Relativity. Exclusively a speed problem.

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Abstract

Special Relativity derived by Einstein is a mathematical approach with the unphysical results of time dilation, length contraction and light speed independent of its source. This paper presents an approach where the Lorenz transformations are build exclusively on equations with speed variables instead of the mix of space and time variables and, where the interaction with the measuring instrument is taken into consideration. The results are transformation rules between inertial frames that are free of time dilation and length contraction. The equations derived for the momentum, energy and the Doppler effect are the same as those obtained with special relativity. The present work shows the importance of including the characteristics of the measuring equipment in the chain of physical interactions to avoid unphysical results.

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.

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

The physical interactions omitted by Einstein are:

- photons are emitted with light speed c relative to their source
- photons emitted with c in one frame that moves with the speed v relative to a second frame, arrive to the second frame with speed $c \pm v$.
- photons with speed $c \pm v$ are reflected with c relative to the reflecting surface
- photons refracted into a medium with $n = 1$ move with speed c independent of the speed they had in the first medium with $n \neq 1$.

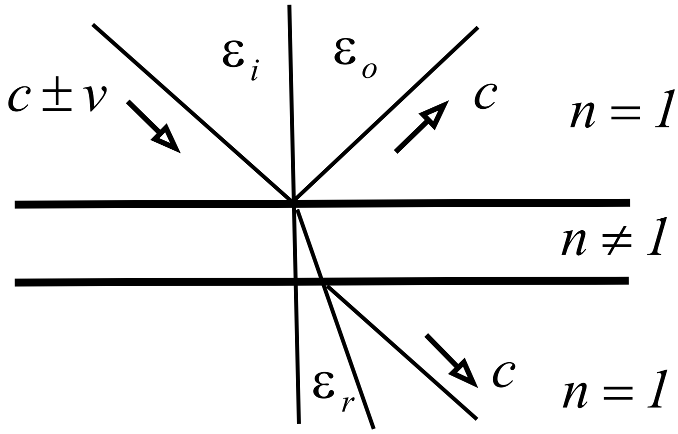

Figure 1: Light speed at reflections and refractions

The concept is shown in Fig. 1

The Lorenz transformation applied exclusively on speed variables, as shown in the proposed approach, is formulated with absolute time and space for all frames and takes into account the physical interactions at measuring instruments which produce the constancy of the measured 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. 2.

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

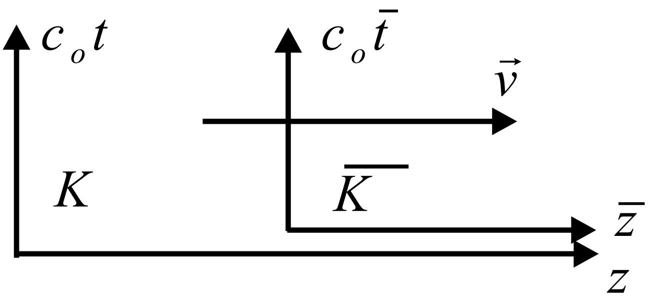

Figure 2: Transformation frames for **space-time** variables

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

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

The fact of equal light speed in all inertial frames is basically a speed problem and not a space and 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** $(\Delta t)^2 = (\Delta \bar{t})^2$ and introducing the forth speed v_c we have

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

The forth speed v_c introduced is the speed of the photons emitted by a light source placed at the frame K. The speed v_c is independent of the speeds v_x, v_y and v_z, forming together a four dimensional speed frame.

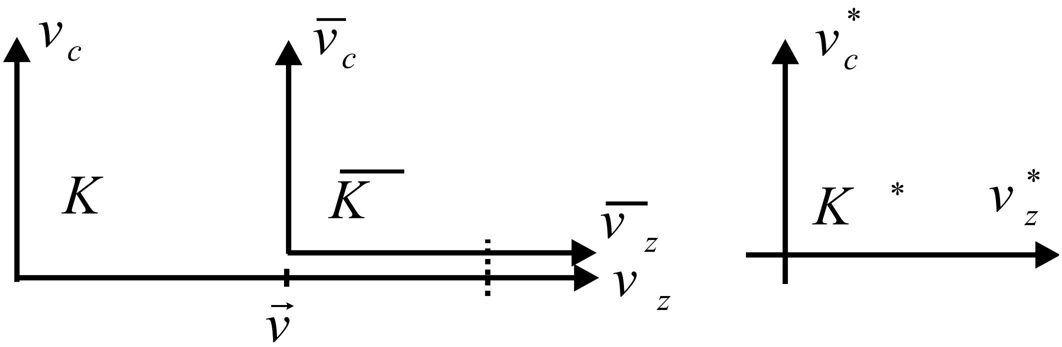

Figure 3: Transformation frames for **speed** variables

For the Lorentz transformation with speed variables as shown in Fig.3 we get the following transformation rules between the source frame K and the virtual frame $\bar{K}$:

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

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

c) $\bar{v}_z = (v_z - v)\ \gamma_v$ $\qquad$ $v_z = (\bar{v}_z + v)\ \gamma_v$

d) $\bar{v}_c = (v_c - \frac{v}{v_c}\ v_z)\ \gamma_v$ $\qquad$ $v_c = (\bar{v}_c + \frac{v}{\bar{v}_c}\ \bar{v}_z)\ \gamma_v$

with $\quad \gamma_v = [1 - v^2/v_c^2]^{-1/2}$

2.1 Transformations for momentum and energy of a particle.

For $v_z = 0$ and $v_c = c$, where c is the light speed, we get

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

c) $\bar{v}_z = -v\ \gamma_v$ $\qquad$ d) $\bar{v}_c = c\ \gamma_v$

The case $v_z = 0$ is the case of a particle placed at the origin of the frame K. The momentum and the energy of the particle in the frame $\bar{K}$ are given by

$$\bar{p} = m\ \bar{v}_z = -m\ v\gamma_v \qquad \bar{E} = mc\ \bar{v}_c = mc\ c\gamma_v = \sqrt{E_o^2 + E_p^2} \tag{6}$$

$$E_o = mc^2 \qquad \textit{and} \qquad E_p = mc\bar{v}_z = mc\ v\gamma_v \tag{7}$$

As the speed v_z in the frame K is parallel to the relative speed v between the frames, equal values for the momentum and the energy must result if we exchange the speeds, with the particle now moving with v in the frame K and the relative speed between the frames v_z. That we obtain multiplying the transformed speeds $\bar{v}_i$ with γ_{v_z}

$$\gamma_{v_z} = \left[1 - v_z^2/v_c^2\right]^{-1/2} \tag{8}$$

We get for the general case with $v_z \neq 0$ the momentum and the energy in the frame $\bar{K}$

$$\bar{p} = m\ \bar{v}_z\gamma_{v_z} = m\ (v_z - v)\gamma_v\gamma_{v_z} \qquad \bar{E} = mc\ \bar{v}_c\gamma_{v_z} = mc\ (v_c - \frac{v}{v_c}v_z)\gamma_v\gamma_{v_z} \tag{9}$$

2.2 Transformations for electromagnetic waves at measuring instruments .

According to the present approach measuring instruments are composed of an interface and the signal comparing part. Interfaces are optical lenses, mirrors or electric antennas.

The concept is shown in Fig.4

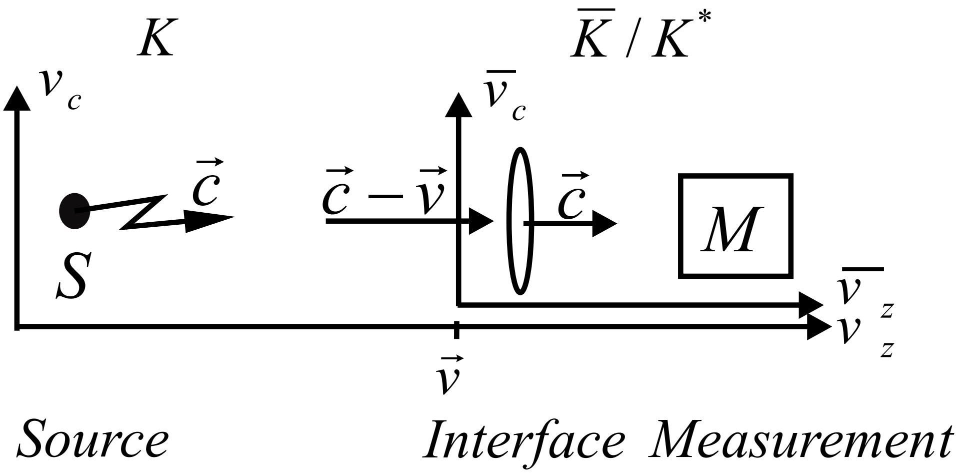

Figure 4: Transformation at measuring equipment's interface

Electromagnetic waves that are emitted with the speed c_o from its source, arrive to a relative moving frame of the measuring instrument with speeds different than light speed, are then absorbed by the atoms of the interface and emitted with light speed c_o from the interface to the signal comparing part.

To take account of the behaviour of light in measuring instruments an additional transformation is necessary.

In Fig 4 the instruments are placed in the frame K^* which is linked rigidly to the *virtual* frame $\bar{K}$. Electromagnetic waves from the source frame K move with the real speed $\bar{v}_{r_z} = c_o \pm v$ in the *virtual* frame $\bar{K}$. The real velocity $\bar{v}_{r_z}$ can take values that are bigger than the light speed c_o.

The links between the frames for an electromagnetic wave that moves with c_o in the frame K are:

	$\mathbf{K}$	$\bar{\mathbf{K}}$	$\overset{*}{\mathbf{K}}$
e)	λ_z	$\bar{\lambda} = \lambda_z$	
f)	$v_z = c_o$	$\bar{v}_{r_z} = c_o \pm v$	$v_z^* = c_o$
g)	$f_z = c_o/\lambda_z$	$\bar{f}_{r_z} = \bar{v}_{r_z}/\lambda_z$	
h)		$\bar{f}_z = \bar{f}_{r_z}\,\gamma$	$f_z^* = \bar{f}_z$

i) $\quad E = h\, f_z \qquad \bar{E} = h\, \bar{f}_z \qquad E_z^* = h\, f_z^*$

e) shows the link between the frames K and $\bar{K}$. The wavelengths $\lambda_z = \bar{\lambda}_z$ because there is **no length contraction**.
f) shows the real Galilean speed $\bar{v}_{r_z}$ in frame $\bar{K}$.
g) shows the real frequency $\bar{f}_{r_z}$ in the frame $\bar{K}$.
h) shows the virtual frequency $\bar{f}_z$ in the frame $\bar{K}$ and the link to the frequency f^* of the frame K^*.
i) shows the equation for the energy of a photon for each frame.

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

Following, equations for physical magnitudes are derived for particles with rest mass $m \neq 0$ that are measured in 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, because of conservations of momentum and energy between rigid linked frames.

3.1 Linear momentum.

To calculate the linear momentum in the virtual frame $\bar{K}$ of a particle moving in the source frame K with v_z and $v_x = v_y = 0$ we use the equation $c)$ of sec 2, with $v_c = c_o$. From (9) we define that

$$\bar{v}_z' = (v_z - v)\gamma_{v_z}\gamma_v \tag{10}$$

The linear momentum $\bar{p}_z$ we get multiplying $\bar{v}_z'$ with the rest mass m of the particle and which is simply a proportionality factor.

$$\bar{p}_z = m\, \bar{v}_z' = m\, (v_z - v)\gamma_{v_z}\gamma_v = p_z^* \tag{11}$$

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

Note: Eq. (11) is the same equation as derived with special relativity.

3.2 Acceleration.

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

$$\bar{a}_z = \frac{d\bar{v}_z^{'}}{dt} \qquad with \qquad \bar{v}_z^{'} = \bar{v}_z\ \gamma_{v_z} = (v_z - v)\gamma_v \gamma_{v_z} \tag{12}$$

what gives for $v_z(t)$ and $\gamma_{v_z}(t)$

$$\bar{a}_z = \frac{d\bar{v}_z^{'}}{dt} = \frac{d\bar{v}_z}{dt}\gamma_{v_z} + \bar{v}_z \frac{d\gamma_{v_z}}{dt} = \frac{dv_z}{dt}\ \gamma_{v_z}\gamma_v + (v_z - v)\gamma_v\ \frac{d}{dt}\gamma_{v_z} \tag{13}$$

From momentum conservation $p_z^* = \bar{p}_z$ we have that

$$\bar{a}_z = a_z^* \tag{14}$$

3.3 Energy.

To calculate the energy in the virtual frame $\bar{K}$ for a particle that moves with v_z in the frame K we use the equation $d)$ of sec 2, with $v_c = c_o$.

$$\bar{v}_c = \frac{v_c - \dfrac{v}{v_c}\ v_z}{\sqrt{1 - v^2/v_c^2}} = (v_c - \frac{v}{v_c}\ v_z)\gamma = \bar{v}_{r_c}\ \gamma \tag{15}$$

To get the energy in the frame $\bar{K}$ we multiply $\bar{v}_c$ with $mc\gamma_{v_z}$. See also eq. (9). We get

$$\bar{E} = mc\ \bar{v}_c \gamma_{v_z} = mc\ (v_c - \frac{v}{v_c} v_z)\gamma_v \gamma_{v_z} \tag{16}$$

Note: Eq. (16) is the same equation as derived with special relativity.

With $v_z = 0$ we get

$$\bar{E} = \frac{m\ c_o^2}{\sqrt{1 - v^2/c_o^2}} = \sqrt{E_o^2\ +\ \bar{E}_p^2} \tag{17}$$

with

$$\bar{E}_p = m\ |\bar{v}_z|\ c_o = |\bar{p}_z|\ c_o \qquad \bar{v}_z = v_z\ \gamma_{v_z} \qquad E_o = m\ c_o^2 \tag{18}$$

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 $v_z = 0$.

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 rest 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 $\bar{K}$.

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

In this section the equations for electromagnetic waves observed from an inertial frame that moves with the relative speed v are derived.

4.1 Relativistic Doppler effect.

To calculate the energy of a photon in the virtual frame $\bar{K}$ that moves with $v_z = c_o$ in the frame K we use the same equation $d)$ of sec 2 used for particles with $m \neq 0$, with $v_z = c_o$ and $v_c = c_o$. We get

$$\bar{v}_c = \frac{v_c - \dfrac{v}{v_c}\, v_z}{\sqrt{1 - v^2/v_c^2}} = (c_o - v)\gamma_v \tag{19}$$

Note: As the energy of a photon is a function of the frequency, the energy in the frame $\bar{K}$ is not afected by the non linear factor γ_z.

The momentum of a photon in the frame K is $p_c = E_{ph}/c_o = h\ f/c_o$ which we multiply with $\bar{v}_c$ to get the energy of the photon in the frame $\bar{K}$. The transformation of the energy between the frames $\bar{K}$ and K^* is $E^* = \bar{E}$ and we get:

For the measuring instrument moving away from the source

$$\bar{E} = p_c\ \bar{v}_c = \frac{E_{ph}}{c_o}\ (c_o - v)\ \gamma_v = E_{ph}\ \frac{\sqrt{c_o - v}}{\sqrt{c_o + v}} = E^* = h\ f^* \tag{20}$$

With $E_{ph} = h\ f$ we get the well known equation for the relativistic Doppler effect

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

and with $c_o = \lambda\ f$ and $c_o = \lambda^*\ f^*$ we get the other well known equation for the relativistic Doppler effect

$$\frac{\lambda}{\lambda^*} = \frac{\sqrt{1 - v/c_o}}{\sqrt{1 + v/c_o}} \tag{22}$$

No transversal relativistic Doppler effect exists.

Note: Eq. (21) is the same equation as derived with special relativity.

Note: The real frequency $\bar{f}_{r_z}$ in the frame $\bar{K}$ is given by the Galilean speed $\bar{v}_{r_z} = c_o \pm v$ divided by the wavelength $\bar{\lambda} = \lambda$. The energy of a photon in the frame $\bar{K}$ is given by the equation $\bar{E}_{ph} = h\ \bar{f}_z$ where $\bar{f}_z = \bar{f}_{r_z}\ \gamma$, with $\bar{f}_{r_z} = (c_o \pm v)/\lambda_z$ the real frequency of particles in the frame $\bar{K}$.

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 Transformation steps for photons from emitter to receiver.

Electromagnetic signals (photons) have to pass an interface at the receiver until a measurement can be made. The interface is an optical lense, a mirror or an antenna. The signals undergo two transformations when travelling from the emitter to the receiver. The first transformation occurs before the interface and the second behind the interface. The concept is shown in Fig.4

If we assume that the emitters signal in the K frame is

$$c = \lambda\, f \tag{23}$$

the signal before the interface of the receiver in the $\bar{K}$ frame is, for the case of the measuring instrument moving away from the source

$$\bar{f} = f\, \frac{\sqrt{c-v}}{\sqrt{c+v}} \qquad and \qquad \bar{\lambda} = \lambda \qquad and \qquad \bar{v}_z = c - v \tag{24}$$

At the output of the interface we get the signal in the K^* frame that is finally processed by the receiver.

$$f^* = f\, \frac{\sqrt{c-v}}{\sqrt{c+v}} \qquad and \qquad \lambda^* = \lambda\, \frac{\sqrt{c+v}}{\sqrt{c-v}} \qquad and \qquad v_z^* = c \tag{25}$$

At the first transformation the wavelength $\lambda = \bar{\lambda}$ doesn't transform (absolute space) and at the second transformation the frequency $\bar{f} = f^*$ (absolute time).

The speed before the interface $c \pm v$ is the galilean speed which changes to $v_z^* = c$, the speed of light, before the processing in the receiver. This explains why always c is measured in all relative moving frames.

5 Conclusions.

Einstein's SR is a perfect example of a classical theory that doesn't include physical interactions of the measuring instruments. The approach arrives to time dilation and length contraction, what is equivalent to say that time and length remain unchanged but that the *time unit* (second) contracts and the *length unit* (meter) dilates. This violates fundamental principles of theoretical and experimental physics because units must be universally valid for all frames.

Based on the presented approach, the following conclusions about relativity between inertial frames were deduced:

- The fact of equal light speed in all inertial frames is a measurement problem and not a space-time problem. Time and space are absolute variables and equal for all frames according to Galilean relativity.
- Electromagnetic waves are emitted with light speed c_o relative to the frame of the emitting source.
- Electromagnetic waves that arrive at the interfaces of measuring instruments like mirrors, optical lenses or electric antennae are absorbed by the electrons of their atoms and subsequently emitted with light speed c_o relative to the nuclei of the atoms, independent of the speed they have when arriving to the measuring instruments. That explains why always light speed c_o is measured in the frame of the instruments.
- 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 (measuring instruments) and result therefore in space and time distortions. The transformation rules based on speed variables, as done in the proposed approach, take into consideration the physical cause (measuring instruments) and therefore don't present space and time distortions.
- All relevant relativistic equations already known can be deduced with the proposed approach. The transformation rules have no transversal components, nor for the speeds neither for the Doppler effect.
- The speed v_c of the fourth orthogonal coordinate gives the speed of the photons reflected, refracted or emitted by the light source.
- Particles with rest mass are more stable when moving relative to masses of real reference frames because of the electromagnetic interactions wit them, and not because of time dilation. An example are Muons moving through the atmosphere.

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

The present work shows how the characteristics of the measuring equipment must be integrated in the chain of interactions to avoid unnatural conclusions like time dilation and length contraction.

6 Bibliography.

Note: The present work is based on a completely new approach to explain the constancy of light speed in inertial frames and correspondingly no reference papers exist.

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