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PALACIOS, RELATIVITY WITHOUT ASYMMETRIC AGING

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ABSTRACT. This writer finds asymmetric ageing, although currently considered a natural consequence of Special Relativity, to be an antinomy. In an effort to reconcile this situation, he has developed his own understanding of how this situation came about and proposed a remedy.[1] In the course of his researches on this matter, he learned that a certain Professor Julio Palacios published in the 1960's a revision of Special Relativity that precludes asymmetric aging from the start.[2] This work, never having been translated from Spanish, is little known outside the Hispanophone cultural area, and even within it, disparaged for its hetrodoxical viewpoint. Nevertheless, this writer, without endorsing every conclusion, found Palacios' theory, in spite of its defects, to be as meritorious as the conventional theory, because of its defects; and translated Palacios's book into English. This article is a collection of extractions from the translation describing the central argumentsts and conclusions.

1. MOTIVATION

One gets to this 'clock' absurdity inevitably by using the Lorentz transformations—a circumstance that suggests that one might be able to make an alteration just there that could serve as a basis for relativity without its current logical problems. We shall examine, therefore, the fundamentals in search of altered transformations meeting this requirement, and then describe our results involving nothing more that the introduction of a factor to the Lorentz transformations that permits one simultaneously to derive two theories, Einstein's and an alternate, by setting this factor as an exponent to either 1 or 0.

2. LORENTZ TRANFORMATIONS

2.1. **The postulates of Einstein's theory of relativity.** Lorentz noted that it is possible to explain the outcome of the Michelson and Morley experiment by replacing Galilean transforms with certain other, well chosen ones; a modification which he tried to justify on the basis of reasoning based on classical mechanics. Einstein[1], on the other hand, made identical deductions, i.e., the Lorentz transformations, based on electromagnetic phenomena involving relative motion of magnets and currents. Subsequently he announced his famous principle upon which he based his deduction of these transformations. In reality, however, even Einstein did not specify explicitely the three principles which he used to derive Lorentz transformations, namely:

(1) Galileo's postulate: *Given any inertial system, S, another system which moves at a constant velocity with respect to it, is also an inertial system.*
(2) Invariance of the speed of light: *Light propagates with the same speed in all inertial frames.*

[1] A. Einstein, *Ann. der Physik,* **17,** 891 (1905).

(3) Relativity principle: *No experiment can distinguish between a stationary system and one moving with a constant velocity.*

The first of these principles or postulates follows from classical mechanics; it is a consequence of the principle of inertia. It specifies, that passage from a system of fixed axes to another set of axes moving at constant velocity with respect to the first set, is regulated by Galilean transformations. Here we formulate this as an independent postulate, that is, valid also were it necessary to change these transformation formulas.

The second postulate is justified by results of Maxwell's theory, following which, the velocity of electromagnetic waves is a universal constant, c, related to two permeabilities (electric and magnetic) of free space. The Michelson and Morley experiment conforms with this postulate but does not itself constitute definitive proof, because it is not possible to verify that velocity of light is the same in both directions, only that the total time taken for a round trip is invariant with respect to orientation of the instrument. Experiments by L. Essen, W. W. Hansen and K. Bol, involving measurements of resonances in microwave cavities, seemed to show that c is independent of direction, but they have been disputed by A. Grünbaum.[2]

Finally, the third postulate is based on the fact that it has not been found possible to do an experiment that permits one to determine whether a reference system is absolutely stationary or in constant motion. Together with the first two postulates, this suffices to construct the theory of Einstein. For our purposes, it is convenient to mention the three, and then to explain how to construct a new theory keeping the first two but abandoning the third.

2.2. **The Lorentz formulas.** Let there be two reference systems, one, S, which we consider fixed, and another, S', which moves with a constant velocity and direction. In order to derive formulas that serve to pass from one system to another, we exploit postulates enunciated in the previous section. With no loss of generality, in as much as passage between two fixed systems offers little difficulty, let us suppose that the X and X' axes coincide and are parallel to the direction of motion, and that the axes Y and Z are parallel respectively to Y' and Z'.

By virtue of Galileo's postulate, it has to be true that movement of a body free of external forces will be rectilinear and uniform, and, when represented in each of two systems S and S', it must follow, therefore, that an encounter of two moving particles can be described as an event that occurs at a common point of their trajectories. In geometric language, it can be said, that between two spaces S and S', there exists a point to point and line to line correspondence, such that intersection of two lines corresponds to intersection of its homologues. This by itself implies that transformation formulas are linear with respect to coordinates, and have the same relation to time, so that a linear motion in S will appear as a linear motion in S'. Moreover, this correspondence may likewise be seen as stipulating that, if two variables describe parallel trajectories in S, then they will not coincide anywhere in S'. That is, they conserve parallelism.

By virtue of the second postulate, it follows that propagation of a light wave can be described the same way in both systems. To examine restrictions that it imposes on transformation formulas, let us suppose that from the origin of S, at the instant $t = 0$, a light pulse is emitted. After a time t, the front of this pulse forms a spherical surface

$$x^2 + y^2 + z^2 = c^2t^2, \tag{2.1}$$

[2]A Grünbaum, *Am. J. of Phys.* **23**, 450 (1955); *idem*, **24**, 588 (1956).

and if the origins of both systems coincide at the instant $t = 0$, this same wave pulse in S' must obey the equation

$$x'^2 + y'^2 + z'^2 = c^2 t^2, \tag{2.2}$$

hence, we suppose that rays in S and S' propagate in like fashion.

Right away, we see that Galilean equations won't fit, because they convert Eq. (1) to

$$(x' + vt)^2 + y'^2 + z'^2 = c^2 t^2,$$

which can not be identified with Eq. (2), except in the trivial case when $v = 0$. This reveals that the solution to this task demands more parameters, and the only consistent recourse is to admit that *to pass from one system to another, one must transform not only spacial coordinates*, *but also time*. In other words: clocks in S and S' can not have the same tempo.

Following this, for Eq. (2) we must take:

$$x'^2 + y'^2 + z'^2 = c^2 t'^2, \tag{2.3}$$

and the problem becomes then of determining the coefficients of the following transformation formulas:

$$\begin{aligned}
x &= a_{11}x' + a_{12}y' + a_{13}z' + a_{14}t' + k_1 \\
y &= a_{21}x' + a_{22}y' + a_{23}z' + a_{24}t' + k_2 \\
z &= a_{31}x' + a_{32}y' + a_{33}z' + a_{34}t' + k_3 \\
t &= a_{41}x' + a_{42}y' + a_{43}z' + a_{44}t' + k_4
\end{aligned} \tag{2.4}$$

such that Eq. (3) is obtained from Eq. (1).

Let us, to begin, impose the condition $t = t' = 0$ when the origins of both systems coincide, which leads to $k_1 = k_2 = k_3 = k_4 = 0$.

Since movement is along the axis $X \equiv X'$, the coordinates y, z corresponding to $P(x', y'z')$ must be independent of time; thus

$$a_{24} = a_{34} = 0.$$

The conservation of parallelism implies that if $x'_1 = x'_2$, then also $x_1 = x_2$ for $t = \text{const.}$, likewise for the other coordinates. This same consideration evaluated on the other axes gives

$$a_{12} = a_{13} = a_{21} = a_{23} = a_{31} = a_{32} = 0.$$

Evidentially, the axis $X \equiv X'$ is an axis of symmetry, for which whatever holds between y and y', is also true for z and z'. As a consequence

$$a_{22} = a_{33} = a.$$

Let $-v$ be the velocity with which points of S move with relation to S', that is

$$\left(\frac{\partial x'}{\partial t'}\right)_x \equiv -v,$$

and this, with the first of Eqs. (4) and, as shown above, that $a_{12} = a_{13} = 0$, also leads to

$$\frac{a_{14}}{a_{11}} = v.$$

The cosiderations above imply, therefore, that by virtue of the first postulate and the way the axes as well as the origin of time were chosen, it has to be true that

$$\begin{aligned} x &= a_{11}(x' + vt'); \\ y &= ay'; \\ z &= az'; \\ t &= a_{41}x' + a_{42}y' + a_{43} + a_{44}t'. \end{aligned} \tag{2.5}$$

Passing now to the second postulate, we see immediately that if the equation

$$x^2 + y^2 + z^2 = c^2t^2$$

must convert to

$$x'^2 + y'^2 + z'^2 = c^2t'^2,$$

then the coefficients of the terms $x'y'$, $y'z'$, $z'x'$ must be nullified, so that

$$a_{41}a_{42} = 0; \quad a_{42}a_{43} = 0; \quad a_{43}a_{41} = 0;$$

and; by virtue of symmetry about the axis $X \equiv X'$, the second of these equations implies that

$$a_{42} = a_{43} = 0,$$

which satisfies all these stipulations.

In addition, the second postulate demands satisfaction of the identity

$$\begin{aligned} a_{11}^2(x' + vt')^2 + & \quad a^2(y'^2 + z'^{2)}) - c^2(a_{41}x' + a_{44}t')^2 \\ \equiv & \quad \rho^2(x'^2 + y'^2 + z'^2 - c^2t'^2), \end{aligned}$$

where ρ^2 is an arbitrary constant. The final result is:

$$a_{11}^2 - c^2a_{41}^2 = \rho^2; \quad a = \rho; \quad v^2a_{11}^2 - c^2a_{44}^2 = -c^2\rho^2;$$

$$va_{11}^2 - c^2a_{41}a_{44} = 0. \tag{2.6}$$

These four equations permit determination of all coefficients of the transformation equations as a function of an arbitrary constant $\rho = a$. To do so, solve the fourth equation for a_{44} and substitute it in the third equation:

$$v^2a_{11}^2 - \frac{v^2a_{11}^4}{c^2a_{41}^2} = -c^2\rho^2.$$

From this result solve for $c^2a_{41}^2$ and substitute it in the first equation, giving, where $\rho = a$:

$$a_{11} = \pm\frac{\rho}{\sqrt{(1 - v^2/c^2)}}.$$

In so far as we supposed that the axes X and X' are oriented in the same sense, we have to take for x and x' the same sign at $t = t' = 0$, let it be "$+$".

The third equation then gives:

$$a_{44} = \pm\frac{\rho}{\sqrt{(1 - v^2/c^2)}},$$

and as $t' > 0$ if $t > 0$, it also has a positive sign.

Finally, the last equation of the set Eq. (6) gives:

$$a_{41} = \rho\frac{v/c^2}{\sqrt{1 - v^2/c^2}},$$

so that the final transformation set is:

$$\begin{aligned} x &= \rho\frac{x'+vt'}{\alpha} \\ y &= \rho y' \\ z &= \rho z' \\ t &= \rho\frac{t'+\frac{v}{c^2}x'}{\alpha} \end{aligned} \tag{2.7}$$

where:

$$\alpha = \sqrt{1-v/c^2}.$$

Einstein's principle of relativity serves to fix the value of the magnitude of ρ such that it has the exponent: zero; then, in order that the systems S and S' be equivalent, it is necessary that one can pass back and forth by changing v to $-v$ and primed symbols can be replaced by unprimed ones.

The results then are such, as is easily seen, that $\rho = 1$, and we get the usual Lorentz formulas:

$$x = \frac{x'+vt'}{\alpha};\quad y = y';\quad z = z';\quad t = \frac{t'-\frac{v}{c^2}x'}{\alpha} \tag{2.8}$$

and their inverses:

$$x' = \frac{x-vt}{\alpha};\quad y' = y;\quad z' = z;\quad t' = \frac{t-\frac{v}{c^2}x}{\alpha} \tag{2.9}$$

From the first of the inverses one deduces that the velocity of S' with respect to S is:

$$\left(\frac{\partial x}{\partial t}\right)_{x'} = v.$$

This shows that relative velocity has the same absolute value in both systems.

3. The clock paradox

One or another clock in S' (for example, one situated on the abscissa x') passes at each instant t' directly past a clock in S, which shows t corresponding to the values given by x' and t'. That times t and t' progress on both clocks unequally, at first glance, does not seem peculiar, as it appears to be a matter comparable to the fact that clocks in Spain preceed by one hour those in Portugal, so that in both Spain or Portugal, nobody is astonished by a difference. But what happens between inertial systems is more complicated, because, in part, a difference in time between two clocks coinciding at one point, one in S and another in S', depends on the place, x', at which an encounter occurs and, moreover, they run at different rates, as if a Spanish hour is shorter than a Portuguese when comparison is made in Portugal, and is the contrary when a comparison is made in Spain.

This astonishing comportment of clocks has its paragon in that which happens with rulers, but in the latter case this process can be visualized referring to the metaphor of a cylindrical lens interjected between a fixed ruler and a moving ruler. One might hope to explain in an analogous way what happens to clocks too, but in this case one can just not imagine a “time lens" which, could be located in front of a clock so as to alter the value it indicates. This is one case in which correspondence or isomorphism between space and time fails in that an explanation that works for rulers, doesn't for clocks.

Among the surprises of Einstein's theory is the issue under the rubric 'clock paradox,' which was anthropomorphized by Longevin and became the object of animated controversy, and which has not yet been clarified to the satisfaction of all. Let us proceed, then, to carefully analyze this paradox; perhaps the most sensible approach consists of trying to resolve the following problem:

For a station, O, consider a passing train that does not stop (system S') in which there is a traveler with a clock that has been previously set against a clock at the station. As the train passes before the station O, there is a clock there that reads: $t = 0$, and the traveler moves the hands of his clock to also read $t' = 0$. Thereafter at time T, measured in S, the train instantly reverses direction and returns to the station at the same speed.

The station master could reason so: let the traveler's clock be retarded, by reason of the $(1-\alpha)$ per hour factor, then one may write:

$$2T' = 2\alpha T + \triangle t', \tag{3.1}$$

where $\triangle t'$ is an advancement to the hands of his clock to take the reversal into account.

For his part, the traveler reasons as follows: a clock at the stations is retarded with respect to mine, because when it shows $2T$, mine shows:

$$2T' = 2T/\alpha + \triangle t'. \tag{3.2}$$

The paradox consists in that these two solutions, each apparently legitimate, are incompatible, as a comparison between Eq. (10) and (11) results in an absurd equation

$$\alpha = 1/\alpha. \tag{3.3}$$

After these two contradictory solutions, a position that seems logical is that of Professor Dingle (*loc. cit.*), which asserts that both are incorrect, and that it must be that $2T' = 2T$, as if clocks in S and S' run parallel. Let us proceed now to examine this question.

To account for a returning train, change from the inertial system S' into another S'' and, although with it one does not change the rate of the clocks, proceed to determine the arbitrary constants that appear in Lorentz transformations applied to new initial conditions. To facilitate considerations, suppose that an interval $\triangle t$ needed to reverse course is negligible, and take $v/c = 0.5$.

The clock problem resulting from supposing that motion reversal is effected with simultaneity in S'. All events between lines a and b are simultaneous in S'. Travelers age slower than those staying in an unaccelerated system.

The traveler who is located always at $x' = 0$, takes as initial conditions for a return trip (See: Fig. 3) the values $x = vT$, $t = T$, and a value of t' given by the Lorentz formula:

$$t = \frac{1}{\alpha}\left(t' + \frac{v}{c^2}x'\right),$$

which, with reference to Fig. 3, are $t' = \alpha T = 5.20$ for $x' = 0$; $t = T = 6$. The initial conditions would be then:

$$x'' = 0,\ t'' = \alpha T \ \text{ for } \ x = vT,\ t = T;$$

so that one has $T'' = \alpha T$; and, the transformation formulas for the traveler's return, supposing that the reversal is carried out simultaneously in S', where, in the traveler's terms:

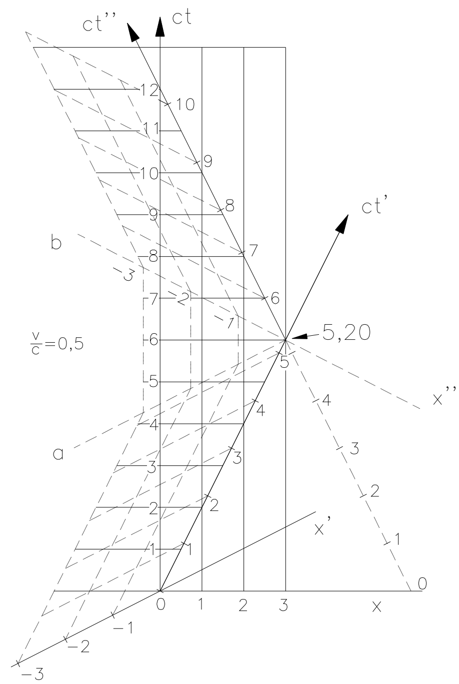

FIGURE 3.1. Clock paradox in moving frame

$$\begin{aligned} x &= \frac{1}{\alpha}(x'' - vt'' + 2vT''), \\ t &= \frac{1}{\alpha}\left(t'' - \frac{v}{c^2}x''\right); \\ x'' &= \frac{1}{\alpha}(x + vt - 2\frac{v}{\alpha}T''), \\ t'' &= \frac{1}{\alpha}\left(t + \frac{v}{c^2}x - 2\frac{v^2}{\alpha c^2}\right) \end{aligned} \tag{3.4}$$

and when both clocks return to be isotopic at $x - x'' = 0$, each's reading respectively would be:

- Station clock:....................$t_0 = 2T = 12$
- Traveler's clock.............$t''_r = 2\alpha T = 10.4$

with the final result:

$$t''_v = \alpha t_0. \tag{3.5}$$

So far so good, but the station master rejects this result, adducing that his clock, which just before the train changed direction, indicated a time t_1 satisfying the equation:

$$t' = \frac{1}{\alpha}\left(t_1 - \frac{v}{c^2}x\right) \text{ for } x = 0,\ t' = \alpha T,$$

so that, $t_1 = \alpha^2 T = 4.5$, suddenly passes by the station again at time t_2, the value of which is obtained from the last of Eq. (13) with $x = 0$ and $t'' = T''$, i.e.,

$$t_2 = \frac{1}{\alpha}\left(1 + \frac{v^2}{c^2}\right) T'' = 7.5,$$

which means that its hands have been advanced, without justifiable cause, by an interval

$$t_2 - t_1 = \frac{2v^2}{\alpha c^2} T'' = 2(1-\alpha^2)T = 3. \tag{3.6}$$

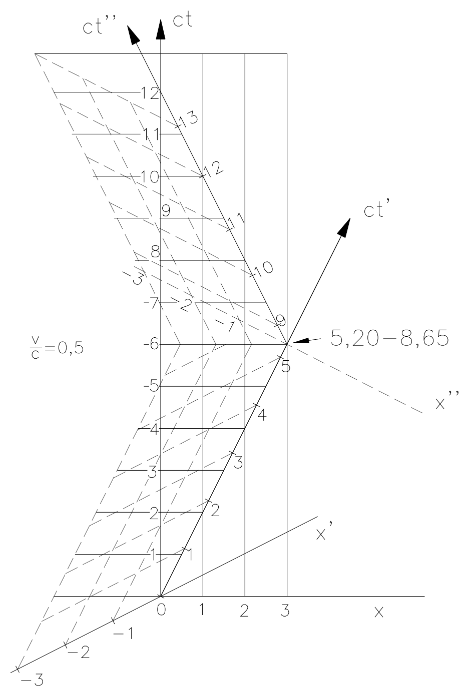

FIGURE 3.2. Clock paradox in rest frame

The clock problem resulting from supposing that motion reversal is effected with simultaneity in S. The hands of the clock jump from $ct = 5.20$ to $ct = 8.65$. Travelers age quicker than those remaining in a non accelerated frame.

To recast the problem from the viewpoint of a station master who is located at $x = 0$ (See: Fig. **??**), one has to take as the initial situation that which results from a proper concept of simultaneity, following which, a reversal of the train is an event which occurs when its clock shows $t = T$, and such that a clock in S', which then passes by $x = 0$, indicates

$$t' = \frac{1}{\alpha}\left(t - \frac{v}{c^2}x\right) = T/\alpha = 6.93,$$

with the value of x' given by

$$x' = \frac{1}{\alpha}(x - vt) = -vT/\alpha.$$

The initial conditions would be, then,

$$x'' = -vT/\alpha,\ t'' = T/\alpha \text{ for } (x=0,\, t=T),$$

with which transformation formulas for a return trip become:

$$\begin{aligned} x'' &= \frac{1}{\alpha}(x+vt-2vT), \\ t'' &= \frac{1}{\alpha}\left(t+\frac{v}{c^2}x\right); \\ x &= \frac{1}{\alpha}\left(x''-vt''+2\frac{v}{\alpha}T\right), \\ t &= \frac{1}{\alpha}\left(t''-\frac{v}{c^2}x''-2\frac{v^2}{\alpha c^2}T\right) \end{aligned} \tag{3.7}$$

At the end of a journey, when both clocks are again isotopic at $x = x'' = 0$, each respectively shows:

$$t_0 = 2T = 12;\quad t_0'' = 2T/\alpha = 13.9;$$

from which

$$t_0'' = t_0/\alpha. \tag{3.8}$$

But now it is the traveler who rejects this solution, as his clock, which before a reversal indicated a time t', satisfied by

$$t = \frac{1}{\alpha}\left(t_1'+\frac{v}{c^2}x'\right) \text{ for } x'=0,\ t=T,$$

so that, $t' = \alpha T = 5.2$, passes the marker suddenly at time t_2'', which one obtains from the last of Eqs. (16) in which $x'' = 0$ and $t = T$, i.e,

$$t_2'' = \frac{1}{\alpha}\left(1+\frac{v^2}{c^2}\right)T = 8.65,$$

which means that its hands were advanced, without justification, by an interval

$$t_2'' - t_1' = \frac{2v^2}{\alpha c^2}T = 3.45. \tag{3.9}$$

We are, then, faced with a dilemma. If solutions given by Eqs. (14) and (17) are valid, we get an absurd result: $\alpha = 1/\alpha$. If one rejects Eq. (14) because it does not satisfy a traveler, one has to reject Eq. (17) because it does not satisfy a station master.

The result of this discussion is that Lorentz transforms give two contradictory solutions, neither of which is acceptable.

We can assert that, when one addresses this problem from the viewpoint of a traveler, one supposes that the outward and return trip of all the points of the train occur simultaneously in S', whereas a station master applies simultaneity criteria in his proper system. But, in both cases the condition that, according to the clock of a traveler he reverse his course when $t = T$ and $t' = \alpha T$, is respected.

4. The new transfoms

New transformations.

Following the path taken in §1.2, the two first principles motivate the following transformation formulas:

$$\begin{gathered} x = \frac{\rho}{\alpha}(x' + vt') \\ y = \rho y' \\ z = \rho z' \\ t = \frac{\rho}{\alpha}(t' + \frac{v}{c^2}x') \end{gathered}$$

where $\alpha = \sqrt{(1 - v^2/c^2)}$, and ρ is an indeterminate constant. In Einstein's theory this constant has the value $\rho = 1$ by virtue of the principle that both system S and S' are equivalent. But, reasoning that served us well for examining the so-called clock paradox, which is in reality a logical absurdity, shows that *duration of a "happening" that transpires at a fixed position in an arbitrary inertial frame has to be equal to that perceived from a fixed frame*; from which it follows that to fix the value of ρ, the condition: $t_1 - t_2 = t'_1 - t'_2$ if $x'_1 = x'_2$, requires that $\rho = \alpha$. Thus, the transformations become:

$$\begin{gathered} x = x' + vt'; \\ y = \alpha y'; \\ z = \alpha z'; \\ t = t' + \frac{v}{c^2}x', \end{gathered} \tag{4.1}$$

where, again, $\alpha = \sqrt{(1 - v^2/c^2)}$, and from which one deduces inverse transformations to be

$$\begin{gathered} x' = \frac{1}{\alpha^2}(x - vt); \\ y' = y/\alpha; \\ z' = z/\alpha; \\ t' = \frac{1}{\alpha^2}(t - \frac{v}{c^2}x). \end{gathered} \tag{4.2}$$

In general, relativistic transformation relationships take the form:

$$\begin{gathered} x = \alpha^{n-1}(x' + vt'); \\ y = \alpha^n y'; \\ z = \alpha^n z'; \\ t = \alpha^{n-1}(t' + \frac{v}{c^2}x'); \\ x' = \alpha^{-n-1}(x - vt); \\ y' = \alpha^{-n} y; \\ z' = \alpha^{-n} z; \\ t' = \alpha^{-n-1}(t - \frac{v}{c^2}x). \end{gathered} \tag{4.3}$$

Setting $n = 0$ gives Einstein's version, and with $n = 1$ we get a new version.

From these equations, Eqs. (21) one deduces that:

$$\left(\frac{\partial x}{\partial t}\right)_{x'} = v; \qquad \left(\frac{\partial x'}{\partial t'}\right)_{x} = -v,$$

which means that, except for the sign, the relative velocity is identical for both systems.

5. Resolution of the clock paradox

Fig. **??** depicts the situation for the 'clock paradox' according to the new formulas supposing that velocity reversal is synchronized in S. The axes of the three inertial systems have precisely the same positions as they have according to Lorentz transforms, but with a change in scale, thanks to which the clock permanently at the origin of the moving system, and taking the route $O \to A \to B$ on a space-time diagram, shows the same time as that

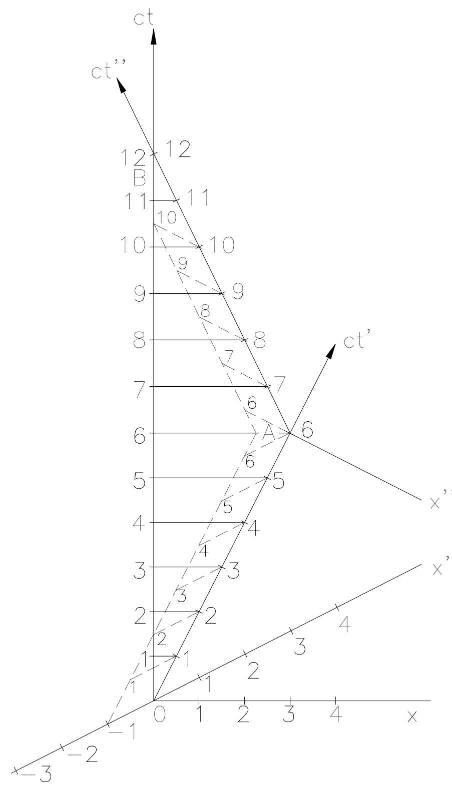

FIGURE 5.1. Solution of the clock paradox using the new formulas

shown by clocks encountered in passage. Thus, when it returns to $x = 0$, it shows $ct'' = 12$ in arbitrary units, i.e., the same time as a clock permanently at rest.

Another clock in a moving system, one situated at $x = -1$ say, in order to be ‘in time’ (cotemporal) with clocks at $x' = x'' = 0$, is not cotemporal with clocks in S without being advanced by the interval $c(t' - t) = 0.5$ in arbitrary units. The passage to S'' happens when $ct = 6.5$, and to force it now to show the same time as other clocks in S'', it is necessary to move its hands back from $ct' = 6.5$ to $ct'' = 5.5$. This has the effect that it appears that duration of a trip to and fro is one unit shorter than it was in fact, a situation for which recently it has been proposed that this ficticious problem could be explained by calling on gravitational fields.

The difference between our new version and that using Lorentz’s transforms rests on the fact that now all is explained by the operation of setting clocks, such that all observers have to impose an invariant clock rate in each inertial system on all clocks.

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