A Simultaneity in the Lorentz Transformation of the time

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ABSTRACT: Using the Lorentz Transformations between (x, y, z, t) and (ξ, η, ζ, τ) and the fact that it is impossible to have clocks in a unique point (infinitesimal clocks), more exactly, the fact that time measured in a system does not depend on format, dimensions and internal mechanism of clocks and any periodical process adopted in measurement, it is proved the simultaneity of events E_1**,** "Time measured at the stationary system (S) is *t*." (Or "Clocks X_1, X_2, X_3, …, X_n at rest at the stationary system indicate or set time t in this system", *i.e.*, no matter the position (x', y, z) of measurement of time t in S, even to $x' \neq x$), and E_2**,** "Time (or schedule, instant, time instant) measured at the moving system (S'), through a stationary clock at this system and at position (ξ, η, ζ), is given by τ.". Such simultaneity is related to the system considered stationary, of coordinates (x, y, z, t), as well as of the system considered in movement with respect to the first one, of coordinates (ξ, η, ζ, τ). Of this simultaneity that is contained in the Lorentz Transformations of the time is easy to prove that is contradictory the definition of Synchronism of Clocks, used in the Special Relativity.

KEY WORDS: Theory of Special Relativity, simultaneity, Lorentz Transformations.

The Lorentz Transformations (L.T.),

$$\tau = \beta\,(t - vx/c^2); \tag{1}$$
$$\xi = \beta\,(x - vt); \tag{2}$$
$$\eta = y; \tag{3}$$
$$\zeta = z; \tag{4}$$

where $\beta = 1/(1-v^2/c^2)^{1/2}$, are the correspondence between the spacetime coordinates (x, y, z, t) and (ξ, η, ζ, τ) to characterize any event E in Theory of Special Relativity (T.S.R.)

domain. They contain one simultaneity in the L.T. of the time. Such simultaneity is related to the system considered stationary, of coordinates (x, y, z, t), as well as of the system considered in movement, of coordinates (ξ, η, ζ, τ).

Simultaneity in which events? Events E_1**,** "Time measured at the stationary system (S) is *t*." (Or "Clocks X_1, X_2, X_3, …, X_n at rest at the stationary system indicate or set time *t* in this system", *i.e.*, no matter the position (x', y, z) of measurement of time *t* in S, even to $x' \neq x$), and E_2**,** "Time (or schedule, instant, time instant) measured at the moving system (S'), through a stationary clock at this system and at position (ξ, η, ζ), is given by τ."

The proof to simultaneity with respect to S is trivial: τ is measured in *t* instant of S, according to L.T.

Upon the simultaneity with respect to S' one would have to prove that if E_1 was previous or later to E_2**,** one would reach a contradiction. In this way one would just have to appeal to the fact that clocks which measure time *t*, stationary with respect to S, and τ, stationary with respect to S', not infinitesimal, but extensive, have got non-null dimensions (lenght, height, width). On the other hand, one can verify conceptual problems to be solved by T.S.R. at the immobility requirement of these clocks, at the system where time is measured: clocks need to be stationary with respect to the respective system, nevertheless, their main components are in (periodic) movement at the same system.

In accordance to what Einstein has written [(1)], "we understand by the "time" of an event the reading (position of the hands) of that one of these clocks which is in the immediate vicinity (in space) of the event. In this manner a time-value is associated with every event which is essentialy capable of observation." It is noticed that to the denomination of "time" it is given the same meaning of schedule, and not necessarily of duration, or interval between two schedules.

Let's suppose that to system S' event E_1 – the measure of *t* in S at the position (x', y, z), $x' \neq x$ – is before E_2 – the measure of τ in S' at position (ξ, η, ζ) – and that between *t* and τ, and between (x, y, z) and (ξ, η, ζ), L.T. are valid. In this case we should have $x' > x$, supposing x, x' and speed v of S' are positive. But to which part of the clock that measures *t* corresponds the value of *x*'? Once every clock has got the same non-null dimensions, we should question ourselves: is the clock geometrical center, which is in *x'*, or the centre of mass, or the part more to the right or more to the left? Is any part of the hour hand, or indicative digits of schedule or any other part of the clock which is, or should be, in *x'*? According to Feymann's writings [(2)] it is not necessary to know anything about clocks' functioning or mechanisms, and therefore we conclude it is also not necessary to know anything about clocks' dimensions and components, except that they can have any non-null dimension and that they must have components.

If the clock which measures τ had a dimension such that the point x' was contained in it during the measurement of this time τ, even if it was for just an instant (particularly the instant τ or t), any part or point of the clock which should correspond to x' could be assumed now. It is obvious that the whole internal part of the clock which measures τ is in time τ of S' – at the moment τ is measured. How can E_1 happens before E_2 if both clocks are placed at the same immediate vicinity (in space) during measurements?

We change case $x' \neq x$ into $x' = x$ through the dimensions' extension of the clock which measures τ. The measures of schedules must be, this way, simultaneous with respect to both systems. It is proved, therefore, the contradiction.

Similar proof can be withdrawn from the hypotheses that E_1 is after E_2, so that we get to the conclusion that E_1 and E_2 are simultaneous with respect to S', for any value of x', even to $x' \neq x$.

To make it simpler for our understanding, let's suppose our clock in movement, Σ, registers $\tau = 3$ o'clock (measured in both the systems), *i.e*, if its hour hand is parallel to the movement's direction and it contains abscissas points x and $x' > x$, ordinate y, at instant t, according to what was measured at the stationary system. It respectively corresponds to abscissas ξ and $\xi' = \beta(x' - vt)$, ordinate η, according to what was measured at the moving system.

When Σ registers schedule τ, its hour hand will be ordinate $\eta = y$ and it will simultaneously contain points x and x', with respect to S, respectively corresponding to ξ and ξ' in S'. Such positions are also simultaneously occupied at that system, for, other way, Σ would register another schedule, and its hour hand would present a slating position with respect to the movement's direction, instead of $\eta = y$, which would lead us to another contradiction. This way, measure t in x' (or x) and measure τ in ξ (or ξ') are simultaneous with respect to S'.

A more generical example: through L.T. we have $\tau' \neq \tau$ if τ' corresponds to the abscissa x', different from the abscissa x, corresponding to τ, to the same time value t of the stationary system, and supposing the movement is towards axis x.

Then, but if our mobile clocks obey, by hypothesis, L.T. and if a clock Σ, which measures time at moving system S', contains points x and x' at instant t, (points ξ and ξ' with respect to S') it turns obvious that τ and τ' measurements must be simultaneous (at the same time), even with respect to S', for x and x' (and ξ and ξ') are located at the the same spatial surroundings, which is immediate during measurements, *i.e.*, they belong to clock Σ interior space. It should make τ and τ' equal to time indicated by Σ, therefore, events E_1**,** "Time measured at steadied system (S) is *t."* (or "Clocks X_1, X_2, X_3, …, X_n, at rest at the stationary system, indicate or point time t in this system.", *i.e.*, for any position of (x', y, z) of time measure t in S, even to $x' \neq x$), and E_2, "Time (or schedule, instant, time instant) measured at moving system (S') through a stationary clock at that system and at position (ξ, η, ζ) is given by τ." are simultaneous with respect to S' (and S).

Of this simultaneity that is contained in the L.T. of the time is easy to prove that is contradictory the definition of Synchronism of Clocks, used in the Special Relativity.

Even admitting time dilation and space contraction, both, true realities of Experimental Physics, I do not believe L.T. regarding time, (1), can be true, based on we proved here. It must not depend on positions, and it possibly shows as $\tau = t/\alpha$, in order to make its accordance to time dilation.

DEDICATION

I dedicate this work to professors Normando Celso Fernandes, André Koch Torres Assis and César Lattes.

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