THE RELATIVITY PRINCIPLE AND THE INDETERMINATION OF SPECIAL RELATIVITY

Rodrigo de Abreu
Departamento de Física do IST

Abstract

The indetermination of Special Relativity (SR) is analysed. Our thesis is that as a result of the indetermination of the one-way speed of light we can not determine the movement at every frame. We only can observe a description of the movement with Lorentz co-ordinates. Only as an approximation this correspond to the movement with synchronized clocks. The Galilean Relativity Principle only holds as an aproximation since for large distances we can have large desynchronizations. To determine the movement in every frame we must know the one-way speed of light in one frame. The meaning of Relativity Principle rise from this analysis.

Introduction: The origin of the indetermination.

Only in one frame *S* can we have clock's synchronization by Einstein method of synchronization [1-5]. This frame is the rest system [1, 3]. The frame where we can synchronize the clocks with Einstein method of synchronization with the assumption that the one-way speed of light is *c* [3-5]. For another frame *S'* moving with velocity *v* in relation to the rest system *S*, we have the Lorentz relations between the Lorentz co-ordinates [3, 4]:

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{k^2}}} \qquad (1)$$

$$y = y'$$

$$z = z'$$

$$t'_L = \frac{t - \frac{v}{k^2}x}{\sqrt{1 - \frac{v^2}{k^2}}} \qquad (2)$$

Equation (2) means that the clocks at *x′* are desynchronized with the clock at the origin *x′=0* [3-5].
Therefore, different *x′* have different t'_L. Of course, we can put at *x′* a clock synchronized with the clock at the origin, marking another "time" *t′* [4-6].
With this new "time" *t′* we have the following relations

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (3)$$

$$t' = \frac{t - \frac{v}{k^2}x}{\sqrt{1 - \frac{v^2}{k^2}}} = \frac{t - \frac{v}{k^2}vt}{\sqrt{1 - \frac{v^2}{k^2}}} = t\sqrt{1 - \frac{v^2}{k^2}} \qquad (4)$$

since the clock at *x′=0* is moving at *S* with *x=vt*. Now the new clock at *x′* is marking the same "time" *t′* (we designate this "time" "synchronized time"), the instant marked by the clock at the origin *x′=0*. (3) and (4) is what we call a synchronized transformation [5]. Einstein definition of velocity [1, 3, 6] is not the usual definition of velocity. This can originate misunderstandings since we are defining a new concept using the same word velocity. The concept of velocity is the quotient of the distance by the transit time, the time necessary to describe that distance; the time elapsed between the events departure and arrival. If the clocks at several points of the movement are synchronized between each other, the transit time is the difference between the times at arrival and at departure. This is not the case if the clocks are desynchronized. Of course, if we know the desynchronization, we can calculate the transit time being aware of the desynchronization. To avoid misunderstandings, we call to Einstein concept of "velocity" Einstein's velocity, v_E, maintaining the usual word velocity, *v*, to the usual concept. Using this clear nomenclature, it is easy to show that twin's paradox, or Dingle's paradox, is a result of not considering the desynchronization between the clocks conjugated with the misunderstanding of the two concepts of "velocity" [3, 6], Einstein velocity and velocity (see 2. and 6.).

The transit time is well defined and unique for the frame where the movement is considered. It is the difference between the instant of arrival and departure marked by clocks synchronized. What are not unique are the several differences between several clocks at two points with several desynchronizations. Therefore, since at a point *x´* we can have two clocks with "Lorentz time" and "synchronized time" the difference between the instant of arrival and departure is different for those pairs of clocks. Synchronization is not a convention [7]. Synchronization is unique and only can be achieved by Einstein method of synchronization if we know the one-way speed of light in that frame. We can not by definition impose that the speed of light is *c* in all frames

[2- 6]. What is c in all frames, by definition, is “Einstein's velocity” of light [1]. It is not a postulate [2-5]. It is a definition, conjugated with a definition of time, “Lorentz time”. In any frame we have only a clock rhythm and only a synchronization [4, 5, 6]. Therefore, for each movement we have only one transit time. If we don't know the one-way speed of light, we cannot synchronize the clocks in that frame although we can desynchronize the clocks with light in a unique manner, the Einstein method of "synchronization". The Einstein method of synchronization is a unique method of desynchronization because it is the same in all frames and leads to Lorentz Transformation. This impossibility to synchronize the clocks in all frames by Einstein method of synchronization is the origin of the indetermination of Special Theory of Relativity because we don't know the “common” time of the clocks and therefore we don't know the transit time of the movement. However, the usual language of SR induce to think that the transit time is the difference between the “Lorentz time” at arrival and departure. Only for one frame that can be so.

1. Einstein velocity and velocity

Suppose we have a movement at S' through the x' axis with absolute velocity v_2, where v_1 is the absolute velocity of S' (the absolute velocity is the velocity in relation to the rest frame S)

Einstein velocity at S' is, from (1) and (2)

$$\frac{dx'}{dt'_L} = v_E = \frac{v_2 - v_1}{1 - \frac{v_1 v_2}{c^2}} \qquad (5)$$

Velocity at S', v_R can be calculated from (3) and (4)

$$\frac{dx'}{dt'} = v_R = \frac{v_2 - v_1}{1 - \frac{v_1^2}{c^2}} \qquad (6)$$

From (5) and (6) we obtain different values for v_E and v_R. Einstein velocity of light is c for every frame. Indeed from (5) and $v_2 = c$ (we have admitted that the speed of light at S is c) we obtain

$$v_E = \frac{c - v_1}{1 - \frac{v_1 c}{c^2}} = c \qquad (7)$$

From (6) and $v_2 = \pm c$ we obtain the velocity of light v_R through x' axis

$$v_{R\rightarrow} = \frac{c - v_1}{1 - \frac{v_1^2}{c^2}} = \frac{c}{1 + \frac{v_1}{c}} \qquad (8)$$

$$v_{R\leftarrow} = -\frac{c+v_1}{1-\frac{v_1^2}{c^2}} = -\frac{c}{1-\frac{v_1}{c}} \qquad (9)$$

2. The relation between “times” at two frames, “Lorentz time” and “synchronized time”.

Consider now two frames *S'* and *S''* with absolute velocities v_1 and v_2. Therefore *S´´* have in relation to *S´* “Einstein velocity” v_{E1} and velocity v_{R1} (in relation to *S´*, 1)

From Lorentz Transformation eq. (1) and (2) we obtain

$$dt'' = dt_L^{'}\sqrt{1-\frac{v_{E1}^2}{c^2}} \qquad (10)$$

And from (10)

$$dt'' = dt'\sqrt{1-\frac{v_{E1}^2}{c^2}}\,\frac{v_{R1}}{v_{E1}} \qquad (11)$$

(11) can be obtained from (10), (5) and (6). Indeed from (5) we have

$$dt'' = \frac{dx'}{v_{E1}}\sqrt{1-\frac{v_{E1}^2}{c^2}} = \frac{dx'}{v_{R1}}\frac{v_{R1}}{v_{E1}}\sqrt{1-\frac{v_{E1}^2}{c^2}} = dt'\sqrt{1-\frac{v_{E1}^2}{c^2}}\,\frac{v_{R1}}{v_{E1}} \qquad (12)$$

We obtain also for a clock of *S'* moving through *S''* (note that $v_{E1} = - v_{E2}$) (in relation to S´´, 2)

$$dt' = dt_L^{''}\sqrt{1-\frac{v_{E2}^2}{c^2}} = dt_L^{''}\sqrt{1-\frac{v_{E1}^2}{c^2}} \qquad (13)$$

and also

$$dt' = dt''\sqrt{1-\frac{v_{E2}^2}{c^2}}\,\frac{v_{R2}}{v_{E2}} \qquad (14)$$

Note that $v_{R1} \neq v_{R2}$ except for $v_1 = - v_2$. We obtain symmetric relations for (10) and (13). But (11) and (14) are not symmetric. Eq. (13) is the well-known relation of Special Relativity relating the time (proper time) of a clock with the Lorentz time of the clocks of the frame where the clock is moving. With relation's (11) and (14) we verify that the times of the clocks moving are different except if the clocks have symmetrical absolute velocities [3]. This shows clearly that the clocks from the two frames have different rhythms. Eq. (10) and (13) holds because the desynchronization of the clocks. Eq. (11) and (14) shows that the rhythm of the clock with small absolute velocity has the slower rhythm. If the clocks have symmetric absolute velocities then have the same rhythms. This solves the twin's paradoxes and answers to Herbert Dingle criticism of Special Relativity [8, 9]. Indeed, a clock cannot have a rhythm faster and slower of the other one [8].

3. The meaning of Relativity Principle

Consider the emission of light from the origin of S' moving with absolute velocity v_1, through $+x'$ and $-x'$. Since light moves with absolute velocity $v_2 = \pm c$ from eq. (5) and (6) we have

$$v_{E\rightarrow} = c \qquad (15)$$

$$v_{E\leftarrow} = -c \qquad (16)$$

$$v_{R\rightarrow} = \frac{c}{1+\frac{v_1}{c}} \qquad (17)$$

and

$$v_{R\leftarrow} = -\frac{c}{1-\frac{v_1}{c}} \qquad (18)$$

Therefore, the rays of light emitted at $x'=0$ arrives at $+x'$ and $-x'$ at Lorentz times $t'_{L+}=x'/c$ and $t'_{L-}=x'/c$. Exactly at the same "instant", the same number marked by the desynchronized clocks at S'. The transit times for those rays of light is

$$t'_{+} = \frac{\frac{x'}{c}}{1+\frac{v_1}{c}} \qquad (19)$$

and

$$t'_{-} = \frac{\frac{x'}{c}}{1-\frac{v_1}{c}} \qquad (20)$$

Therefore, we have two different transit times for the arrival of light at the two coordinates $+x'$ and $-x'$. We don't have symmetry. We only have a symmetric description with Lorentz time because with Lorentz clocks we have the same number marked by the clocks at x' and $-x'$ for the arrival of light. The restricted Relativity Principle (rRP) is the generalization of this result. With Lorentz co-ordinates we have a similar description for every equal phenomenon for every frame independently of the absolute velocity of that frame. Since for the "rest frame" the "Lorentz time" is equal to the "synchronized time" the description coincides with the actual movement at the "rest frame". But it is important to note that is only the description that is the same. The actual movement (with synchronized coordinates) is different.

As a simple example consider the fire of two identical guns from the origin of S' through the targets located at $+x'$ and $-x'$. The rRP states that the movement of the bullets has the same description for every frame if we adopt Lorentz co-ordinates. Like the experiment with light, the bullets arrive at $+x'$ and $-x'$ at the same "instant", at the same Lorentz Time. We have a similar description with Lorentz coordinates for the movement of the two bullets and the description is also the same for different frames. That description is also the same for the rest system (this being so a more appropriated designation for the rRP was the restricted Absolute Principle, because the description is absolute, does not depend of the frame choused).

Why is this so is obvious for light. Light moves with speed c on the rest system independently of the absolute velocity of the frame where the source of light is located. This is one of the assumptions that lead to Lorentz Transformation [3]. Another is the definition of time for every coordinate x' with the mapping $x'=ct'$ [3]. Therefore for every phenomena resulting of electromagnetic interactions, we have an explanation of the similar description for every frame. Since the coordinates are defined with a similar physical procedure with light, we have a similar description. Of course, for other coordinates the description is different, but the phenomena is exactly the same. With clocks synchronized we don't have a symmetric description. The arrival of the bullets to the targets is not simultaneous. This does not mean that the phenomena are different. The phenomena are the same as the phenomena of the emission of light previously referred. For small absolute velocities of the frame considered and for small distances the description is the same for Lorentz time or synchronized time. Therefore, the equivalence principle of every frame does not hold for synchronized time as the Galileo Relativity Principle can induce us to think. The restricted Relativity Principle does not affirm the equivalence of all frames with synchronized clocks. Only with Lorentz time we have equivalence, a similar description for every frame. The covariance of the physical Laws is the affirmation of the independence of the coordinates chosen. Therefore, the statement that the Relativity Principle is the statement of this covariance is not equivalent to the statement that the physical Laws have the same form, the same description with Lorentz coordinates. This is the generalized Relativity Principle. For the Lorentz co-ordinates we obtain from the Relativity Principle the restricted Relativity Principle. If we know the physical laws with those coordinates, we know the physical laws for other coordinates.

4. The observer and the Relativity Principle

Consider another simple example, a generalization of the example with the bullets. Consider at the origin of S' two equal spaceships. One is a replica of the other. The computers, the hardware, the software and the programmation are also equal. The pilots are also twins. These two spaceships have the same movement if both departure from the same point (the origin of S') at the same instant for the same direction. But what's happen if this two space ships travel from the origin of S' trough $+x'$ and $-x'$? With rRP we accept that the movement has the same description with Lorentz co-ordinates. But the movement is not the same for synchronized clocks. Therefore, the transit time from the origin to the two points is not the same. Because the absolute velocities of the spaceships are not symmetrical except if S' is at absolute rest.

Suppose now an observer located at $(0, 0, z)$. What movement saw the observer? The observer saw a symmetric description because the speed of light is not the same for the several points where the spaceships pass. For example when one of the space ships passes $-x'$ the space ship emits light to the observer with a direction different of the direction of emission to the observer from the space ship at $+x'$. The velocity of light is different for both directions and compensates the non-simultaneity of the events. Light emitted from $-x'$ is slower that light emitted from $+x'$. Therefore, the observer saw the passage of the space ships to the two symmetrical points at the same instant. Therefore, the observation of a trajectory from one point does not permit to solve the indetermination of the movement. The result of that observation is exactly the same when the frame is at absolute rest.

5. The indetermination of Special Relativity

Since with Lorenz co-ordinates the "movement" is the same for all frames independently of the absolute velocity of the frames, with co-ordinates alone we don't have the movement determined. We can not have a complete description of the movement since we have similar descriptions for different frames. Therefore, observing the movement with Lorentz co-ordinates does not permit to know the absolute velocity of the frame, does not permit to determine the desynchronization of the clocks of that frame. We don't know the common time of the clocks because the observable data has the same values for different frames. Being aware of that we can not affirm the equivalence of every frame if with equivalence we mean a complete equivalence and not equivalence in the restricted sense explained. Being aware of that we can not affirm that the "rest system", the "aether" is superfluous. The "aether" is superfluous only for the determination of the description since we know that description with Lorentz co-ordinates for every frame. Lorentz Transformation without the determination of absolute velocities is undetermined. We have quantities that we want to measure and without the determination of the common time of the clocks we can not measure. The transit time is one example. We know that the transit time exists and for two coordinates x'_1 and x'_2 is different for every frame, for the same phenomena, for example for the movement of light between these two coordinates. The aging of the twins located in every frame is different for the aging of the twins located in another frame except for frames with symmetrical absolute velocities. Therefore, it is not possible to compare the aging of the moving twin with the aging of the twin's at “rest” if we don't know the relative ages of the twins at “rest”. The meaning of the relativity principle as usually is interpreted, that all the frames are equivalent, and all frames can be considered at rest means that relativity is always assuming the “point of view” of the rest frame. This of course can not be considered as the only “point of view”. However, as a procedure it is possible to arbitrate a particular frame as the "rest system", "synchronize" the clocks with Einstein method of synchronization and in any other frame obtain the “Lorenz time” and the “synchronized time”. Since we know the "absolute" velocity of that frame we can determine the "velocity" of light in that frame. This of course can be confirmed experimentally if Nature follows Lorentz Transformation. This is another way to state the indetermination of special relativity since this same procedure can be done for another frame.

Einstein's velocity of light is *c* in every frame. But this affirmation does not hold any information about the velocity of light in a concrete frame. Only with the measure of the one-way speed of light can the theory be completed.

6. The non-equivalence of Lorentz Relativity and Einstein Relativity

Lorentz, based on the existence of a rest frame where Maxwell's equations are verified derived Lorentz Transformation. With Lorentz co-ordinates it was shown that the Maxwell's equations were Lorentz "invariant". With that co-ordinates we can write the physical laws in every frame exactly in the same form as in the rest frame. Those laws can be written with the same form with those co-ordinates. This of course is a particular case of the covariance of physical laws. But the Lorentz, Larmor, Fitzgerald and Poincaré work about this matter assumes only that with those coordinates we have only the same description for every frame. "The approach of Einstein differs from that of Lorentz..." [10]. Einstein indeed assumes that every frame can be considered at "rest". This can be done as a procedure. That procedure results from the mathematical properties of Lorentz Transformation. But it is not the only procedure. And we must be aware of the meaning of that procedure. Einstein affirms that every frame is equivalent. Therefore, at every frame the clocks are synchronized by Einstein's method of synchronization. Also, that at every frame the one-way speed of light is *c*. But indeed, what Einstein affirms in the article of 1905 is the invariance of what we call Einstein's velocity of light. The transit time also can not be the same at every frame for the same distance and for the same Einstein's velocity. What is the same is the difference between the Lorentz time for the arrival and departure. All this can be explained by Lorentz theory based on the existence of a rest frame. There are also some phenomena, therefore observable, that only depend of the Einstein's velocity relative of the two frames [6]. For this observable data the "aether" is superfluous. But we know also that some quantities only can be observable with physical meaning if we know the absolute velocity of the frames. As an example, we have the transit time. Other is the relation of the rhythms of two clocks with two absolute velocities v_2 and v_1. If we only know Einstein's velocity of the two clocks we can not know the relation between the rhythms of the two clocks. Because we can have the same v_E with different absolute velocities and from (11) with different absolute velocities we have different v_R. Therefore, we do not agree completely with the conclusions of Szabo and Bell [10, 11]. Particularly Szabo affirms that the physical content of Einstein's analysis and Lorentz analysis is completely equivalent and therefore "thus the birth of Special relativity was a terminological turn, rather than a revolution in our conception of space and time". Szábó also affirms that the rest system is located at the International Bureau of Weights and Measures (BIPM) in Paris where we have the "etalons". We agree that is necessary to have the "etalons" but it is not sufficient. It is also necessary to know the one-way velocity of light in that frame. We don't know that velocity and therefore only with the "etalons" we don't determine completely the theory. Of course, as a procedure we can suppose that at BIPM the one way speed of light is c but also we can suppose other values consistent with the value c for the two-way speed of light. The existence of "etalons" at two frames does not permit to affirm that we can determine the transit time of other frame because that time is dependent of what frame is "considered" at absolute rest. Therefore, we must know the one-way velocity of light in one frame. Or equivalently we must know what frame is at absolute rest. Therefore, Einstein's special relativity does not solve the problem of the indetermination of Lorentz relativity because for some physical phenomena the existence of "aether" is not superfluous.

Einstein's theory affirms that every frame has synchronized clocks. Affirms also that the relation between the time of a clock moving through a set of clocks at rest is given by (10). This relation does not depend on what frame is choused as the rest frame. Only depend on the relative motion. But this leads to a contradiction. We can also calculate the relation of another clock moving in relation of the same frame and calculate the relation of the rhythms of the clocks between each other. The result is given by (11). Therefore, the relation between Lorentz time and transit time is given by

$$dt' = dt_L' \frac{v_{R1}}{v_{E1}} \qquad (21)$$

(21) depends on absolute velocities. Therefore, to determinate that quantity we must know what is the frame at absolute rest. Only for the rest frame the transit time and Lorentz time are equal.

This being so we agree with John Bell's "how to teach special relativity" [10]. But it is very important to address that the necessary assumption existence of the "aether" does not solve the indetermination of the theory. Einstein's relativity only apparently solves that indetermination.

7. One spherical wave in both frames as a result of a spherical wave only in one frame.

Suppose the emission of two light waves from the origin of *S* and *S´* at $t=t´=0$. Since we admit that the speed of light is *c* at *S* we have only one spherical wave as result of the two emissions. But SR induces to think that we have two spherical waves, one wave per frame, propagating with velocity *c* and that affirmation is necessary if we admit that every frame is equivalent of another frame. Of course, from rRP we can easily understood the meaning and scope of that affirmation. From RP we have that a spherical wave in *S* is a reality, a geometric object, independent of the coordinates used to describe that reality. From rRP we also know the description with Lorentz co-ordinates at S´. If we consider at *S´* the same "instant" we have the same description of the rest frame. A spherical wave at *S'*.

Consider the propagation through *x*-axes. If the emission is at $(x_0,0,0)$ $(x'_0, 0, 0)$ at $t=0$ with galilean transformation we have

At *S*

$$x - x_0 = c(t - t_0) = ct \qquad (22)$$

At *S'* we have

$$x´_0 = x_0 \qquad (23)$$

$$x´_0(t) = x_0 - vt \qquad (24)$$

$$x´ = x - vt \qquad (25)$$

Therefore, we have

$$x´ - x´_0(t) = x - x_0 = ct \qquad (26)$$

Therefore, we have a spherical wave propagating in the two frames. The sphere at *S'* has the center at $(x'_0, 0, 0)$. As a particular case we have

$$x_0 = 0 \qquad (27)$$

and

$$x = ct = x' - x'_0 \qquad (28)$$

Consider now the synchronized co-ordinates. From (3) and (4) we have

$$x'_0(t') = \frac{-vt}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (29)$$

and therefore

$$x = \left[x' - x'_0(t')\right]\sqrt{1-\frac{v^2}{c^2}} \qquad (30)$$

From (3) and (29) we have

$$x' - x'_0(t') = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{-vt}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{x}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (31)$$

Since $x=ct$ from (30) we have

$$x = ct = \left[x' - x'_0(t')\right]\sqrt{1-\frac{v^2}{c^2}} \qquad (32)$$

and

$$x' - x'_0(t') = \frac{ct}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{ct'}{1-\frac{v^2}{c^2}} \qquad (33)$$

From (33)

$$x' = x'_0 + \frac{ct'}{1-\frac{v^2}{c^2}} \qquad (34)$$

and from (29)

$$x' = -\frac{vt'}{(1-\frac{v^2}{c^2})} + \frac{ct'}{(1-\frac{v^2}{c^2})} = \frac{c-v}{(1-\frac{v^2}{c^2})}t' = \frac{c}{(1+\frac{v}{c})}t' \qquad (35)$$

For a first order approximation we have from (33) and (35)

$$x' - x'_0 = ct' \qquad (36)$$

and

$$x' = (c-v)t' \cong ct' \qquad (37)$$

Only for a first order approximation (36) and (37) correspond to a wave at *S´* with center at the origin of *S´*. Although the spherical wave was emitted at the origin of *S´* the wave propagates as a sphere at *S* with center at the origin of *S*. A relativistic analysis must be consistent with this obvious result.

At *S´* the velocity of the wave trough *x´* is

$$\frac{x'}{t'} = \frac{c-v}{1-\frac{v^2}{c^2}} \qquad (38)$$

The velocity of light only as a first order approximation is *c*.

For the Galilean Transformation the "velocity" in relation of the point of emission is

$$\frac{x' - x'_0}{t'} = c \qquad (39)$$

However, the same quantity for the Synchronized Transformation is not *c*

$$\frac{x' - x'_0}{t'} = \frac{c}{1 - \frac{v^2}{c^2}} \qquad (40)$$

This is a result of the change of the "etalons". We can also calculate another "velocity", Einstein's velocity if we introduce a desynchronization.

$$t'_L = t' - \frac{v}{c^2} x' \qquad (41)$$

(Of course, the introduction of clocks desynchronized does not change the reality of the spherical wave at *S*.)

From (40) and (41) we have for the front wave

$$t'_L = t' - \frac{v}{c^2} x' = t' - \frac{v}{c^2} \frac{c - v}{(1 - \frac{v^2}{c^2})} t' \qquad (42)$$

(42) can be written

$$t'_L = \frac{c - v}{c(1 - \frac{v^2}{c^2})} t' \qquad (43)$$

Therefore, we have

$$ct'_L = \frac{c - v}{(1 - \frac{v^2}{c^2})} t' \qquad (44)$$

Einstein's velocity *c* is consistent with the usual concept of velocity

$$\frac{c - v}{(1 - \frac{v^2}{c^2})} \qquad (45)$$

The equation of the spherical wave at S is

$$x^2 + y^2 + z^2 = c^2 t^2 \qquad (46)$$

From (4), (30) and (46) we have

$$(1-\frac{v^2}{c^2})(x'-x'_0)^2 + y'^2 + z'^2 = c^2 \frac{t'^2}{(1-\frac{v^2}{c^2})} \qquad (47)$$

and after some algebra

$$x'^2 + y'^2 + z'^2 = c^2 (t' - \frac{v}{c^2} x')^2 \qquad (48)$$

Therefore, we have two equations for the wave.

A spherical wave for the Lorentz co-ordinates and an ellipsoid for the synchronized co-ordinates from (47) and (48)

$$x'^2 + y'^2 + z'^2 = c^2 t'^2_L \qquad (49)$$

and

$$(1-\frac{v^2}{c^2})^2 (x'-x'_0)^2 + (1-\frac{v^2}{c^2}) y'^2 + (1-\frac{v^2}{c^2}) z'^2 = c^2 t'^2 \qquad (50)$$

Both equations represent the same reality the same "geometric object"; a spherical wave at S. Equation (50) results from the change of the "etalons" at S'. Equation (49) results from the same change of the "etalons" and also from the desynchronization of the clocks. Therefore, we don't have a spherical wave propagating at S' with the clocks synchronized. Minkowsky elegant formalism of relativity must be interpreted with physical meaning.

8. The problem of the acceleration of two space ships, the Fitzgerald-Lorentz contraction and the relativity principle.

The old problem addressed by John Bell [10] of the acceleration simultaneous of two space ships have a clear physical meaning if we suppose that the space ships are at absolute rest. For two space ships moving we can give an easy answer to the problem if we accept the relativity principle.

Suppose initially two spaceships A and B (without rotation) and a third space ship C, equidistant of A and B [10], at absolute rest at *S*. The two spaceships A and B are accelerated simultaneously in the direction of the line defined by the two space ships [10], the x-axes, (after receiving a signal from A) and with identical acceleration programs. The distance of the two spaceships at *S* remain fixed, *L*. But what's happen at *S'*. After the spaceships accelerate we know that the distance of the space ships at *S* is *L* and therefore the distance at *S'* increase and it is given by Fitzgerald contraction. This result can be easily confirmed by telemetry. Indeed, if we measure the distance of the two space ships emitting light from one ship to a mirror at the other space ship the time for the two-way trip at *S*, is given by

$$\Delta t = \Delta t_1 + \Delta t_2 = \frac{L}{c-v} + \frac{L}{c+v} = \frac{2L}{c(1-\frac{v^2}{c^2})} \qquad (51)$$

And from Larmor dilatation of time [10] we have

$$\Delta t' = \Delta t\sqrt{1-\frac{v^2}{c^2}} = \frac{2L}{c(1-\frac{v^2}{c^2})}\sqrt{1-\frac{v^2}{c^2}} = \frac{2L}{c\sqrt{1-\frac{v^2}{c^2}}} \qquad (52)$$

From (52) and since the two-way speed of light is *c* we conclude that the distance measured at *S'* is

$$\frac{L}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (53)$$

This result can be obtained by an electromagnetic analysis [10]. Eq. (53) means that a rod at *S'* is contracted when oriented at a direction parallel to the x-axes. The acceleration of two spaceships simultaneously from rest implies an increase of the distance measured on the frame were the space ships are at rest after the acceleration and this result does not depend of the direction of the acceleration, positive or negative. But if the two spaceships are moving a "simultaneous" acceleration of the two spaces ships depends on the direction of the acceleration ("simultaneous" now means with Lorentz clocks of the spaceships marking the same number). If we accelerate (positively) the distance decrease and if we break the distance increase. Indeed, since the clocks are desynchronized and if we suppose that the two space ships are moving in the direction of the positive x-axes of *S*, the first ship to accelerate is the located at second place "on the ride". Therefore, we can think that the change of the distance to the other depends on the direction of acceleration and therefore the effect of acceleration is not symmetrical except if the spaceships are at absolute rest. This is not so and the distance measured at the frame of the space ships increases as if the space ships were initially at rest as the relativity principle prescribes . As John Bell points out a fragile thread that links the accelerated space ships must break.

9. The electromagnetic field, Lorentz Transformation and the indetermination of Special Relativity

Consider the rest frame *S* and the frames *S'* and *S''* with absolute velocities v_1 and v_2. At the origin of *S''* is located a charge *q*. The origins of the frames coincide at $t=t'=t''=0$. The problem to address is the determination of the *x'* component of the electric field at *x'* when the charge is located at the origin of *S'*. For three physical frames with "etalons" the problem is completely defined, and the answer is unique. Does not depend on the "point of view". Of course, the answer only can be given if we know also the one-way speed of light or equivalently if one of the frames is at absolute rest. The answer is the following and coincides with the resolution based on the assumption that the Maxwell's equations are valid at the rest frame [10]:

The *x''* component of the electric field at *x''* is given by (based on rRP)

$$E_{x''} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x''^2} \qquad (54)$$

Since the *x* component of the electric field at *S* is equal [10] we have

$$E_x = E_{x''} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x''^2} \qquad (55)$$

The *x* co-ordinate is calculated by the LT and we obtain from (1) for $t=0$

$$x'' = \frac{x}{\sqrt{1-\frac{v_2}{c^2}}} \qquad (56)$$

Therefore from (55) and (56)

$$E_x = E_{x''} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x^2}(1-\frac{v_2^2}{c^2}) \qquad (57)$$

Since we have

$$x = x''\sqrt{1-\frac{v_2^2}{c^2}} \qquad (58)$$

and

$$x = x'\sqrt{1-\frac{v_1^2}{c^2}} \qquad (59)$$

we have also

$$x'' = x'\frac{\sqrt{1-\frac{v_1^2}{c^2}}}{\sqrt{1-\frac{v_2^2}{c^2}}} \qquad (60)$$

(60) can be writen [3]

$$x'' = x'\sqrt{1-\frac{v_E^2}{c^2}}\,\frac{1-\frac{v_1 v_2}{c^2}}{1-\frac{v_2^2}{c^2}} \qquad (61)$$

Therefore from (54) and (56) we have

$$E_{x'} = E_{x''} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x''^2} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x'^2}\frac{1}{(1-\frac{v_E^2}{c^2})}\frac{(1-\frac{v_1 v_2}{c^2})^2}{(1-\frac{v_2}{c^2})^2} \qquad (62)$$

From (62) we conclude that the answer to our problem depends on the absolute speeds of the frames.

Another problem is the following. What is the *x′* component of the electric field at *x′* for *t′=0*. When the charge is at the origin of *S′* at *x′* the Lorentz clock marks

$$t' = -\frac{v}{c^2}x' \qquad (63)$$

Therefore when we consider that for the same *x′* the instant *t′=0* the charge already moves out of the origin *x′=0*. We can calculate the *x″* correspondent to the *x′=0* at *t′=0*. From Lorentz transformation we obtain

$$x'' = \frac{x' + v_E t'}{\sqrt{1 - \frac{v_E^2}{c^2}}} = \frac{x'}{\sqrt{1 - \frac{v_E^2}{c^2}}} \qquad (64)$$

Then we have

$$E_{x'} = E_{x''} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x''^2} = \frac{q}{4\pi\varepsilon_0}\frac{1}{x'^2}\left(1 - \frac{v_E^2}{c^2}\right) \qquad (65)$$

This result is what we obtain for the electric field at *S* if $v_2 = v_E$. Then as a prodedure we can calculate the field at a *x′* of a frame at *t′=0* supposing that the charge is at the origin and the clocks are synchronized, as the frame was at absolute rest. This is what the rRP prescribed. But this is only a procedure that is independent of the knowledge of the absolute velocities.

Conclusion

The indetermination of Special Relativity results from the indetermination of the one-way speed of light in every frame. We only know the one-way “Einstein speed” of light. But this knowledge results from the definition of "velocity" introduced by Einstein in the article of 1905 that leads to Lorentz Transformation. It is accepted as an experimental fact that the two-way speed of light is *c* in every frame [12]. If it is accepted also that the one-way speed of light is c in one frame than the one-way speed of light is not *c* in any other frame. The assumption of the existence of a frame where the one-way speed of light is *c* and the asumption that the two-way speed of light is *c* in any other frame leads to Lorentz Transformation with a particular definition of time, the Lorentz time. This implies that “Einstein´s velocity” of light is *c* in every frame. This implies also that the one-way velocity of light is not *c* This clarifies the method to obtain the Lorentz Transformation, solves the problem of the internal inconsistency of usual interpretation of relativity but also shows that the "aether" is not superfluous. "Aether" is essential to complete the theory. "Aether" as the rest system, the frame where the one-way speed of light is *c*. From this analysis it is clear that we can not obtain a complete theory only with the experimental information of the two-way speed of light. We must also have the information about the one-way speed of light in one frame. From this analysis the meaning of Relativity Principle is reanalysed and the non-equivalence of Lorentz Theory with Einstein Theory is stated.

References

1. Einstein, A. Ann. Phys. 17, 132 (1905): "*On the Electrodynamics of Moving Bodies*", "*Einstein´s Miraculous Year, Five Papers That Changed the Face of Physics*" Edited and Introduced by John Stachel, Princeton University Press (1998).
2. de Abreu, R. Ciência & Tecnologia dos Materiais, vol. 14, nº 1, p. 32 (2002).
3. de Abreu, R. http://arxiv.org/abs/physics/0203025 ; EPS-12 Trends in Physics, Abstracts p. 270, Budapest (2002).
4. de Abreu, R. http://arxiv.org/abs/physics/0210023
5. de Abreu, R. http://arxiv.org/abs/physics/0212020
6. Homem, Gustavo fisica.ist.utl.pt/~left/2002-2003/Apresentacoes/16-12-2003/Gustavo_Homem.pdf
7. Miller, A. I. *Albert Einstein's Special relativity Theory of Relativity* (Springer-Verlag New York, Inc.), p. 187 (1997).
8. Dingle, H. Nature vol. 195, nº 4845, p. 987 (1962).
9. Dingle, H. *Science at the Crossroads*, (Martin Brian & O'Keeffe, London) (1972).
10. Bell, J. S. *Speakable and unspeakable in quantum mechanics*, How to teach special relativity, p. 67 (Cambridge University Press) (1993).
11. Laszlo E. Szabo http://xxx.lanl.gov/abs/physics/0308035
12. Consoli, M. Contanzo, E. http://www.arxiv.org/abs/astro-ph/0311576