Realistic Lorentz Transformation.

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Abstract.

The Lorentz transformation has been developed in order to determine the conditions so that the velocity of light always appears constant in all moving frames. We explain here the fundamental meaning of physical measurements carried out in external frames. This leads to a realistic interpretation. We also show that there is an error in the conventional Lorentz transformation. After that correction is taken into account, the Lorentz transformation becomes compatible with Galilean geometry and realistic physics, in which the change of clock rate and length is due to a normal perturbation of atoms and molecules due to the increase of kinetic energy. We see that when we apply the principle of mass-energy conservation, the size of the physical units of length and time changes naturally with kinetic energy. That physical change of length and clock rate is in perfect agreement with the mathematics of quantum mechanics. We can now explain logically, all the physical phenomena previously attributed to relativity, which did not previously seem compatible with Newton physics and conventional logic.

1-Introduction.

During the 19th century, the velocity of light has been measured with an increasing precision. At the same time, astronomical data led to a more and more accurate description of the solar system so that we could understand clearly that the Earth was traveling at 30 km/s in its orbit around the Sun. Using Newton mechanics and conventional logic, it became normal to expect an annual change of velocity of light with respect to the Earth, due to its motion around the Sun. Many scientists attempted to measure that expected variation of velocity of light with respect to the moving observer on Earth. Astonishingly, everyone failed. Therefore, questions have been raised about the frame, with respect to which light travels. Does light travel with respect to an absolute frame in space, or does it travel with respect to the observer? How can we explain that light emitted by the Sun would travel at the same velocity c with respect to the moving Earth? It did not seem possible to explain logically the observed constant velocity of light in all frames. By the end of the 19th century, this problem was discussed in many papers by Fitzgerald, Lorentz, Einstein and others. Lorentz calculation and Einstein's interpretation is the one, which was generally accepted in the 20th century. However, it was a challenge to a logical interpretation.

Unfortunately, all these hypotheses ignore that when a clock is carried from a rest frame to a moving frame, the atoms of the moving clock have absorbed energy, which changes its natural frequency as calculated in quantum mechanics. We have also seen previously that other physical standards are also modified when carried to a different frame.

2 - Meaning of Observational Data.

Let us scrutinize the fundamental knowledge that can be extracted from the experimental observations of the velocity of light c. Those observations form the basic arguments in the Lorentz transformation. We must notice that the only thing that is really observed experimentally can be expressed by the two following statements:

1- An observer at rest measures the velocity of light equal to c when using a reference meter at rest and a clock at rest.

2- Using the reference meter and the clock that have been brought from rest into motion, an observer in motion measures that the velocity of light is represented by the same number c.

Lorentz and Einstein made an unspecified hypothesis, implying that the length of a reference meter remains constant when it is carried from the rest frame to the moving frame. Similarly, when a reference clock is carried from the rest frame to the moving frame, it is also arbitrarily assumed that the clock rate remains the same. Einstein never gave any argument to support the validity of those hypotheses.

However, recently, many new results have been revealed (1-3) when we apply the principle of mass-energy conservation and quantum mechanics. Of course, the mass of particles increases with kinetic energy. Therefore, the electrons inside these atoms acquire an extra mass, which modifies the Bohr radius inside the atom. Consequently, due to a change of Bohr radius, this leads to a change of length of bodies (and reference meters) and also a change of rate of atomic clocks. Unfortunately, quantum mechanics was not developed when Einstein proposed relativity theory. Then, he ignored the change of length of a reference meter and the rate of atomic clocks due to the increase of electron mass. We also note that Einstein did not always apply his calculation to a constant velocity of light in a moving frame as measured by an observer also located in that moving frame. Depending on the version of the paper used, a shift of assumptions has been reported (4) in Einstein's papers. Here we strictly consider the Lorentz assumptions 1 and 2 given above.

We have seen previously (1,2) that when a mass is accelerated to velocity v, the electron and the proton masses inside these atoms, increase with kinetic energy, according to the well-known relationship:

$E=mc^2$. 1

Furthermore, using quantum mechanics, we have seen (1,2) that the more massive electron inside the accelerated atom increases the Bohr radius r_o. This physical mechanism leads to a logical realistic solution because the increase of Bohr radius changes the physical size of matter and changes the clock rate in the exact way so that the velocity of light appears the same in all frames. Instead of using quantum mechanics, let us now calculate the same parameters (change of Bohr radius and the change of clock rate) using a completely independent method. We calculate here the required change of length and the required change of clock rate that will satisfy exactly the number c, representing the velocity of light in all frames. As we will see, this is equivalent to the Lorentz transformation.

3 - Realistic Physics Quantities.

By convention, physics uses quantities given by the number of times of a physical standard. These physical standards are erroneously assumed to be constant in all frames (1-3). When we apply the principle of mass-energy conservation, the electrons inside the atoms absorb energy that changes the size of the atoms and the clock rate. Consequently, due to the change of "reference length" and "reference clock rate" between frames, pure mathematical numbers are no longer sufficient to give a full representation of a physical length and of a time interval. Therefore, we must consider that a physical quantity is completely defined only when the mathematical number is accompanied each time by the corresponding physical standard.

In a rest frame, a distance is defined as the number of times a standard reference unit of length in that frame is needed to represent the distance under study. We can see that a standard reference length can be defined with a reference iridium rod as used some decades ago, or the wavelength of a well-chosen spectroscopic wavelength. All those definitions are equivalent. Only the accuracy differs. Using rest units, a distance is then the pure number ℓ_o, times the physical length of the reference unit L_o. This distance r_o is:

$r_o=\ell_o L_o$ 2

The expression of a distance is incomplete when expressed uniquely by the pure mathematical number ℓ_o. Even if we add that we refer to a "meter", this is still incomplete unless we specify which meter we refer to. We must specify in which frame the reference meter is located. The same remark must also be always applied to all other existing units in physics.

The moving observer uses his own reference meter that has been carried from the rest frame. When that reference meter is carried to a moving frame (with kinetic energy), the electron mass of the atoms increases, so that the Bohr radius changes. Due to the change of Bohr radius, the length of the moving meter is now different in the moving frame. That change of length (as a function of velocity) has been calculated previously (1,2) using quantum mechanics, but here we calculate the change of length, only using the fact that the number c, representing the velocity of light, is constant in all frames. The length of the reference meter "in motion" is represented by the symbol L_v. The number ℓ_v of units represents the number of times the moving reference length L_v is counted to cover the distance. Therefore, using the moving units, the distance r_v is written:

$r_v=\ell_v L_v$ 3

Similarly, a "time interval" is defined as the pure number "t_o", times the duration of a standard unit of time T_o, on a local clock existing in a rest frame. We can also see, that in the case of time, it is always perfectly equivalent to use a reference time interval, either using an atomic clock, or any kind of mechanical clock (for example a pendulum). Any of those definitions are perfectly equivalent (when in the same frame).

In a rest frame (o), a time interval is then described by the number t_o, multiplied by the unitary reference time interval T_o. This is written:

Time interval (o) = $t_o T_o$ 4

Furthermore, when the moving observer measures a time interval, he uses the same clock as the one used by the rest observer. However, that clock has been carried to the moving frame so that the electrons in the moving clock have more mass. Therefore the clock runs at a different rate, as calculated in quantum mechanics (1,2).

The physical duration of the unitary time interval defined by the reference clock in motion is represented by the symbol T_v. The number of units representing the number of local seconds (displayed on clock) is t_v. Therefore, using the moving frame units, the time interval measured is the number t_v, multiplied by the local reference second T_v.

Time interval (v)= $t_v T_v$ 5

It is important to recall that c, t_o and t_v are pure mathematical numbers. Also, L_o, T_o, L_v and T_v are reference units (pure physical quantities). Also, the number of units corresponding to the velocity of light c is constant, in agreement with the constant number of units representing the velocity of light in any frame. Therefore:

$c_o=c_v=c$ 6

For brevity, here we do not include the size of the units "velocity" (as for v and c). Since any velocity is the quotient of the length over time, it is easy to show that the quotient of those two fundamental units is always equal to unity in any frame. The constant size of the unit "velocity" in all frames has already been demonstrated (1) previously.

Let us now calculate the distance traveled by light in one second, using rest units (rest clock). This is the velocity of light. In that time interval, the number of local units of velocity is then equal to c local meters (L_o). This gives:

Velocity (o)=cL_o 7

However, the observer in the moving frame, which also measures that same light, finds the same number c, times the local moving reference length (distance L_v). The velocity of light in the moving frame is written:

Velocity (v)=cL_v 8

We must realize that, due to the velocity of the moving observer, the absolute physical velocity of light with respect to each observer, is not necessarily the same, but it is expressed by the same number c of units (equations 7 and 8). The moving observer travels with respect to the wave front, but he uses a different reference meter. We will see that this compensates for the fact that he is moving with respect to the light velocity.

4 - Fundamental Considerations.

After those definitions, using Lorentz method, we can now calculate the relationships between the reference length L_o and the reference length L_v. Also, we can calculate the relationship between the clock rates T_o and T_v. These parameters can be calculated because they must compensate exactly for the fact that, the number c of local units of velocity of light is measured to be exactly the same in all frames (using local units). This is the meaning of the constancy in the velocity of light. It has never been demonstrated that the absolute physical velocity of light is "physically" the same with respect to observers moving away. It has only been shown that the number (c) of local units is the same, when using local clocks and local meters. With that description, we see that no space-time distortion is needed.

Using conventional logic and realistic physics, we now derive a realistic Lorentz transformation, which agrees with the observational fact that the number representing the local velocity of light c is constant in all frames. Since the measurements in the moving frame are done using the local meter and the local clock, (which have been accelerated to velocity v), this provides a mean to calculate (without quantum mechanics) by how much the local meter and the local clock are modified, due to their velocity in the new frame. We will see below that the two methods are in perfect agreement.

5 - Realistic Lorentz Transformation.

Let us assume that a pulse of light is emitted at time t_o=0 from the origin of coordinates of a frame F_o at rest, at the same instant the origin of a moving frame F_v passes at that same location. The indexes o or v, normally designate the frame where the reference units used are located. In previous papers (1-3) a special notation has been developed for this purpose, but here we use a simplified notation. A special case will be explained explicitly in the text below. Figure 1 gives an illustration of both frames, when the pulse of light is emitted.

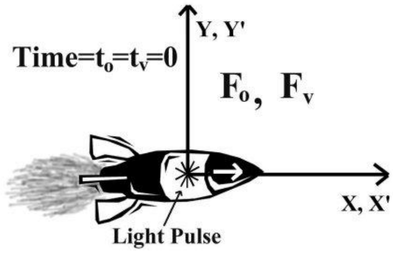

Figure 1

At the instant t=0, all clocks are synchronized. We have:

$$t_o=t_v=0 \qquad 9$$

Therefore, on figure 1, the frame F_v moving at velocity v is superimposed on the rest frame F_o, at the exact instant a pulse of light is emitted from origin 0_o, which is at the same location as 0_v. Later, after a time interval t_oT_o, figure 2 shows the relative position of the two frames and the wave front of the emitted wave. Figure 2 illustrates the experiment as seen by an observer at rest, before considering the hypothesis of a constant velocity of light in the moving frame. Light is emitted at an angle θ with respect to the x_o-x_v axis, and reaches the coordinates (x_o,y_o) after a time interval t_o.

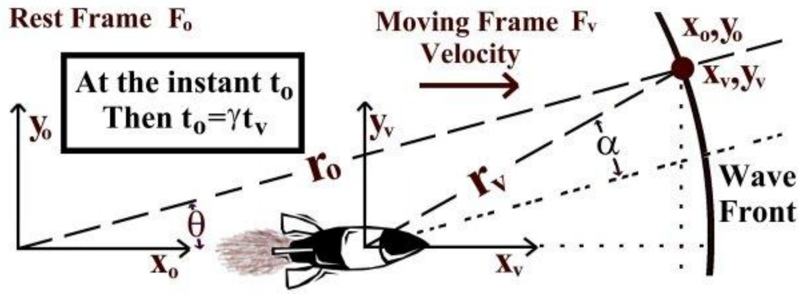

Figure 2

In order to simplify figure 2, a rotation has been made around the x_o-x_v axis, so that the z_o component (perpendicular to the paper sheet) is zero. Figure 2 shows the x_o-0-y_o and the x_v-0-y_v planes. Figure 2 illustrates the wave front, as it exists "at one given instant". However, the observers located in different frames, each using their own local clocks, will measure independently a different number of local seconds ($t_o \neq t_v$) after synchronization. On the wave front, at location (x_o,y_o), we see the moving parameters x_v,y_v, which correspond to the same location as (x_o,y_o). After the time interval t_o, the origin (0_v) of the moving frame has moved forward across the distance vt_o. Therefore, the x_v coordinate is smaller than x_o by vt_o. Furthermore, the angle θ increases by the angle α. This is a classical result, even when the constant velocity of light in the moving frame is taken into account.

In the rest frame, the distance r_o traveled by light, as a function of time (t), is equal to the distance traveled in one local second (equation 7), multiplied by the time interval (equation 4) which is $t_o\,T_o$. This distance $r_o(t)$ is:

$$r_o(t) = cL_o\ t_oT_o \qquad 10$$

For the moving observer in frame F_v, (taking now into account the constant velocity of light), the distance traveled by light is equal to the distance traveled in one local second (equation 8) multiplied by the time interval t_vT_v (equation 5). The distance $r_v(t)$ is:

$$r_v(t) = cL_v\ t_vT_v \qquad 11$$

We must remember that both origins of the moving frame and of the rest frame are at the same location when the pulse of light is emitted.

Galilean Geometry.

In Galilean geometry, the distance traveled in the rest frame (on figure 2) is given by the mathematical relationship:

$$r_o^2 = x_o^2 + y_o^2 \qquad 12$$

As explained above, the z-axis component is reduced to zero after a rotation around the x_o-x_v axis. Then only the y-axis can show the transverse motion. Let us use the physics notation of distances as described in equation 2. Equation 12 becomes:

$$(r_o L_o)^2 = (x_o L_o)^2 + (y_o L_o)^2 \qquad 13$$

However, since the distance traveled by light is the velocity c multiplied by the time interval, we have (in short notation):

$$r_o^2 = \left(x_o^2 + y_o^2\right) = c^2 t_o^2 \qquad 14$$

Of course, from equation 14, the physics notation is:

$$(x_o L_o)^2 + (y_o L_o)^2 = c^2 t_o^2 T_o^2 \qquad 15$$

Similarly to equation 12, but in the moving frame, the geometrical distance is also given by the same relationship (short notation):

$$r_v^2 = x_v^2 + y_v^2 \qquad 16$$

Therefore, using the physics notation, the Galilean distance measured by the moving observer in frame F_v becomes:

$$(x_v L_v)^2 + (y_v L_v)^2 = c^2 t_v^2 T_v^2 \qquad 17$$

Subtracting equations 17 from 15, we get:

$$\left\{(x_o^2 + y_o^2) L_o^2\right\} - \left\{(x_v^2 + y_v^2) L_v^2\right\} = c^2 t_o^2 T_o^2 - c^2 t_v^2 T_v^2 \qquad 18$$

Also these equations give:

$$\left\{(x_o^2 + y_o^2) L_o^2\right\} - c^2 t_o^2 T_o^2 = \left\{(x_v^2 + y_v^2) L_v^2\right\} - c^2 t_v^2 T_v^2 \qquad 19$$

When y_o and y_v are different from zero, equation 19 cannot be calculated immediately. We must remember that there is a relationship between r_o and r_v as seen on figure 2, because light must travel in strait line. Consequently, in equation 19, the parameter y_o does not change independently with respect to x_o, and y_v does not change independently with respect to x_v. Due to that relationship between r_o and r_v, the variables involved are r_o and r_v, so that if we write $\left\{(x_o^2 + y_o^2) L_o^2\right\} = x_o^2 L_o^2 + y_o^2 L_o^2$ and $\left\{(x_v^2 + y_v^2) L_v^2\right\} = x_v^2 L_v^2 + y_v^2 L_v^2$ a relationship is missing in equation 19.

On figure 2, the absolute distance y_o is equal to the distance y_v. However, when the constancy of the velocity of light is taken into account, the value of y_v measured in the moving frame might be different from y_o (measured in the rest frame). This will be calculated below in section 6.

Let us assume for the moment that there is no transverse component of velocity. We have y_o=y_v=0. Furthermore, the distance traveled by the moving frame is equal to the velocity times the time interval. This gives:

$$x_o L_o = v_x\, t_o T_o \qquad 20$$

Equation 19 becomes:

$$\left(x_o^2 L_o^2\right) - c^2 t_o^2 T_o^2 = \left(x_v^2 L_v^2\right) - c^2 t_v^2 T_v^2 \qquad 21$$

Let us propose the following solution. When y_o=y_v=0, it can be demonstrated that the solution of equations 18, 19 and 21 gives the following relationships for light:

$$x_v L_v = \gamma(x_o L_o - v_x t_o T_o) \qquad 22$$

and

$$t_v T_v = \gamma\left(t_o T_o - (v_x / c^2) r_o L_o\right) \qquad 23$$

The definition of γ is:

$$\gamma = \frac{1}{\sqrt{1-(v^2/c^2)}} \qquad 24$$

The algebra that gives equations 22 and 23 is painstaking and is omitted here. However, the perfect validity of these two equations is very easily verified by substituting these two equations into the right hand side of equation 21. Equations 22 and 23 are in excellent agreement with the solution calculated by Lorentz "along the x-axis".

6 - Lorentz Transformation Along the Transverse Axis.

Let us now find the solution of equations 18 and 19 when light moves perpendicular to the moving frame velocity as seen by the rest observer. Then, the frame velocity is v_x along the x-axis, and the transverse velocity component of the moving frame is zero (v_y=0). Also the x component of the velocity of light is zero in the rest frame. Light moves in the y direction and reaches the coordinate (0_o, y_o) after a time interval t_o. This is illustrated on figure 3.

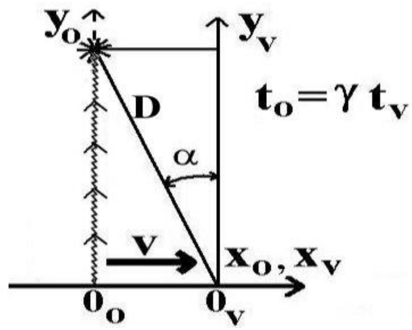

Figure 3

However, light does not move along line 0_v-y_v in the moving frame. Although light has a zero x-velocity component in the rest frame, it has a non-zero velocity component (y_o-y_v) in the moving frame. On figure 3, due to the x component of the velocity of light that exists only in the moving frame, the distance traveled by light, which is 0_o-y_o in the rest frame, becomes larger in the moving frame. This is what Lorentz failed to notice. Figure 3 shows that the distance traveled by light becomes larger (0_v-y_o) in the moving coordinates, even before we take into account the constant velocity of light.

On figure 3, we see that light is traveling to location (0, y_o), perpendicular to the velocity of the moving frame. Light is emitted from the origin 0_o on the rest frame toward location y_o. The moving frame travels along the x_o-x_v axis. The two clocks are synchronized at time t_o=t_v=0 when a pulse of light is emitted from 0_o (and 0_v, which are at the same location at time t_o=t_v=0). When light reaches y_o, the origin of the moving frame has moved to 0_v as shown on figure 3. Therefore in the moving coordinates, light has moved from the origin in 0_v to location y_o with coordinates ($-vt_v$, y_v). We have t_v is the time interval measured in the moving frame. Due to the motion of the moving frame, in the moving coordinates the distance D traveled by light is $[0_v \leftrightarrow y_o] = D$. Also, due to the displacement of the moving frame, the moving observer measures a change of direction α as illustrated on figure 3. The corresponding change of direction α is also shown on figure 2. That change of direction α is responsible for an increase of distance traveled by light when measured from a moving frame, which was ignored by Lorentz. Since light moves at the same velocity c in the moving frame, the distance traveled by light in the moving coordinates is

$$[0_v \leftrightarrow y_o] = D = ct_v \qquad 25$$

We use a square bracket $[0_v \leftrightarrow y_o]$ to represent all Galilean distances between two points spaced by $\leftrightarrow$ and which are not submitted to any hypothetical space or time distortion. The hypothetical space-time distortion is totally irrelevant here with the Galilean distance $[\ \leftrightarrow\ ]$.

We see on figure 3, that for the rest observer, the distance y_o that light travels in his frame is $[0_o \leftrightarrow y_o]$, which is equal to $[0_v \leftrightarrow y_v]$. However, the rest observer also finds that the classical distance D that light must travel with respect to the moving observer is $[0_v \leftrightarrow y_o]$. This gives:

$$[0_v \leftrightarrow y_o] = D = \frac{[0_v \leftrightarrow y_v]}{\text{Cos}\ \alpha} \qquad 26$$

The angle α gives the light direction in the moving coordinates. On figure 3, we have:

$$[0_o \leftrightarrow y_o] = [0_v \leftrightarrow y_v] = y_v \qquad 27$$

We see that the distance $[0_v \leftrightarrow y_o]$ is larger than the distance $[0_o \leftrightarrow y_o]$ due to the parallax (neglected by Lorentz) created by the displacement of the moving coordinates. On figure 3, let us consider the three sides of the rectangular triangle $[y_o \leftrightarrow y_v]$, $[0_v \leftrightarrow y_v]$ and $[0_v \leftrightarrow y_o]$. We have:

$$[0_v \leftrightarrow y_o]^2 = [0_v \leftrightarrow y_v]^2 + [y_o \leftrightarrow y_v]^2 \qquad 28$$

On figure 3, $[y_o \leftrightarrow y_v]$ is the distance x_v traveled by the moving frame along the x-axis. It is equal to vt_v.

$$[y_o \leftrightarrow y_v] = vt_v = -x_v \qquad 29$$

In which $-x_v$, is the x-coordinate in the moving frame, reached by the pulse of light. Furthermore, the coordinate of the origin (0_v) of the moving frame as measured using the rest coordinates is $x_o(0_v)$.

$$vt_o = x_o(0_v) \qquad 30$$

Equations 25 and 29 in 28 give:

$$[0_v \leftrightarrow y_v] = \sqrt{[0_v \leftrightarrow y_o]^2 - [y_o \leftrightarrow y_v]^2} = \sqrt{(ct_v)^2 - (vt_v)^2} \qquad 31$$

Equation 26, gives:

$$\text{Cos}\ \alpha = \frac{[0_v \leftrightarrow y_v]}{[0_v \leftrightarrow y_o]} \qquad 32$$

Substituting equations 31 and 25 in 32 gives:

$$\text{Cos}\ \alpha = \frac{[0_v \leftrightarrow y_v]}{[0_v \leftrightarrow y_o]} = \frac{1}{ct_v}\sqrt{(ct_v)^2 - (vt_v)^2} \qquad 33$$

Which is:

$$\text{Cos}\ \alpha = \sqrt{1 - \frac{v^2}{c^2}} = \frac{1}{\gamma} \qquad 34$$

Therefore, using equation 34 in 26, the classical distance traveled by light in the moving frame with respect to the distance traveled by light in the rest frame is:

$$[0_v \leftrightarrow y_o] = D = \gamma\ [0_v \leftrightarrow y_v] \qquad 35$$

Equation 35 shows that due to the motion of the moving frame, the moving observer measures that the classical distance traveled by light in his frame is γ times larger than in the rest frame. Therefore:

$$[0_v \leftrightarrow y_o] = \gamma [0_v \leftrightarrow y_v] = \gamma [0_o \leftrightarrow y_o] \qquad 36$$

We must notice that up to now, everything is Galilean. Taking into account these above observations, we calculate now the relationship, which is compatible with a constant velocity of light in all frames. Using the mathematical notation, in the rest frame we have:

$$x_o^2 + y_o^2 = c^2 t_o^2 \qquad 37$$

Since the velocity of light is constant in all frames, (Lorentz postulate) in the moving frame we must have:

$$x_v^2 + y_v^2 = c^2 t_v^2 \qquad 38$$

Similarly to the case of light moving parallel to the moving frame, let us consider first, the following solution to equations 37 and 38.

$$x_v = \gamma\ x_o - \gamma\ vt_o \qquad 39$$

$$y_v = \gamma\ y_o \qquad 40$$

$$t_v = \gamma\, t_o - \gamma \frac{v\, x_o}{c^2} \qquad 41$$

As seen on figure 3, since light is moving in the transverse direction with respect to the rest frame, the final location reached by light (in equation 41) requires that the coordinate of the pulse of light after a time interval t_o is equal to x_o=0. In that case, equations 39 and 41 become:

$$x_v = -\gamma\, vt_o \qquad 42$$

Also,

$$t_v = \gamma\, t_o \qquad 43$$

Equation 40 remains identical.

7 - Testing the Transverse Lorentz Transformation.

Let us calculate the velocity of light traveling across distance $[0_o \leftrightarrow y_o]$. We have:

$$[0_o \leftrightarrow y_o] = ct_o = \sqrt{x_o^2 + y_o^2} \qquad 44$$

In the example chosen above on figure 3, the x coordinate at y_o is x_o=0. In the moving frame the distance traveled by light is $[0_v \leftrightarrow y_o]$. Assuming the constant velocity of light in that moving frame, and using equation 25 we must get the same value of "c" using the moving parameters. This is:

$$[0_v \leftrightarrow y_o] = ct_v = \sqrt{x_v^2 + y_v^2} \qquad 45$$

Let us transform equation 45 using the proposed solution with equations 40, 42 and 43. Equations 35 and 25 in 45 give:

$$[0_v \leftrightarrow y_o] = \gamma [0_v \leftrightarrow y_v] = ct_v = \sqrt{x_v^2 + y_v^2} \qquad 46$$

Substituting equations 43, 29 and 40 into 46 gives:

$$[0_v \leftrightarrow y_o] = \gamma\, ct_o = \sqrt{(-\gamma v t_o)^2 + (\gamma\, y_o)^2} \qquad 47$$

Which is:

$$ct_o = \sqrt{(-vt_o)^2 + (y_o)^2} \qquad 48$$

Equation 30 in 48 gives:

$$ct_o = \sqrt{(-x_o)^2 + (y_o)^2} \qquad 49$$

Equation 49 (which is identical to equation 37) is exactly the equation required to prove that light moves at the same velocity of light "c" in the moving frame as in the rest frame, when we use the solution given by equations 40, 42 and 43. One must conclude that, contrary to the previous Lorentz calculation, the distance traveled by light must increase γ times, in order to be compatible with a constant velocity of light in all frames. Lorentz ignored that the light path is longer in the moving frame when light possesses a transverse velocity component.

Let us show now that the non-corrected Lorentz solution is not compatible with a constant velocity of light in the moving frame. Let us verify what happens when we consider, as Lorentz, that the y-axis is constant. Instead of the relationship 40, Lorentz assumed:

$$y_v = y_o \qquad 50$$

Then equation 46 becomes:

$$\gamma\, ct_o = \sqrt{(-\gamma v t_o)^2 + y_o^2} \qquad 51$$

and

$$\gamma\, ct_o = \sqrt{(-\gamma\, x_o)^2 + y_o^2} \qquad 52$$

We see that equation 52 cannot be compatible with a constant velocity of light in all frames, except when there is no transverse velocity (then y_o=0).

8 - Where did Lorentz Made His Mathematical Error?

Lorentz error is related to equation 20 above. Since the moving frame has shifted forward across the distance x_oL_o, Lorentz transformation implies that the observer at rest calculates that the x component of the distance traveled by light in the moving frame should be given by the relationship:

$$x_v = x_o - v_x t_o T_o \qquad 53$$

Of course, this equation is correct. But is it complete? In physics, when we compare the velocity of light between two different frames, it is not sufficient to compare "only" the x component of the velocity of light. The traveler in motion does not see the light moving in the same direction. There is a change of angle α, which makes the path longer. The change of total distance traveled by light, requires more than the corrections due to the simple displacement of the moving frame of equation 53. We must find the relationship between the distances "r_o" traveled by light for the rest observer, compared with the corresponding distance "r_v" calculated for the moving observer. When the angle $\theta \neq 0$, instead of equation 53 we must calculate the following relationship:

$$r_v = r_o - v_x t_o T_o \qquad 54$$

Equations 53 and 54 are not equivalent, as explained in the paragraph below equation 19. The correct distance traveled by light is given by equation 54 and not equation 53.

We can see on figure 2 that in the moving frame, the correct value of r_v, is:

$$r_v^2 = x_v^2 + y_v^2 \qquad 55$$

In the rest frame we have

$$r_o^2 = x_o^2 + y_o^2 \qquad 56$$

Furthermore the observer at rest measures that using always his own units (rest), at one instant, the distance y_o (rest)=y_v(rest). We must insist here that those two quantities y_o (rest) and y_v(rest) represent the same point existing in both, the rest frame and the moving frame, but always measured using the same units of the rest observer. The meaning of y_o (rest)=y_v(rest) here is different from equation 40. Equation 40 is different because it gives the relationship referring to measurements of the corresponding transverse distances, but measured using the rest frame unit y_o compared with the moving frame unit y_v.

Using y_o(rest)=y_v(rest) and equations 55 and 56 give:

$$r_o^2 - x_o^2 = r_v^2 - x_v^2 \qquad 57$$

Substituting equation 53 in 57, we get:

$$r_o^2 - x_o^2 = r_v^2 - (x_o - v_x t_o T_o)^2 \qquad 58$$

Which is equal to

$$r_o^2 - x_o^2 = r_v^2 - x_o^2 - (v_x t_o T_o)^2 + 2x_o v_x t_o T_o \qquad 59$$

or

$$r_v^2 = r_o^2 + (v_x t_o T_o)^2 - 2x_o v_x t_o T_o \qquad 60$$

Of course in equation 60, when x_o is equal to r_o, (then θ=0) equation 60 becomes identical to equation 53. This is what Lorentz has calculated.

However, in the general case when $\theta \neq 0$, equation 53 is insufficient. Equation 60 gives the exact relationship of the light path between frames before the constant velocity of light is taken into account. Since equation 60 is different from equation 53, one must conclude that the use of equation 53 by Lorentz is erroneous.

Lorentz Mathematical Test. We have seen that Lorentz tested his answer by substituting his proposed solution into the fundamental equation (19). Since Lorentz solution is perfectly compatible with the equation containing the original constraints, this test eliminated any skepticism about the correctness of the solution. However, we will see now that exceptionally, this test is not sufficient. Let us now explain why that mathematical test used in the Lorentz transformation is invalid.

As explained above, Lorentz demonstration starts with a constant velocity of light in the rest frame, which is written:

$$x_o^2 + y_o^2 + z_o^2 - c^2 t_o^2 = 0 \quad 61$$

In the moving frame, the constant velocity of light is written:

$$x_v^2 + y_v^2 + z_v^2 - c^2 t_v^2 = 0 \quad 62$$

Then Lorentz proposed solution compatible with equations 61 and 62 is:

$$x_v = \gamma\left(x_o - vt_o\right) \quad 63$$

$$y_v = y_o \quad 64$$

$$z_v = z_o \quad 65$$

and

$$t_v = \gamma\left(t_o - (v/c^2)x_o\right) \quad 66$$

The compatibility of that solution is indeed correct when we substitute equations 63, 64, 65 and 66 in 62. However, this solution is wrong for the following mathematical reason. Let us look at the internal details taking place during that mathematical substitution. Equations 61 and 62 yield:

$$x_o^2 + y_o^2 + z_o^2 - c^2 t_o^2 = x_v^2 + y_v^2 + z_v^2 - c^2 t_v^2 \quad 67$$

Substituting Lorentz solution with equations 64 and 65 in 67 gives:

$$x_o^2 - c^2 t_o^2 + z_o^2 + y_o^2 - z_o^2 - y_o^2 = x_v^2 - c^2 t_v^2 \quad 68$$

Which is mathematically equal to:

$$x_o^2 - c^2 t_o^2 = x_v^2 - c^2 t_v^2 \quad 69$$

Equation 69 shows that, due to that unfortunate choice of Lorentz hypothesis as mentioned above using the hypotheses 64 and 65, all the parameters y_o, y_v, z_o, and z_v disappear completely as seen in equation 69. That prevents any mathematical testing in the y and z axis. Since all the parameters y_o, y_v, z_o, and z_v disappear, the test is invalid because no parameter involving y_o, y_v, z_o, and z_v exists after the mathematical substitution as seen in equation 69. This is the reason for which the Lorentz proposed solution on the y and z axes "seems to be" valid. It is an invalid confirmation to test a relationship when the most important parameters to be tested are non-existent in the calculation.

We must conclude that when the y-axis is implied, equations 64 and 65 become:

$$y_v = \gamma\, y_o \quad 70$$

$$z_v = \gamma\, z_o \quad 71$$

When light moves in a transverse direction, equations 70 and 71 provide the correct solution to Lorentz equations, compatible with a constant velocity of light in all frames.

9 - Interpretation and Conclusion.

May be an easy way to perceived the error in the Lorentz transformation is to notice that Lorentz considers the geometrical distance, $\left[0_v \leftrightarrow y_v\right]$ on figure 3. Of course, by construction, the distance $\left[0_v \leftrightarrow y_v\right]$ is identical to the distance $\left[0_o \leftrightarrow y_o\right]$. However, since the Lorentz demonstration is based on the distance traveled by light, the correct distance traveled by light is $\left[0_v \leftrightarrow y_o\right]$ rather than $\left[0_v \leftrightarrow y_v\right]$. Therefore, in the Lorentz calculation, there is confusion between the transverse distance $\left[0_v \leftrightarrow y_v\right]$, which is not the correct distance traveled by light, and the real longer distance $\left[0_v \leftrightarrow y_o\right]$ traveled by light. We see that the definition of the parameters x_o, y_o and z_o and x_v, y_v and z_v given by Lorentz at the beginning of his demonstration, gives the coordinates of the pulse of light. However, light is never passing through the coordinate y_v (therefore never traveling along the distance $\left[0_v \leftrightarrow y_v\right]$) as seen on figure 3. Therefore the use of $\left[0_v \leftrightarrow y_v\right]$ to calculate the distance traveled by light in the moving frame is totally irrelevant. The distance traveled by light in the moving frame is γ times longer. Due to the mathematical error shown above, one must conclude that the assumed space distortion between the longitudinal axis and the transverse axes of a moving body does not exist as claimed previously.

We have shown that the transformations calculated by Lorentz are valid only along the longitudinal axis. Similarly, we have calculated above, what the transformation must be, when light travels perpendicular to the direction of the velocity of the moving frame. Using figure 3, it can easily be seen that the correcting factor in the transverse y and z directions is not constant and not always equal to γ at different angles. It can be calculated that the increase (or decrease) of light path, (leading to γ when light moves perpendicular to the frame velocity), is a function of the angle θ (see figure 2). For example, a slight decrease of the angle θ around the 90 degrees direction changes the correction factor γ from a value above unity to smaller than unity. Details will be presented in a future paper. Consequently, there is no constant factor, valid at all angles, which can be applied to the transverse components of light velocity, so that the velocity of light could have a constant velocity in the moving frame. When we extend the calculations for the case of light traveling in a direction having simultaneous x and y components, the change on light path with the angle θ leads to a model of space, which becomes contracted or dilated depending on the angle θ, which exists with respect to a random direction in space. This cannot be compatible with the constant factor (unity) found by Lorentz. This is in agreement with the observations of Múnera (7) who made an analysis showing that in fact, in a moving frame, the velocity of light is different in different directions. This also agrees with the fact that the absolute velocity of light is not constant with respect to a moving observer as clearly required with the GPS (6). The absolute constant velocity of light in all frames is an illusion.

More logically, these same equations can simply mean that the size of all matter (including the reference units of length) is dilated in the moving frame. This has been demonstrated naturally using mass-energy conservation and quantum mechanics (1-3). Furthermore, due to the increase of kinetic energy, this realistic solution implies that the Bohr radius of the atoms in the moving frame increases so that atomic and mechanical clocks run at a slower rate.

Using the realistic interpretation explained here, the kinetic energy is transformed into mass so that the electron mass of atoms increases. That increase of electron mass changes the quantum levels of atoms in such a way, that the Bohr radius gets larger. Of course, this produces a change in the reference meter and the reference clock. Using quantum mechanics, it was shown in 1997, (1) (chapter 7), that the size of macroscopic matter increases as predicted in the corrected Lorentz transformation. Quantum mechanics shows that matter is dilated equally in all the three x, y, and z-axis exactly as predicted in the corrected Lorentz transformation. The asymmetric distortion predicted by Lorentz would mean that the quantum wave functions of atoms would become flattened in the forward direction at high velocity. No observation supports such a strange prediction. Furthermore the increase of the Bohr radius is such that atomic clocks become slower by the amount (γ) predicted in the corrected Lorentz transformation.

Consequently, there is a realistic solution to the fact that the velocity of light appears constant in all frames when local units are used. Furthermore, without having to assume any new hypothesis, we have seen that this realistic solution leads naturally to a classical explanation of the advance of the perihelion of Mercury (5). The same realistic model explains how the Sagnac correction is required in the GPS (6). It also explains how the velocity of light, which is $c \pm v$, seems to be c in all frames. All the physical phenomena, which seemed to require relativity in the past, can now be explained using conventional logic, mass-energy conservations and Newton physics in Galilean space.

10 - References.

1- P. Marmet, Einstein's Theory of Relativity versus Classical Mechanics, Newton Physics Books (1997), 2401 Ogilvie, Gloucester, On. Canada, K1J 7N4. Book on the Web. http://www.newtonphysics.on.ca/EINSTEIN/index.html

2- P. Marmet, Natural Length Contraction Mechanism Due to Kinetic Energy, Journal of New Energy, Vol. 6, No: 3, 2002
Web http://www.newtonphysics.on.ca/kinetic/length.html

3- P. Marmet, Natural Physical Length Contraction Due to Gravity, Web address: http://www.newtonphysics.on.ca/Gravity/gravity.html

4- N. E. Munch, "Unwarranted Assumption Shifts in Relativity and Suggestions for Improved Controls", Proceedings of 2nd Cologne workshop, "Physics as a Science", Aug., 2000; Also published in "Journal of New Energy", pages 5-15, Vol. 5, No. 3, Winter, 2001

5- P. Marmet, Classical Description of the Advance of the Perihelion of Mercury, Physics Essays, Vol. 12, No: 3, 1999, P. 468-487.
Also, A Logical and Understandable Explanation to the Advance of the Perihelion of Mercury, P. Marmet, Meeting of Society for Scientific Exploration, Albuquerque, June 3-5, 1999. Also on the Web: A Detailed Classical Description of the Advance of the Perihelion of Mercury.
http://www.newtonphysics.on.ca/MERCURY/Mercury.html

6- P. Marmet, Explaining the Illusion of the Constant Velocity of Light, Meeting "Physical Interpretations of Relativity Theory VII" University of Sunderland, London U.K., 15-18, September 2000. Conference Proceedings "Physical Interpretations of Relativity Theory VII" p. 250-260
Ed. M. C. Duffy, University of Sunderland. Also: The GPS and the Constant Velocity of Light. Acta Scientiarum, Universidade Estadual De Maringá, Maringá-Paraná-Brazil, Vol. 22 No: 5, page 1269-1279, December 2000. Also: The GPS and the Constant Velocity of Light. NPA Meeting University of Conn. Storrs, Connecticut in June 2000. Also, Galilean Electrodynamics accepted for publication. On the Web at:
http://www.newtonphysics.on.ca/Illusion/index.html

7- Héctor Múnera, Centro Internacional de Física A. A. 251955, Bogotá D.C. Columbia, “Michelson-Morley Experiment Revisited: Systematic Errors, Consistency Among Different Experiments and Compatibility with Absolute Space.” Apeiron, P. 37-54, Vol. 5, Nr, 1-2, January-April 1998. Also Abstract on the Web at:
http://www.newtonphysics.on.ca/faq/Michelson-Morley.html

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