# The Symmetric Lorentz Transformations

(Symmetric Special Relativity)

*The purpose of this paper is to introduce the Symmetric Lorentz transformations. These new transformation equations are the foundations of a new theory of relativity called: Symmetric Special Relativity. In this paper several issues are analysed. Firstly, I derive the formula for time dilation. Secondly, I derive the formula for length contraction. Thirdly, I derive a new relativistic velocity composition formula which encompasses part of Einstein's counterpart. Fourthly, I prove that Newton's law of Universal Gravitation is invariant under the new transformation. Fifthly, I prove that the leptobaryonic formula for the fine-structure constant is invariant under the transformation. Lastly, I mention that the de Broglie formula is not invariant under the transformation (the proof is not included in this article). It seems both the Lorentz transformation and the Symmetric Lorentz transformation can indicate whether a given classical mathematical description of nature is relatively accurate in its respective domain (e.g. Maxwell's equations are invariant under a Lorentz transformation while Newton's Gravity Law is invariant under a Symmetric Lorentz transformation). Therefore, the two transformations complement each other. One marvellous advantage of having "complementary" transformations is that we can take advantage of them.*

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## 1. Introduction

The Lorentz transformation equations are the mathematical framework of Einstein's Special Theory of Relativity. Despite the fact that the Lorentz transformations are generally attributed to H. A. Lorentz, they were discovered by W. Voigt in 1887 and published in 1904. This means that the transformations were discovered before the Special Theory of Relativity [1] was born. These transformations reduce to the Galilean equations when the velocity of the body, $v$, is small compared to the speed of light, $c$. A law of physics could be invariant under a given transformation but it could turn out to be not invariant under a different set of transformations. Acceleration, for example, is invariant under a Galilean transformation but is not invariant under a Lorentz transformation. In contrast, Maxwell's equations of electromagnetism are not invariant under a Galilean transformation but they are invariant under a Lorentz transformation. The Lorentz transformations are shown in Table 1.

| Lorentz Transformations<br>*Direct transformations*<br>(Values of system $S'$ in terms of values of system $S$ ) | Lorentz Transformations<br>*Inverse transformations*<br>(Values of system $S$ in terms of values of system $S'$ ) |
|---|---|
| $x' = \frac{x - v t}{\sqrt{1-\beta^2}}$ (1.1)<br>$y' = y$ (1.2)<br>$z' = z$ (1.3)<br>$t' = \frac{t - \frac{v x}{c^2}}{\sqrt{1-\beta^2}}$ (1.4) | $x = \frac{x' + v t'}{\sqrt{1-\beta^2}}$ (1.5)<br>$y = y'$ (1.6)<br>$z = z'$ (1.7)<br>$t = \frac{t' + \frac{v x'}{c^2}}{\sqrt{1-\beta^2}}$ (1.8) |

**TABLE 1:** *The Lorentz transformations of coordinates.*

I shall call *direct transformations* the set of equations containing minus signs (first column of Table 1) in the numerator, and *inverse transformations* the set containing plus signs (second column of Table 1). The problem with the Lorentz transformations is that they are classical, meaning that they cannot be applied to the quantum world which is characterized by both a minimum quantum distance, $L_P$ , and a minimum quantum time, $T_P$ . I have corrected this problem in three articles I published online recently [2, 3, 4]. Another point to observe is that the transformations assume a relative velocity vector, $\vec{v}$ , between two inertial reference systems: $S$ and $S'$, parallel to one of the three Cartesian coordinates axes of system $S$ (normally parallel to the $x$-axis). Despite this fact, the Lorentz transformations seem to be the correct set of equations simply because the spacetime interval, $s$, which is defined through the relation

$$s^2 = x^2 + y^2 + z^2 - c^2 t^2 \tag{1.9}$$

is invariant under the transformation. In the next section I shall modify the transformations so that the velocity vector $\vec{v}$ can have any arbitrary direction. This new set of equations are the Symmetric Lorentz Transformations (*SLT*). Then I shall show that the new transformations are useful in an unexpected way. **Appendix 1** contain the nomenclature used in this paper, **Appendix 2** contains a glossary and **Appendix 3** contains the meaning of symmetry in the context of these transformations.

## 2. The Symmetric Lorentz Transformations

The "Symmetric Lorentz Transformations" are a symmetrical version of the original Lorentz transformations. I shall refer to **Figure 1** for the remainder of this section. In the new transformations the direction of the velocity vector, $\vec{v}$, in general, does not coincide with any of the coordinate axes of system *S*. Let us begin by considering two Cartesian coordinate systems: system *S* and system *S′*. We assume that system *S′* moves at a constant speed *v* (*yellow arrow*) along an arbitrary direction (*yellow dash line*) with respect to system *S*. We also assume that, in general, this direction does not coincide with any of the coordinate axes of system *S* or system *S′*. We shall also consider a point *P* (*blue point*) that represents the centre of mass of a rocket that moves along a straight line (*blue dash line*) at a constant speed *u′* with respect to system *S′* and at constant speed *u* with respect to system *S*. We also have two observers: an observer in system *S* called John (also known as observer *O*) and another observer in system *S′* called Sophia (also known as observer *O′*).

These two observers will describe the same event differently (for example the length of an object, the time interval of an event, etc.)

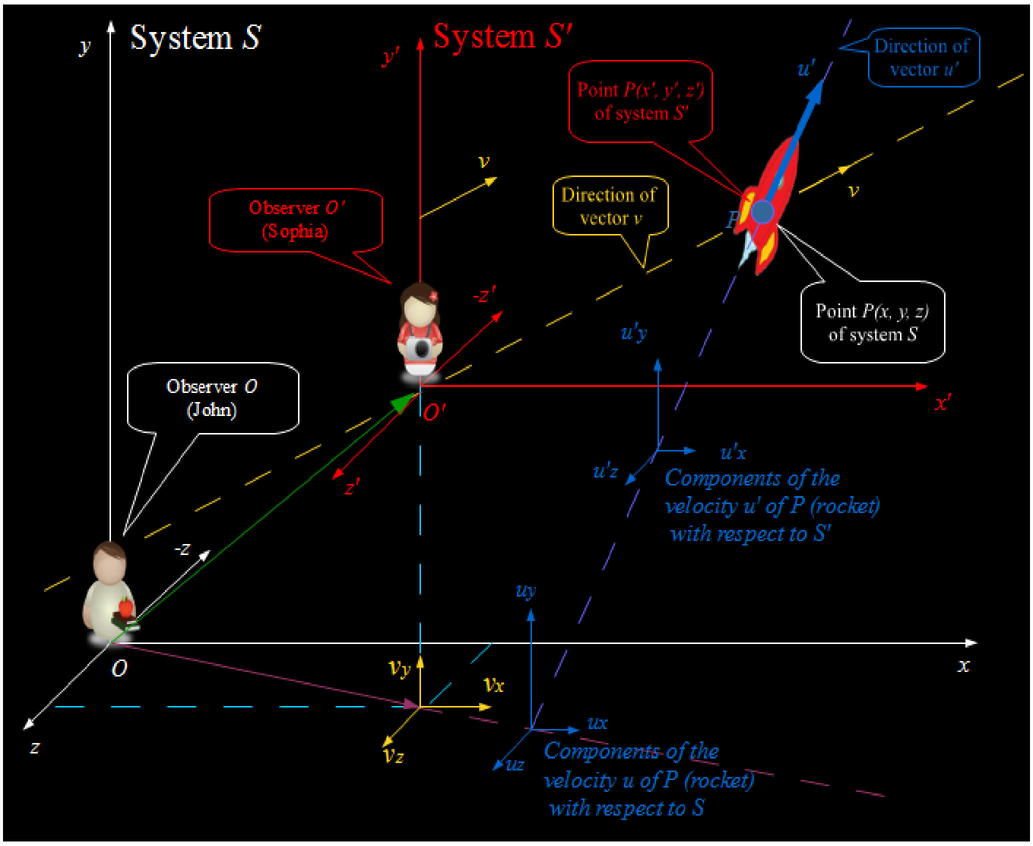


**FIGURE 1:** *Reference system S′ moves along the straight yellow dash line at a constant speed v in an arbitrary direction with respect to system S. Vector components are no to scale.*

The velocity $\vec{v}$ is the velocity of system *S′* with respect to system *S*. We assume that this velocity is constant and its module, *v*, can be expressed in terms of its components: $v_x, v_y$ and $v_z$ through the following formula

$$v=\sqrt{v_x^2+v_y^2+v_z^2} \tag{2.1}$$

These components are constant because we have assumed that $\vec{v}$ is a constant vector. It is worthwhile to observe that, in general, the direction of the vector $\vec{v}$ does not coincide with any of the coordinates axes of system *S*. In order to simplify the equations and the derivations I shall also use two standard parameters:

(a) $\beta$ , which is defined as

$$\beta = \frac{v}{c} \tag{2.2}$$

and:

(b) $\gamma$ , the Lorentz factor, which is a scale factor (or scaling factor) [5]. This factor is defined as

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{1}{\sqrt{1-\beta^2}} \tag{2.3}$$

Let us assume that Sophia (system *S'*) describes an event though a set of numbers: ($x'$, $y'$, $z'$, $t'$). Let us also assume that John (system *S*) describes the same event though another set of numbers ($x$, $y$, $z$, $t$). The problem is to find the relationship between these two set of numbers when these two observers are in relative uniform motion, so that, Sophia moves in any arbitrary direction (*yellow dash line*) with respect to John. The relationships we are looking for are the "Symmetric Lorentz Transformations". These transformations are given, without proof, in Table 2.

(Continue on the next page)

| Symmetric Lorentz Transformations<br>*Direct transformations*<br>(Values of system $S'$ in terms of values of system $S$ ) | | Symmetric Lorentz Transformations<br>*Inverse transformations*<br>(Values of system $S$ in terms of values of system $S'$ ) | |
|---|---|---|---|
| $x' = \dfrac{x - v_x t}{\sqrt{1-\beta^2}} = \gamma\left(x - v_x t\right)$ | (2.4) | $x = \dfrac{x' + v_x t'}{\sqrt{1-\beta^2}} = \gamma\left(x' + v_x t'\right)$ | (2.8) |
| $y' = \dfrac{y - v_y t}{\sqrt{1-\beta^2}} = \gamma\left(y - v_y t\right)$ | (2.5) | $y = \dfrac{y' + v_y t'}{\sqrt{1-\beta^2}} = \gamma\left(y' + v_y t'\right)$ | (2.9) |
| $z' = \dfrac{z - v_z t}{\sqrt{1-\beta^2}} = \gamma\left(z - v_z t\right)$ | (2.6) | $z = \dfrac{z' + v_z t'}{\sqrt{1-\beta^2}} = \gamma\left(z' + v_z t'\right)$ | (2.10) |
| $t' = \gamma\left(t - \dfrac{v^2 x}{c^2 v_x}\right) = \gamma\left(t - \beta^2 \dfrac{x}{v_x}\right)$ | (2.7a) | $t = \gamma\left(t' + \dfrac{v^2 x'}{c^2 v_x}\right) = \gamma\left(t' + \beta^2 \dfrac{x'}{v_x}\right)$ | (2.11a) |
| $t' = \gamma\left(t - \dfrac{v^2 y}{c^2 v_y}\right) = \gamma\left(t - \beta^2 \dfrac{y}{v_y}\right)$ | (2.7b) | $t = \gamma\left(t' + \dfrac{v^2 y'}{c^2 v_y}\right) = \gamma\left(t' + \beta^2 \dfrac{y'}{v_y}\right)$ | (2.11b) |
| $t' = \gamma\left(t - \dfrac{v^2 z}{c^2 v_z}\right) = \gamma\left(t - \beta^2 \dfrac{z}{v_z}\right)$ | (2.7c) | $t = \gamma\left(t' + \dfrac{v^2 z'}{c^2 v_z}\right) = \gamma\left(t' + \beta^2 \dfrac{z'}{v_z}\right)$ | (2.11c) |

**TABLE 2:** *The "Symmetric Lorentz transformations" of coordinates. Note that equations (2.7a), (2.7b) and (2.7c) yield the same value of time t'. Similarly, equations (2.11a), (2.11b) and (2.11c) yield the same value of time t. It is worthwhile to remark that if* $v_x$ *(or* $v_y$ *, or* $v_z$ *) approaches zero, then x (or y, or z) will also approach zero. The equations are valid for* $v_x > 0, v_y > 0$ *and* $v_z > 0$.

Because there are three + three different spatial transformation equations (three direct eq: 2.4, 2.5 and 2.6; and three inverse eq: 2.8, 2.9 and 2.10), and three + three equivalent time transformation equations (Three direct eq: 2.7a, 2.7b y 2.7c; and three inverse eq: 2.11a, 2.11b y 2.11c), the "Symmetric Lorentz Transformations" are symmetric transformations with respect to space and time (See **Appendix 3**). For this reason these transformations are called: *symmetric*. In section 5 we shall see that this formulation produces symmetrical velocity composition formulas for each coordinate axis. Hence the name: *Symmetric Special Relativity.*

## 3. Derivation of the Time Dilation Formula from the Symmetric Lorentz Transformations

For this derivation I shall use the inverse Symmetric Lorentz transformation (2.11a) of Table 2.

$$t = \gamma\left(t' + \frac{v^2 x'}{c^2 v_x}\right) \qquad \text{(Equation 2.11a)}$$

It is worthwhile to remark that we could have also used either transformation (2.11b) or transformation (2.11c) to get the same result. From equation (2.11a) we calculate the beginning of the time interval, $t_1$

$$t_1 = \gamma\left(t'_1 + \frac{v^2 x'_1}{c^2 v_x}\right) \qquad \text{(beginning of the time interval)} \qquad (3.1)$$

and the end of the time interval, $t_2$

$$t_2 = \gamma\left(t'_2 + \frac{v^2 x'_2}{c^2 v_x}\right) \qquad \text{(end of the time interval)} \qquad (3.2)$$

Then we calculate the time interval $t_2 - t_1$ measured by an observer of system *S* (John)

$$t_2 - t_1 = \gamma\left[t'_2 + \frac{v^2 x'_2}{c^2 v_x} - \left(t'_1 + \frac{v^2 x'_1}{c^2 v_x}\right)\right] \qquad (3.3)$$

$$t_2 - t_1 = \gamma\left[t'_2 - t'_1 + \left(x'_2 - x'_1\right)\frac{v^2}{c^2 v_x}\right] \qquad (3.4)$$

Because the time measurements are made at the same location, the difference of the space coordinates must be zero. Consequently, we write

$$x'_2 - x'_1 = 0 \qquad (3.5)$$

With this simplification, equation (3.4) reduces to

$$t_2 - t_1 = \frac{t'_2 - t'_1}{\sqrt{1-\beta^2}} \qquad (3.6)$$

But the time difference $t_2 - t_1$ is the time interval, *t*, measured by an observer of system *S* (John)

$$t_2 - t_1 = t \qquad (3.7)$$

And the time difference $t'_2 - t'_1$ is the time interval, $t_0$, measured by an observer of system *S′* (Sophia)

$$t'_2 - t'_1 = t_0 \qquad (3.8)$$

From equations (3.6), (3.7) and (3.8) we finally get

$$t = \frac{t_0}{\sqrt{1-\beta^2}} \tag{3.9}$$

This formula is the Einstein's time dilation formula. Thus Special Relativity and Symmetric Special Relativity yield the same result with respect to time dilation.

# 4. Derivation of the Length Contraction Formula from the Symmetric Lorentz Transformations

Let us assume that Sophia has a sphere of diameter $d' = d_0$ which is at rest with respect to her (we can imagine that the rocket shown in **Figure 1** has been replaced by a sphere). The problem is to find a formula for the sphere's diameter, *d,* measured by John for whom the sphere travels through space with a relatively high velocity *v.* Let us begin by finding the diameter, measured by Sophia, in the direction of motion, which is the direction of the velocity vector $\vec{v}$ (*green dash line*). The diameter Sophia measures is given by

$$d'^2 = d_0^2 = \left(x'_2 - x'_1\right)^2 + \left(y'_2 - y'_1\right)^2 + \left(z'_2 - z'_1\right)^2 \tag{4.1}$$

Using the Symmetric Lorentz Transformations we rewrite equation (4.1) in terms of $x_1, x_2, y_1, y_2, z_1$ and $z_2$ . This yields

$$d_0^2 = \left[\gamma\left(x_2 - v_x t_2\right) - \gamma\left(x_1 - v_x t_1\right)\right]^2 + \left[\gamma\left(y_2 - v_y t_2\right) - \gamma\left(y_1 - v_y t_1\right)\right]^2 + \left[\gamma\left(z_2 - v_z t_2\right) - \gamma\left(z_1 - v_z t_1\right)\right]^2 \tag{4.2}$$

working algebraically we get

$$d_0^2 = \gamma^2\left[\left[x_2 - x_1 - v_x\left(t_2 - t_1\right)\right]^2 + \left[y_2 - y_1 - v_y\left(t_2 - t_1\right)\right]^2 + \left[z_2 - z_1 - v_z\left(t_2 - t_1\right)\right]^2\right] \tag{4.3}$$

Because all measurements are made at the same time we have

$$t_2 - t_1 = 0 \tag{4.4}$$

Thus equation (4.3) reduces to

$$d_0^2 = \gamma^2\left[\left(x_2 - x_1\right)^2 + \left(y_2 - y_1\right)^2 + \left(z_2 - z_1\right)^2\right] \tag{4.5}$$

But the quantity within the square bracket is the square of the diameter, $d^2$ , measured by an observer of system *S.*

$$d^2 = \left(x_2 - x_1\right)^2 + \left(y_2 - y_1\right)^2 + \left(z_2 - z_1\right)^2 \tag{4.6}$$

Thus from equations (4.5) and (4.6) we can write

$$d_0 = \gamma d \tag{4.7}$$

$$d = \frac{d_0}{\gamma} \tag{4.8}$$

$$d = d_0 \sqrt{1 - \beta^2} \tag{4.9}$$

This is the length contraction formula of this formulation. It is worthwhile to remark that, according to this formulation, the sphere will contract in all directions and not only in the direction of one of the axes. In contrast, Special Relativity cannot predict this effect since only contemplates motion along one and only one coordinate axis. Thus, Sophia's sphere (system $S'$) will still appear to be a sphere to John (from system $S$), although he will see a smaller sphere due to the relativistic length contraction effect caused by the relative motion between the two observers. This result can be easily derived by carrying out a similar analysis in any other direction of space (different to the direction of vector $\vec{v}$ ).

## 5. Relativistic Velocity Composition (or "Addition")

In non-relativistic physics the velocities are added according to the formula: $u = u' + v$ . But in both Special Relativity and Symmetric Special Relativity the velocities must be "added" using more complex and counter-intuitive formulas. The purpose of this section is to find these formulas.

Let us start by defining the velocities of the point $P$ (the coordinates of $P$ could represent the coordinates of the centre of mass of a spaceship travelling trough space at a speed close to the speed of light, perhaps at 0.9c or so) with respect to each coordinate system, $S'$ and $S$. Thus, if $(x', y', z', t')$ and $(x, y, z, t)$ refer to a moving point $P$, their velocities with respect to system $S'$ and system $S$ are $u'$ and $u$, respectively (See Figure 1). The components of these two velocities are shown in Table 3.

| Components of the velocity $u'$ of point $P$ (rocket) with respect to system $S'$ | Components of the velocity $u$ of point $P$ (rocket) with respect to system $S$ |
|---|---|
| $u'_x = \dfrac{dx'}{dt'}$ (5.1a) | $u_x = \dfrac{dx}{dt}$ (5.2a) |
| $u'_y = \dfrac{dy'}{dt'}$ (5.1b) | $u_y = \dfrac{dy}{dt}$ (5.2b) |
| $u'_z = \dfrac{dz'}{dt'}$ (5.1c) | $u_z = \dfrac{dz}{dt}$ (5.2c) |

**TABLE 3:** *Components of the velocity of the point P with respect to both system S′ and S.*

## a) Derivation of the Velocity Composition Formula: $u_x = f\left(u'_x, v_x, v\right)$

Now we shall find the expression for the component, $u_x$ , along the $x$ axis, of the velocity, $\vec{u}$ , of the point $P$ (representing the rocket) with respect to system $S$

$$u_x = \frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} \tag{5.3}$$

$$\Delta x = \gamma\left(\Delta x' + v_x \Delta t'\right) \tag{5.4}$$

$$\Delta t = \gamma\left(\Delta t' + \frac{v^2}{c^2 v_x} \Delta x'\right) \tag{5.5}$$

$$u_x == \lim_{\Delta t \to 0} \frac{\gamma\left(\Delta x' + v_x \Delta t'\right)}{\gamma\left(\Delta t' + \frac{v^2}{c^2 v_x} \Delta x'\right)} \tag{5.6}$$

Dividing numerator and denominator by $\Delta t'$ yields

$$u_x = \lim_{\Delta t \to 0} \frac{\left(\frac{\Delta x'}{\Delta t'} + v_x\right)}{\left(1 + \frac{v^2}{c^2 v_x} \frac{\Delta x'}{\Delta t'}\right)} \tag{5.7}$$

Finally we get the relativistic composition of velocities of Symmetric Special Relativity

Symmetric Special Relativity's velocity “addition” formula

$$u_x = \frac{\left(u'_x + v_x\right)}{\left(1 + \frac{v^2 u'_x}{c^2 v_x}\right)} \tag{5.8}$$

In similar way we get

$$u'_x = \frac{\left(u_x - v_x\right)}{\left(1 - \frac{v^2 u_x}{c^2 v_x}\right)} \tag{5.9}$$

### *Special Case: Special Relativity*

Let us examine the special case when the components of $v$ along the $y$ and the $z$ axes are zero If $v_y = v_z = 0$ , then according to equation (2.1) the direction of the velocity of system $S'$ with respect to system $S$ turns out to be along the $x$ axis. Thus

$$v = v_x \tag{5.10}$$

This means that equation (5.8) can be simplified as follows

$$u_x = \frac{(u'_x + v)}{\left(1 + \frac{v^2}{c^2 v} u'_x\right)} \tag{5.11}$$

and hence we get

$$u_x = \frac{(u'_x + v)}{\left(1 + \frac{u'_x v}{c^2}\right)} \tag{5.12}$$

This is the formula for the composition of velocities of Einstein's Special Relativity.

## b) Derivation of the Velocity Composition Formula: $u_y = f(u'_y, v_y, v)$

By applying a similar mathematical treatment as we did before we get the velocity component, $u_y$ , along the $y$ axis

$$u_y = \frac{(u'_y + v_y)}{\left(1 + \frac{v^2 u'_y}{c^2 v_y}\right)} \tag{5.13}$$

## c) Derivation of the Velocity Composition Formula: $u_z = f(u'_z, v_z, v)$

By applying a similar mathematical treatment as we did before we get the velocity component, $u_z$ , along the $z$ axis

$$u_z = \frac{(u'_z + v_z)}{\left(1 + \frac{v^2 u'_z}{c^2 v_z}\right)} \qquad (5.14)$$

## d) Comparison of the Velocity Composition Formulas of Special Relativity and Symmetric Special Relativity

Table 4 shows the formulas for the composition of velocities of the two theories.

| Special Relativity | Symmetric Special Relativity |
|---|---|
| $u_x = \frac{u'_x + v}{1 + \frac{u'_x v}{c^2}}$ (5.15a) | $u_x = \frac{u'_x + v_x}{1 + \frac{v^2 u'_x}{c^2 v_x}} = \frac{u'_x + v_x}{1 + \beta^2 \frac{u'_x}{v_x}}$ (5.16a) |
| $u_y = \frac{u'_y}{\beta \left(1 + \frac{u'_x v}{c^2}\right)}$ (5.15b) | $u_y = \frac{u'_y + v_y}{1 + \frac{v^2 u'_y}{c^2 v_y}} = \frac{u'_y + v_y}{1 + \beta^2 \frac{u'_y}{v_y}}$ (5.16b) |
| $u_z = \frac{u'_z}{\beta \left(1 + \frac{u'_x v}{c^2}\right)}$ (5.15c) | $u_z = \frac{u'_z + v_z}{1 + \frac{v^2 u'_z}{c^2 v_z}} = \frac{u'_z + v_z}{1 + \beta^2 \frac{u'_z}{v_z}}$ (5.16c) |

**TABLE 4:** Comparison of the formulas for the composition of velocities for the two theories. The velocities: $u'_x$ , $u'_y$ and $u'_z$ are defined in table 3.

# 6. Invariance of Newton's Law of Universal Gravitation Under a Symmetric Lorentz Transformation

Newton's law of Universal Gravitation has been superseded by Einstein's general relativity. Like all scientific theories, Einstein's theory may one day be superseded by quantum gravity and/or other more accurate and sophisticated gravitational models. In this section I shall show that Newton's Gravity Law is invariant under a Symmetric Lorentz transformation.

Let us consider two masses, $M'$ (depicted as *The Earth*) and $m'$ (depicted as the *Moon*), at rest with respect to system $S'$. Due to relativistic effects, John, measures $M$ and $m$, respectively. The masses are general and they are depicted as the Earth and the Moon for illustrative purposes only.

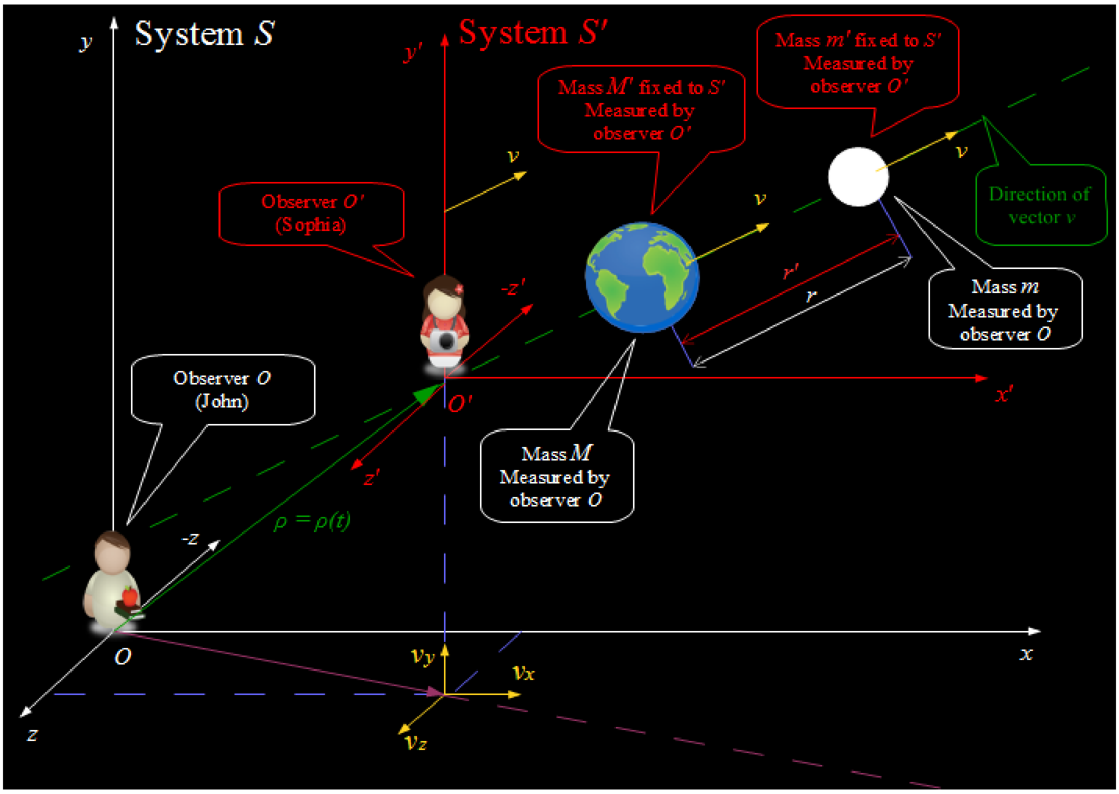


**FIGURE 2:** *Reference system S' moves at a constant speed v along an arbitrary direction with respect To system S (green dash line). The distances, r' and r, between the shown masses, are the distances measured by Sophia and John, respectively. These distances appear to be identical in this figure but, in fact, they are different.*

As we did before, we shall consider the most general case in which the direction of the velocity vector $\vec{v}$ does not coincide with any of the coordinate axes of system *S*. Now let's see whether Newton's law of Universal Gravitation is invariant under a Symmetric Lorentz transformation. Let us begin by considering Newton's Gravity law from the point of view of an observer (John) of reference system *S*

For an observer of system *S* (John)

$$F = \frac{G M m}{r^2} \tag{6.1}$$

Here *r,* the distance between the masses *M* and *m,* is measured by John. According to him the square of this distance is

$$r^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2 \tag{6.2}$$

Where $(x_1, y_1, z_1)$ are the coordinates of the centre of mass *M* and $(x_2, y_2, z_2)$ are the coordinates of the centre of mass *m*. The inverse Symmetric Lorentz Transformations given in Table 1 relate the values of the coordinates (*x, y, z, t*) measured by an observer of system *S* with the corresponding coordinates, ($x'$, $y'$, $z'$, $t'$), measured by an observer of system $S'$.

Now I shall express the square of the distance $r$ in terms of the coordinates of Sophia's reference system ($S'$). To achieve this task I shall substitute, in equation (6.2),

(a) $x_2$ and $x_1$ with the corresponding values obtained through equation (2.8) of the *SLT*,
(b) $y_2$ and $y_1$ with the corresponding values obtained through equation (2.9) of the *SLT*; and
(c) $z_2$ and $z_1$ with the corresponding values obtained through equation (2.10) of the *SLT*.
This gives

$$r^2 = \left[\gamma\left(x_2'+v_x t_2'\right)-\gamma\left(x_1'+v_x t_1'\right)\right]^2+\left[\gamma\left(y_2'+v_y t_2'\right)-\gamma\left(y_1'+v_y t_1'\right)\right]^2+\left[\gamma\left(z_2'+v_z t_2'\right)-\gamma\left(z_1'+v_z t_1'\right)\right]^2 \tag{6.3}$$

Now we take $\gamma^2$ as a common factor

$$r^2 = \gamma^2\left[\left[\left(x_2'+v_x t_2'\right)-\left(x_1'+v_x t_1'\right)\right]^2+\left[\left(y_2'+v_y t_2'\right)-\left(y_1'+v_y t_1'\right)\right]^2+\left[\left(z_2'+v_z t_2'\right)-\left(z_1'+v_z t_1'\right)\right]^2\right] \tag{6.4}$$

Rearranging the terms we get

$$r^2 = \gamma^2\left[\left[x_2'-x_1'+v_x\left(t_2'-t_1'\right)\right]^2+\left[y_2'-y_1'+v_y\left(t_2'-t_1'\right)\right]^2+\left[z_2'-z_1'+v_z\left(t_2'-t_1'\right)\right]^2\right] \tag{6.5}$$

Now considering that

$$t_2'-t_1'=0 \tag{6.6}$$

we can write

$$r^2 = \gamma^2\left[\left(x_2'-x_1'\right)^2+\left(y_2'-y_1'\right)^2+\left(z_2'-z_1'\right)^2\right] \tag{6.7}$$

but the expression within the square bracket is the square of the distance between the centres of $M'$ and $m'$, $\left(r'^2\right)$ , measured by Sophia (System $S'$). Mathematically, this is expressed as

$$r'^2 = \left(x_2'-x_1'\right)^2+\left(y_2'-y_1'\right)^2+\left(z_2'-z_1'\right)^2 \tag{6.8}$$

Thus $r^2$ and $r'^2$ are related by the following equation

$$r^2 = \gamma^2\, r'^2 \tag{6.9}$$

Also according to Einstein's relativistic mass law (this law is common to both Special Relativity and Symmetric Special Relativity) we can write the following two equations

$$M = \frac{M'}{\sqrt{1-\beta^2}} = \gamma M' \tag{6.10}$$

$$m = \frac{m'}{\sqrt{1-\beta^2}} = \gamma\, m' \tag{6.11}$$

Now in equation (6.1) we can substitute $r^2$ with the second side of equation (6.9), *M* by the third side of equations (6.10) and *m* by the third side of equations (6.11). This yields

$$F = G\frac{\gamma\, M'\,\gamma\, m'}{\gamma^2\, r'^2} \tag{6.12}$$

After simplification the last relation can be written as

$$F = G\,\frac{M'm'}{r'^2} \tag{6.13}$$

But, according to Sophia, the gravitational force between the two masses *M′* and *m′* is

For an observer of system *S′* (Shophia)

$$F' = G\,\frac{M'm'}{r'^2} \tag{6.14}$$

Because the second side of equations (6.13) and (6.14) are identical, the first sides must also be identical. Thus we can write the following equality

$$F = F' \tag{6.15}$$

Consequently, Newton's law of Universal Gravitation has exactly the same form for any two inertial observers in relative motion. Mathematically, this means that Newton's law of Universal Gravitation is invariant under a Symmetric Lorentz Transformation.

***Lorentz Invariance as an Excluding Meta-law***

*It is a well known fact that Einstein's theory of General Relativity superseded Newton's law of universal gravitation. However, we have just found that Newton's Gravity Law is invariant under a Symmetric Lorentz transformation. This means that we have proved that Lorentz invariance is a necessary but not a sufficient condition for a law of nature to be true. Because all Lorentz transformations, including the new formulation presented in this paper, can be considered meta-laws, there must be other equally or more important meta-laws that, when mathematically "invoked", should yield the true laws of nature. One of the physicist's and scientist's mission, in general, is to find these yet unknown Excluding Meta-laws.*

## 7. Invariance of the Formula for the Population of Neutrons in Chain Reactions Under a Symmetric Lorentz Transformation

The formula for the population of neutrons in a nuclear chain reactions gives the number of neutrons, *N(t)*, as a function of time, *t*

$$N(t) \approx 2^{\frac{t}{T}} \tag{7.1}$$

Where *T* is the time taken by a neutron to travel a given distance before starting a nuclear fusion of an atomic nucleus such as U235 (Uranium 235). We assume that Sophia is an observer from reference system *S'*. We also assume that she is at rest with respect to the U235 atoms involved in the chain reaction process before the reaction takes place. Thus, according to Sophia, will the number of neutrons in the reaction will be

$$N(t') \approx 2^{\frac{t'}{T'}} \tag{7.2}$$

Because $t' = t_0$ and $T' = T_0$ we can write

$$N(t_0) \approx 2^{\frac{t_0}{T_0}} \tag{7.3}$$

Now we wat to find how an observer in relative motion with respect to Sophia describes the same formula, this is How does John describe equation (7.3)?. To answer this question I shall use the time dilation formula from the Symmetric Special Relativity which is exactly the same formula Einstein derived in 1905 - equation (3.9)

$$t = \frac{t_0}{\sqrt{1-\beta^2}} \tag{7.4}$$

Solving for *t* we get

$$t_0 = t\sqrt{1-\beta^2} \tag{7.5}$$

Similarly

$$T = \frac{T_0}{\sqrt{1-\beta^2}} \tag{7.6}$$

Solving for $T_0$ we get

$$T_0 = T\sqrt{1-\beta^2} \tag{7.7}$$

Now, the exponent of equation (7.3) can be written in therms of equations (7.5) and (7.7) as follows

$$\frac{t_0}{T_0} = \frac{t\sqrt{1-\beta^2}}{T\sqrt{1-\beta^2}} = \frac{t}{T} \tag{7.8}$$

Therefore we replace the exponent of (7.3) by the second side of equation (7.8). This yields

$$N(t_0) \approx 2^{\frac{t}{T}} \tag{7.9}$$

But this means that

$$N(t_0) = N(t) \tag{7.10}$$

Consequently, the law that governs the population of neutrons in chain reactions has exactly the same form for any two inertial observers in relative motion. Mathematically, this means that the formula for the population of neutrons in chain reactions is invariant under a Symmetric Lorentz Transformation. It is worthwhile to remark that because both *SR* and *SSR* yield the same time dilation formula, the population of neutrons formula is also invariant under a Lorentz Transformation.

## 8. Invariance of the Leptobaryonic Formula for the Fine-structure Constant Under a Symmetric Lorentz Transformation

The leptobaryonic formula for the fine-structure constant is given by

John's reference system

$$\alpha \approx 2^{-18\left(\frac{m_{e0} - m_{l0}}{m_{n0} - m_{p0}}\right)} \tag{8.1}$$

It is worthwhile to remark that I have used the rest masses of the particles. We shall use the Einstein's relativistic mass formula

$$m = \frac{m_0}{\sqrt{1-\beta^2}} \tag{8.2}$$

An observer from system *S*, which is moving at a speed *v* with respect to the four particles involved in the formula, will describe equation (8.1) in terms of the relativistic masses. Therfore, Shophia will write

Sophia's reference system

$$\alpha' \approx 2^{-18\left(\frac{m_e - m_l}{m_n - m_p}\right)} \tag{8.3}$$

where

$$m_e = \frac{m_{e0}}{\sqrt{1-\beta^2}} = \gamma\, m_{e0} \tag{8.4}$$

$$m_l = \frac{m_{l0}}{\sqrt{1-\beta^2}} = \gamma\, m_{l0} \tag{8.5}$$

$$m_n = \frac{m_{n0}}{\sqrt{1-\beta^2}} = \gamma\, m_{n0} \tag{8.6}$$

$$m_p = \frac{m_{p0}}{\sqrt{1-\beta^2}} = \gamma\, m_{p0} \tag{8.7}$$

where $\gamma$ is the Lorentz factor which is defined as

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} \tag{8.8}$$

and $\beta$ is the ratio between the speed of the body or particle to the speed of light

$$\beta = \frac{v}{c} \tag{8.9}$$

Equations (8.4), (8.5), (8.5) and (8.7) allow us to write equation (8.3) as follows

$$\alpha' \approx 2^{-18\left(\frac{\gamma\, m_{e0} - \gamma\, m_{l0}}{\gamma\, m_{n0} - \gamma\, m_{p0}}\right)} \tag{8.10}$$

and after simplification we get

$$\alpha' \approx 2^{-18\left(\frac{m_{e0} - m_{l0}}{m_{n0} - m_{p0}}\right)} \tag{8.11}$$

Because the second side of equations (8.1) and (8.11) are identical, the first sides must also be identical. This means that

$$\alpha' = \alpha \tag{8.12}$$

This result tell us that the leptobaryonic formula for the fine-structure constant has exactly the same form for any two inertial observers in relative motion, meaning that the formula is invariant under a Symmetric Lorentz Transformation. Because both Special Relativity and Symmetric Special Relativity share the same relativistic mass law [Eq. (8.2)], we draw the conclusion that the leptobaryonic formula for the fine-structure constant is also invariant under a Lorentz Transformation.

# 9. Comparison

Table 5 shows a comparison of the original Lorentz transformations with the Symmetric counterpart.

| Feature under comparison | Lorentz Transformations | Symmetric Lorentz Transformations |
|---|---|---|
| Length contraction formula | $l = l_0 \sqrt{1-\beta^2}$ (Spheres do not keep their shapes) | $d = d_0 \sqrt{1-\beta^2}$ (Spheres keep their shapes) |
| Time dilation formula | $t = \frac{t_0}{\sqrt{1-\beta^2}}$ | $t = \frac{t_0}{\sqrt{1-\beta^2}}$ |
| "Addition" of velocities formula (only the equation for the component of the velocity along the *x*-axis is shown. See Table 4) | $u_x = \frac{\left(u'_x + v\right)}{\left(1 + \frac{v u'_x}{c^2}\right)}$ | $u_x = \frac{\left(u'_x + v_x\right)}{\left(1 + \frac{v^2 u'_x}{c^2 v_x}\right)}$ |
| Is the spacetime interval, *s*, defined by the following relation: $s^2 = x^2 + y^2 + z^2 - c^2 t^2$ invariant under the transformation? | Yes | No |
| Are the Maxwell equations invariant under the transformation? | Yes (This indicates that the law on the first column is an acceptable description of nature – see Appendix 2: Glossary) | No |
| Is the Newton's Law of Universal Gravitation: $F = \frac{G M m}{r^2}$ invariant under the transformation? | No | Yes (This indicates that the law on the first column is an acceptable description of nature – see Appendix 2: Glosssary) |
| Is the formula for the population of neutrons in chain reactions: $N(t) \approx 2^{\frac{t}{T}}$ invariant under the transformation? | Yes | Yes |

(this table continues on next page)

(this table starts on the previous page)

| Feature under comparison | Lorentz Transformations | Symmetric Lorentz Transformations |
|---|---|---|
| Is the lepton-baryonic formula for the fine-structure constant: $\alpha \approx 2^{-18\left(\frac{m_{e0}-m_{l0}}{m_{n0}-m_{p0}}\right)}$ invariant under the transformation? [6, 7] | Yes | Yes |
| Is the de Broglie formula: $\lambda = \frac{h}{p}$ invariant under the transformation? | No | No |

**TABLE 5:** *The Lorentz transformations versus the "Symmetric Lorentz transformations"*

# 10. Conclusions

The new theory of relativity presented in this paper has, so far, the following implications:

1. The phenomenon of Lorentz contraction affects bodies, such as spheres, that move, in any arbitrary direction, with respect to system *S*. However, if the direction of the relative velocity $v$ between the reference systems does not coincide with any of the coordinates axes of system *S*, then spheres will conserve their spherical shapes. This result seems to make more sense than the corresponding result from *SR*. Although common sense does not mean much in physics, specially in quantum physics.

2. The formula for the composition of velocities turned out to be similar but not identical to that derived from the original Lorentz transformations. However, if the direction of the velocity vector, $v$, coincides with the $x$ axis of system *S*, then the composition of velocities in the direction $x$ yields the same formula obtained from *SR*. Thus, Special Relativity's velocity composition formula, in the $x$-direction, is a special case of the Symmetric Special Relativity's counterpart.

3. Newton's law of universal gravitation turned out to be invariant under a Symmetric Lorentz Transformation. This seems to indicate that, except for Mercury (this means under normal conditions), Newton's Gravity Law is a good description of our solar system's planetary motion.

4. The formula for the population of neutrons in chain reactions and the lepto-baryonic formula for the fine-structure constant turned out to be invariant under both transformations. Since the fine-structure constant is a fundamental constant of Nature, and since the fundamental constants of Nature should be invariant under both transformations, the invariance shown by the lepto-baryonic law indicate that this law is a true law of Nature.

5. The de Broglie formula is not invariant under neither formulations.

The above list is not exhaustive and, as further research continuous in this field, it is likely that the list will grow in the future.

In summary, this research suggests that the original Lorentz transformations and the Symmetric Lorentz transformations play different roles. On the one hand, the fact that Newton's Gravity Law is invariant under a Symmetric Lorentz transformation suggests that this formulation is able to indicate whether a given law of physics is "an acceptable description of nature"(see **Appendix 1 – Glossary** for definitions), even if the model does not propagates at the speed of light (Although experiments seem to indicate that gravity propagates at the speed of light, Newton's Gravity Law requires propagation at infinite speed). On the other hand, the fact that the Maxwell's equations are invariant under a Lorentz transformation indicates that these laws involve propagation at the speed of light. Therefore we can draw the following conclusions:

*a) If a given law of nature is invariant under a Lorentz transformation, but is not invariant under a Symmetric Lorentz transformation, then the law is an "acceptable description of nature". Information and energy propagate at the speed of light and the law complies with Einstein's Special Relativity.*

*b) If the law of nature is invariant under a Symmetric Lorentz transformation, but is not invariant under a Lorentz transformation, then the law is an "acceptable description of nature". Information and energy do not propagate at the speed of light and the law does not comply with Einstein's Special Relativity. In some cases, it could mean that information/energy will propagate at infinite speed (erroneously) as in the case of Newton's Law of Universal Gravitation.*

*c) If a given law of nature is invariant under a Lorentz transformation and is also invariant under a Symmetric Lorentz transformation, then the law is an acceptable description of nature. In this case: (i) the law probably is a relatively simple law dealing with either time or mass (or both). This is so because both theories are equivalent with respect to time (identical time dilation formulas) and mass (identical relativistic mass formulas); (ii) the law does not deal with the phenomenon of propagation of information or energy.*

*d) If a given law of nature is not invariant under a Lorentz transformation and, additionally, is not invariant under a Symmetric Lorentz transformation either, then the law could still be an acceptable description of nature (e.g. the de Broglie law).*

If a description of nature is not invariant under the Symmetrical formulation, no conclusion can be drawn since the description could still be an acceptable description of nature. If this happens, then, we could "invoke" the Lorentz transformations to find the answer. Finally it is worthwhile to

emphasize that, at least, two questions remain unanswered. The first question is:
(a) which formulation yields the correct length contraction formula, *SR* or *SSR*? Something is clear: Special Relativity does not contemplate the case in which the motion of Sophia's reference system does not coincides with any of John's coordinate axis. Then Special Relativity cannot provide a general formula for length contraction. The second question is: (b) which formulation yields the correct composition of velocities formulas, *SR* or *SSR*? We have the same situation here.
Special Relativity does not consider the case in which the motion of Sophia's reference system does not coincides with any of John's coordinate axis. What's even worse is the fact that the relativistic velocity composition equations of *SSR* does not reduce to the corresponding *SR*'s equations for the $y$ and $z$ axis. They only agree on the $x$-axis (the direction of relative motion between Sophia and John in *SR*). There is, however, another possibility that could resolve these issues, and that is that both formulations could be incorrect*, meaning that the correct "Lorentz Transformations" are yet to be discovered (more general formulas). I think that either the experiment or a deeper theoretical research can give us the correct answers to the above two questions. Finally, I would like to say that the role of the "Symmetric Lorentz Transformations" as a set of equations that allows to decide the acceptability of a given law of Nature (such as the Newton's Gravity Law), makes them useful even if they were found to be partially correct*.

* or partially correct. For example, both formulations yield the same time dilation formula which has been confirmed by the experiment. Therefore both theories are correct with respect to time dilation.

# Appendix 1
# Nomenclature

The following are the symbols and acronyms used in this paper

## SYMBOLS

$c =$ Speed of light in vacuum
$G =$ Newton's gravitational constant
$L_P =$ Planck length
$T_P =$ Planck time
$S =$ Reference system $S$ (Cartesian coordinate reference system)
$S' =$ Reference system S' (Cartesian coordinate reference system)
$l_0 =$ Proper length
$l =$ "Contracted" length
$d' =$ Proper diameter (diameter with respect to system $S'$)
$d_0 =$ Proper diameter
$d =$ "Contracted" diameter (diameter with respect to system $S$)
$t_0 =$ Proper time
$t =$ "Dilated" time
$(x', y', z', t') =$ Coordinates of a given event in system $S'$
$(x, y, z, t) =$ Coordinates of the same event in system $S$
$P =$ Point of coordinates $(x', y', z')$ in system $S'$ and $(x, y, z)$ in system $S$
$\vec{v} =$ Relative velocity vector between system $S$ and system $S'$

$v =$ Module of the relative velocity vector between system $S$ and system $S'$
$u' =$ Velocity of the point $P$ with respect to system $S'$
$u =$ Velocity of the point $P$ with respect to system $S$
$\beta =$ Velocity ratio. Ratio of the group velocity, $v$, of a body to the speed of light, $c$, in vacuum.
$\gamma =$ Lorentz transformations' factor (Lorentz factor, Lorentz transformations' scale factor or scaling factor)
$M' =$ Rest mass of a body relative to system $S'$
$m' =$ Rest mass of a body relative to system $S'$
$M =$ Relativistic mass of a body relative to system $S$
$m =$ Relativistic mass of a body relative to system $S$
$r' =$ Distance between $M'$ and $m'$ relative to system $S'$
$r =$ Distance between $M$ and $m$ relative to system $S$
$F' =$ Gravitational force between $M'$ and $m'$ measured by an observer of system $S'$
$F =$ Gravitational force between $M$ and $m$ measured by an observer of system $S$
$N(t) =$ Population of neutrons (number of neutrons at time $t$)
$T = T_0 =$ Time taken by a neutron to travel a given distance before producing a nuclear fusion process through a collision with a suitable atomic nucleus. The nucleus, for example, could belong to a Uranium 235 atom. (Depending on the context $T$ and $T_0$ may denote different time intervals. $T$, for example, may refer to the duration of an event as measured by an observer of system $S$ while $T_0$ may refer to the duration of the same event as measured by an observer of system $S'$. We assume that system $S'$ is in uniform relative motion with respect to system $S$. The relative velocity between the two coordinate systems is $v$, which is always smaller than the speed of light, $c$.)
$m_e =$ Relativistic mass of the electron
$m_l =$ Relativistic mass of the electrino
$m_n =$ Relativistic mass of the neutron
$m_p =$ Relativistic mass of the proton
$m_{e0} =$ Rest mass of the electron
$m_{l0} =$ Rest mass of the electrino
$m_{n0} =$ Rest mass of the neutron
$m_{p0} =$ Rest mass of the proton

## ACRONYMS

*LT* = Lorentz transformations
*SR* = Special Relativity
*SLT* = Symmetric Lorentz Transformations
*SSR* = Symmetric Special Relativity

# Appendix 2
# Glossary

**Symmetric Transformations**
A symmetric transformation is a transformation whose equations are symmetric with respect to space, time or with respect to any other variable or parameter. The "Symmetric Lorentz Transformations", for example, are symmetric with respect to space because the transformation equations for each space coordinate (*x, y,* and *z*) have all exactly the same form. They are also symmetric with respect to time (see **Appendix 3** for more information). As a result of the symmetric nature of the formulation, the formulation also produces symmetrical composition of velocities formulas for each coordinate axes.

**Asymmetric Transformations**
An asymmetric transformation is a transformation whose equations are asymmetric with respect to space, time or with respect to any other variable or parameter. The Lorentz transformations, for example, are asymmetric with respect to space because the transformation equation for the *x* coordinate is different (or has a different form) to the equations for the *y* and *z* coordinates.

**Symmetric Special Relativity**
Symmetric Special Relativity refers to the new theory of relativity presented in this paper which is based on the so called Symmetric Lorentz Transformations.

**A true description of nature**
A true description of nature means a highly accurate description of nature, or a description of nature that works relatively well under extreme conditions. For example, according to this definition, Einstein's General Relativity would be a true description of nature while Newton's Law of Universal Gravitation would not. I have to clarify that this definition rest on the definition of *extreme conditions.* In the case of black holes, for example, if we consider that extreme conditions include the behaviour at the Planck scale, then General Relativity fails because it does not include the Universal Uncertainty Principle (UUP) [8] or any other uncertainty relations. For example, the formula for the temperature of a black hole discovered by S. Hawking is an excellent approximation but is not a true law of nature. I published a more accurate formula for the temperature of a black hole [9] which yields Hawking's formula as a special case. However, this new formula, which is based on the UUP, is probably not a true law of nature either. In other words, we should keep in mind the following three possibilities:
(a) there are no true descriptions of nature, or
(b) there are true descriptions of nature but only a few are known to man, or
(c) there are true descriptions of nature, but they are yet to be discovered.

**An acceptable description of nature**
An acceptable description of nature means a description of nature that works relatively well under normal conditions but not so well under extreme conditions. For example, according to this definition, Newton's Law of Universal Gravitation is an acceptable description of nature.

# Appendix 3
# Symmetry in the Context of this Paper

Symmetry, in the context of this paper, refers to the symmetry of the equations of the transformation and not to the symmetry of the laws of physics that are invariant under these transformations. Then, from this point of view, the "Symmetric Lorentz Transformations" are more symmetrical than the original Lorentz transformations. I shall illustrate this point. Let us consider the spatial Lorentz transformations for values of system *S′* in terms of values of system *S* (direct transformations):

$$x' = \frac{x - v\,t}{\sqrt{1-\beta^2}} \tag{A3.1}$$

$$y' = y \tag{A3.2}$$

$$z' = z \tag{A3.3}$$

The corresponding Symmetric Lorentz transformations are:

$$x' = \frac{x - v_x t}{\sqrt{1-\beta^2}} = \gamma\left(x - v_x t\right) \tag{A3.4}$$

$$y' = \frac{y - v_y t}{\sqrt{1-\beta^2}} = \gamma\left(y - v_y t\right) \tag{A3.5}$$

$$z' = \frac{z - v_z t}{\sqrt{1-\beta^2}} = \gamma\left(z - v_z t\right) \tag{A3.6}$$

While, in the Lorentz transformations, the equation for the *x′* coordinates has a different form to that of the equations corresponding to the other two coordinates (*y′* and *z′*); in the Symmetric Lorentz transformations the equation for each and every space coordinate has exactly the same form. In fact, if we represent each coordinate with a different sub-index, such as: $x = x_1$ , $y = x_2$ and $z = x_3$ then the transformations can be written with a single equation as follows:

$$x_i' = \frac{x_i - v_{xi} t}{\sqrt{1-\beta^2}} = \gamma\left(x_i - v_{xi}\, t\right) \tag{A3.7}$$

for $i = 1, 2, 3$
where

$v_x = v_{x1}$
$v_y = v_{x2}$
$v_z = v_{x3}$

Thus, we can say that the Symmetric Lorentz transformations treat each spatial dimension equally, and therefore, from this point of view, they are more symmetrical that the Lorentz transformations. Also, as can be seen from Table 2, the Symmetric Lorentz transformations, have 3 different equations (sharing the same form) for space and 3 equivalent equations for time (all 3 yield the same value of the time coordinate). In contrast, the Lorentz transformations have 3 different equations for space and only 1 equation for time. We therefore draw the conclusion that, from a mathematical point of view of the equations, that the *SLT* are more symmetrical than the *LT*.

If we use the definition of symmetry proposed by the physicist Herman Weyl:

*"An object is said to be symmetrical if one can subject it to certain operation and it appears exactly the same after the operation as before. Any such operation is called a symmetry of the object."*

we can state that the "Symmetric Lorentz equations" are symmetric because if we change the coordinate axis (this is the operation Weyl refers to, in this particular case), the mathematical operations between the corresponding variables of the transformation do not change. Or to put it another way, the form of the equations is exactly the same for each and every coordinate axis. Generalizing this, we can state that the "Symmetric Lorentz transformations" are symmetric because:

(a) the transformation equations have the same form, and
(b) there is the same number of equations for space and for time (3 equations for space and 3 for time. However, the 3 equations for time are equivalent).

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