GALILEAN ELECTRODYNAMICS

Experience, Reason, and Simplicity Above Authority
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Galilean Electrodynamics aims to publish high-quality scientific papers that discuss challenges to accepted orthodoxy in physics, especially in the realm of relativity theory, both special and general. In particular, the journal seeks papers arguing that Einstein's theories are unnecessarily complicated, have been confirmed only in a narrow sector of physics, lead to logical contradictions, and are unable to derive results that must be postulated, though they are derivable by classical methods.

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Many thanks go to Frank Pio Russo for proofreading this entire issue of Galilean Electrodynamics.

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From the Editor's File of Important Letters:

Analysis of the Around-the-World Atomic Clocks Experiment

The description of the experiment, published in 1972 in Science by J.C. Hafele and R.E. Keating is here revisited. The first Part, called: Predicted Relativistic Time Gains, showed the theoretical background for the calculated time gains. The second Part, called "Observed Relativistic Time Gains", showed the results of the measurements.

The basic idea was to differentiate the time transformation formula with respect to t, leading to:

$$d\tau / dt = d\left\{\beta\left[t-(v/c^2)x\right]\right\}\Big/dt \quad ,$$

with: $\beta = 1\Big/\sqrt{1-v^2/c^2}$.

It turns out that the authors didn't realize that the variable x, in the theory as described by Einstein, is defined as a constant in the system K in rest. (x is projected in the system k, moving with constant speed v in the direction of the x-axis w.r.t. K, so only this projection is a function of time.)

In the differentiation process they wrote dx/dt as v, but with $x=0$, it has to be zero.

Doing so, the result is the formula applied by them:

$$d\tau / dt = \sqrt{1-v^2/c^2} \approx 1 - v^2/2c^2 \quad .$$

However, applying $dx/dt = 0$ would have resulted in:

$$d\tau / dt = 1\Big/\sqrt{1-v^2/c^2} \sim 1 + v^2/2c^2 \quad .$$

This change of sign plays an essential role in the predicted time-gain / time-loss between the stationary and flying clocks, presented as nsec per day, as shown in the tables below:

published $d\tau/dt$

effect:	eastward:	westward:
gravitational	144	179
kinematic	184	96
net	40	275

correct $d\tau/dt$

effect:	eastward:	westward:
gravitational	144	179
kinematic	184	–96
net	328	83

Remarks:

1) The measurements have been carried out with a 707 and a Concorde.

2) The gravitational time difference, predicted by the GRT as the authors claim, is calculated as gh/c^2, with $g = 9.8\ \mathrm{m/sec^2}$ and h the height of the airplane.

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Internal Contradictions in Lorentz Transformation: the End of Space-Time Mixing

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A simple example is used to show that the Lorentz transformation (LT) is physically invalid because it leads to the conclusion that clock rates depend on the speeds of distant objects. This lack of internal consistency in Special Relativity Theory (SRT) is traced to an undeclared Assumption that Einstein made regarding a normalization factor appearing in his original derivation of the LT. An alternative Lorentz transformation (GPS-LT) is obtained by replacing this false assumption with another that demands that a strict proportionality exists between the rates of clocks in different inertial systems, exactly as is assumed in the methodology of the Global Positioning System (GPS). The GPS-LT is consistent with all known experimental observations, as well as with Einstein's relativistic velocity transformation (RVT). The success of the GPS-LT in removing the inherent contradictions of the LT demonstrates that Einstein's famous position that space and time are inextricably mixed is fundamentally in error. The relativity principle (RP) when applied to the Ives-Stilwell transverse Doppler experiment and the muon decay studies is also shown to prove that Fitzgerald-Lorentz length contraction (FLC) does not occur in Nature, and that the dimensions of accelerated objects actually increase by the same fraction in all directions as the rates of clocks are slowed, *i.e.* isotropic length expansion accompanies time dilation in a given rest frame. The GPS-LT is also consistent with Newtonian absolute remote simultaneity, and does away with Einstein's symmetry principle whereby two clocks in relative motion can supposedly both be running slower than each other at the same time. The accompanying theory restores the principle of objectivity of measurement that was universally believed until the dawn of the 20th century.

Keywords: postulates of special relativity, Lorentz transformation (LT), relativistic velocity transformation (RVT), Global Positioning System (GPS), alternative Lorentz transformation (GPS-LT), uniform scaling of coordinates, transverse Doppler effect

1. Introduction

The Lorentz transformation (LT) is the cornerstone of Einstein's Special Relativity Theory (SRT)[1]. It satisfies the condition of Lorentz invariance of four-vector lengths, and it leads to a number of potentially testable predictions, such as time dilation and FitzGerald-Lorentz length contraction (FLC).

The LT satisfies Einstein's two Postulates of SRT: the relativity principle (RP) first introduced by Galileo in 1632, and the light-speed postulate (LSP), which holds that the speed of light ($c = 2.99792458 \times 10^8$ ms-1) is independent of the state of motion of both the light source and the observer. The LT has been subjected to many experimental tests over the past century, and there is widespread, although not universal, agreement among physicists that it has been confirmed in all cases.

A physical theory must, however, do more than agree with experiments. It must also be consistent with established logical principles, and it should be single-valued; *i.e.*, it must provide a unique answer to any question that falls within its range of application. In the following it will be shown that the LT does not satisfy either of these theoretical criteria, and in fact also is inconsistent with well-known experimental tests that were carried out as early as 1938 [2,3].

2. Clock-Rate Ratios Violate Einstein Causality

The LT consists of relationships between the three spatial coordinates and the one temporal coordinates for the same event measured by observers in two different inertial systems of coordinates, S and S′. Einstein [1] assumed that the origins of S and S′ coincide for a starting time $t = t' = 0$, *i.e.* $x = x' = 0$, $y = y' = 0$ and $z = z' = 0$. The LT equation relating the two time variables is given as follows (x is the location of the event as measured by a stationary observer in S; S′ is moving away from S along the x axis with speed v):

$$t' = \gamma(t - vx / c^2) = (\eta^{-1}\gamma)\, t \quad , \tag{1}$$

with $\eta^{-1} = 1 - vx / c^2 t$ and $\gamma = 1\big/\sqrt{1 - v^2 / c^2}$.

It should be noted that the variables t', x and t in Eq. (1) are actually intervals relative to their respective origins: $t' = 0$, $x = 0$ and $t = 0$. The corresponding intervals between *two* events are obtained by subtraction to be $\Delta x = x_2 - x_1$, *etc.* Since speeds are always defined as the ratio of spatial and time intervals, it is important to have an alternative version of Eq. (1) for these quantities. If v is assumed to be constant, this alternative relation for spatial and time intervals is seen to be:

$$\Delta t' = \gamma(\Delta t - v\Delta x / c^2) = \gamma\eta^{-1}\Delta t \quad , \tag{2}$$

with $\eta^{-1} = 1 - v\Delta x / c^2 \Delta t$.

Both the above equations have played a very important role in theoretical physics. Poincaré [4] was the first to point out that they indicated that the long-held concept of absolute remote simultaneity of events [5] might be incorrect because there can be a null time difference in one inertial system ($\Delta t = 0$) without the other vanishing as well. According to Eq. (2), this situation can occur whenever both $v \neq 0$ and $\Delta x \neq 0$. He emphasized that no experimental data existed at that time which would rule out this possibility from occurring in nature. It was also pointed out that the LT indicates that the Newtonian concept of complete separation of space and time may also not be correct, since the timing result ($\Delta t'$) of one observer may depend on the spatial coordinate (Δx) of the same event measured by another observer who is stationary in a different rest frame, and not just on the latter's timing result (Δt). Space-time mixing is an important assumption in modern-day cosmology, as for example in String Theory [6].

Consider, however, the following simple application of Eq. (2). The two observers follow the course of a far-distant object traveling at constant velocity $\mathbf{u}$. The stationary observer in S finds that the object moves a distance Δx during an elapsed time Δt, *i.e.* $\Delta x = u_x \Delta t$ (how far the object moves along the y and z axes is not important for the present discussion). He therefore used Eq. (2) of the LT to compute the corresponding elapsed time $\Delta t'$ measured for the same event. Dividing this result by Δt leads to the following relation:

$$\Delta t' / \Delta t = \gamma(1 - v\Delta x / c^2 \Delta t) = \gamma(1 - vu_x / c^2) = \gamma / \eta \quad . \qquad (3)$$

Note that $\Delta t' / \Delta t$ is the ratio of the elapsed times for this event measured in S and S′, respectively. *It is, however, also the ratio of the clock rates in the same two inertial systems,* since the elapsed time is by definition proportional to the corresponding clock rate. As a result, Eq. (3) allows us to conclude that the ratio of clock rates depends, not only on the relative speed v of S and S′, but also on u_x, the x-component of the object's velocity measured by the stationary observer in S. This result is, however, completely unacceptable from a physical standpoint. It means that a change in velocity of the object, which is potentially light-years distant, affects one or both of the rates of proper clocks in S and S′. Moreover, there is nothing standing in the way of applying Eq. (3) to a series of objects moving at a wide variety of velocities.

It might be thought that the above problem with the LT is that it involves three bodies, the two observers in S and S′ and the distant object under observation from both. One can just as well use event calculus in connection with Eq. (1) to come to the same conclusion. First, the two observers consider an event at location x_1, t in S, from which they conclude that the ratio of their respective clock rates is t' / t. Then they simply turn their attention to a different event that occurs at exactly the same time but at a different location x_2 in S. The conclusion from Eq. (1) is that the value of t' must have changed because the value of x is now different while that for t is the same as before. As a result, the t' / t clock-rate ratio must have changed as well, despite the fact that the only perceivable 'cause' for this effect is that the location of the event under mutual consideration by the stationary observers in S and S′ is not the same in the two cases.

One can also conclude that such a change in the clock-rate ratio would stand in contradiction to Newton's First Law (law of inertia). Since the two clocks are both moving in pure translation (with no unbalanced forces), neither of their rates can be expected to change and therefore the corresponding ratio must also remain constant.

In short, the above example proves that Eqs. (1-3) are not valid physically, which also means that the LT itself is not acceptable as a component of a theory of relativity. Instead, what we have is a clear violation of Newtonian causality [7]. Therefore, any conclusions that have previously been made on the basis of the LT need to be carefully reconsidered.

3. The GPS Lorentz transformation

In order to understand how Einstein arrived at a physically invalid space-time transformation, it is important to critically examine the derivation of the LT he gave in his original work [1]. Lorentz noted as early as 1899 [8,9] that there was an undefined degree of freedom in the most general space-time transformation (GLT) that leaves Maxwell's equations invariant. One can express this relationship by inserting a *normalization* factor ε in each of the four equations below:

$$\Delta t' = \gamma\varepsilon(\Delta t - v\Delta x / c^2) = \gamma\varepsilon\eta^{-1}\Delta t \quad , \qquad (4a)$$

$$\Delta x' = \gamma\varepsilon(\Delta x - v\Delta t) \quad , \qquad (4b)$$

$$\Delta y' = \varepsilon\Delta y \quad , \qquad (4c)$$

$$\Delta z' = \varepsilon\Delta z \quad , \qquad (4d)$$

with $\eta^{-1} = 1 - v\Delta x / c^2 t = 1 - vu_x / c^2$. Exactly the same equations were derived by Einstein based on his two Postulates of SRT [1], except that he used a slightly different notation than Lorentz (he referred to the normalization factor as φ instead of ε). He eliminated the uncertainty posed by the degree of freedom in the GLT by asserting (see p. 900 of Ref. 1) that "φ is a temporarily unknown function of v." He then showed on the basis of symmetry considerations that $\varphi = 1$ is the only allowed value for the normalization function under these circumstances, thereby producing the LT upon substitution in Eqs. (4a-d); this includes the offending relation in Eq. (2). However, it is important to understand that a clear assumption is involved in the above conclusion. *It amounts to a third postulate of relativity theory.*

The fact that Einstein did not declare it as an additional postulate is at the very least an interesting fact of history, but this would be an insignificant development if the assumption were actually true. The analysis of the previous section indicates instead that the normalization constant (Lorentz's ε or Einstein's φ) must be chosen so as to satisfy the condition, $\Delta t' = \Delta t / Q$, where Q is the ratio of proper clock rates in the two inertial systems S and S′. It depends only on characteristics of these two rest frames and is completely unaffected by the motion of distant objects, specifically not on u_x in the example of the previous section. The corresponding value of ε is obtained easily by equating the value of $\Delta t'$ in Eq. (4a) to the value in the above proportionality condition:

$$\Delta t' = \gamma\varepsilon(\Delta t - v\Delta x / c^2) = \gamma\varepsilon\eta^{-1}\Delta t / Q \quad , \qquad (5)$$

One therefore concludes that the physically allowable value is:

$$\varepsilon = \eta / \gamma Q \quad . \tag{6}$$

Substitution of this value into the GLT of Eqs. (4a-d) leads to the desired alternative Lorentz transformation (GPS-LT):

$$\Delta t' = \Delta t / Q \quad , \tag{7a}$$

$$\Delta x' = \eta(\Delta x - v\Delta t) \quad , \tag{7b}$$

$$\Delta y' = \eta \Delta y / \gamma Q \quad , \tag{7c}$$

$$\Delta z' = \eta \Delta z / \gamma Q \quad . \tag{7d}$$

The GPS-LT satisfies both of Einstein's postulates of relativity while at the same time insuring that there is no contradiction involving the ratio of elapsed times $\Delta t' / \Delta t$. By contrast, the LT, which is given below, demands that this ratio be a function of $\Delta x / \Delta t$, in clear violation of Newtonian causality:

$$\Delta t' = \gamma(\Delta t - v\Delta x / c^2) = \gamma \eta^{-1} \Delta t \quad , \tag{8a}$$

$$\Delta x' = \gamma(\Delta x - v\Delta t) \quad , \tag{8b}$$

$$\Delta y' = \Delta y \quad , \tag{8c}$$

$$\Delta z' = \Delta z \quad . \tag{8d}$$

It is important to recognize that the relativistic velocity transformation (RVT) can be obtained from each of the above three space-time transformations by simply dividing each of the various spatial equations for $\Delta x'$, $\Delta y'$ and $\Delta z'$ by the corresponding relation for $\Delta t'$. The result in each case is given below, with $u'_x = \Delta x' / \Delta t'$, *etc.*:

$$u'_x = (1 - vu_x / c^2)^{-1}(u_x - v) = \eta(u_x - v) \quad , \tag{9a}$$

$$u'_y = \gamma^{-1}(1 - vu_x / c^2)^{-1} u_y = \eta \gamma^{-1} u_y \quad , \tag{9b}$$

$$u'_z = \gamma^{-1}(1 - vu_x / c^2)^{-1} u_z = \eta \gamma^{-1} u_z \quad . \tag{9c}$$

The normalization factor ε in the GLT of Eqs. (4a-d) is simply cancelled out in each of the divisions, and therefore does not appear at all in the RVT [note also that η appears in all three equations by virtue of Eq. (4a) of the GLT].

A number of the most important results of relativity theory actually result directly from the RVT, and thus do not rely in any way on Einstein's assumption about the normalization factor. These include the aberration of starlight at the zenith [10] and the Fresnel light-drag experiment [11], both of which were quite important in Einstein's thought process [12]. The RVT also guarantees compliance with the light-speed postulate. It is used directly in the derivation of the Thomas precession of a spinning electron [13,14] and thus the LT is not essential in this case either. Moreover, the proof that Maxwell's equations are invariant to the GLT [Eqs. (4a-d)] demonstrate that the value chosen for ε / φ is inconsequential for this purpose as well. Indeed, it was this fact that caused Lorentz to introduce the normalization factor ε into the general transformation in the first place [9].

The GPS-LT can be obtained somewhat more directly by combining Eq. (5) and/or Eq. (7a) with the RVT of Eqs. (9a-c); *i.e.*, multiplying the various velocity components with the corresponding times in S and S′, respectively. The clear distinction between the GPS-LT and the LT is that there is *no space-time mixing* in the former set of equations. The arguments in Einstein's version of relativity for *remote non-simultaneity of events* as a necessary condition for satisfying the LSP are therefore *negated* by the GPS-LT [15]. There is also no possibility of forcing a violation of Newtonian causality through time reversal [16] since the constant Q in Eq. (5) is necessarily positive. It is seen that by multiplying each of the four LT equations with the same factor η / γ on the right-hand side, one obtains the corresponding four equations of the GPS-LT.

While it is clear that the GPS-LT satisfies the light-speed postulate because of its direct relationship to the RVT, it still remains to show that the choice for the normalization factor in Eq. (6) also satisfies the other of Einstein's relativity postulates, the RP [1]. This question is closely tied up with the condition of Lorentz invariance that is a key feature of the LT. Squaring the four relations of the GLT in Eqs. (4a-d) and adding them leads to the following result:

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = \varepsilon^2 (x^2 + y^2 + z^2 - c^2 t^2) \quad . \tag{10}$$

The value for the normalization factor of $\varepsilon = 1$ assumed by Einstein [1] to obtain the LT leads to the aesthetically pleasing and transparently symmetric form that is so familiar to theoretical physicists. Most importantly, Einstein's version of Eq. (10) satisfies the RP since it looks exactly the same from the vantage point of both observers. It is less obvious how any other choice of ε can satisfy the latter requirement, and this has been used to justify adopting the value of unity in deriving the LT. Specifically, the question arises as to whether the choice of $\varepsilon = \eta / \gamma Q$ in Eq. (6) that leads to the GPS-LT is also consistent with the RP.

To consider this possibility it is helpful to first write down the corresponding result obtained from the inverse of Eqs. (4a-d), which can be found most simply by algebraic manipulation of Eq. (10):

$$x^2 + y^2 + z^2 - c^2 t^2 = \varepsilon^2 (x'^2 + y'^2 + z'^2 - c^2 t'^2) \quad . \tag{11}$$

To satisfy the RP, the latter equation must be consistent with an alternative form of Eq. (10) that is obtained by switching the roles of the two inertial systems and the respective observers in these rest frames. Exchanging all primed and unprimed subscripts and changing the sign of their relative speed from v to $-v$ produces the result:

$$x^2 + y^2 + z^2 - c^2 t^2 = \varepsilon' (x'^2 + y'^2 + z'^2 - c^2 t'^2) \quad . \tag{12}$$

Satisfaction of the RP therefore demands that **a)** the normalization factor ε' be defined in a manner completely analogous to ε, and **b)** that the following relation between ε and ε' be satisfied:

$$\varepsilon^2 \varepsilon'^2 = 1 \quad . \tag{13}$$

It is obvious that Einstein's value of $\varepsilon = \varepsilon' = 1$ satisfies both of the above requirements. Indeed, a value of $\varepsilon = \varepsilon' = -1$ also is not excluded by these conditions.

The value of ε from Eq. (6) that was used to derive the GPS-LT of Eqs. (7a-d) is substituted in Eq. (13), and that leads to:

$$\eta^2 (\gamma Q)^{-2} \eta'^2 (\gamma Q')^{-2} = 1 \quad , \tag{14}$$

whereby η' must be obtained from

$$\eta = (1 - vc^2 \Delta x / \Delta t)^{-1} = \eta (1 - vu_x / c^2)^{-1}$$

in the standard way, *i.e.* consistent with condition **b)** above, by exchanging corresponding primed and unprimed values and changing v to $-v$: hence, $\eta'^{-1} = 1 + vu'_x / c^2 = 1 + vc^2 \Delta x' / \Delta t'$. The value of γ remains the same because it is a function of v^2, and the value of $Q' = Q^{-1}$ is fixed by forming the inverse of Eq. (7a), *i.e.* $\Delta t = Q'^{-1} \Delta t' = Q \Delta t'$. *Thus,* Q *and* Q' *bear a reciprocal relationship to one another, as one expects from an objective theory of measurement.*

Substitution in Eq. (14) thereby simplifies the condition of relativistic invariance to:

$$\eta^2 \eta'^2 / \gamma^4 = 1 \quad . \tag{15}$$

From the definitions of η and η', it follows that [17]

$$\eta \eta' = \gamma^2 \quad . \tag{16}$$

This result is obtained by using Eq. (9a) of the RVT to define u'_x in η' in terms of u_x. It is obviously compatible with Eq. (15), as required by the RP.

The above discussion demonstrates *that space-time mixing is not essential to satisfy the RP.* The direct proportionality assumed in Eq. (7a) between the respective clock rates in S and S' is quite consistent with experimental findings, including the GPS methodology, but it also seemingly conflicts with the conventional view that all inertial systems are equivalent and therefore indistinguishable [18]. Galileo's original arguments when he introduced the RP in 1632 shed considerable light on this issue. He used the example of passengers locked in the hold of a ship who were trying to determine whether they were still located at the dock or were moving on a perfectly calm sea [19]. His main point was that it would be impossible for them to make this determination on the basis of their purely *in situ* observations.

More interesting in the present context, however, is that this argument does not exclude the possibility that objects on the ship, including the passengers themselves, did not undergo changes in their physical measurements as a result of the ship's motion. Rather, the assertion is that *all such changes must be perfectly uniform*, and that this is the fundamental reason why no distinction can be observed without carrying out measurements outside the ship's hold. That interpretation is also consistent with Einstein's original work [1] in which he concluded that acceleration of a clock leads to a decrease in its rate. After the acceleration phase is concluded and a new state of motion is reached, it seems reasonable to assume that the clock's rate continues to be slower than in its original state. The RP simply states that the rates of all clocks are altered in the same proportion when they make the transition between the same two inertial systems. Similarly as with the First Law of Thermodynamics, it does not matter which intermediate states were reached in the process as long as the initial and final states are identical [20].

4. Asymmetric Time Dilation

One of the basic goals of relativity theory is to establish the relationship between the measured values of a given quantity obtained by two observers in relative motion to each other. The LT was used to derive two key effects involving measurements of space and time variables: time dilation and FitzGerald-Lorentz length contraction (FLC). Both are characterized by a symmetry principle in STR whereby two observers in relative motion each find that the other's clock is running slower than his, or the other's measuring rod is contracted relative to his. These results conform to a *subjective* view of the measurement process; *i.e.*, which clock is running slower, or which meter stick is shorter, is purely a matter of perspective.

In 1938, Ives and Stilwell [2] carried out the first experimental test of time dilation with their study of the transverse Doppler effect. Their results confirmed Einstein's prediction [1] that the frequency of light ν_r observed in the laboratory would always be less than the value of the emitted frequency ν_e from a moving source [21]:

$$\nu_r = \nu_e / \gamma \quad . \tag{17}$$

Note that, in agreement with Einstein's symmetry principle, the above equation implies that the measurement process is *subjective*. In this experiment, the light source was accelerated in the laboratory where the receiver is at rest. According to Eq. (17), a decrease in frequency would also be observed if the tables were turned and light emitted from the laboratory were observed in the rest frame of the original moving source. In other words, each observer would say that it was the other's clock that slowed. This result was believed to be the inevitable consequence of the RP. Since the Ives-Stilwell study was only a 'one-way' experiment, however, it was incapable of verifying this aspect of Einstein's prediction.

This situation was remedied with the high-speed rotor experiments carried out by Hay *et al.* in 1960 using the Mössbauer technique [22]. In this case it was the absorber/detector rather than the light (x-ray) source that was subject to acceleration since it was mounted on the rim of the rotor. The empirical findings for the shift in frequency $\Delta\nu / \nu$ are summarized by the formula:

$$\Delta\nu / \nu = (R_a^2 - R_s^2) \omega^2 \big/ 2c^2 \quad , \tag{18}$$

where R_a and R_s are the respective distances of the absorber and x-ray source from the rotor axis (ω is the circular frequency of the rotor). It shows that a shift to higher frequency (blue shift) is observed when R_a is greater than R_a, as in the present case. The corresponding result expected from Eq. (17) would be:

$$\Delta\nu / \nu = \gamma^{-1}(\,|\, R_a - R_s \,|\, \omega) - 1 \approx -(R_a - R_s)\omega^2 \big/ 2c^2 \quad , \quad (19)$$

i.e., a red shift should be observed in all cases in accordance with the symmetric interpretation of time dilation. However, the results shown in Eq. (18) indicate on the contrary that the effect is *anti-symmetric*, in clear contradiction to both Eq. (17) and the LT. Hay *et al.* [22] nonetheless declared that their results were consistent with Einstein's theory [1] without mentioning the difficulty with the prediction of the LT. They also noted that Eq. (9) can be derived from Einstein's equivalence principle [23], which equates centrifugal force and the effects of gravity. Subsequent experiments by Kündig [24] and Champeney *et al.* [25] also found that their results were summarized by Eq. (18). Kündig stated explicitly that the results confirmed the position that it is *the accelerated clock that is slowed by time dilation*, thereby asserting that the measurement process is *objective* in this experiment, contrary to the prediction of Eqs. (17) and (19).

A more detailed discussion of the transverse Doppler experiments and their relation to the LT may be found in a companion publication [26]. The main conclusion in the context of the search for an internally consistent version of the Lorentz transformation is that *the amount of the time dilation increases with the speed* v_{i0} of the x-ray source relative to the axis. Specifically, it is proportional to $\gamma(v_{i0})$ [27-28]. A completely analogous result was obtained in the Hafele-Keating experiments with atomic clocks located on circumnavigating airplanes [29-30], which show clearly that it is the speed v_{i0} relative to the earth's center of mass that ultimately determines their rates. In that case the elapsed time τ_i on a given clock satisfies the relation:

$$\tau_1\gamma(v_{10}) = \tau_2\gamma(v_{20}) \quad . \quad (20)$$

The Hafele-Keating experiments also provide the basis for the methodology of the Global Positioning System (GPS). It is assumed that the rates of satellite clocks satisfy Eq. (20) as well as a comparable relation for the gravitational red-shift [31]. In particular, it is found that the satellite clocks run slower than their counterparts on the ground when gravitational effects are excluded. Thus, *the symmetry principle predicted by the LT is contradicted by the everyday operations of GPS*. Exactly the same formula [26] applies to the rotor experiments [22, 24-25], in which case the axis of the rotor serves as reference for the speeds of the absorber and x-ray source that are to be inserted in the γ factors. Expansion of Eq. (20) with $v_{i0} = R_i\omega$ and $\tau_i = 1/v_i$ leads directly to the empirical formula given in Eq. (18).

Thus, Eq. (20) can be called the 'Universal Time-Dilation Law' (UTDL). It is a simple matter to convert this equation into the form of the GLT for time dilation given in Eq. (4a), *i.e.* Eq. (7a) of the GPS-LT. In this equation Q is the ratio of clock rates in S and S′ as determined by the UTDL. Accordingly, $Q > 1$ if the clock at rest in S′ runs more slowly, and by virtue of the fundamental objectivity of the revised theory, $Q < 1$ if it runs faster than that in S. In the typical case where the clock at rest in S′ has been accelerated relative to S before returning to a state of uniform translation, $Q = \gamma(v)$. Eq. (20) is more general since it also accounts for the situation when both clocks being compared are moving relative to the original rest frame S_0. It is clearly necessary in applying Eq. (20) to first identify the above rest frame; it has been referred to as the objective rest system (ORS) in earlier work [32]. The relative speed v of S and S′ is not directly involved in the UTDL, thereby eliminating the subjective character of the measurement process otherwise inherent in Einstein's LT.

5. Isotropic Length Expansion

The GPS-LT and LT also differ sharply with regard to length variations. In the following example the two observers (O and O′) are initially at rest in inertial system S. They each measure the diameter of a sphere and agree that it has a value of D m. O′ then places the sphere on his rocket ship and moves away from O. After some time he assumes a constant relative velocity v in the common x, x' direction so that he is now at rest in inertial system S′. He then repeats the length measurements on the sphere and finds in accordance with the RP that its diameter still has a value of D m in all directions. According to the FLC, O finds that the sphere has contracted along the x direction, but that its dimensions along all perpendicular directions have remained the same. Thus,

$$\Delta y = \Delta y' = D \quad . \quad (21)$$

There is another way to carry out these measurements, however; namely, to take advantage of Einstein's LSP [1]. Indeed, the modern-day definition of the meter [33] as the distance traveled by a light pulse in c^{-1} sec ($c = 2.99792458 \times 10^8$ ms^{-1}) requires that the diameter be measured using clocks that are at rest in S and S′, respectively. The theory assumes that the two clock rates are not the same because of time dilation on the rocket ship and therefore that the measured elapsed times for the light to traverse the sphere satisfy the GPS-LT relation of Eq. (7a) with $Q = \gamma$:

$$\Delta t' = \Delta t / \gamma \quad . \quad (22)$$

Accordingly, the above distance values have the following relation:

$$\Delta y' = c\Delta t' = c(\Delta t / \gamma) = \gamma^{-1}c\Delta t = \gamma^{-1}\Delta y = D \quad . \quad (23)$$

The conclusion is that the two observers must *disagree* on their measured values for the diameter of the sphere and *by increasingly larger amounts* depending on how close their relative speed v approaches c; *i.e.*, $\Delta y = \gamma D$ from Eq. (23). This clearly contradictis the result determined in Eq. (21) on the basis of the FLC.

It needs to be emphasized that all of the above values come directly from application of Einstein's theory [1]. There is never a question about how the corresponding measurements to obtain the various quantities mentioned in Eqs. (21-23) are actually carried out in practice. For example, it might be thought that the contradiction can be removed by simply arguing that the various results are not obtained at the same time. The problem with that approach is that S and S′ move with constant relative velocity and thus there is no reason to expect that any of the measured values will change with time. The above example has been referred to in earlier work [34] as the 'Clock Riddle' to distinguish it from the far better known 'Clock Paradox' used to illustrate the essential role of acceleration in time dilation [35].

Comparison of the two theoretical methods for length measurements in the direction parallel to $\mathbf{v}$ also uncovers another discrepancy. According to the FLC , the length of the sphere should contract on the rocket ship (S′):

$$\Delta x' = \gamma \Delta x = D \quad . \tag{24}$$

Since the rates of clocks are independent of orientation, one expects a perfectly analogous prediction to Eq. (23) in this case; namely:

$$\Delta x' = c\Delta t' = c(\Delta t / \gamma) = \Delta x / \gamma = D \quad . \tag{25}$$

Instead of observing a contraction in the parallel direction, O actually finds that the sphere's diameter has *increased* by the same fraction as above ($\Delta x = \gamma D$). The conclusion is that *isotropic length expansion* accompanies time dilation in S′, not the type of anisotropic length contraction expected from application of the FLC. As with Eq. (3), the clear indication from this discussion is that the LT, from which the FLC is derived, is not a valid physical transformation.

The above discussion has been purely theoretical. What does experiment have to say about whether the lengths of objects expand or contract? Examination of previous claims of length-contraction observations [36] shows that they involve distributions of a large ensemble of particles such as electrons. As such, they ignore the effects of de Broglie wave-particle duality [37] which is known to produce a decrease in the wavelength of the distribution in inverse proportion to the momentum of the particles ($p = h / \lambda$). It should be noted that STR length contraction (FLC) has a substantially different dependence on the speed of particles than does the de Broglie duality [38]. For example, doubling v in the latter case leads to a reduction in the de Broglie wavelength of the particles by 50%, where if the STR length contraction is invoked, a much smaller decrease is expected, namely by a maximum factor of $\gamma(2v) / \gamma(v) \approx 1 + 1.5v^2 / c^2$, since $v / c < 10^{-6}$ in the experiment [36].

A better place to begin is the Ives-Stilwell study of the transverse Doppler effect [2]. A light source with a standard wavelength λ_0 is accelerated and the wavelength λ of the radiation is measured in the laboratory. Two values are obtained for opposite directions of the light source. Averaging of these two values therefore eliminates the first-order Doppler effect caused by the motion of the light source to and from the observer, respectively. It is found that the average wavelength is *larger* than the standard value. Einstein's LSP is then assumed, from which is concluded that the average frequency ν measured in the laboratory is inversely proportional to the average wavelength and therefore that $\nu < \nu_0$. For example, if the speed of the light source is $0.866c$, this means that $\nu = \nu_0 / 2$. This value of the frequency is then taken to be experimental proof that clocks in the rest frame of the light source run slower than their identical counterparts in the rest frame of the laboratory, in quantitative agreement with SRT. Yet, the experiment actually measures wavelengths directly and finds that they are *larger* in the laboratory than in the rest frame of the light source: $\lambda = 2\lambda_0$. The analogous conclusion that the experiment demonstrates that *lengths expand instead of contract* is never made in textbooks discussing this experiment.

Sometimes, the argument is made that the observed result can be ignored because length contraction only refers to 'material objects'. This conclusion overlooks the effect of Einstein's first postulate of relativity, however, the RP. It states that the observer co-moving with the light source will measure the standard wavelength value for the light source, *i.e.* $\lambda' = \lambda_0$, even though his colleague in the laboratory measures a larger value for the same radiation. The only rational conclusion from the RP is that the diffraction grating (or comparable measuring device) in the rest frame of the light source has increased by the same fraction as the wavelength, so no change is noticeable. The observer himself must also have experienced the same amount of length expansion in all directions since otherwise he would be able to distinguish between the two rest frames, in direct contradiction of the RP.

The situation is made clearer by considering the results of another experiment. Rossi *et al.* [3] showed that the *range of decay* of meta-stable particles such as muons *increases* when they are accelerated in the upper atmosphere. Because of the RP, the corresponding range must be smaller for observers co-moving with the particles. Although the original authors did not mention it, their results have been hailed as a confirmation of length contraction in various textbooks [39,40]. The truth is that this experiment tells us just the opposite. The reason the observer moving with the muons measures smaller distances is precisely because the length of his meter stick has *increased* as a result of the acceleration. *The numerical value of a measurement is inversely proportional to the unit in which it is expressed*. When the meta-stable particles are produced in collisions, the rates of all clocks in their rest frame slow down and the lengths of all objects increase in the same proportion so that measured speeds of other objects are unaffected by these changes; in other words, the units of both time and distance change by the same fraction. The Rossi *et al.* experiment is therefore just another confirmation of isotropic length expansion accompanying time dilation, not anisotropic length contraction as the LT unquestionably predicts.

6. Conclusion

Investigation of the time equation of the Lorentz transformation (LT) shows that it requires the ratio of clock rates (t / t') in two different inertial systems to be a function of the location of the event in question. The LT therefore violates the causality principle and is consequently invalid. This analysis also shows that the only way for a space-time transformation to avoid a violation of the causality principle is to have the above ratio of clock rates be constant as long as the two rest frames continue to travel at constant velocity. This condition is shown to be consistent with Einstein's two postulates of relativity and also with Newton's First Law. It requires that the normalization factor in the General Lorentz Transformation (GLT) introduced by Lorentz in 1898 have a value of

$$\varepsilon = \sqrt{1 - v^2 / c^2} \Big/ Q(1 - vx / c^2 t) = \eta / \gamma Q \quad ,$$

where Q satisfies the clock-rate proportionality relation $t' = t / Q$. This value replaces that assumed by Einstein [1] in his original derivation of the LT, namely $\varepsilon = 1$.

The resulting alternative Lorentz transformation (GPS-LT) is given in Eqs. (8a-d). It is consistent with the relativistic velocity transformation (RVT) introduced by Einstein in the same work. This is an important observation since some of the most important results of relativity theory such as the aberration of starlight at the zenith and the Fresnel light-drag experiment are actually obtained directly from the RVT and therefore do not depend in any way on the LT itself. On the other hand, the GPS-LT is not consistent with a number of controversial predictions of the LT such as FitzGerald-Lorentz length contraction (FLC) and the symmetry principle, which holds that two clocks can both be running slower than each other at the same time. It is found instead that time dilation occurs asymmetrically, as for example is assumed in the methodology of the Global Positioning System (GPS). Surprisingly, the GPS-LT also indicates that isotropic length expansion accompanies time dilation in a given rest frame. The latter prediction finds confirmation in the results of the Ives-Stilwell transverse Doppler study and the Rossi *et al*. measurements of the average length of decay of accelerated muons. It is also obviously consistent with the requirement of the light-speed postulate that the wavelength of light always be proportional to the corresponding period.

Ultimately, the main result of the present study is that a consistent version of relativity theory can be formulated on the basis of the assumption of a strict proportionality between clock rates in different inertial systems. When clock rates slow, both the unit of time and the unit of distance increase by the same fraction, so that the corresponding unit of velocity is not changed. This relationship is clearly consistent with the LSP. The clock-rate proportionality factors satisfy a Universal Time-Dilation Law [see Eq. (20)]. A key difference between the GPS-LT/RVT version of relativity and that employing the LT is that the speeds of clocks must be measured relative to a definite rest frame (objective rest system ORS) in order to compute the necessary time-dilation factors from the UTDL. This conclusion is consistent with the Hafele-Keating measurements of the rates of atomic clocks carried onboard circumnavigating airplanes, for example, and also with the results of the transverse Doppler studies employing high-speed rotors.

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Correspondence

The Incredible Bradley!

James Bradley's work on stellar aberration was extremely accurate, bettering even most modern renditions, thereby enabling the extraction of the diurnal factor. This letter identifies the secret of Bradley's fantastically accurate aberration observations and discoveries. It also offers some conclusions regarding my own three decades of work, done as direct consequences from Bradley's work.

Today there are many professionals who do not realize the monumentality of Bradley's work, which was announced in 1728. For a start, in his day there were no reliable longitude clocks, because it wasn't till 1764 that the first one was tested after being invented by John Harrison. And secondly, it wasn't till 1838 that Bessel first accomplished parallax measurement. Hence Bradley had to do all of his work with measurements of declination only. He actually commented that the stars varied throughout the year and day, such that they were furthest south or furthest north always at about 6 am or 6 pm [1]. It is just common sense: look at a globe of Earth and project the inferred diurnal motion of celestial East from the ecliptic pole, and realize that at 6 am the stars would appear to move southwards and at 6 pm they would appear to go northwards.

The latter actually fits in well with his declination measurements, because it is at both 6am and 6 pm that he would have lined-up with the orbital speed of the earth - so no mystery there ! Now it is generally acknowledged that it was the fantastic accuracy of his instruments that allowed Bradley to make his discoveries... they were made by the famous George Graham. However regardless of this, "A History of Astronomy" implies that in Bradley's day the error of measurement should have been no greater than 2 arc seconds (2) . However the latter revelation does not fit in very well with the incredible acumen and skill displayed by Bradley - although it is consistent with what I have noticed myself - so much so that there must be another explanation for Bradley's excellence! I mean, a few days ago I went to see this beautiful 18 inch telescope at the "Shell-Lap Supplies" store... it is extremely well made and almost 3 centuries to the future of Bradley's instruments, and yet I think I read somewhere that it has a pointing error of about two and a half arc seconds.

After putting my full attention on the problem, I have come to believe that Bradley's phenomenal success was due to what most people would consider an act of stupidity by his predecessor, Samuel Molineux. Most people would show very low esteem to one who would fix his telescope to his chimney, such that he can only mainly observe one star, *i.e.* Gamma Draconis! Most people would want to be able to point their telescope at whatever they wish, *e.g.* Mars, the Moon, Sirius or the rings of Saturn... not to mention the moons of Jupiter of course! But there was some method in Molineux's 'madness': he was trying to discover stellar parallax, which was to become invaluable to sea travellers. Naturally, Molineux was wealthy and a member of parliament, so 'waste' was not an issue. Molineux went on to employ and work together with Bradley because of Bradley's superior astronomical skills, not to mention the fact that he was also a fellow of the prestigious "Royal Society".

Yes! It may have appeared as a 'stupid' act to fix the telescope to the chimney, but it was actually a stroke of 'genius'! For one could virtually assume that the central position of Gamma Draconis was correct to 10 decimal figures of an arc second! Then any oscillations and variations are actual and real, rather than being due to any inherent pointing error !

This actually goes a long way in explaining why, in the following centuries, there was so much variability in attempting to define the 'aberration constant', until eventually all efforts were abandoned and a theoretical rendition was adopted. The incredible accuracy of Bradley could not be replicated, as its secret had not been exposed and realized by anybody until now !

In view of the foregoing there are many new features of my nearly 29 years of work on stellar aberration and the speed of light. For a start, my absolute - (or aberration) - speed of light of 304,476 km/sec plus or minus 125 km [3] now becomes incredibly accurate because the bulk of the error was attributable to the then considered imprecise 'polar' aberration constant of 20.18 or 'ecliptic' of 20.47 (arc seconds). In other words, if one were to assume that the aberration constant is 'beyond reproach', the then derived 'absolute', or aberration, speed of light ends up having a plus and minus error of only 10 kilometres... that is certainly both a massive and drastic improvement on the previous error level.

Furthermore, it is clear that the diurnal considerations can easily be extricated from the system. With most of Bradley's early observations - which were sort of referenced to 6 am or 6 pm - the rotation of the earth of 465.10 m/sec or its ecliptic vector of 426.6 m/sec did not affect the aberration observed, simply because of the respective geometrical orientations... in other words Bradley would have seen a 'polar' observation of 20.2 arc seconds (my value today is 20.18).

In conclusion, I must say that I've greatly enjoyed the intricate detective work that I've carried out in regards to Bradley over the past now nearly 30 years. Hopefully, this last discussion polishes up my work somewhat, making it more easily understood. Things have stagnated for far too long in the now surpassed shadow of Einstein.

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GPS and the Invariance of Light Speed

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Distances are currently determined in Global Positioning System (GPS) in accord with the founding assumption of Special Relativity Theory (SRT): the signals are presumed to travel from satellite S to receiver R on the Earth and to other satellites with identical speed, and this speed does not depend on the Earth's rotation. It is shown here that negligible errors arise in the GPS because of the Sagnac effect. But greater errors take place due to the moving atmosphere: the atmosphere moves relative the orbits and changes the speeds of light, causing all signals to travel with different speeds.

Introduction

The Second Postulate of SRT states that the speed of light depends neither on the motion of the light source nor on the motion of the observer measuring this speed. That is, the speed of light is the same in any inertial frame, and is equal to $c = 299792458$ m/s in absolute vacuum. Regardless of the Earth rotation, the orbit planes of the satellites retain their orientation relative to the inertial frame associated with the stars. Because the Earth together with its atmosphere rotates relative to the inertial frame and relative to orbits, the atmosphere **moves** relative to orbits and relative to satellites. Electromagnetic signals travel in all directions relative to atmosphere with identical speed $c/n \approx c$ and therefore the GPS signals travel relative inertial frame from west to east faster than from east to west..

Before considering the GPS signals, let us analyze a simple situation where light travels in a rotating glass disc.

2. Light Speed in a Rotating Medium

Let a pulse source S be in a rotating glass disc. When S is at the point A of the laboratory, it sends signal to the immovable point B in the laboratory (Fig. 1).

If the disc is at rest, the photons travel with a speed c/n relative to disc and relative to laboratory, which we approximately consider as inertial frame. They successively pass the points a_1, a_2, a_3 lying on the line AB and at the moment $t_0 = nL_{\mathrm{AB}}/c$ reach the point B.

When the disc rotates, photons of the first wavefront are reradiated from moving atoms of the glass and move relative to laboratory in all directions with different speeds. However, the trajectories of all **first** photons are the straight lines relative to inertial frame and intersect in the point A of the laboratory in which the source was at the moment of a radiation. It is obvious that the photons move relative to the disc in curve trajectories.

The points a_1, a_2, a_3 move with different speeds, and therefore the photons reradiated by the atoms of the glass move relative to laboratory with different speeds $\mathrm{a}_1 - \mathrm{b}_1$, $\mathrm{a}_2 - \mathrm{b}_2$, $\mathrm{a}_3 - \mathrm{b}_3$ but their projections on the direction AB are the same for all points a_1, a_2, a_3.

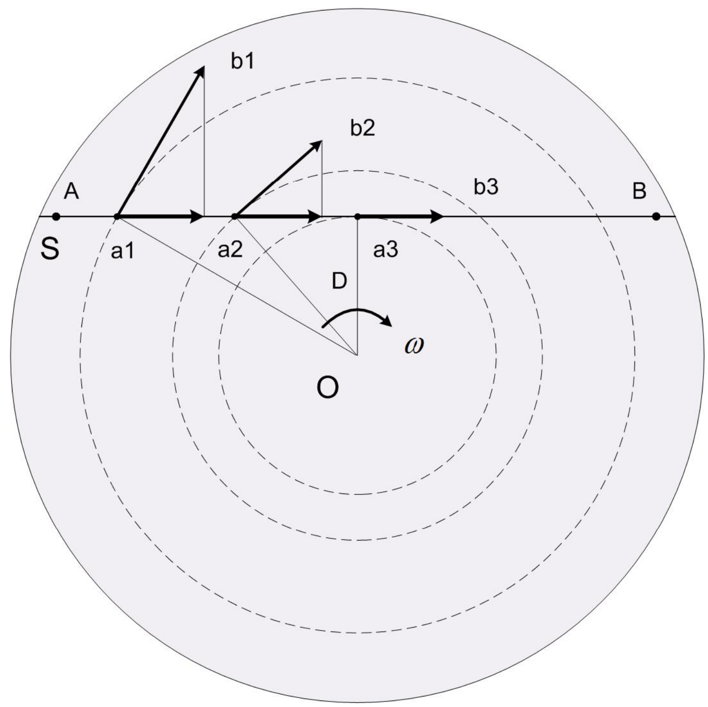

Figure 1. The signal propagation in a rotating glass disc.

From the point A to the point B, photons move with identical speed $c/n + \omega D$, which depends only on the distance D from the axis of rotation to the line AB. If the source is in the point B and sends the pulse to the point A, photons move from B to A at a slower speed $c/n - \omega D$. Thus, photons come from the point A to the point B faster than from point B to point A.

As well as optical signals, radio signals from source A travel to receiver B along straight line AB relative to the inertial frame. Because signals travel in the atmosphere rotating together with Earth, the Sagnac effect arises, and the signal travels relative to the atmosphere along a curved trajectory. If angular speed ω is constant, the signal travels along the bow of the circle of radius $c/n\omega$ and covers a distance greater than AB. But for the angular speed of the Earth $\omega = 7.27^{-5}\,\mathrm{s}^{-1}$ and $n = 1$, the radius is so great that the length of the bow at the distance of 30,000 km is only 6 mm longer than chord AB. That is, the Sagnac effect in GPS is negligibly small. Traveling time of the signal increases when the signal travels, for example, from the Earth to the Moon.

Motion of the Atmosphere Relative to the Orbit Planes of the Satellites

Regardless of the Earth rotation, the orbit planes of the satellites are at rest relative to an inertial frame associated with the stars. The Earth, together with the atmosphere, rotates inside the sphere formed by six immovable orbits of the GPS satellites. The atmosphere moves relative to the orbits and relative to the satellites like the glass moves in Fig. 1 relative to the points A and B that are at rest relative to laboratory. As result, the speeds and the traveling times change in GPS. In the case where the satellite GPS rotates in the plane that does not coincide with the plane of the equator, the interaction with moving atmosphere leads to the continuous change of the speed of the satellite. But because the atmosphere is very rarefied, the effect is too small and we do not know whether this leads to the significant shift of the orbit planes of the GPS satellites. The effect absents in geostationary satellites where the orbital speed is the same as the speed of atmosphere. In the case where the satellite rotates in the plane of the equator, the motion of the atmosphere leads to the change of the speed of the satellite and may be one of the reasons of the secular acceleration of the Moon and the precession of the *perihelion of Mercury*. However, in this paper we are interested in the influence of the atmosphere motion on the speeds of the signals but not on the speeds of the satellites. Because of this motion, the signals from satellites travel from west to east faster than from east to west.

The Earth rotates inside the sphere of the diameter 26500 km formed by six orbits of 24 GPS satellites. Rotating together with the Earth, the atmosphere moves relative to each satellite in the plane of equator with the speed $V_A = 2\pi 26500/86400 = 1.9271$ km/s. Because all orbits are inclined to the equator by 55 degrees, relative to satellites that are currently the most distant from the equator, the atmosphere moves with the speed 1.1 km/s. At 20000 km from Earth surface, each cubic centimeter of the atmosphere contains 10^8 atoms. Such a rarefied atmosphere has significantly less impact on the speeds of the GPS satellites than the satellites of low orbits. But the rarefied atmosphere influence is much greater on the speeds of the light or radio signals. The photons are re-radiated in a medium where the distances between the atoms are about 1 mm, as well as in atmosphere near Earth surface. The only difference is that the process of the re-radiation takes some more distances. After the re-radiation photons move relative to atmosphere with speed $c/n \approx c$. Because the atmosphere moves relative to a source with speed V_A, the signals cover practically all distance between the source and the receiver with a speed $c \pm V_A$ to the inertial frame.

Influence of Moving Atmosphere on GPS Signal Speeds

Consider simplest situations when the satellites S1 and S2 are at the plane of equator or when they are at identical distances from he plane of equator and - send the signals to each other (signals from S1 to S2 and from S2 to S1), - send signals to receiver R on the Earth (signals from S1 and S2 to R), - receive signals from the point E on the Earth (signals from E to S1 and S2).

Basic Information:

- The planes of the orbits are at rest relative to the inertial frame of reference
- Orbits are inclined to the equator at an angle of 55 degrees
- Satellite velocity is $V_0 = 3.874$ km/s at a radius of 26500 km
- The angular speed of the Earth atmosphere relative to inertial frame and relative to the orbits is $\omega = 2\pi / T_E = 7.27^{-5}$ /s,
- With respect to the satellite, the atmosphere moves near equator with the speed of $V_A = 2\pi 26500/86400$ for the satellites that are are currently near equator, and with the speed $V_A \cos(55)$ =1.1 km/s for the satellites that are the most distant from the equator.
- The distance from S1, S2 to the Earth center is 26500 km
- The circumference of radius 26500 is $2\pi R$ = 166 504.41 km.

1. The Signals Between Satellites

1.1 The case when satellites **S1** and **S2** move on different orbits and at the moment are **in the equatorial plane** (Fig. 2).
- The distance between the satellites S1 and S2 - 26500 km,
- Orbital speeds V_o are directed at the angle $55°$ to the direction S1-S2.

a) First suppose that atmosphere **does not rotate** together with Earth and signals travel with identical speed. Relative to the atmosphere, the signals travel with identical speed $c/n \approx c$.

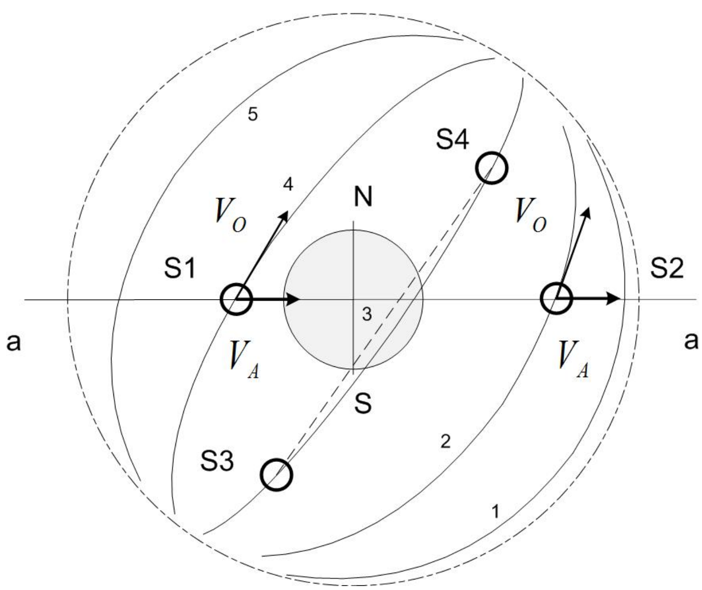

Figure 2. The satellites are in the equatorial plane.

Because satellites move with a speed $V_0 = 3.874$ at the angle $55°$ to the direction S1-S2, satellite S2 recedes from S1 while signal travels from satellite S1 to S2 and satellite S1 approaches to S2 while signal travels from satellite S2 to S1. Therefore the time t_1 is more than the time t_2:

$$t_1 = 26500 \big/ \left[c - 3.874 \cos(55°) \right]$$
$$= 0.088\,395\,140\,404\,452\,480\,018\,426\,795\,065\,77 \text{ s} \quad ,$$

$$t_2 = 26500/\left[c + 3.874\cos(55°)\right]$$
$$= 0.088\,393\,830\,060\,280\,261\,065\,577\,727\,538\,39 \text{ s} \quad .$$

The time difference is

$$t_1 - t_2 = 1.310\,344\,172\,218\,952\,849\,067\,527\,377\,547\,6 \times 10^{-6}\text{s}$$
$$= 1310 \text{ ns} \quad .$$

That is, if we suppose that signals travel with identical speed $C/n \approx C$, the signal from S1 to S2 arrives 1310 ns later than from S2 to S1.

b) Since in fact the atmosphere moves relative satellites with the speed V_A = 1.9271 km/s, the speed of the signal from S1 to S2 increases by $1.9271\cos(30°)$ but the speed of the signal from S2 to S1 dencreases by $1.9271\cos(30°)$ (in Fig. 3, the angle between the speed V_A and direction S1-S2 is $30°$). The signals travel with different speeds:

- **from S1 to S2** signal travels with the speed $c + 1.9271\cos(30°) =$
299 794.126 917 555 632 991 716 178 370 92 km/s
and reaches S2 in the time

$$t_1^* = L/\left[c + 1.9271\cos(30°) - 3.874\cos(55°)\right]$$
$$= 0.088\,394\,648\,315\,776\,131\,391\,583\,353\,258\,3 \text{ s}$$

which is **less** by 492 ns than t_1:

$$t_1 - t_1^* = 0.000\,000\,492\,088\,676\,348\,626\,843\,441\,807\,47 \text{ s.}$$

- **from S2 to S1** signal travels with speed $c - 1.9271\cos(30°) =$
299 790.789 082 444 367 008 283 821 629 08 km/s
and reaches S2 in the time

$$t_2^* = L/\left[c - 1.9271\cos(30°) + 3.874\cos(55°)\right]$$
$$= 0.088\,394\,322\,139\,846\,249\,989\,579\,920\,368\,19 \text{ s}$$

which is **greater** by 492 ns than t_2:

$$t_2^* - t_2 = 0.000\,000\,492\,079\,565\,988\,924\,002\,192\,829\,8 \text{ s.}$$

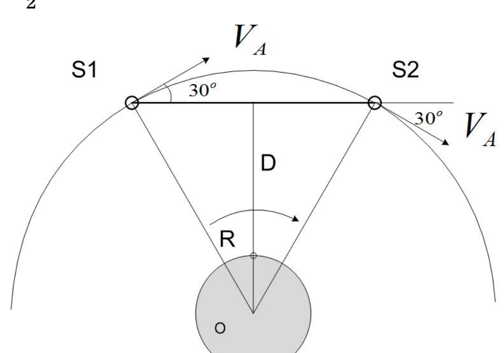

Figure 3. The signals between satellites in rotating atmosphere.

The time difference

$$t_1^* - t_2^* = 3.2617592988140200343289010678 12 \times 10^{-7} \text{ s} \approx 326 \text{ ns} .$$

Because the signals travel from west to east faster than from east to west, the time difference decreases by 984 ns. That is, the signsl from S1 travels to S2 longer by 326 ns but not by 1310 ns.

1.2 The case where satellites **S3** and **S4** move on the same orbit and at the moment are **at identical distances from equator** (Fig. 2):

- the distance between satellites S3 and S4: 37500 km,
- the angle between the direction S3-S4 and equator: $55°$,
- the angle between the direction S3-S4 and the tangent to the trajectory - $45°$

a) If we suppose that the atmosphere does not rotate and signals travel with identical speed.

Relative atmosphere the signals travel with identical speed $c/n \approx c$.

The signal from satellite S3 reaches S4 in the time

$$t_{3-4} = 37500/(c - V_0) =$$
$$= 0.125\,088\,152\,122\,563\,813\,170\,417\,456\,590\,01 \text{ s} ,$$

signal from satellite S4 reaches S3 in the time

$$t_{4-3} = 37500/(c + V_0) =$$
$$= 0.125\,084\,919\,317\,825\,409\,551\,708\,591\,284\,57 \text{ s}$$

and the time difference

$$t_{3-4} - t_{4-3} =$$
$$3.232\,804\,738\,403\,618\,708\,865\,305\,444\,183\,5 \times 10^{-6} \text{ s} \approx 3\,233 \text{ ns.}$$

b) Because the atmosphere moves relative satellites, the speeds of the signals change.

Satellites S3 and S4 at the moment are at the distance $\frac{1}{2}37500\cos(35°)$ from the equator, where atmosphere moves relative satellites GPS with the speed 1.57 km/s. A projection of this speed on direction S3-S4 is 1.57 $\cos(55°)$ $\cos(45°)$ = 0.637 km/s.

Signal from S3 reaches S4 in the time

$$t_{3-4}^* = 37500/(C + 0.637 - V_0)$$
$$= 0.12508788633197722609246181002619 \text{ s}$$

which is **less** by 266 ns than t_{34}

$$t_{34} - t_{34}^* = 0.000000\mathbf{265}7905865870779556465638 2 \text{ s}$$

The signal from S4 reaches S3 in the time

$$t_{4-3}^* = 37500/(C - 0.637 + V_0)$$
$$= 0.12508518509580332699573954856156 \text{ s}$$

which is **greater** by 266 ns than t_{4-3}

$$t_{4-3}^* - t_{4-3} = 0.000\,000\,\mathbf{265}\,77797791744403095727699 \text{ s} .$$

The time difference $t_{34}^* - t_{43}^* =$

$$0.00000270123617389909672226146463 \text{ s} \approx 2701 \text{ ns}$$

Because the signals travel from west to east faster than from east to west, the time difference decreases by 532 ns. That is, the signsl from S1 travels to S2 longer by 2701 ns, but not by 3233 ns.

3. The Signals from the Satellites to the Receiver on the Earth

2.1 The case when satellites **S1**, **S2** and receiver **R** are **in the plane of equator** and the distances S1-R = S2-R (Fig.4) :

- the distance between satellites S1-S2 - 30730 km,
- the distances from satellites to receiver S1-R = S2-R - 21710 km,
- the angle between the directions S1-R and S2-R - $90°$,
- the angles between S1-R & V_A and S2-R & V_A - $80.3°$,

- the distances D from S1-R and S2-R to the Earth center - 4470 km.

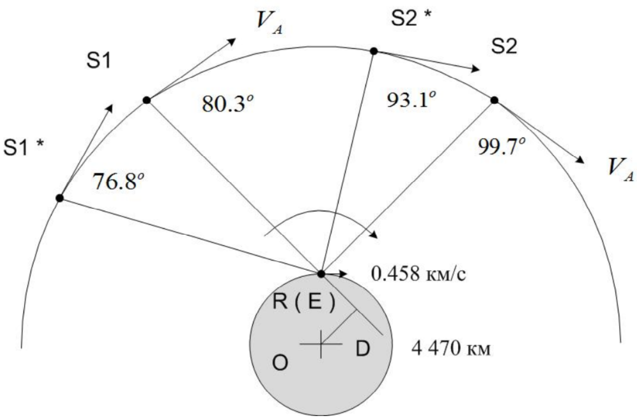

Figure 4. The signals between satellites. And Earth.

a) If we suppose that atmosphere **does not rotate** and signals travel with identical speed, the signals from satellites S1 and S2 reach the receiver R in the identical time, $21710/c=$ 0.07241660733158074469563111475233 s . That is, there is no time difference.

b) Because the atmosphere moves relative the satellites with speed V_A = 1.9271 km/s , the speeds of the signals relative inertial frame change. The projections of the speed on directions S1-R , S2-R $V_A\cos(80.3°)=\omega D$ are equal to **0.324** km/s, that is the signals from satellites travel to receiver R with different speeds: with speed $C/n+0.324$ from S1 and with $C/n-0.324$ from S2. But both signals reach the receiver **simultaneously** because the receiver is on rotating Earth and moves relative inertial frame with the speed 0.458 km/s, receding from S1 with speed $0.458\cos(45°)$ = **0.324** km/s and with the same speed $0.458\cos(45°)$ = **0.324** km/s approaching to S2. Therefore, in this case the motion of atmosphere does not change the times and **there is no difference of the times.** S2 *

2.2 The case when satellites S1*, S2* and receiver R are **in the plane of the equator** but the distances S1-R and S2-R are different (Fig.4):

The distance between satellites S1* and S2* is 30730 km,

The distances to receiver are:

S1*-R = 24100 km and S2* -R = 20340 km.

The angle between S1*-R and vector V_A: $76.8°$,

The angle between S2*-R and vector V_A: $93.1°$,

The angle between S1*-R and speed 0.458 km/s: $16.12°$,

The angle between S2*-R and speed 0.458 km/s: $76.72°$,

Projection of 0.458 km/s on S1*-R: 0.458 cos(16.12 °) = 0.44 km/s,

Projection of 0.458 km/s on S2*-R: 0.458 cos(76.72 °) = 0.1 km/s

a) If we suppose that the atmosphere **does not rotate,** and signals travel with identical speed, then the signals reach the receiver in the times

$24100/c$ = 0.080 388 946 942 754 643 947 713 988 188 46 s ,

$20340/c$ = 0.067 846 936 963 304 126 883 672 303 724 2 s ,

and the time difference is

0.012 542 009 979 450 517 064 041 684 464 26 s .

b) Because atmosphere moves relative satellites, the signal speed from S1* increases relative inertial frame by $1.9271\cos 76.8°$ = 0.44 km/s. But because the Earth rotates, receiver R recedes from satellite S1* with the same speed 0.458Cos16.12 = 0.44 km/s and therefore the signal comes to receiver in the same time $24100/c$ = 0.080 388 946 942 754 643 947 713 988 188 46 s as in a case when atmosphere is at rest.

Analogously, because of the Earth rotation, the speed of signal from S2* decreases by $1.9271\cos(93.1°)$ = 0.1 km/s. But because the receiver R approaches the satellite with the same speed 0.458 Cos 76.72 = 0.1 km/s , the signal reaches receiver in the same time $20340/c$ = 0.067 846 936 963 304 126 883 672 303 724 2 s as in a case when atmosphere is at rest. That is, and in this case, the motion of atmosphere **does not change** the times and the time difference.

Thus, because both the receiver R and atmosphere move with the same angular speed $\omega=7.27^{-5}$, the times for signals **from any satellite to the receiver R on the Earth do not depend** on the motion of the atmosphere.

4. Signals from Earth Surface to Satellites

4.1 The case when satellites **S1** and **S2** are in the plane of the equator **at identical distances from the source E**

a) Because the satellites move on the orbits with speed $V_0=3.874$ km/s, satellite S1 with speed $3.874\cos(80.3°)$ = 0.653 km/s approaches to source E and satellite S2 with the same speed recedes from E.

If we suppose that signals travel with identical speed $c/n\approx c$, then the signal from E comes to satellite S1 in the time

$$t_{E-S1}=21710/(c+0.653)=$$

0.072 416 607 331 580 744 695 631 114 752 33 s,

and the signal from E comes to satellite S2 in the time

$$t_{E-S2}=21710/(c-0.653)=$$

0.072 416 922 804 144 029 220 545 238 052 79 s,

and the time difference is

= 0.000 000 315 472 563 284 524 914 123 300 46 s.

That is, the signal from source E comes to satellite S1 **315** ns earlier than to S2.

b) Because atmosphere moves relative inertial frame with speed V_A = 1.9271 km/s , the speed of signal from source E decreases to the satellite S1 by $\omega D=V_A\cos(80.3°)$ = 0.324 km/s and increases to the satellite S2 by $\omega D=V_A\cos(99.7°)$ = - 0.324 km/s .

The signal from E reaches S1 in the time

$$t^*_{E-S1}=21710/(c-0.324\text{km/s}+0.653\text{km/s})$$

=0.072 416 685 595 574 385 850 717 615 831 1 s

which is **greater** than t_{E-S1} by 78 ns:

$t^*_{E-S1}-t_{E-S1}$ = 0.000 000 078 263 993 641 155 086 501 078 77 s

The signal from E reaches S2 in the time

= 0.072 416 844 539 637 663 402 430 422 047 54 s

which is **less** than t_{E-S2} by 78 ns:

$t_{E-S2}-t^*_{E-S2}$ = 0.000 000 078 264 506 365 818 114 816 005 25 s

The time difference is:

$t^*_{E-S2}-t^*_{E-S1}$ = 0.000 000 158 944 063 277 551 712 806 216 44 s

$$\approx 159 \text{ ns}.$$

Because the signals travel from the west to the east faster than in opposite direction, the difference of the times $t^*_{E-S2} - t^*_{E-S1}$ = 159 ns is by 156 ns **less** than $t_{E-S2} - t_{E-S1}$ = 315 ns.

4.2 The case when satellites **S1*** and **S2*** are in the plane of the equator **at different distances from the source E:**

E-S1*=24100 km , E-S2*=20340 km (See Fig.4)

a) Because the satellites move with speed $V_0 = 3.874$ km/s, satellite S1 with the speed $3.874\cos(76.8°)$ = 0.885 km/s approaches source E and satellite S2 with the speed $3.874\cos(93.1°) = 0.21$ km/s recedes from E.

If we suppose that signals travel with identical speed $c / n \approx c$, the signal reaches satellite S1* in the time

$$t_{E-S1^*} = 24100 / (C + 0.885)$$

$$= 0.080\,388\,709\,631\,887\,990\,254\,673\,533\,561\,42 \text{ s},$$

and the signal reaches satellite S2* in the time

$$t_{E-S2^*} = 20340 / (c - 0.21) =$$

$$= 0.067\,846\,984\,489\,071\,912\,226\,362\,837\,774\,24 \text{ s}$$

and the time difference

$$t_{E-S1^*} - t_{E-S2^*} =$$

$$0.012\,541\,725\,142\,816\,078\,028\,310\,695\,787\,18 \text{ s}.$$

b) Because atmosphere moves relative inertial frame with speed V_A = 1.9271 km/s , the speed of signal from source E decreases in direction to satellite S1* by $1.9271\cos(76.8∫)$ = 0.44 km/s and increases in direction to satellite S2* by $1.9271\cos(93.1°)$ = 0.1 km/s .

Signal from E reaches satellite S1* in the time

$$t^*_{E-S1^*} = 24100 / (c - 0.44 + 0.885)$$

$$= 0.080\,388\,827\,616\,776\,505\,213\,000\,322\,425\,91 \text{ s}$$

This is **greater** by 118 ns than t_{E-S1^*}

$$t^*_{E-S1^*} - t_{E-S1^*} = 0.000\,000\,117\,984\,888\,514\,958\,326\,788\,864\,49 \text{ s}$$

Signal from E reaches satellite S2* in the time

$$t^*_{E-S2^*} = 20340 / (c + 0.1 - 0.21)$$

$$= 0.06784696185774561530836670988013 \text{ s}$$

This is **less** by 23 ns than t_{E-S2^*}

$$t^*_{E-S1^*} - t_{E-S2^*}$$

$$= 0.000000117984888514958326788864449 \text{ s}$$

The time difference

$$t^*_{E-S1^*} - t^*_{E-S2^*} =$$

$$= 0.012\,541\,865\,759\,030\,889\,904\,633\,612\,545\,78 \text{ s}.$$

Because the signals travel from west to east faster than from east to the west, the time difference

$t^*_{E-S1^*} - t^*_{E-S2^*}$ =0.012 541 865 759 030 889 904 633 612 545 78 s

is greater than

$t_{E-S2} - t_{E-S1}$ = 0.012 541 725 142 816 078 028 310 695 787 18 s

by 141 ns .

5. Conclusion

Because the atmosphere rotates relative to the satellites orbits, which are at rest relative to the inertial frame, the GPS signalsof travel from west to east faster than from east to west. The motion of the atmosphere does not change the times of signals from satellites to the receiver on the Earth but it changes the times of the signals between satellites and the times of signals from the Earth to satellites. The amendment to the velocity signals can significantly improve the accuracy of the GPS. The fact that signals travel from west to east with speed greater than c proves the falsity of SRT and the Einstein's method of synchronization.

Correspondence

Analysis of the Around-the-World Atomic Clocks Experiment

Continued from page 62

3) The value 179 follows from an height of 19000 m, clearly the height of the Concorde.

4) The normal flight height of a 707 is 10000 m, but that height would lead to the value 94.

5) The value 144 is found when the height would be 15300 m, clearly the mean value of the heights of the Concorde and the 707.

6) That means that it may be expected that the kinematic contribution is also a mean value of both airplanes

The following questions now arise:

1) Why have these values been mixed? Nothing has been explained about this approach. The reader has to find out this by himself, by checking the presented numbers.

2) There has been a Concorde flying westward, of which the results are presented separately. There must also have been a Concorde flying eastward. Why are the results of this flight not presented separately?

3) The same question can be asked for the 707, flying eastward.

4) Might it be that only the mixed value showed enough similarity?

5) Was the so-called predicted value of these mixed flights really predicted, or calculated after the experiment had been carried out and evaluated?

Regarding the accuracy of the observations: isn't it accidentally that they observed the (wrong) predicted time gains with a claimed accuracy of not more than 10 ns per day, while, as they wrote:

Concluded on page 80

Proposed Experiment to Disprove Relativity Theory

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This paper presents an idea for an experiment that could give results contradicting the predictions of Special Relativity Theory (SRT). The experiment consists of using two low energy (below 0,4Ge.V) colliding beams, the relative velocity of which, according to the model of Euclidean Reality, should be equal to the speed of light. The possibility of obtaining a relative velocity equal to the speed of light with the help of only finite energies results from the new transformation of velocities published independently in two papers in Galilean Electrodynamics. According to the article presented here, during the measurement of total proton-proton (pp) cross sections in a collider, for the relative speed of colliding protons equal (and almost equal) to the speed of light, in a very strict and very narrow range of energies, a sharp spike should be visible on the pp cross section diagram. Existence of this spike will prove that the hitherto rule of transformation of velocities and consequently the Lorentz transformations are wrong. Moreover it will prove that the idea of deformation of dimensions as a function of speed is also wrong.

1. Introduction

In 2007, GED published two papers regarding the Euclidean model of Reality – mine {1] and van Linden's [2]. Both papers proposed a new rule of velocity composition. Although they were derived in different ways, both rules led to identical results. The new result for velocity composition still does not allow one to exceed the speed of light; however, it allows particles to reach the relative velocity *equal* to the speed of light with the use of finite energies. If the new result for velocity composition is true, then, within a certain range of particle energies, differences should be noted between the experimental results and the predictions of Relativity Theory, because Relativity Theory does not allow the magnitude of the relative velocity between particles to reach the speed of light.

One could argue that if this phenomenon were true, then these differences should have beeen noted some time during the numerous experiments performed during last few decades. However, this is not true because – as will be shown further on - the predicted differences would only be noticed in the range of energies lying beyond those usually applied in similar experiments, and the range of energies that allow one to notice the results predicted here is very narrow.

2. New Rule of Velocity Composition

The new model of Four dimensional Euclidean Reality (FER) – according to the interpretation presented in my papers [1,3-8], describes the reality as one composed of certain dimensions which describe distances without having the notion of time or space assigned to them in advance. According to this model, the time and space that we know are not the real dimensions creating the reality, but they are directions in the FER which depend on the observer and the observed object. The time and space dimensions are not the true dimensions creating the reality – they are simply some directions in the FER that we perceive while observing other objects in the FER. According to the model, in the case of the rectilinear and uniform motion, the direction in FER interpreted by us as the time dimension overlaps the trajectory of an observer in the FER, and the directions in FER interpreted by us as the space dimensions are the directions perpendicular to the trajectory of a currently observed object. In such reality, the relative velocity of bodies is equal to the sinus of angle between the trajectories of the observer and the observed object. The relation between the objective dimensions creating the Euclidean reality and the observed dimensions *xyzt* is shown in Fig. 1. The two cases are shown separately for greater readability. To underline the fact that the dimensions creating the FER carry no meaning of time or space, they are marked with the letters *A B C D*. The observer's space axis is perpendicular to the time axis of the observed body.

Fgure 1a. Body 1 is the observer, and the frame x_1t_1.

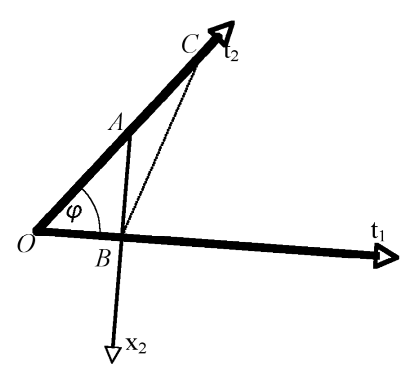

Figure 1b. The observer is Body 2 and the frame x_2t_2.

Axes of the coordinate systems of both observers are presented in the same scale, so both cases could be presented on a single Figure. The trajectories of the signals sent by the observed body and received by the observer are indicated by a dotted line - BC sections in Figures 1a and 1b. OBA are the right triangles.

The relative velocity in such defined frames equals to the sinus of an angle between the trajectories of bodies: $V = \sin\phi$.

A more detailed description of the FER can be found in [1,3-8]

According to the model of Euclidean reality, a velocity is defined as sinus of an angle between trajectories (time axes) of bodies. Such a definition introduces in a natural way, on the one hand, a limitation of velocity to the value of '1', but on the other hand, it changes the rule of composition of velocities, which now relies on adding angles between trajectories – Fig. 2

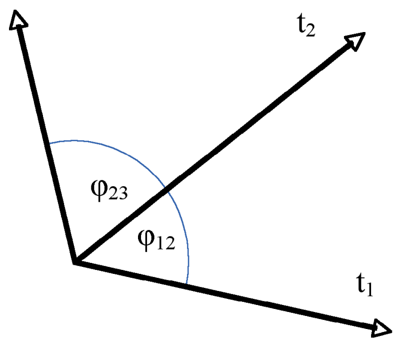

Figure 2. Trajectories of three objects $1, 2, 3$ presented according to the alternative model. Trajectory (the time axis) of object i is denoted as t_i, $i = 1, 2, 3$. Relative velocities are equal to the sinuses of angles between the trajectories. The angles between the trajectories i and k are marked with symbols φ_{ik} where $i, k = 1, 2, 3$.

According to Fig. 2, the relative velocities are equal to:
The velocity of Object 2 in relation to Object 1 is:

$$V_{12} = \sin\varphi_{12} \quad . \tag{1}$$

The velocity of an Object 3 in relation to Object 2 is:

$$V_{23} = \sin\varphi_{23} \quad . \tag{2}$$

The new rule of composition of velocities results directly from the definition of velocity and the resultant velocity of object 3 in relation to 1 is equal to:

$$\begin{aligned} V_{13} &= \sin\left(\varphi_{12} + \varphi_{23}\right) = \sin\varphi_{12}\cos\varphi_{23} + \sin\varphi_{23}\cos\varphi_{12} \\ &= V_{12}\sqrt{1 - V_{23}^2} + V_{23}\sqrt{1 - V_{12}^2} \end{aligned} \tag{3}$$

while the transformation of velocities resulting from SRT is described with the formula:

$$V_{13} = \left(V_{12} + V_{23}\right) / \left(1 + V_{12}V_{23}\right) \tag{4}$$

This means that while composing the velocities according to the formula (3) we can, in some cases, obtain motion along trajectories inclined at an angle of 90^0 and greater, or - to use a notion from the Lorentzian space-time model – to accelerate an object to the speed of light (trajectory inclined at an angle of 90^0 to trajectory of an observer) and after that to continue acceleration, wherein further acceleration will theoretically cause decreasing velocity – Fig. 3 [1,2,,4].

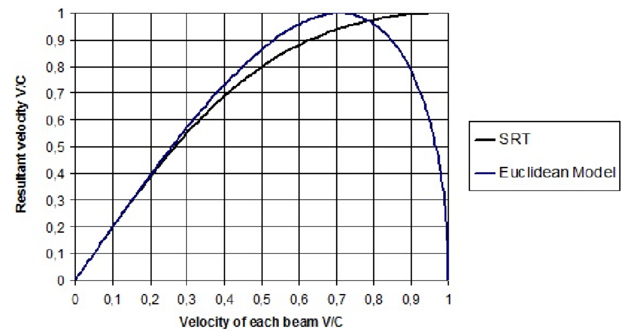

Figure 3. Comparison of the two rules of composition of velocities – the rule based on SRT described with formula (4) and the rule based on the Euclidean model described by formula (3). The composed velocities have equal value – in formulas (3) and (4) $V_{12} = V_{23}$. In case of trajectories described with formula (3), inclined to each other at an angle of less than $90°$, the observed velocity is lower than the speed of light. When these trajectories are inclined to each other at an angle of 90^0 then the relative velocity is equal to the speed of light. For angles greater than $90°$ velocity decreases from one to zero, however in this case a particle probably cannot be observed with the help of quanta.

However, most likely an object moving along such a trajectory will not be observable, so discussing velocities for such types of trajectories makes little sense. The limitation of velocity to the value of '1' does not mean any restrictions on trajectories – all of the trajectories are allowed. It is only a limitation regarding the observation. As follows from Fig. 1 an observer most likely is only able to observe (with the help of EM signals) objects having trajectories inclined to its trajectory at angle less than $90°$.

3. Potential for Experimental Verification

The new rule of velocity composition – different from the one valid for SRT - still does not allow one to exceed the speed of light – Fig. 3. However, it allows one to reach the kind of trajectories that, according to SRT, cannot be reached. Since the rule of velocity composition is the result of transformation of coordinates while moving from one coordinate system to another, the new rule of velocity composition must be a result of a transformation different than the Lorentz transformation [4]. Therefore, designing the experiment that would verify the predictions of the new alternative approach presented here should be possible, regardless of the fact that there already are a lot of experiments allegedly confirming SRT.

Consider an example experiment: comparison of measurements of total cross section for collisions of protons for proton beam hitting stationary hydrogen target and two colliding protons beams. To test the new rule of composition of velocities I propose an analysis of the comparison of measurements of total cross sections for proton-proton collisions for two cases:

1) A proton beam hits a stationary hydrogen target – the Beam-Target method;

2) Collision of two proton beams in a collider.

The total cross section is a function of velocity of one of the particles in the frame bound with the second particle and only this velocity determines the value of cross section. The existence of two alternative rules of composition of velocities means that for two colliding beams, two different relative velocities can be found at the same time, depending on whether we apply formula (3) or (4), and consequently we should expect two different results of measurements. Since in case of a stationary target (for instance $V_{23} = 0$) both formulas (3) and (4) are identical, we can use the results of measurements that use the stationary target as a basis for a comparison with the experiment with two colliding beams having – according to formulas either (3) or (4) – identical relative velocities as the beam in the experiment with a stationary target. The results obtained with the help of the two methods should prove which rule of transformation of velocities is true (if any). As will be shown, the differences are significant but they occur in a specific, strictly defined, narrow range of energies.

How does the proposed experiment work in practice? Let us consider cosmic origin particles of very high energy, approx. 10^8GeV. The total p-p cross section for these energies equals approx. 110mb [9] or more [10]. First, we will discuss the problem according to the current SRT model based on transformation (4):

The velocity of protons is very high here, however in case of experimental physics the notion of center of mass energy $\sqrt{s}$ is applied instead of velocity. Equality of the center of mass energies is equivalent to the equality of relative velocities of particles regardless of the applied experimental method (stationary target or two colliding beams).

The square of the center of mass energy s equals:

- For the beam –stationary target system:

$$s = 2Em + 2\mathrm{m}^2 \tag{5}$$

where E is the energy of hitting beam, and m is the proton's mass in eV

- For the collider in case of two colliding beams having identical energy E each:

$$s = 4E^2 \tag{6}$$

The above reasoning and formulas are derived on the basis of transformation (4) which is in fact embedded in formulas (5) and (6). Based on these formulas, we can conclude that, for energy of cosmic origin protons $E = 10^8\,\mathrm{GeV}$, the center of mass energy is: $\sqrt{s} \approx 1.37 \times 10^4\,\mathrm{GeV}$. This means that in case of the experiment with colliding beams, identical cross sections should be obtained for energy of each of the beams equal to (6): $E = \sqrt{s}/2 \approx 6.85 \times 10^3\,\mathrm{GeV}$

This means that if the transformation (4) is true, then the cross section obtained for cosmic beams of energy 10^8GeV can also be obtained in a collider where the energies of colliding beams are equal to 6.85×10^3GeV each.

Now consider the same problem according to the transformation (3) resulting from the alternative Euclidean approach. Since, in the text above, the equality of center of mass energies was applied instead the equality of velocities, now we will use the equality of angles between the trajectories, which according to the Euclidean approach is equivalent to equality of velocities. The problem of a beam hitting a stationary target is presented in Fig. 4a and for the energy of cosmic origin protons the angle between the beam trajectory and the stationary target is equal to almost (formula 3) $\varphi_2 = \arcsin(V) \approx 90°$ ($C = 1$ here). The corresponding case of two beams is presented in Fig. 4b where the angle between two beams is also equal to $\varphi_2 = 90^0$, however the angle of trajectory of each of the beams in a laboratory system equals to $\varphi_2/2 = 45^0$ which corresponds to velocity (3): $V = \sin(\varphi_2 / 2) \approx \sin(45°) \approx 0.707c$

Consequently, it corresponds to $\sqrt{s} \approx 2{,}654\,\mathrm{GeV}$ (according to SRT model) and it means that energy of a single beam in a laboratory system should be equal to almost 1,327GeV or kinetic energy equal to 389MeV.

This means that if the transformation (3) is true, then the cross section obtained for cosmic beams of energy 10^8GeV can also be obtained in a collider where the energies of colliding beams are equal to 1,327GeV each. This energy includes the proton's rest mass energy and it corresponds to the kinetic energy equal to 389MeV.

We can create he diagram showing the predicted results of measurements using two colliding beams by performing the above reasoning for the measurements of p-p cross section in all ranges of energies – Fig. 5, and compare it with the existing data – Fig. 5. Since the 90^0 angle between trajectories, corresponding to relative velocity of beams equal to the light speed, is obtained for kinetic energy equal to 389 MeV for each of the beams, then one can expect that all the already known experimental results of measurements of p-p cross section can be obtained for two colliding beams in the kinetic energy range from 0 to 389MeV (for each of the beams) or, if we use the notion of center of mass energy – for $1{,}877\mathrm{GeV} < \sqrt{s} < 2{,}654$ GeV. Therefore the graph representing all existing experimental data obtained with the beam – target method – Fig.5 - for two colliding beams will be compressed within this range of energies, however the results for high energy collisions will be compressed into a very narrow spike.

The graph of expected cross sections for colliding beams as a function of center of mass energy, superimposed on the existing experimental data[10], is shown in Fig. 5. For kinetic energies of colliding beams of protons within the range from 0 to 389MeV (center of mass energies from 0 to 2,654 GeV) the following differences in relation to the hitherto results should be observed:

1) The first maximum of the cross section's curve for the center of mass energy of approx. 2.36 GeV should be shifted for -0.16GeV in relation to the hitherto results.

2) For center of mass energy approx. 2,654 GeV corresponding to the kinetic energy of colliding beams equal to 383-389 MeV (for each of the beams), a narrow spike of width (for each of the beams) 6keV for 60mb, 0,8 keV for 70mb and 0,1 keV for 80mb should be observed. Within this spike all the values of cross sections already measured with the help of cosmic rays should appear. Figures 4a and 4b show trajectories of two colliding protons in two cases of beam–target methods.

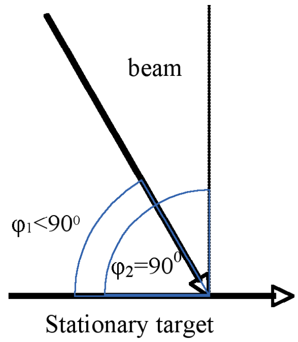

Figure 4a. Trajectories of colliding protons in the case with both beam trajectories inclined to the trajectory of the laboratory frame at an angle of 45^0.

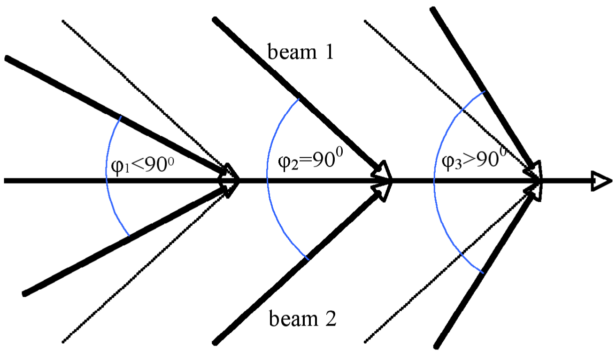

Figure 4b. Trajectories of colliding protons in the case of two colliding beams the trajectories of the colliding particles can be inclined to each other at angles 0^0-180^0 while for the beam target method – only at angles 0^0-90^0. The two colliding beams with trajectories inclined to the trajectory of laboratory frame at an angle of 45^0 each.

All the existing experimental data for colliders are, according to the presented approach, compressed within a range of low energies. So what results should be obtained for the higher energies? In fact, some of the results presented in Fig. 5 for center of mass energies higher than 2,654 GeV were obtained with the help of a collider experiment.

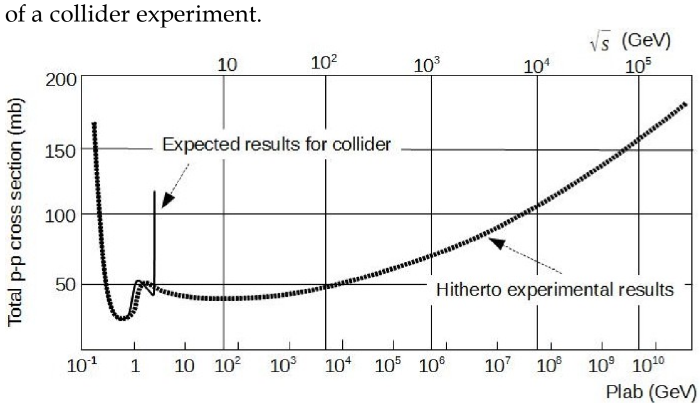

Figure 5. These are the cross sections for the center of mass energy over 10^2 GeV (Fig. 5 - upper scale) or momentum in the laboratory frame over 10 TeV (Fig. 5 -lower scale).

For beams with center of mass energies higher than 2,654 GeV (kinetic energies over 389MeV for each of the beams) the trajectories of colliding particles are inclined to each other at an angle greater than 90^0 (Fig. 6b – the angle φ_3). Theoretical dependency of the cross sections for this range of angles is not known yet. The situation is here in a way symmetrical to the situation for kinetic energies of beams below 389MeV. The similarity is shown in Fig. 6, presenting the time axes of two bodies inclined at angle lower than 90^0 – Fig. 6a - and greater than 90^0 - Fig. 6b. On both figures the orientation of time axes is identical while their senses, on the Fig. 6b, are opposite to each other.

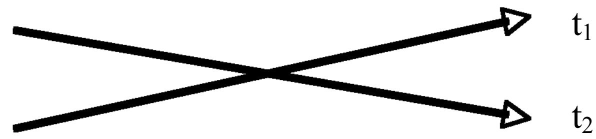

Fig. 6a. Trajectories of two colliding proton beams. In Fig. a, the trajectories are inclined to each other at an angle lower than 90^0, in Fig. b,

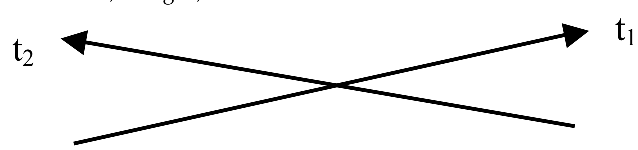

Figure 6b. Trajectories at an angle greater than 90^0. Orientations of the trajectories are identical on both figures while the senses differ.

Conclusion

According to the considerations above, one can achieve interesting results for colliding beams not in the range of great energies that these devices were designed for, but for relatively small energies for which a single beam hitting the stationary target could be applied successfully. I'd like to stress here that comparing the cross sections for beam-target reactions with two colliding beams in a low kinetic energy range – below 1GeV – can also constitute an additional test for the veracity of the Relativity Theory and, to go into more detail – for the veracity of the rule of composition of velocities, and consequently for the veracity of the Lorentz transformation. On the other hand, the appearance of the high, narrow spike in the graph showing the dependency of the total cross section from energy will be an unambiguous proof for the correctness of the alternative approach presented here.

It could be said that the RT was confirmed enough times with the help of numerous experiments and if the phenomena described above existed, they would have been found by now. In fact – all the already performed experiments should give practically identical results for both RT and the new approach presented here. However, only some experiments with strictly determined energies of colliding beams, much lower than usually applied, should produce some detectable discrepancies between the RT and the alternative approach. The experiment confirming the new approach is possible, but it needs a very narrow energy distribution of colliding particles due to a very narrow range of energies for which this effect should occur. Therefore any accidental detection of the discrepancies described above does not seem to be possible.

The positive result of the proposed experiment will prove that the hitherto rule of composition of velocities is false. Since the hitherto rule of composition of velocities is the result of Lorentz Transformation, then the Lorentz transformation will be proven to be false, too. Moreover, the construction of the FER uses the inclination of space dimensions in relation to to the time axis of the observer instead of stretching the dimension as it is assumed in the RT. Therefore the fact of deformation of dimensions as a function of velocity should be false as well.

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Analysis of the Around-the-World Atomic Clocks Experiment

Continued from page 75

"However, no two "real" cesium beam clocks keep precisely the same time, even when located together in the laboratory, but generally show systematic rate (or frequency) differences which in extreme cases may amount to time differences as large as 1000 nsec per day."

and:

"A much more serious complication is caused by the fact that the relative rates for cesium beam clocks do not remain precisely constant. In addition to short term fluctuations in rate caused mainly by shot noise…………"

and:

"These unpredictable changes in rate produce the major uncertainty in our results."

Besides the error in the expression for $d\tau / dt$ the authors overlooked another fundamental phenomenon. They wrote:

"Because the earth rotates, standard clocks distributed at rest on the surface are not suitable in this case as candidate clocks of an inertial space. Nevertheless, the relative timekeeping behaviour of terrestrial clocks can be evaluated by reference to hypothetical coordinate clocks of an underlying non-rotating (inertial) space (6).

"For this purpose, consider a view of the (rotating) earth as it would be perceived by an inertial observer looking down on the North Pole from a great distance. Λ clock that is stationary on the surface at the equator has a speed $R\Omega$ relative to nonrotating space, and hence runs slow relative to hypothetical coordinate clocks of this space in the ratio $1 - R^2\Omega^2 / 2c^2$ 1, where R is Earth's radius and Ω its angular speed. On the other hand, a flying clock circumnavigating Earth near the surface in the equatorial plane with a ground speed v has a coordinate speed $R\Omega + v$, and hence runs slow with a corresponding time ratio $1 - (R\Omega + v)^2 / 2c^2$. Therefore, if τ and τ_0 are the respective times recorded by the flying and ground reference clocks during a complete circumnavigation, their time difference, to a first approximation, is given by $\tau - \tau_0 = -(2Rv + v^2)\tau_0 / 2c^2$ -."

Why did the authors choose this position for the 'inertial observer', instead of a position at such a great distance from Earth that this observer would have seen, not only the velocities as described, but also the speed, let say w, of Earth due to its rotation around the Sun? This speed is not only much larger than $R\Omega$ and v (~100000 km/hour), it would also have led to a completely different theoretical consideration, not only due to the fact that the influence of w is very large on the result, but also due to the fact that $R\Omega$ and $\mathbf{v}$ are continuously differently oriented with respect to $\mathbf{w}$.

Incorporating the influence of w would lead to the speed for the ground reference clock:

$$v_r = w + R\Omega \cos(\Omega t)$$

and for the airplane:

$$v_{\mathrm{a}} = w + (R\Omega + v_{\mathrm{r}}) \cos\left[\Omega t + \varphi(t)\right]$$

with $\varphi(t)$ representing the position of the airplane w.r.t. the position of the ground reference clock.

Due to the square of the speeds v_{r} and v_{a} in the expression for $\tau - \tau_0$ the influence of w on the time difference is very large.

Maybe our Earth does have yet another speed, together with our solar system. Maybe even much larger than w! However (the position in universe of) the reference of this speed is unknown, so the "hypothetical inertial observer" cannot be placed. To quote, cynically, a statement in the HK article:

"In science, relevant experimental facts supersede theoretical arguments."

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