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The Relativity Program

The physical and mathematical meanings of the symbols in the equations
by which Einstein tried to derive the Lorentz Transformation Equations.

by du Gabriel, 2003

The following analysis of Einstein's 1905 relativity paper will show that the physical requirements imposed by the Lorentz Transformation Equations ("LTE") contradict the concepts of the Special Theory of Relativity ("STR"), therefore of present Theoretical Physics as well.

Each numbered step, below, is to be taken as a line in a computer-type operating program the equations must obey. Any Einstein postulate or assumption will be quoted as a line-item, generally in the order it appeared in his 1905 paper. Any remarks inserted within such quoted portions will be enclosed in [brackets].

Discussions below a line item will also be enclosed in brackets. They are relevant to the overall thesis but are not part of the line-item instruction per se.

Any steps quoted from Einstein must be accepted without argument. Any arguments about other items must be within the context of instructions to there, since that's what the equations obey. Any step that changes the prior program will be highlighted by an asterisk next to its number. As mathematically demonstrated herein, any such change in the program is needed in order for Einstein's revised assertion(s) to hold good.

In his introductory remarks Einstein wrote, "The introduction of a 'luminiferous ether' will prove to be superfluous inasmuch as the view here to be developed will not require 'an absolutely stationary space' provided with special properties, nor assign a velocity-vector to a point of the empty space in which electromagnetic processes take place." That states what his entire program intended to accomplish via his ensuing steps. We will now begin to study that program.

1. "The laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good."

[The equations of mechanics included the Galilean transformation equations, which are valid only in Euclidean-cartesian co-ordinate systems. ("Euclidean-cartesian" is my term, hereafter called "Euclidean" for brevity.) Regardless of their various states of motion the size of the units of length of all such systems were and remained identical in all directions and so did their clock-rates and settings. Because of the latter, no "time" transformation was needed.]

2. "Light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body."

[This takes "empty space" as the referent for the physical speed of light. In an Appendix V added in 1952 to his 1916 book "Relativity: The Special and General Theory" Einstein repeated that on page 148, saying that STR "takes over from the theory of Maxwell-Lorentz the assumption of the constancy of the velocity of light in empty space."]

3. "Let us take a system of co-ordinates in which the equations of Newtonian mechanics hold good."

[The equations of Newtonian mechanics were based on Euclidean systems and Galilean transformations. As shown below, however, non-galilean transformations thus non-euclidean systems are required in order for the laws of electrodynamics and optics to remain invariant in moving systems. Taken together, lines 3 and 2 contradict line 1. We will therefore wait for further instructions.]

4. "In order to render our presentation more precise and to distinguish this system of co-ordinates verbally from others which will be introduced from time to time, we will call it 'the stationary system'."

[In accordance with lines 1 through 4 this is a classical Euclidean system whether or not it is at rest in the "empty space" in which Einstein postulated that light travels at c.

If we choose a rod whose length is any elected distance whatsoever and define that as "one unit of length", then we can define "one second" as being the time it takes a ray of light to traverse that distance in a vacuum, as measured by a locally stationary system. Given that, we will herein let c = 1 unit/second ("c = 1" for short).]

5. " 'Time' [is to be taken as] the positions of the small hands of [a] watch."

[Einstein said a bit later, "If at the point A of space there is a clock, an observer at A can determine the time values of events in the immediate proximity of A by finding the positions of the hands which are simultaneous with these events."

Note that Einstein's "simultaneous", there, means "at the same instant" independently of the "time" of any clocks at all; as it always meant prior to September, 1905.

He continued, "If at the point B of space there is another clock in all respects resembling the one at A, it is possible for an observer at B to determine the time values of events in the immediate neighborhood of B. But it is not possible without further assumption to compare, in respect of time, an event at A with an event at B."

Before then, the further assumption had been that all clocks A and B have and maintain the same rates and settings everywhere.

"We have so far defined only an 'A time' and a 'B time'. We have not defined a common 'time' for A and B, for the latter cannot be defined at all unless we establish *by definition* that the 'time' required by light to travel from A to B equals the 'time' it requires to travel from B to A."]

6*. "Let a ray of light start at the 'A time' tA from A toward B, let it at the 'B time' tB be reflected at B in the direction of A, and arrive at A at the 'A time' tA'. In accordance with [this] definition the two clocks synchronize if

tB - tA = tA' - tB."   Equation 1

[The only system mentioned so far is "the stationary system" and the only referent for the speed of light is "empty space". Accordingly, this method of setting its clocks *would* result in truly synchronous clocks. However, if a system is moving through his empty space then clocks "*esynched*" by this method would have different settings than each other in the direction of motion. They would thus be "*sinchronous*" rather than synchronous. (What that physically and mathematically requires will be explained later.)

As Poincare', who invented this method of setting clocks on Earth, said in a 1904 symposium, "The watches adjusted in that manner do not mark, therefore, the true time, they mark what one may call 'the local time', so that one of them is late compared to the other." Which is to say, clocks *so adjusted* would no longer remain *synchronous*. Einstein redefined the word and I merely provided more accurate terms for such truly esynched thus truly unsynchronous clocks of moving systems.

The reason this item was asterisked is because such esynched thus sinchronized moving systems are no longer Euclidean thus no longer obey line item 3. However, since clocks and coordinate systems are inventions of Man and since we decide how to create, define and use them, this is not an objection to Einstein's method. Rather, it's a refinement of his semantics.]

7. "We assume that this definition of synchronism [and sinchronism] is free of contradictions, and possible for any number of points; and that the following relations are universally valid:-

1. If the clock at B synchronizes with the clock at A, the clock at A synchronizes with the clock at B.
2. If the clock at A synchronizes with the clock at B and also with the clock at C, the clocks at B and C also synchronize with each other."

[His next sentence is, "Thus with the help of certain imaginary physical experiments we have settled what is to be understood by synchronous stationary clocks located at different places, and have evidently obtained a definition of 'simultaneous,' or 'synchronous,' and of 'time.'" Only *one* of those imaginary *experiment**s*** remains present in his published paper. Evidently the rest were deleted.

In order to clarify the physics beneath the emerging relativistic equations, we will therefore do some of the imaginary experiments in the line-items between steps 14 and 15, below.]

8. "We further assume the quantity

$$2AB/(tA' - tA) = c \qquad \text{[Equation 2]}$$

to be a universal constant - the velocity of light in empty space."

[If t is a co-ordinate of a stationary system, the equations would agree with this new assumption. If, however, the system is inertially moving through empty space but must *plot* the round-trip relative speed of light as equal to its "definite velocity c in empty space", this requires that *the rate at which a moving system's clocks beat* must physically change. If they *didn't* the equation would fail in any but a moving system whose units of length contract by $Q = 1 - v^2/c^2$ in the direction of motion and by $q = \sqrt{(1 - v^2/c^2)}$ in the perpendicular directions. (That's because the average two way relative speed of light on the axis of motion is Q and on the perpendicular axes it is q. Therefore, if the apparatus shrunk by those amounts in those directions it would take 2 seconds for a ray to round trip a Q shrunken unit length on the axis of motion and 2 seconds to round trip a q shrunken unit length in the perpendicular directions, thus the velocity would be c = 1 as measured by the clocks of such a system. Accordingly, no rate change of the clocks would be needed.)

Note that Einstein again gave empty space as the referent for what is thereupon the absolute velocity of light. However, just because the velocity of light is c in a local vacuum on Earth doesn't necessarily mean that it has that same velocity in vacuo everywhere in the entire universe. Actually, since not all vacuo - which are spaces filled with non-atomic matter - are identical, it's a physically false assumption. But that's outside the scope of this article.]

9. "It is essential to have time defined by means of stationary clocks in the stationary system, and the time now defined being appropriate to the stationary system we call it 'the time of the stationary system'." If we take a moving system as referent we will call the time defined by means of clocks at rest in that system "the time of the moving system".

[Einstein called the latter "the time of the 'stationary' system". Since enclosing "stationary" in quotation marks means that the system is moving, item 9 amends his triply redundant statement in order to avoid confusion.

Via E's method of setting relevant clocks, the time (readings of the hands of clocks) of a stationary system will be synchronous and the time of a moving esynched system will be sinchronous.]

10*. "The laws by which the states of physical systems undergo change are not [to be] affected, whether these changes of state be referred to one or the other of two systems of co-ordinates in uniform translatory motion."

[This now requires that *all* coordinate systems must hold the laws of nature (actually *our equations*, especially Maxwell's) applicable, regardless of any states of motion in the "empty space" of lines 2 and 8. That rules out a moving coordinate system in which the Galilean transformations of Newtonian mechanics hold good, thus amends line 1.

In the next four line-items, which are from his section 2, "On the Relativity of Lengths and Times", we will explore what's needed in order to support this new requirement.]

11. "Let there be given a stationary rigid rod [rAB]; and let its length be [L = 1] as measured by a measuring-rod which is also stationary. We now imagine the axis of the rod lying along the axis of X of the stationary system of co-ordinates, and that a uniform motion of parallel translation with a velocity v along the axis of X in the direction of increasing x is then imparted to the rod."

[The rod initially attached to the stationary system is now set in motion at v, presumably in empty space. We will let this be a unit rod and let v equal .6c in the ensuing steps.]

12. "We imagine further that at the two ends A and B of the rod, clocks are placed which synchronize with those of the stationary system; that is to say that their indications correspond at any instant to the 'time of the stationary system' at the places where they happen to be. These clocks are therefore 'synchronous in the stationary system'."

[Independently of any co-ordinate system, the clocks are attached to the ends of a rod that is moving at .6c in empty space. Since Maxwell based his laws on an ether made of particles statistically at rest in Newton's metrical empty space, *truly* synchronous clocks attached to a system moving through either empty space or that medium would not measure the one way relative speeds of light as a constant. Hence Maxwell's laws would not hold good in moving systems. Knowing this, Einstein proceeded accordingly.]

13. "We imagine further that with each clock there is an observer, and that these observers apply to both clocks the method established [above] for the synchronization of two clocks. Let a ray of light depart from A at the time* tA; let it be reflected at B at the time tB; and reach A again at the time tA'."

[His footnote is "* 'Time' here denotes 'time of the stationary system' and also 'position of hands of the moving clock situated at the place under discussion'." Once clocks have been esynched, that rules out signal transit intervals as playing any role in the time co-ordinates of a given event as plotted by different systems.]

14. "Taking into consideration the principle of the constancy of the velocity of light ["in empty space"] we find that

$$tB - tA = rAB/(c - v) \text{ and } tA' - tB = rAB/(c + v)$$

where rAB denotes the length of the moving rod - measured in the stationary system."

[Letting rAB = r, note that r denotes the length of the moving rod as measured in the stationary system.

His next sentence is, "Observers moving with the moving rod would thus find that the two clocks were not synchronous, while observers in the stationary system would declare the clocks to be synchronous." Those observers would find their synchronous clocks "not synchronous" only if the relative speed with which light physically passes such moving systems is *not* equal to c. The moving clocks therefore need to be esynched.

There is nothing in his published paper that shows how to do that. We will do the relevant mental experiment in step 14.3.]

14.1. Let a ray initiate from A at $tA = t_0 = 0$. Letting tB be denoted as t_1 and tA' as t_2, solve the equations of line 14 and print the values of t_1 and t_2.

[The equations print: "$t_1 = t_1 - 0 = rAB/(c-v) = 1/.4 = 2.5$; $t_2 - t_1 = rAB/(c+v) = 1/1.6 = .625$;

wherefore $t_2 = 2.5 + .635 = 3.125$."

Accordingly, $t_1 - t_0 = 2.5$ is unequal to $t_2 - t_1 = .625$. *This* was why Einstein said that observers on the moving rod would claim that their synchronous clocks are not synchronous.

Note that $tA' - tA = 2L/(c^2 - v^2)$, so $2L/(tA' - tA) = 2L/[2L/(c^2 - v^2)] = c^2 - v^2$. Accordingly, c' = Qc, in which c' here denotes the average round-trip velocity of light relative to the moving rod. If, therefore, clocks of a physically undeformed moving system don't change intrinsic rate then that system would find that c' =/= c.

We will now consider the missing steps which would allow Equation 2 to hold good in a moving system. For that purpose we will introduce two coordinate systems, neither of which was used in the program to here nor prior to Section 3 of Einstein's published paper. (Perhaps that's because his treatment had initially been restricted to clocks and a moving rod lying parallel to its direction of motion and the "time" it would take light to traverse the moving rod; without using any spatial co-ordinates at all.)]

14.2. Let coordinate system K (x, y, z; t) be attached to the moving rod. Let coordinate system k (x', y', z'; t') be attached to a rod at rest in the stationary system of line 4. Let $^{dt}/_{dt'}$ denote the ratio of the rate at which clocks of K beat compared to those of k, as plotted by k. Print the value of $^{dt}/_{dt'}$ that is needed in order for Equation 2 to hold good in the moving system.

[The equations print: "$^{dt}/_{dt'} = Q$."

Demonstration: For the moving clocks to obey Equation 2 it is required that t_2 = 2 seconds rather than the 3.125 seconds found above. The required *ratio of rates* is therefore

$$^{dt}/_{dt'} = 2/3.125 = .64 = 1 - v^2/c^2 = q^2 = Q.$$

Applying this rate-change to clocks of the moving system and letting $a' = {}^{dt}/_{dt'} = Q$ we obtain

$$t_2 = {}^{dt}/_{dt'}t' = a'\,t' = .64 \times 3.125 = 2 \text{ seconds; so } 2rAB/(tA' - tA) = 2/2 = 1 = c.$$

Hence Equation 2 is satisfied as plotted by the moving system K."

Standard Objection (S.O. hereafter). "That's wrong. You have to let lengths in the direction of motion shrink by the square root of $(1 - (v/c)^2)$ as viewed by a differently moving system, wherefore rates have to run slow by $q = \sqrt{(1 - v^2/c^2)}$ asviewedbyadifferentlymovingsystem not by Q!"

Answer: There was nothing in his program to here that says lengths shrink at all, in *any* direction.

S.O. "Neither is there any such thing as 'the ratio of rates' in Einstein's paper." Answer: His derivational equations have in them $^{ðt'}/_{ðt}$. Since, as he said a bit later, the equations are linear, $^{ðt'}/_{ðt} = {}^{dt'}/_{dt}$ *is* the ratio of rates, as plotted by K.

S.O. "But *his* t is the time of the stationary system K, not a moving system K. Answer: Before he revised his proof copies (for reasons explained below), his tau (t' herein) denoted the time of a clock of what initially was "the stationary system" and t was the time of "the 'stationary' system K." <-- That's from a remnant that he overlooked editing in his hastily revised proof copy. (See page 61 of the Dover Books' rendition of his paper.

About 50 times in that paper we find "the stationary system". In four places, though, he has "the 'stationary' system". On page 48 both forms appear with only one intervening sentence.) Such unedited remnants are a few of the places which show that he had been treating "the 'stationary' system K", i.e. the moving system K taken as referent when it is plotting "the stationary system"**period**. We too will let K be the stationary system and k the deformed moving system, when we get to where he did that in his Section 3. Meanwhile note that although $^{dt}/_{dt'} = Q$ held c' equal to c for a round-trip as plotted by the moving system K, it would find that on the outbound leg

$$t = tB - tA = {}^{dt}/_{dt'}t' - 0 = Q[(1/c\text{-}v)] = .64 \times 2.5 = 1.6$$

and on the inbound leg $t = tA' - tB = {}^{dt}/_{dt'}t' = Q[1/(c+v)] = .64 \times .625 = .4.$

That leaves c' a variable in the one way trips. But in order for Equation 1 to hold good in moving systems, the velocity of light as measured by them must be equal to c in the one way trips as well. We will now show what that requires.]

14.3. Let O denote the **o**ffset of the time of a given clock compared to that of other clocks of the same system. Let dO denote the local time offset between two given clocks of that system. Let $^{dO}/_{dx}$ denote that quantity for clocks that are x units apart *as measured by their own moving system* itself. If clocks of system K don't obey Equation 1 then adjust them so that they do. Letting x equal 1, solve for $^{dO}/_{dx}$ and print the results.

[The equations print: "$tB - tA = {}^{dt}/_{dt'}t' + {}^{dO}/_{dx} = .64AB/\{c - v\} + {}^{dO}/_{dx} = 1.6 + {}^{dO}/_{dx} = 1,$

so $^{dO}/_{dx} = -.6 = -vx/c^2;$

whereupon $tA' = {}^{dt}/_{dt'}t' = a'\,t' = a'(2L/(c^2 - v^2) = .64(2/.64) = 2$ and $tB - tA = tA' - tB = 1.$"

Equations 1 and 2 now both hold good, in the direction of motion of this esynched moving system.

In obedience to their instructions to here, the equations slowed the K clocks by $^{dt}/_{dt'} = c^2 - v^2 = Q$ and turned back all successive clocks in the direction of motion by vx/c^2 seconds, in which x is the distance between any of its clocks and its own origin clock as measured by the moving system itself. (The value of $^{dO}/_{dx}$ for a given value of x is a constant even if lengths in that direction deform by any amount at all and regardless of the value of the point when transformed into any other system.)]

14.4. Let event A occur at x = x' = 0 at t'A = tA = 0 and event B at t'B = 0, x = 1. Calculate tB and print the relations between the four values.

[The equations print: "$tB = tA - vx/c^2 = -.6;$ wherefore t'A = t'B = tA = 0 =/= tB."

Although Einstein didn't show this mental experiment he knew its result and that's why he wrote next, "So we see that we cannot attach any *absolute* significance to the concept of simultaneity, but that two events which, viewed from a system of co-ordinates, are simultaneous, can no longer be looked upon as simultaneous events when envisaged from a system which is in motion relatively to that system."

If spatially separate events are plotted by the stationary system as occurring at the same time we will call the events "simultaneous". If separate events are plotted by a moving *esynched* system as occurring "at the same time" we will call the events "zymultaneous". (It is misleading to let one word denote two entirely different things.) Because of the $-vx/c^2$ offset per consecutive clock of a moving system, two spatially separate events that are zymultaneous in the direction of motion, as measured by the moving esynched system, are not simultaneous at all. However, two events occurring on or parallel to the perpendicular axes of such an esynched system are both simultaneous and zymultaneous if plotted "at the same time" in that system. That's because, as shown in the next step, O = zero with regard to successive clocks on those axes.]

14.5. Let rays of light travel up and then down the Y and Z axes of K. Let $^{dO}/_{dy,z}$ denote the offsets per clock on the perpendicular axes and let $^{dy}/_{dy'}$ and $^{dz}/_{dz'}$ denote the ratio of size of unit-rods of K compared to k in those directions, as measured by system k. Print the values required for Equations 1 and 2 to hold good in the moving system K.

[The equations print: "$^{dO}/_{dy,z} = 0$, $^{dy}/_{dy'} = {}^{dz}/_{dz'} = 1/q$."

Demonstration: A ray of light on the moving Y or Z axes travels the hypotenuse of a right triangle as plotted by a stationary system. Its velocity relative to those axes would thus be $\sqrt{(1 - v^2/c^2)} = q = .8c$. It would therefore take 1/.8 = 1.25 seconds for the ray to move from the origin to y = 1 or to z = 1 and another 1.25 seconds to return. Spatially undeformed system K would plot this as Qt' = .64 x 1.25 = .8 seconds each way. Hence the transit time is the same each way, wherefore no offsets are needed to satisfy Equation 1 in the perpendicular axes. But the moving system would find that c' =/= c in those directions, which would contradict Equation 2.

If, therefore, units of length of K expand by 1/q = 1.25 in the perpendicular directions, then y = z = 1 would extend to y' = z' = 1.25 and a ray would take 1.25/q = 1.5625 seconds per leg, as plotted by k. Running at Q = .64 rates, clocks of K would plot this as t = Qt' = .64 x 1.5625 = 1 seconds each way. Equations 1 and 2 would now hold good in *all* directions as measured by such an esynched physically deformed moving system.]

15. "We now inquire as to the length of the moving rod, and imagine its length to be ascertained by the following two operations:-

(a) The observer moves together with the given measuring-rod and the rod to be measured, and measures the length of the rod by directly superposing the measuring-rod, in just the same way as if all three were at rest.

(b) By means of stationary clocks, set up in the stationary system and synchronizing in accordance with [line 6], the observer ascertains at what points of the stationary system the two ends of the rod to be measured are located at a definite time. The distance between these two points, measured by the measuring-rod already employed, which in this case is at rest, is also a length which may be designated 'the length of the rod'."

[Einstein's paper continued, "In accordance with the principle of relativity the length to be discovered by the operation (a) -- we will call it 'the length of the rod in the moving system' -- must be equal to the length L of the stationary rod. The length to be discovered by the operation (b) we will call 'the length of the (moving) rod in the stationary system.'"

Nothing to here required any change in the size of a moving rod lying parallel to its direction of motion. He continued, "This we shall determine on the basis of our two principles and we shall find that it differs from L.

Current kinematics tacitly assumes that the lengths determined by these two operations are precisely equal, or in other words, that a moving rigid body at the epoch t may in geometrical respects be perfectly represented by the same body at rest in a definite position." The published version *never again considered* operations (a) and (b); nor used the terms he so carefully defined!

We will now do some of the gedanken experiments that had to be there to justify those remarks as well as the title of what is now his Section 2, "On the Relativity of Lengths and Times".]

15.1. Let ${}^{dx}/_{dx'}$ denote the ratio of size of units of length in the direction of motion, as plotted by k. Let unit-rod rAB lie on X of system K. Print the length L of the moving rod and the resulting value of ${}^{dx}/_{dx'}$ as plotted by a classical coordinate system via above methods (a) and (b).

[The equations print: "$L = {}^{dx}/_{dx'} = 1$ both ways."

Classical kinematics overtly used synchronous clocks and equal sized units of length in all directions in all systems. The state of rest or motion therefore makes no difference since *all* Euclidean systems would accurately plot whatever any rod's size might actually be, thus would obtain identical measurements as each other. As shown next, however, although Euclidean system k would plot a physically undeformed unit-rod of K as being 1 unit long, esynched system K would *not* plot a unit-rod at rest on X' of k as being 1 unit long.]

15.2. At t = t' = 0 let unit-rod L' of system k extend from the origin to x' = 1. Using method (b), let system K measure the length of this relatively moving rod at t = 0. Print the length of L' thereby obtained and the value of ${}^{dx'}/_{dx}$ as plotted by K.

[The equations print: "$L' = {}^{dx'}/_{dx} = Q$."

Demonstration: At t = t' = 0 end A of L' is at x' = x = to = 0. At that instant end B is at x = 1, where the local time is $t_x = to - vx/c^2 = -.6$. At t' = .6 rod L' will have moved -vt' = -.36 units to the left on X of K, thus end B will be at x = .64. The clock at that point will then register

$$t = {}^{dt}/_{dt'}t' - {}^{dO}/_{dx}x = (.64 \times .6) - (.6 \times .64) = 0.$$

Accordingly, end A will be at x = 0 and end B at x = .64 when t = 0 per place, wherefore an undeformed rod of the stationary system will *appear* to be Q-shrunken as plotted by this esynched "stationary" system K. (Perhaps this "*appear* to be" was one of the things that later led Einstein to think that *all* relativistic length or rate deformations are *exclusively* a result of mathematical procedures.)]

15.3. At t' = 0 let rod $L'_{y'}$ of system k extend from the coinciding origins to y' = 1. Let system K, expanded by 1/q in that direction, plot the length of this relatively moving unit-rod at t = 0 via method (b). Print the result.

[The equations print: "$L'_{y'} = q$."

Demonstration: At t' = 0 end A of $L'_{y'}$ is at y = t = 0. At that instant end B is at y = .8 of the 1/q expanded Y axis of K, where the local time is also t = 0. Accordingly, end A will be at y = 0 and end B at y = .8 at t = 0 in both places. Hence the length of the undeformed rod of the stationary system will appear to be ${}^{y'}/_{dy} = .8/1$ = q-shrunken as plotted by deformed system K. Similarly, a k rod at rest on Z' will appear q-shrunken as plotted by K. We will symbolize and quantify this deformation as Q,q,q;1 in x, y, z and t.

With system k taken as referent, the direct transformation from y' = 1 of k to y = .8 of K for a given point as plotted by these two systems is

$$y = (1/{}^{dy}/_{dy'})y' = Ø(K_v)y' = qy' = .8,$$

in which $K_v = .6c$ denotes the velocity of K; and $Ø(K_v) = 1/({}^{dy}/_{dy'}) = q$ denotes the corrective factor used by k.

The inverse transformation equation, in which system K taken as referent, is

$$y' = (1/{}^{dy'}/_{dy})y = Ø(k_v)y = y/q = 1,$$

in which $k_v = -.6c$ denotes the velocity of k and $Ø(k_v) = 1/{}^{dy'}/_{dy} = 1/q$ denotes the corrective factor as plotted by K.]

15.4. Let system K use method (B) to plot the rate at which clocks of system k beat. Using the origin clock of k as an example, print the resulting value of ${}^{dt'}/_{dt}$ as determined by K.

[The equations print: "${}^{dt'}/_{dt} = 1$."

Demonstration: At t = t' = 0 the origin clocks coincide. At t' = 1 the k clock, moving at v = -.6c relative to system K, will be at x = -.6. The local time of the K clock at that point at that instant will be

$$t = Qt' - v(-x)/c^2 = .64 + .36 = 1.$$

Accordingly, dt' = dt = 1 wherefore K will find that k clocks run at the same rate as K clocks, thus that ${}^{dt'}/_{dt} = 1$.

Note that method (b) requires two clocks of a given system for it to measure the length of a relatively moving rod or the rate at which a differently moving clock keeps time. That's why the local-time offsets of esynched systems' clocks play a major role in all such measurements, thus in the transformation equations as well.

The above demonstrations showed that 1,1/q,1/q;Q deformed K would plot Euclidean k as Q,q,q;1 deformed. In all such non-Euclidean transformation groups the value of the ratio of units of length in the direction of motion changes place with that of the ratio of units of time when we switch which of the two systems is taken as the viewing frame of reference, and the value of the ratio of lengths in the perpendicular axes as plotted by the second system is the numerical inverse of that found by the first one. Since the length and time ratios are numerically equal as plotted by either system in the LTE, this exchange, though still there, is hidden.

In all such transformation equations the sign of v merely indicates the direction of motion of the viewed system relative to the viewing system as referent. It therefore changes if we switch from one to the other of the two systems as referent.

A valuable little equation expressing the relation between the amounts of physical deformations required by any and all of the infinite number of transformation equation groups that obey and support the postulates and assumptions of STR is,

$$\left(\frac{dt}{dt'} * \frac{dy}{dy'} * \frac{dz}{dz'}\right) / \frac{dx}{dx'} = 1 \qquad \text{Equation A}$$

in which $\frac{dx}{dx'} = q\left(\frac{dy}{dy'}\right)$, $\frac{dy}{dy'} = \frac{dz}{dz'}$ and $\frac{dt}{dt'} = Q / \frac{dx}{dx'} = q / \frac{dy}{dy'}$.

Given the value of any one of these ratios, the others can be found from that equation. Unless the value of one of them is known there is no way to mathematically derive the value of any of them.

S. O. "Einstein did, in his 1905 paper itself!" Answer: "As proved a bit later (and elsewhere), "No he didn't!"]

16. "Any ray of light moves in the 'stationary' [i.e. *inertially moving*] system of co-ordinates with the determined velocity c, whether the ray be emitted by a stationary or by a moving body. Hence

velocity = (light path)/(time interval);

where time interval is to taken in the sense of the definition [given above]."

[Most textbooks omit or ignore those italicized portions. That thereby makes it seem as though light *does* move at c in differently moving systems, independently of whether or how its speed is measured! *If* it did, then clocks set by Einstein's method in moving systems *would* be synchronous, whereupon "the relativity of simultaneity" would disappear. {It is and always was a consequence of the offsets between any two clocks of a given esynched moving system, thus of the idea that the speed of light is physically constant only in empty space and therefore must pass moving systems at varying relative speeds.}

Only *after* the clock-rates have been changed (either manually or by underlying physical causes) and after the required offsets have been *hand-placed* into successive clocks of a moving system by esynching them, and *after* lengths in those systems have appropriately deformed, would it *then* follow that "any ray of light moves in the 'stationary' system of co-ordinates with the determined [i.e. measured] velocity c, whether the ray be emitted by a stationary or by a moving body." Why, then, did Einstein delete all but one of the mental experiments which would have explained the physical events required to justify his various assumptions? Evidently this: When Poincare's paper arrived at the post office, Einstein saw the LTE there, including $t' = ß(t - vx/c^2)$ in which $ß = 1/\surd(1 - v^2/c^2)$, so defined by Poincare' who got it from equation (3) of Lorentz's 1904 paper which, says an editor's footnote in the Dover book, Einstein had not read. He also saw that Poincare' had set "l = 1"; which *seemed* to be the only value that kept the inverse transforms reciprocal thus satisfied the Principle of Relativity set forth by Poincare' in 1903. Einstein instantly realized that the LTE imposed a different set of deformations than he had set forth. He ran all the way home to begin revising his proof copy to accord with Poincare's thesis and the equations which Poincare' entitled "The Lorentz Transformation Equations Group".

(By replacing Lorentz's x with x + vt Poincare' had converted Lorentz's deformation equations between two *co-moving* systems into transformations between two *differently* moving systems. That didn't change the fact that intrinsic deformations of lengths and rates of thereby deformed relativistic systems are needed in order for the LTE to work. However, since systems k and K were co-moving at +v in Lorentz's widely misunderstood 1904 paper, by replacing x with x + vt instead of x - vt Poincare' had set system (x',y',z';t') at rest, thus had arrived at the *inverse* LTE; in which the *stationary* system moves at -v relative to the moving system taken as the referent!

Except for the fact that in LTE physics $^{dt'}/_{dt} = {}^{dx'}/_{dx} = {}^{dt}/_{dt'} = {}^{dx}/_{dx'} = q$, Poincare's step would have been mathematically wrong. (For instance, if $^{dt}/_{dt'} = Q$ then in the inverse case $^{dt'}/_{dt} = 1$ and disappears.) Even so, it was calamitous. It prompted Einstein's error-filled and blindfolding revision of the proof copy of his already-accepted paper.

First he inserted Poincare's P of R, elevating it "to the status of a postulate". Evidently he then inserted the entire present Section 3, "Theory of the Transformation of Co-ordinates and Times from a Stationary System to another System in Uniform Motion of Translation Relatively to the Former"; which, I believe, he had not considered at all prior to seeing the LTE in Poincare's paper. (Note that from the LTE on, without giving any justification for the change, he wrote "$1 - v^2/c^2$" for the first time in his paper, instead of the expression "$c^2 - v^2$" he had been using until there and even afterwards.)

To make room for the new section and because they didn't fit the deformations required by the LTE, Einstein deleted almost all his initial imaginary experiments. The easiest way to revise the rest of his paper with a minimum of type-setting changes was to attach co-ordinate system x',y',z';t' to the moving physical system and system (x,y,z;t) to the stationary one. We will now do that too, wherefore k (x',y',z';t') will be the deformed inertially moving non-Euclidean system and K the stationary Euclidean one as we continue.

Starting here, in his published paper, Einstein began his attempt to derive Poincare's LTE. As will become increasingly evident below, he seems to have proceeded a little way before getting stuck; then he seems to have written in the target equations and worked *backward* from them, putting into his equations whatever he needed whether or not it came from or even fit his prior equations.]

17. "Let us in 'stationary' space take two systems of co-ordinates, i.e. two systems, each of three material lines, perpendicular to each other and issuing from a point. Let the axis of X of the two systems coincide, and their axes of Y and Z respectively be parallel. Let each system be provided with a rigid measuring-rod and a number of clocks, and let the two measuring-rods, and likewise all the clocks of the two systems be in all respects alike."

[Here, *for the very first time* in the published version, he defined a co-ordinate system. One normally defines one's terms the first time each is used. Line-item 3, however, now appears four pages prior to his definition in section 3. (That is another indication that he radically revised the proof copy of his already type-set paper.}]

18. "Now to the origin of one of the two systems (k) let a constant velocity [v = .6c] be imparted in the direction of the increasing X of the other system (K), and let this velocity be communicated to the axes of the co-ordinates, the relevant measuring rod and the clocks. To any time of the stationary system K there will correspond a definite position of the axes of the moving system, and [we] assume that the motion of k may be such that the axes of the moving system are at the time t (this 't' always denotes a time of the stationary system) parallel to the axes of the stationary system."

[Accordingly, once X and X' of the two system have been aligned on the direction of motion, they coincide *permanently* thereafter and the other axes remain parallel to each other.

Although it might seem that it was here that he changed from K to k as the moving system, the change was made *after* his next few steps, as shown by Section 3's ensuing equations themselves. Meanwhile, we will assume that the change was a bit retroactive thus applies here too.]

19. "We now imagine space to be measured from the stationary system K by means of the stationary measuring-rod, and also from the moving system k by means of the measuring-rod moving with it; and that we thus obtain the co-ordinates x,y,z and [x',y',z'] respectively."

[Einstein used Greek letters as the symbols for the co-ordinates of k. For html reasons, I use x',y',z';t' instead. Either way, item 19 means that if system K plots a point in space as being at x,y,z then a differently moving system, k, will plot the very same point as being at x',y',z'.]

20. "Further, let the time of the stationary system be determined for all points thereof at which there are clocks by means of light signals in the manner indicated [above]; similarly let the time t' of the moving system be determined for all points of the moving system at which there are clocks at rest relatively to that system by applying the method, given [above], of light signals between the points at which the latter clocks are located."

[After having been thereby esynched to obey Equation 1, clocks of a stationary system will be synchronous and those of a moving system will be sinchronous.]

21. "To any system of values x,y,z,t, which completely defines the place and time of an event in the stationary system, there belongs a system of values x',y',z',t', determining that event relatively to the system k, and our task is now to find the system of equations connecting these quantities."

[To here, the 1,1/q,1/q;Q length and rate deformations remain present in any inertially moving system, as do the offset local times of its various esynched clocks. Hence system k is now a relativistic co-ordinate system, to every displaced point of which an observer, with his own esynched clock, is permanently attached. The "time" and "space" and "spacetime" per relativistic system are attached to, thus co-move and co-deform with the physical system taken as referent.

All of that was mathematically quantified, conceptually justified and fully explained in Lorentz's generally misunderstood 1904 paper.]

22. "In the first place it is clear that the equations must be linear on account of the properties of homogeneity which we attribute to space and time."

["Homogeneity" holds true for non-deformed Euclidean co-ordinate systems, moving or not, but it doesn't hold true for Minkowski's curved spacetime continuum and isn't even valid for the deformed coordinate systems of special relativity, whose units of length in the direction of motion have to be q shorter than those in the perpendicular axes. (The transformation equations are linear nevertheless.)]

23. "If we place x' = x - vt, a point at rest in the system k must have a system of values x',y,z, independent of time."

[When k was stationary and unit-rods of the moving system K remained unchanged in their direction of motion, the transformation equation would have been x = x' - vt'. Letting the primes now be attached to the moving system this would have been x' = x - vt. Here, however, Einstein's x' isn't a Greek symbol of the moving system, so his equation didn't convert a K co-ordinate into a co-ordinate obtained by k for the same point. We will therefore let r replace his x'.

Setting r = x - vt then transposes the origin of the stationary system to that of the moving system at successive instants, which is mathematically equivalent to attaching the origin and axes of a permanently Euclidean system to those of a deformed moving system, just as Lorentz did in his generally misunderstood paper.]

24. "We first define t' as a function of r,y,z and t. To do this we have to express in equations that t' is nothing else than the summary of the data of clocks at rest in system k, which have been [set] according to the rule given in #1."

[Although the value of t' is a function only of the rate at which its own clocks beat and which of its clocks is chosen, if we want to describe the relation between the time of a k clock at a point and that of a K clock at the same place, as viewed by system K, then that *is* a function of r,y,z and t. However, because clocks in the direction of motion of an esynched system are offset by $-vx'/c^2$ seconds relative to each other, clocks at rest in such a system indicate every "time" there is, from infinite past to infinite future all at the very same instant; wherefore no such "summary" is possible.

As things turned out, Minkowski generalized this "summary" to let the "time axis" of his "spacetime continuum" contain all such time-readings at the same instant. The trajectory of an object was then mapped in terms of it being at successively different pre-existing space-time points, wherefore (it is said) "nothing moves in spacetime". Although that was a useful mathematical mapping device, none of it *physically* exists.]

25. "From the origin of system k let a ray be emitted at the time t'_0 along the X-axis to r, and at the time t'_1 be reflected thence to the origin of the co-ordinates, arriving there at the time t'_2."

[Evidently system k attached a reflecting mirror to end B of a rod at rest on X', and at t'_0 sent a ray from end A, at x' = 0, to end B at a point x' whose value isn't given. Even so, at t'_0 the mirror would have been at a point x of system K. Though he then let r = x - vt, the mirror isn't attached to r or x, so a ray couldn't be sent "to r" as its target. This step in his procedure is therefore ambiguous, though not necessarily wrong.]

26. "We then must have

$$.5(t'_o + t'_2) = t'_1." \qquad \text{Equation 1}$$

[Equation 1 was tB - tA = tA' - tB in line 6. When system k was the stationary system, that would have been t'B - t'A = t'A' - t'B. Adding equals to equals that becomes: 2t'B = t'A' + t'A. Letting t'A be denoted as t_o, t'B as t_1 and t'A' as t'_2, then 2t'B = t'A' + t'A is equal to "$5(t'_o + t'_2) = t'_1$".

Now that t' is a co-ordinate of the moving system, however, this step asserts that Einstein's definition of synchronism must hold good even in *moving* systems. It remains a definition nevertheless, prompted only by Poincare's desire to keep Maxwell's equations applicable in inertially moving systems. (There is nothing wrong with that, if the underlying physical requirements are explained and understood.)

No symbols for any length or rate deformation had been given in Einstein's published paper to here, nor was there any for the local-time offsets that are required in order for moving systems to obey equation 1. His problem, therefore, was how to get them into his derivation equations thus into their target, the LTE. Before examining the debacle that ensued, we will look at one of the steps he omitted.]

26.1. Let rod r, at rest on X of K, be defined as "one unit long". Let the time it takes for the front of a light ray to traverse that stationary rod be defined as "one second". Let the rod now be attached to X' of system k and extend from x' = 0 to x' = 1 whereupon r = 1 as plotted by k. Let end A be at x = 0 at t = 0 and t' be a function of the values plotted by K. Print the equation that permits equations 1 and 2 to hold good as determined by system k.

[The equations print:

$$".5[\{(1/\{c - v\} + 1/\{c + v\})^{dx'}/_{dx}\}^{dt'}/_{dt}] = [(1/\{c - v\})\,^{dx'}/_{dx}]^{dt'}/_{dt} + {}^{dO}/_{d(x/}{}^{dx'}/_{dx)}." \qquad \text{Equation A}$$

Demonstration: If we use the LTE values, ${}^{dx'}/_{dx} = {}^{dt'}/_{dt}$ = q and let v = .6c, then equation A yields,

$$t' = .5[\,(.8/.4 + .8/1.6).8] = 1 = [.8/.4].8 - .6 = 1,$$

in which ${}^{dO}/_{d(x/}{}^{dx'}/_{dx)} = {}^{dO}/_{d(.8/.8)} = {}^{dO}/_{dx'} = -vx'/c^2 = -.6$. For this value of v, that will always be the offset of the k clock at x' = 1 even though the value of proximate point x depends on the value of ${}^{dx'}/_{dx}$. Similarly, the value of t' will be t' = 1 on both sides of the equation for any chosen value of ${}^{dx'}/_{dx}$ or ${}^{dt'}/_{dt}$.

Since ${}^{dO}/_{d(x/}{}^{dx'}/_{dx)} = {}^{dO}/_{dx'} = -vx'/c^2 = -.6$ for all of the co-functional values of ${}^{dx'}/_{dx}$ or ${}^{dt'}/_{dt}$, equation A yields,

$$t' = .5[(1/.4 + 1/1.6).64] = 1 = [1/.4].64 - .6 = 1.$$

Note that ${}^{dO}/_{d(x/}{}^{dx'}/_{dx)} = {}^{dO}/_{dx'}$ doesn't denote a difference in the indication of a moving clock compared to that of a stationary clock some distance away; it denotes the difference in the simultaneous settings of two different clocks *of the same system* that are dx' apart as measured by that system itself. Note also that the value of t' is just as much a function of the length deformation in the direction of motion as it is of the time t; which is *itself* a function of any such deformations.

In the inverse transformations, the values of ${}^{dx'}/_{dx}$ and ${}^{dt'}/_{dt}$ heretofore found change places, so ${}^{dt}/_{dt'} = 1$ and ${}^{dx'}/_{dx}$ = Q. That will help explain some of the convolutions beneath Einstein's ensuing equations.

The next step is where Einstein began to work backward from Poincare's LTE, trying to connect them to his derivational steps to here and to the deformations he'd found by his deleted mental experiments. As we shall see, *those* deformations remained present in his mind and blocked him from understanding the physics imposed by the LTE.]

27. "By inserting the arguments of the function t' and applying the principle of the constancy of the velocity of light in the stationary system", thus its variable velocity relative to system k, we obtain:-

$$".5[t'(0, 0, 0, t) + t'(0, 0, 0, t + r/\{c - v\} + r/\{c + v\})] = t'(r, 0, 0, t + r/\{c - v\})". \qquad \text{Equation 3}$$

[Setting r = x - vt *seems* to let r represent the length of the moving path as plotted by K, but r isn't a point nor a distance in either system, it is just the value of x - vt. (That's why no such point is part of Equation A.) The only purpose of the *point* r in equation 3 was to justify the insertion into his next equation of a symbol denoting the local offset of k-clock B.]

28. "Hence, if r be chosen infinitesimally small,

$$.5(1/\{c - v\} + 1/\{c + v\})^{\eth t'}/_{\eth t} = {}^{\eth t'}/_{\eth r} + (1/\{c - v\})^{\eth t'}/_{\eth t} \qquad \text{[Equation 4]}$$

or

$^{ðt'}/_{ðr} + ^{ðt'}/_{ðt}/(c^2 - v^2) = 0.$" Equation 5

[There was nothing gained by setting r "infinitesimally small" other than to make it seem that "calculus" justified r = 1 in equation 4. However, it was neither calculus nor the fairly simple algebra that let to above Equation A. It was just a way to get some needed but underived mathematical expressions into his equations. Although he had now somewhat gratuitously introduced a symbol for a possible rate change of the moving clocks, and one for the required offset per successive clock, there still was no symbol for a ratio of size of the units of length. That doesn't fit the $^{d\mathbf{x}'}/_{d\mathbf{x}} = q$ deformation required by the LTE, but it *does* fit the $^{d\mathbf{x}'}/_{d\mathbf{x}} = 1$ deformation imposed by his prior steps to here. However, as will now be shown, equation 4 is mathematically defective nevertheless.]

28.1. Let k-clock A be at x' = x = t = t' = 0 when a light ray emits toward a mirror attached to k-clock B at x' = 1. Letting the ratio of clock rates first be $^{dt'}/_{dt} = Q$ and then be $^{dt'}/_{dt} = q$, solve equation 4 and the value of $^{dt'}/_{dr}$ and print the results.

[The equations print: "1. For $^{dt'}/_{dt} = Q$:

$.5[1/\{c-v\} + 1/\{c+v\}]^{dt'}/_{dt} = .5[1/.4 + 1/1.6].64 = 1 = ^{ðt'}/_{ðr} + (1/\{c-v\})^{dt'}/_{dt} = ^{dt'}/_{dr} + (1/.4).64 = 1,$

so $^{ðt'}/_{ðr} = ^{dt'}/_{dr} = -.6.$

2. For $^{dt'}/_{dt} = q$:

$.5[1/\{c-v\} + 1/\{c+v\}]^{dt'}/_{dt} = .5[1/.4 + 1/1.6].8 = 1.25\ ^{ðt'}/_{ðr} + (1/\{c-v\})^{dt'}/_{dt} = ^{dt'}/_{dr} + (1/.4).8 = 1.25,$

so $^{ðt'}/_{ðr} = ^{dt'}/_{dr} = -.75.$"

In the expression $^{ðt'}/_{ðr}$, ðr is infinitesimally small, thus the setback of clock B cannot be .6 *or* .75; as it can for dr = 1. However, as shown elsewhere, the offset must always be given in terms of where the given clock is as plotted *in its own system*, because the offset at a given value of x' is the same for a given value of v no matter *what* length or rate deformations might occur. The only value of the offset of a k-clock at x' = 1 compared to a k-clock at x' = 0 is $dt' = -vx/c^2 = -.6$. Since clock B is at x' = 1 the offset therefore can't have two different values, as in the above solutions. Also, in solution 1 the ray would travel 2 units of k in 2 k-seconds, thus at c = 1, but in solution 2 it would take 2.5 k-seconds for the ray to travel 2 k-units, which contradicts Equation 2's postulate.

There are an infinite number of possible values of $^{dt'}/_{dt}$ that can be used in equation 4, each of which gives a different value for $^{dt'}/_{dr}$ as plotted by K. Observers attached to the moving system would have had to know in advance which value of $^{dt'}/_{dt}$ was going to be used and have then attached end B exactly as far from end A as needed in order to let the length of the moving rod be r = 1 unit long as plotted by K no matter what the value of $^{d\mathbf{x}'}/_{d\mathbf{x}}$ might then have to be.

Although the way Einstein worded the quoted portion in step 28 makes it seem as though equation 5 came from equation 4, the only relation between the two equations is that they both contain $^{ðt'}/_{ðr}$. The real purpose of equation 5, however, was to get rid of that symbol as follows:

$$^{ðt'}/_{ðr} + v^{ðt'}/_{ðt}/(c^2 - v^2) = 0, \text{ wherefore } ^{ðt'}/_{ðr} = - v^{ðt'}/_{ðt}/(c^2 - v^2).$$

These "partial differential expressions" can now be treated as *purely algebraic* symbols that are equal, thus can be substituted for each other! And ***<u>that</u>*** is exactly what Einstein soon did.

A bit later we will trace the circuitous path that led Einstein to retroactively insert equation 5 into his paper and why he wrote it as

$$^{ðt'}/_{ðr} + v^{ðt'}/_{ðt}/(c^2 - v^2) = 0 \quad \text{rather than} \quad ^{ðt'}/_{ðr} - v^{ðt'}/_{ðt}/(c^2 - v^2) = 0.$$

Meanwhile, we will put together elements of equations 3 and 4 to illustrate an entirely different issue.

$$.5[t'(0, 0, 0, t + 1/\{c - v\})^{dt'}/_{dt}] = t'(r, 0, 0, t + 1/\{c - v\})^{dt'}/_{dt}.$$

In this equation, as in equations 3 and 4, there are four expressions for the time of the one way trip from A to B, two by system K and two by system k. On the left, the time of system k is given by clock A at r = x - vt = 0. On the right, the k-time for the same trip is given by clock B at r = x - vt = 1. On both sides of the equation the one way time plotted by system K is t = 1/{c - v} = 2.5 seconds.

If we now merge elements of this equation with some from equation 5 we get,

$$(1/\{c - v\})^{dt'}/_{dt} = ^{ðt'}/_{ðr} + (1/\{c-v\})^{dt'}/_{dt},$$

in which the left side gives the time of k-clock A and the right side gives the time of k-clock B. Letting $^{dt'}/_{dt} = Q$, the time of clock A is t' = 2.5 x .64 = 1.6 seconds when the time of clock B is t' = 1 second. The equations thus show that the time of k-clock A differs by .6 seconds from that of its own esynched clock B, as plotted "at the same time" by system K.

Accordingly, the *equations* unequivocally prove that if either of two differently moving systems' esynched clocks *are* synchronous, those of the other are not. Regardless of the value of $^{dt'}/_{dt}$ or $^{dt'}/_{dr}$ or the length of the moving rod as plotted by K, equations 3 and 4 would have been absurd had they not been just a way for Einstein to insert a symbol for the ratio of rates and one for the needed offsets into his derivational equations.

To here, though, no symbol appeared for the ratio of size of units of length in the direction of motion. Of the infinite number of subgroups that fit the General Transformation Group that Einstein reached (see step 34, taken from the top of Dover's page 46), only two allow one or the other of the two ratios, $^{d\mathbf{x}'}/_{d\mathbf{x}}$ and $^{dt'}/_{dt}$, to be omitted:

1. The case in which the physical deformations are by 1, 1/q, 1/q; Q in X, Y, Z and t. In this case the metrical deformations found by the deformed moving system when plotting the stationary one are by Q, q, q; 1.
2. The case in which the physical deformations are by Q, q, q; 1. In this case the deformations found by the deformed moving system when plotting the Euclidean one are by 1, 1/q, 1/q; Q.

In case 1, $^{d\mathbf{x}'}/_{d\mathbf{x}} = 1$ and can be omitted from the direct transformation but not from the inverse transform, in which $^{d\mathbf{x}}/_{d\mathbf{x}'} = Q$ but $^{dt'}/_{dt} = 1$and can be omitted. In case 2, $^{dt'}/_{dt} = 1$ and can be omitted from the direct transformation but not from the inverse transform, in which $^{dt'}/_{dt} = Q$ but $^{d\mathbf{x}}/_{d\mathbf{x}'} = 1$ and can be omitted. Since Einstein omitted *any* symbol for a ratio of lengths, his equations were therefore restricted to one or the other of these two cases, neither of which fits the LTE. (That omission suggests that *he didn't know* that the size of a rod may physically change when its local motion changes.)

After equation 5, Einstein wrote, "It is to be noted that instead of the origin of the co-ordinates we might have chosen any other point for the origin of the ray, and the equation just obtained is therefore valid for all values of r,y,z." Again without using any symbol for a ratio of size of units of length, he continued, "An analogous consideration -- applied to the axes of Y and Z -- it being borne in mind that light is always propagated along those axes, when viewed from the stationary system, with the velocity $\sqrt{(c^2 - v^2)}$, gives us

$$^{\partial t'}/_{\partial y} = 0, \quad ^{\partial t'}/_{\partial z} = 0."$$

That confirms step 14.5's demonstration that $^{dO}/_{dy,z} = 0$, thus that no offsets are needed in those directions in order for Equation 1 to hold good but it still says nothing about what's needed in order for a moving system to plot the relative velocity of light as being c' = c in the perpendicular directions.]

29. "Since t' is a linear function, it follows from these equations that

$$t' = a(t - vr/\{c^2 - v^2\}) \qquad \text{[Equation 6]}$$

where *a* is a function Ø(v) at present unknown, and where for brevity it is assumed that at the origin of k, t' = 0, when t = 0."

[Equation 6 and its underived and undefined new symbol *a*, which Einstein said "is a function Ø(v)", seem to have been prompted by a reversal of Poincare' procedure, by substituting r = x - vt for x in Poincare's LTE. That is equivalent to transposing the origin of a stationary Euclidean system to that of a moving system at successive instants, which is then the mathematical equivalent of Lorentz's 1904 equations (4) and (5),

$$x' = ßlx, \quad y' = ly, \quad z' = lz, \qquad (4)$$
$$t' = lt/ß - ßl(v/c^2)x \qquad (5)$$

in which permanently Euclidean system x,y,z;t is co-moving at v with the deformed system x',y',z';t'. Although Einstein evidently didn't know those equations, we will use them to help trace his path.

Substituting x-vt for x in equation (5) and postulating that l = 1 we get

$$t' = t/ß - vß(x - vt)/c^2$$
$$= qt - [v(x - vt)/c^2]/q = qt - (vx/c^2 - v^2/c^2)/q$$
$$= [t(1 - v^2/c^2) - (vx/c^2 - v^2/c^2)/q$$
$$= [t - v^2t/c^2 - vx/c^2 + v^2t/c^2]/q = (t - vx/c^2)/q$$
$$= ß(t - vx/c^2).$$

The 1,1/q,1/q;Q deformed moving system would have found that the stationary system *appeared* to be Q,q,q; 1 deformed, which required that $^{dt'}/_{dt} = 1$ and $^{dy'}/_{dy} = q$ as plotted by the initially moving system K. Setting a = lt/ß, with $l = 1/^{dy'}/_{dy} = 1/q$ as plotted by the deformed system as referent, also lets $a = 1$. Either way, the inverse transformation with the moving system as referent and r replacing x lets Lorentz's 1904 equation (5) become

$$t' = lt/ß - vßlx/c^2 = t - vßlx = t - (vx)/Q = a(t - vr/\{c^2 - v^2\})$$

which is Equation 6.

In equation (5) the expression lt/ß gives the time, $t' = (^{dt'}/_{dt})t$, of the origin clock of system X'. Hence, $l/ß = {}^{dt'}/_{dt}$. In equation 6 the time of the origin clock of system k is $t' = at$. It therefore follows that

$$a = {}^{ðt'}/_{ðt} = {}^{dt'}/_{dt} = l/ß = q.$$

In equation (5) the expression $ßl(v/c^2)x$ gives the offset of the X' clock at x' = ßlx. By substituting a for l/ß and r for x we get $t' = at - ßl(v/c^2)r$, in which at equals the time of the origin clock of system k and $ßl(v/c^2)r$ denotes the offset of k-clock B at x' = ßlx = ßlr. If we now let l = ß, which it does if $^{ðt'}/_{ðt} = Q$, then in Einstein's $v^{ðt'}/_{ðt}/(c^2 - v^2)$ the expression $v/(c^2 - v^2)$ equals $ßl(v/c^2)$. Substituting equals for equals into Lorentz's equation (5) we thus arrive at equation 6's

$$t' = lt/ß - ßl(v/c^2)x = at - vr^{ðt'}/_{ðt}/(c^2 - v^2) = at - vra/\{c^2 - v^2\} = a(t - vr/\{c^2 - v^2\}).$$

(Since $a = l/ß = {}^{dt'}/_{dt} = Q/^{dx'}/_{dx}$, if r and v are given as fractions of c = 1 then the reverse mathematics gives us

$$t' = a(t - vr/\{c^2 - v^2\}) = at - avr/Q = at - avß^2r = lt/ß - v(l/ß)ß^2r = lt/ß - ßlvx/c^2.)$$

Note that if we entirely ignore length changes in any direction, as he did, and let nothing happen to the actual size of a moving rod in its direction of motion, then the use of esynched clocks running Q slow to plot the rate at which k clocks beat and the size of k rods would find no change of rates and Q-shrunken rods in their direction of motion even though the contraction was indeed "only as viewed by a differently moving system", just as the relativists now proclaim. It seems that he therefore added to the introductory remarks leading to line-item 1, "Examples ... suggest that the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest."

If, however, no "frame of reference" is at rest in Newton's empty space, then *all* of them are moving. Given that, together with the notion that clocks attached to a moving rod run Q slower than they would have *if* the rod had been stationary, then the deformations system K would plot for *any* differently moving system would be by 1, q, q, Q; as demonstrated above in steps 15.2, 15.3 and 15.4.

Einstein's deleted mental experiments had evidently found that $a = {}^{ðt'}/_{ðt} = Q$ and $l = 1/Ø(K_v) = q$ as plotted by the stationary system k, and that $Ø(k_v) = q = 1/ß$ as inversely determined by K. With K now taken as the stationary system, it is K that would find that l = q and $^{ðt'}/_{ðt} = Q$. Using theses values, equation 6 becomes,

$$t' = a(t - vr/\{c^2 - v^2\}) = lt/ß - avr/\{c^2 - v^2\} = qt/(1/q) - Qvr/\{c^2 - v^2\} = Qt - vr/c^2$$

in which, since $^{dx'}/_{dx} = 1$ for this case, $r = (^{dx'}/_{dx})x' = x'$ wherefore $-vr/c^2 = -vx'/c^2$. If we now use the value of t for the time it took the ray to get to k-clock B in his prior equations, this yields,

$$t' = .64 \times 2.5 - .6 = 1.6 - .6 = 1.$$

which is exactly what this case required.

Perhaps Equation 4 had initially been a mirror of Poincare's INVERSE Lorentz transforms, with 1,1/q,1/q,Q deformed K taken as "the 'stationary' system" viewing the appears-to-be Q,q,q,1 deformed k. If, then, k moved at -v relative to K the offset would have been +.6 seconds. That's why eq 5 is

$$^{ðt'}/_{ðr} \textit{ plus } v^{ðt'}/_{ðt}/(c^2 - v^2) = 0 \text{ instead of } ^{ðt'}/_{ðr} \textit{ minus } v^{ðt'}/_{ðt}/(c^2 - v^2) = 0.$$

It's because he wanted to substitute $-v^{ðt'}/_{ðt}/(c^2 - v^2)$ for $^{ðt'}/_{ðr}$ when he switched from stationary k viewing 1,1/q,1/q, Q deformed system K to the inverse case in which the stationary system appears Q,q,q,1 deformed.

Two pages later, however, Einstein asserted that Ø(v) = 1. If a = l/ß = Ø(v) =1 then that requires that l = ß = 1/q, thus that the ratio of size of units of length in the perpendicular axes is q. That then requires that $^{dy',z'}/_{dy,z} = q$ and $^{dx'}/_{dx} = Q$ and $^{dt'}/_{dt} = 1$. *Those* are the values the 1,1/q,1/q,Q deformed *moving* system K would have plotted for the stationary Euclidean system k. Accordingly, if we took deformed K as "the 'stationary' system" relative to which k moves at v = -.6c, equation 4 would have yielded,

$$t' = .5(^{ðt'}/_{ðt}/\{c + v\} + ^{ðt'}/_{ðt}/\{c - v\}) = .5(1/\{c + v\} + 1/\{c - v\})^{ðt'}/_{ðt} = .5(.64/1.6 + .64/.4)$$

$$= ^{ðt'}/_{ðr} + (^{ðt'}/_{ðt}/\{c + v\}) = .6 + .64/1.6 = 1.$$

The value of t' for the time it would take a ray of light to make a round trip on the moving path is then

$$t' = (1/\{c + v\} + 1/\{c - v\})^{ðt'}/_{ðt} = .64/1.6 + .64/.4 = 2,$$

in which the length of the moving path isn't r = 1, it is $^{ðt'}/_{ðt} = 1$. But since $^{ðt'}/_{ðt}$ is the ratio of *rates*, which isn't a distance, that would have been absurd unless Einstein had switched from k to K as the stationary system. Since the value of the ratio of lengths is always equal to the ratio of rates when we switch to the other system as referent, such a switch would let $^{ðt'}/_{ðt} = Q$ as plotted by K be equal to $^{d\mathbf{x}}/_{d\mathbf{x}'} = Q$ as plotted by k, and $^{dt}/_{dt'} = 1$ as plotted by k be equal to $^{d\mathbf{x}'}/_{d\mathbf{x}} = 1$ as plotted by K.

Similarly, since the values of the ratios of length in the perpendicular axes are numerically inverse when we switch referent, then $l = 1/(^{dy'}/_{d\mathbf{y}}) = q$ would be changed to $l = 1/(^{d\mathbf{y}}/_{d\mathbf{y}'}) = 1/q$. Letting clock A be at r = 0 as in equation 4 and using *those* values, equation 6 then yields,

$$t' = a(t - vr/\{c^2 - v^2\}) = lt/ß - avr/Q = t - 0 = 2.$$

Equation 6 thereupon fits the *inverse* transformation for the case Einstein's missing steps imposed.

His problem now was how to get from the deformations in which no length changes in any direction had even been mentioned, to the q, 1, 1, q deformations required by Poincare's LTE, for which (contrary to relativistic assertions) rods must *physically* shrink by q in their direction of spatial motion no matter which system is chosen as the frame of reference. Writing equation 6 as t' = *a*(t - vr/Q) instead of t' = *a*t - vr/Q did that for him because (whether or not he knew it) $^{d\mathbf{x}'}/_{d\mathbf{x}}$ is a function of $a = ^{d\mathbf{t}'}/_{d\mathbf{t}}$, as shown in Equation A.]

30. "With the help of this result we easily determine the quantities x', y', z' by expressing in equations that light (as required by the principle of the constancy of the velocity of light ["in empty space"], in combination with the principle of relativity) is also propagated with velocity c when measured in the [esynched] moving system.

"For a ray of light emitted at the time t' = 0 in the direction of the increasing X'

$$x' = ct' \text{ or } x' = ac(t - vr/\{c^2 - v^2\}).$$

[In his prior equations, the time for the outbound ray to reach B was t = r/(c-v) = 1/(c-v) = 2.5 seconds. That value of t gives us x' = *a*c(2.5 - .6/.64) = 1.5625*a*. Since, to here, $a = ^{dt'}/_{dt} = Q = .64$ that gives us x' = 1. As all the way in his program to here, that requires that $^{d\mathbf{x}'}/_{d\mathbf{x}} = 1$, which fits $^{dt'}/_{dt} = Q$ but contradicts the LTE. (If we substitute x - vt for r we'd get

$$x' = ac(t - vr/Q) = Qt - v(x - vt) = Qt - vx + v^2t = 1.6 - .6x + .9 = 2.5 - .6x = 1,$$

which requires that x = 2.5 thus that if x = t, $x' = t - vx/c^2 = x - vt$. If x is *not* equal to t, that equation fails to give a correct value of x'.]

31. "But the ray moves relatively to the initial point of k, when measured in the stationary system, with the velocity c - v, so that x'/(c - v) = t. If we now insert this value of t in the equation for x' we obtain

$$x' = ac^2r/(c^2 - v^2)."$$

[That got rid of the t in his prior equation, thus of the restriction that x must equal t. Let $r = ^{d\mathbf{x}'}/_{d\mathbf{x}} = 1$, as to here, and his latter equation yields

$$x' = ac^2r/(c^2 - v^2) = a/.64 = 1,$$

which fits step 30's x' = r = x - vt = 1, thus still requires that $a = ^{dt'}/_{dt} = q = .64$. However, when system K was the moving system taken as "the 'stationary' system", this had been the inverse transform, in which $^{dt'}/_{dt} = 1$ and $^{d\mathbf{x}'}/_{d\mathbf{x}} = Q = c^2 - v^2$. *That* was the reason why he inserted equation 5 above. It let him substitute $-v^{ðt'}/_{ðt}/(c^2 - v^2)$ for $^{ðt'}/_{ðr}$ on the way to $x' = ar/(c^2 - v^2)$.]

32. "In an analogous manner, we find, by considering rays moving along the two other axes, that

$$y' = ct' = ac(t - vr/\{c^2 - v^2\})$$

when

$$y/\sqrt{c^2 - v^2} = t, r = 0."$$

[If we let y = 1, then the latter equation yields, $t = y/\surd\{c^2 - v^2\} = 1/q = 1.25$ seconds. In order for system k to find that c' = c, the mirror would have had to be placed at y' = ßy = 1.25. That requires unit lengths of the moving system to be q-shorter than those of K, thus that $^{dy'}/_{dy} = q$ and l = ß.

The fact that there is no symbol denoting a ratio of lengths in his entire paper suggests that Einstein thought the length changes of the stationary system in the direction of relative motion, as plotted by the initially moving system K, didn't physically happen (which was correct for $^{\eth t'}/_{\eth t} = Q$). Although he did consider the *settings* of clocks on rods perpendicular to their direction of motion he never considered relative lengths in those directions at all, therefore didn't understand the physical or even the mathematical meaning of the l in the LTE's y' = ly, in which $l = 1/^{dy}/_{dy'}$, as explained above in step 15.3.]

33. "Thus $y' = acy/\surd(c^2 - v^2)$ and $z' = acz/\surd(c^2 - v^2)$."

[If *a* = Ø(v) and $^{dy'}/_{dy} = ^{dz'}/_{dz} = q$, whereupon $Ø(v) = 1/\surd(c^2 - v^2)$, those equations are correct. As shown far above, however, since $^{dx'}/_{dx} = q^{dy'}/_{dy}$ that requires that $^{dx'}/_{dx} = Q$. Note, then, that the Q,q,q,1 deformations of system k, imposed by his equations with K as the stationary system, are what the initially 1/1/q,1/q;Q deformed *moving* system K would have found as "the 'stationary' system" plotting "the stationary system" k.

Even so, since derivational equations aren't restricted to LTE physics we will allow that despite all the oddities in his procedure to here his prior steps were ambiguous rather than false.]

34. "Substituting for r its value, we obtain The General Transformation Equations ("GTE"):

$$t' = Ø(v)ß(t - vx/c^2),$$
$$x' = Ø(v)ß(x - vt),$$
$$y' = Ø(v)y,$$
$$z' = Ø(v)z,$$

where $ß = 1/\surd(1 - v^2/c^2)$, and Ø is an as yet unknown function of v."

[Here, for the first time in Einstein's paper, Poincare's $(1 - v^2/c^2)$ appears, instead of what to there and later was $(c^2 - v^2)$. In any event, for $y' = acy/\surd(c^2 - v^2)$ to become y' = Ø(v)y requires that

$$Ø(v) = ac/\surd(c^2 - v^2) = a/q.$$

However, if "*a* is a function Ø(v)" means that *a* = Ø(v), then Einstein had let $Ø(v) = ^{dt'}/_{dt} = l/ß = ql$, which requires that Ø(v) is unequal to l, thus that his Ø(v) was NOT just a new symbol for the Lorentz-Poincare' *l*, as it automatically seems to have been. As we continue to unravel the tangled skein of revisions by which Einstein arrived at equations 3, 4, 5 and 6 on the way to the perfectly correct but neither mathematically derived nor physically grounded GTE, it will be increasingly evident that Poincare's otherwise inconsequential error had borne its misleading fruit. Einstein evidently didn't understand the mathematical meanings of Ø(v) or l nor, perhaps, of the very purpose of the transformation equations themselves.]

35. "In the equations of transformation which have been developed there enters an unknown function Ø of v, which we will now determine. For this purpose we introduce a third system of coordinates K', which relatively to the system k is in a state of parallel translatory motion parallel to the axis of X, such that the origin of coordinates of system k moves with velocity -v on the axis of X. At the time t = 0 let all three origins coincide, and when t = x = y = z = 0 let the time t" of the system K' be zero. We call the coordinates, measured in the system K', x",y",z", and by a twofold application of our equations of transformation we obtain

$$t'' = Ø(-v)ß(-v)(t' + vx'/c^2) = Ø(v)Ø(-v)t,$$
$$x'' = Ø(-v)ß(-v)(x' + vt') \quad = Ø(v)Ø(-v)x,$$
$$y'' = Ø(-v)y' \quad = Ø(v)Ø(-v)y,$$
$$z'' = Ø(-v)z' \quad = Ø(v)Ø(-v)z.$$

"Since the relations between x",y",z" and x,y,z do not contain the time t, the systems K and K' are at rest with respect to one another, and it is clear that the transformation from K to K' must be the identical transformation.

Thus $$Ø(v)Ø(-v) = 1."$$

[For a "twofold application" of transformations, going from K to k values and back again, NO third system is needed. The first step is to transform the value of y at a point P, as plotted by K, into the value of y' at point P as plotted by k. The equation for that is y' = Ø(v)y; in which v denotes the velocity of k as plotted by K. Having thus found the y' value, we now convert it into a K value. The transformation for that is y = Ø(-v)y'; in which -v is the velocity of K' as plotted by k. The final step is to substitute Ø(v)y for y' to arrive at: y = Ø(-v)Ø(v)y. The -v of k as plotted by K' doesn't appear in the twofold equations *at all*.

Even so, if K was the system inertially moving at v in his initial treatment and K' was system K by another name, then k *would* have been moving at -v as viewed by both K and K' and x" = x would be correct. In that case, however, the sign of v in his middle equations, from k to K', should have been Ø(v) rather than Ø(-v).

Another way that k can move at v relative to K and at -v relative to K' with K and K' being "at rest with respect to each other" is for the + sign on the X axis of K' to be on the left of the origin and the - sign on the right. In that unlikely case then x" = -x, wherefore x" = Ø(v)Ø(-v)x = x would be incorrect.

If we assume that what he meant to write was, "For this purpose we introduce a third system of coordinates K' which, relatively to the system k, is in a state of translatory motion parallel to the axis of X, such that the origin of coordinates of system K' moves with velocity -v on the X axis", then that would allow K' to be at rest with K and the signs of v in his twofold applications to be correct. In any of the above choices, however, neither the -v nor the +v in the twofold applications would have been by K' as the referent. His invention of system K' moving at v relative to system k therefore had only one clear purpose, revealed in our next step. As to his Ø(v)Ø(-v) = 1, he never did accurately explain why. {It's because $l(v) = 1/{}^{dy'}/_{dy} = {}^{dy}/_{dy'} = 1/l(-v)$.}]

36. "We now inquire into the signification of Ø(v). We give our attention to that part of the axis of Y of system k which lies between x' = 0, y' = 0, z' = 0 and x' = 0, y' = l, z' = 0. This part of the axis of Y is a rod moving perpendicularly to its axis with velocity v relatively to system K. Its ends possess in K the coordinates

$$x_1 = vt, \quad y_1 = l/\O(v), \quad z_1 = 0$$

and

$$x_2 = vt, \quad y_2 = 0, \quad z_2 = 0.$$

The length of the rod measured in K is therefore l/Ø(v); and this gives us the meaning of the function .Ø(v)."

[The periods in front of and after Ø(v in the phrase "the function .Ø(v)." are either another "typographical error" or proof that he continued his radical revisions right up to the very last moment. To find out we will examine what he was trying to clarify here.

He opened with, "We now inquire into the signification of Ø(v)." The "signification" denotes the sign of v, presumably in his prior twofold application's conclusion that "Ø(v)Ø(-v) = 1". As we saw in step 15.4 above, in all such transformation equations the sign of v merely indicates the direction of motion of the viewed system relative to the viewing system as referent. It therefore changes if we switch from one to the other of the given two systems as referent. That is entirely different than letting two system move in opposite directions on a third system as the only referent.

Even more significant, here, is that the "signification" of v has nothing to do with "the meaning" of the function Ø(v)! Indeed, he never did explain what it means. (To here, it meant either "*a* is a function Ø(v)" or (from his equations) Ø(v) = *a*/q. Either way, it was a function of the ratio of rates, not of lengths.)

That may explain why Einstein thought that any and all length changes are only as viewed by a differently moving system. Rather, they are caused by pressure changes on a body moving through the compressibly resistive continuous material that everywhere fills "the empty space" of relativity theory.]

37. "From reasons of symmetry it is now evident that the length of a given rod moving perpendicularly to its axis, measured in the stationary system, must depend only on the velocity and not on the direction and the sense of the motion. The length of the moving rod measured in the stationary system does not change, therefore, if v and -v are interchanged."

[Perhaps he *did* think that it made no difference "if v and -v are interchanged" on the X axis itself, whereupon k could move at -v as plotted by K' even if K' remained at rest with system K. Perhaps that's part of the reason he wrote y" = Ø(v)Ø(-v)y rather than y "= Ø(-v)Ø(v)y, as it would be in the twofold application.

Either he had merely interchanged the significations on the X axis of system K (which would have been the reason for introducing a third system which had no actual role in the significations of v in his twofold exercise) or he had now let a middle system become the referent relative to which a second and third system move in opposite directions at +/- v.]

38. "Hence follows that l/Ø(v) = l/Ø(-v), or Ø(v) = Ø(-v)."

[If two systems move at identical velocities in opposite directions "in empty space" their lengths will deform identically so the ratio of their lengths would be the same as plotted by a stationary system in the middle.

Regardless of the amount of deformation in the perpendicular directions, Ø(v) therefore *would* be equal to Ø(-v). Suppose, however, that system k is moving at v = .6c "as measured in the stationary system" K, so K moves at -v relative to k, and "we introduce a third system" K' moving at v as plotted by k. To system k, rods K and K' move at equal velocities ±.6c in the opposite sense and direction as each other. Assuming that Y oriented unit-rods physically shrink as a function of their velocity either "in empty space" or relative to "the stationary system" (here being K), the K rod will be longer than rods k and K'; but rod K' will be shorter than rod k. The rods of K will therefore appear *expanded* and those of K' *contracted* as measured by the middle system.

If we now let Ø(v) = Ø($v_{K'}$) and Ø(-v) = Ø(v_K) as plotted by "the 'stationary' system" k, then contrary to Einstein's assertions, Ø(v) =/= Ø(-v) as determined by the middle system even though the numerical value of v is the same in both places!]

39. "It follows from this relation and the one previously found that Ø(v) = 1, so that the transformation equations which have been found become

$$t' = ß(t - vx/c^2),$$
$$x' = ß(x - vt)$$
$$y' = y \qquad \text{[The LTE]}$$
$$z' = z,$$

where $ß = 1/\sqrt{(1 - v^2/c^2)}$."

[There is *no relation* between his "Ø(v) = Ø(-v)" and his prior finding that "Ø(v)Ø(-v) = 1". There are only *two* systems in his twofold application's "Ø(v)Ø(-v) = 1" treatment. System k moves to the right at +v as viewed by K and system K moves to the left at -v as viewed by k. The change of the sign of v only denotes that we switched from K to k as the *referent.*

In his "Ø(v) = Ø(-v)" treatment there are *three* systems. The +v in Ø(v) denotes system two moving to the right and the -v in Ø(-v) denotes system three moving to the left, both of them relative to the *middle* system, K.

His conclusion that "It follows from this relation and the one previously found that Ø(v) = 1" is therefore totally false. Accordingly, he never did accurately derive the Lorentz Transformation Equation Group.

Since the General Group is far less restrictive than the LTE Group, why did he try to force them to be the LTE? Because, as did Poincare', he thought that's the only group that permits reciprocity, thus justifies the P of R. As demonstrated in the "The Painted Pony" and elsewhere, however, since Ø(v) becomes its own numerical inverse when we switch from one to the other of two systems as referent, all we need do is let Ø(v) denote the numerical inverse of the ratio of perpendicular unit-lengths *as measured by the appointed referent system*, and Einstein's GTE keep the same form both ways thus already do obey Poincare's Principle of Relativity.

In his section 4, "Physical Meaning of the Equations Obtained in Respect to Moving Rigid Bodies and Moving Clocks", Einstein said that as "viewed from the stationary system", "the X dimension" of a moving rigid body "appears shortened in the ratio 1 : $\sqrt{(1 - v^2/c^2}$". He then added, "It is clear that the same results hold good of bodies at rest in the 'stationary' system, viewed from a system in uniform motion." Without showing the physical causes of those results he continued, "Further, we imagine one of the clocks which are qualified to mark the time t when at rest relatively to the stationary system, and the time t' when at rest relatively to the moving system, to be located at the origin of the coordinates of k, and so adjusted that it marks the time t'. What is the rate of this clock, when viewed from the stationary system?

"Between the quantities x, t and t', which refer to the position of the clock, we have, evidently, x = vt and

$$t' = {}^{1}/\surd_{(1 - v^2/c^2)}(t - vx/c^2).$$

Therefore,

$$t' = t[\surd(1 - v^2/c^2)] = t - (t - \surd(1 - v^2/c^2))t$$

whence it follow that the time marked by the clock (viewed in the stationary system) is slow by $1 - \surd(1 - v^2/c^2)$ seconds per second, or - neglecting magnitudes of fourth and higher order, by $(v^2/c^2)/2$."

Note the expression $1/\surd(1 - v^2/c^2)$ rather than ß, in the first equation. Perhaps this had been $1/(c^2 - v^2)$ before being changed. The only reason that the origin clock would be slow by $1 - \surd(1 - v^2/c^2)$ seconds compared to t of the stationary system is that the moving clocks physically run slow. Perhaps, then, Einstein *did* know that moving clocks run at physically different rates (perhaps by Q rather than q, initially) and that moving bodies *do* physically change lengths in various directions. Having denied that any system corresponds to "the idea of absolute rest", however, perhaps he thought the deformations were only as plotted by use of the esynched clocks of each moving system.

Either way, he later seems to have followed his teacher Minkowski, who wrote in a 1908 paper "On Space and Time",

"Lorentz called the t' combination of x and t the local time of the electron in motion, and applied a physical construction of this concept, for the better understanding of contraction. But the credit of first recognizing clearly that the time of one electron is just as good as that of the other, that is to say, that t and t' are to be treated identically, belongs to A. Einstein. Thus time, as a concept unequivocally determined by phenomena, was first deposed from its high seat." (In its place, we got Minkowski's "spacetime continuum", in which - unknown to him - you have to know the place of an esynched clock in its own moving system in order to know the "time" of *that* system at that place.) Einstein followed the wrong leader. He should have followed the lead of Lorentz.

We will now look at some of Einstein's # 7, "Transformation of the Maxwell-Hertz Equations for Empty space."]

40. "Let the Maxwell-Hertz equations for empty space hold good for the stationary system K, so that we have

$$\frac{\partial X}{c\partial t} = \frac{\partial N}{\partial y} - \frac{\partial M}{\partial z}, \quad \frac{\partial L}{c\partial t} = \frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y},$$
$$\frac{\partial Y}{c\partial t} = \frac{\partial L}{\partial z} - \frac{\partial N}{\partial x}, \quad \frac{\partial M}{c\partial t} = \frac{\partial Z}{\partial x} - \frac{\partial X}{\partial y}, \qquad \text{[Equations 7]}$$

[etcetera]

where (X, Y, Z) denote the vector of the electric force, and (L, M, N) that of the magnetic force.

"If we apply to these equations the transformations developed in #3, by referring the electromagnetic processes to the system of co-ordinates there introduced, moving with the velocity v, we obtain the equations

$$\frac{\partial X}{c\partial t'} = \frac{\partial}{\partial y'}\{ß(N - vY/c)\} - \frac{\partial}{\partial z'}\{ß(M + vZ/c)\}, \quad \frac{\partial L}{c\partial t'} = \frac{\partial}{\partial z'}\{ß(M + vZ/c)\},$$
$$\frac{\partial}{c\partial t'}\{ß(Y - vN/c)\} = \frac{\partial L}{\partial x'} - \frac{\partial}{\partial z'}\{ß(N - vY/c)\}, \qquad \text{[Equations 8]}$$

[etcetera]

where $ß = 1/\surd(1 - v^2/c^2)$."

[Equations 8 aren't the force levels that a moving deformed system (x',y',z';t') would find, they are those that a moving *Euclidean* system (x',y',z';t') would find. If we did apply the Lorentz transformations to equations 7 we would *not* get equations 8. The LTE transform *co-ordinates* per given point, not force measurements at those points. Accordingly, it is evident that Einstein didn't even know what the relativistic transformations actually do!

He continued, "Now the principle of relativity requires that if the Maxwell-Hertz for empty space hold good in system K, they also hold good in system k; that is to say that the vectors of the electric and magnetic force -- (X', Y', Z') and (L', M', N') -- of the moving system k, which are defined by their ponderomotive effects on electric or magnetic masses respectively, satisfy the following equations

$$\frac{\partial X'}{c\partial t'} = \frac{\partial N'}{\partial y'} - \frac{\partial M'}{\partial z'}, \quad \frac{\partial L'}{c\partial t'} = \frac{\partial Y'}{\partial z'} - \frac{\partial Z'}{\partial y'},$$

$$\frac{\partial Y'}{c\partial t'} = \frac{\partial L'}{\partial z'} - \frac{\partial N'}{\partial x'}, \quad \frac{\partial M'}{c\partial t'} = \frac{\partial Z'}{\partial x'} - \frac{\partial X'}{\partial y'}, \qquad \text{[Equations 9]}$$

[etcetera]."

Other than that the symbols for the vectors and co-ordinates are those of k, Equations 9 are identical to Equations 7 for the stationary system K and, as Lorentz's entire 1904 paper showed, the equations a deformed moving system would obtain at given points *would* have exactly the same form as those of a stationary system.

Einstein continued, "Evidently the two systems of equations [8 and 9] found for system k must express exactly the same thing, since both systems of equations are equivalent to the Maxwell-Hertz equations for system K."

Since deformed system k would arrive at Equations 9 but only a moving Euclidean system would arrive at Equations 8, his "two systems of equations" were *not* "found for system k" nor are they equivalent to each other.

He continued, "Since, further, the equations of the two systems agree, with the exception of the symbols for the vectors, it follows that the functions occurring at corresponding places must agree, with the exception of a factor W(v), which is common for all functions of the one system of equations, and is independent of x', y', z' and t' but depends upon v. Thus we have the relations,

$$X' = W(v)X, \quad L' = W(v)L,$$

$$Y' = W(v)ß(Y - vN/c), \quad M' = W(v)ß(M + vZ/c), \qquad \text{[Equations 10]}$$

$$Z' = W(v)ß(Z + vM), \quad N' = W(v)ß(N - vY/c).$$

"If we now form the reciprocal of this system of equations, firstly by solving the equations just obtained, and secondly by applying the equations to the inverse transformations (from k to K), which is characterized by the velocity -v, it follows, when we consider that the two systems of equations thus obtained must be identical, that W(v)W(-v) = 1."

One doesn't apply "the equations to the inverse transformations", one applies the inverse transformations to the equations in order to obtain the co-ordinates (not the force values) of the other system once those of the first system are known. In equations 10, however, there are no co-ordinates at all!

He continued, "Further, from reasons of symmetry * W(v) = W(-v), and therefore W(v) = 1, and our equations assume the form [etcetera]." Here is his footnote: "* If, for example, X = Y = Z = L = M = 0, and N =/= 0, then from reasons of symmetry it is clear that when v changes sign without changing its numerical value, Y' must also change sign without changing its numerical value." One justifies his argument the first time it is used. The fact that it appears *here* rather than in his prior appeal to "reasons of symmetry" is another clue that he radically revised his paper.

Furthermore, by "applying the equations to the inverse transformations (from k to K)" we get the value Y of system K, not Y'. If, as in his example, "X = Y = Z = L = M = 0", then the sign of Y is meaningless. So are his resulting equations [etcetera], from which he concluded that "questions as to the 'seat' of electrodynamic electromotive forces now have no point."

In place of a material medium to conduct the electrodynamic events which cause electromotive forces to arise in responding masses, his entire paper substituted "empty space". The fact that the continuous non-reflective material medium ["dark matter"] is easily movable and resistively compressible, being the same matter out of which reflective thus visible particles are formed, does rule out Lorentz's universally stationary ether. It joins common sense in also denying the existence of Newton's empty space (a void) anywhere that electromagnetic wave systems or any other kind of invisible pressure waves ["dark energy"] exist.

Conclusion.

STR's equations, including the LTE, rest on the deformations of lengths and rates of physical systems and their attached co-ordinate systems that presumably occur as a consequence of their motions relative to Newton's mythical absolute empty space or Lorentz's mathematically equivalent but equally mythical universally stationary ether. In terms of Lorentz's stationary substrate, the local-time offsets between clocks of a moving system are also really there, imposed by using Einstein's method to set them without needing to know the value of absolute v of the given system, where - as in reality, "absolute velocity" is always with regard to the background material medium in which the motions locally occur.

Those local offsets are what let a relativistic system disagree with others as to the "simultaneity" of given events. THEY are what permit a Lorentzian system to plot the other one as q-contracted in the direction of relative motion. THEY are what let every member of the General Group obey reciprocity. Without them, and without the co-variant *physical* length and clock-rate deformations, no relativistic transformations would work.

The ratios of units of measure, even as variably plotted by differently moving thus differently deformed relativistic systems, are based on the physically real deformations that are a function of the *absolute* velocity per system. So are those our experiments measure.

All such non-Euclidean systems know they did mark the same point at the same instant if their different co-ordinate values per such point and instant interconvert via an appropriate group of transformations. The fact that their co-ordinate values *do* interconvert proves that they marked the same thereby-absolute point at the same thereby-absolute instant; the very same instant throughout the entire universe. That, and only that, is what the transformation equations, whether relativistic or Galilean, actually do.

Misled by the myriad semantic and mathematical errors in Einstein's 1905 paper, later compounded by Minkowski and others, our theoretical physicists have completely misunderstood the true nature of the physical world.

In an October 30, 1954 letter to me Einstein wrote, "Reasoned considerations just do not have much influence upon the actions of men." Hopefully, this analysis will help prove him wrong there too.