables are free of time dilation 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 proposed 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.

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