On Einstein's Non-Simultaneity, Length-Contraction and Time-Dilation

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Non-simultaneity of two simultaneous events which occur at different positions within an inertial reference-frame passing by at a speed v; length-contraction of a rod passing by at a speed v; and time-dilation caused by a clock passing by at a speed v, have been milestones of Einstein's Special Theory of Relativity for more than 100 years: Here, these aspects are meticulously derived from the Lorentz-transformation: It is found that the actual physics responsible for non-simultaneity of two simultaneous events has not been correctly explained by Einstein. It is also found that length-contraction cannot occur at all, and that time-dilation does not violate Newton's concept of absolute time at every instantaneous position in gravity-free space.

1. Introduction

Galileo Galilei[1)] convincingly argued that within an "enclosed space", like a ship's cabin with no portholes to look to the "outside", it is impossible to do any physical measurement which would be able to prove whether the cabin is uniquely stationary within the universe or moving along with a constant speed v relative to a reference frame that is <u>really</u> uniquely stationary within the universe. This well-established behaviour, according to which any moving object can be considered as being uniquely stationary within the universe, has become known as "inertia". All reference-frames within our universe which move with constant speeds relative to one another are thus, in this sense, each uniquely stationary; and therefore they are known as Galilean, or inertial reference-frames.

Galileo's logic obviously demands that the laws of physics must be the same within any inertial reference-frame as if such a reference-frame is the only uniquely-stationary reference-frame within our universe. If this were not so, one would be able to do an experiment or a measurement within an inertial reference-frame, which can prove whether such an inertial reference-frame is uniquely stationary, or moving relative to a really unique reference-frame that is actually the only stationary reference-frame within our universe.

Newton[2)], in his famous *Principia*, quantified Galileo's ideas by introducing the concepts of rest-mass and momentum: According to Newton, the reason why a moving body is stationary within its own inertial reference-frame $K^{/}$, is that the body has a rest-mass m: Inertia is thus the result of this rest-mass resisting any effort to move a body out of its state of rest within its own inertial reference-frame $K^{/}$.

When, however, viewed from another inertial reference-frame K, which is moving with a speed $-v$ relative to $K^{/}$, the body with mass m (that is at rest within $K^{/}$) is seen to be moving past at a speed v within K. This, however, still means that this mass is at rest within its own inertial reference frame: This "moving inertia" within K has been defined by Newton as momentum p; which he calculated by taking the product of the rest mass m and the speed v relative to K: i.e. $p = mv$.

His second law postulates that in order to move a body with mass m within its own inertial reference frame $K^{/}$, within which it is initially at rest, a force must be applied to such a body. This force accelerates the body from its position of rest, thus causing such a body to gain momentum within the inertial reference-frame in which it had been at rest before the force acted: Since this body picks up speed, it is continuously generating new inertial reference-frames within which it would be stationary if the applied force is suddenly switched off.

As required by Galileo's fundamental principle of inertia, Newton's physics cannot be used within an "enclosed" inertial reference frame to determine whether this reference frame is moving or not moving with a constant speed v.

Waves and their interactions had been well-known long before it was conclusively established that light consists of waves. Since all previously-known waves form within a substance that determines the speed with which the waves can move through this substance, it was logically reasoned that there must be such a stationary substance (that was called the ether), which must fill the whole universe so that light waves move with a speed c through this substance.

If there is such a substance within which light-waves move with a speed c, this substance must be uniquely stationary within our whole universe: Einstein[3)] realised that if this is so, it will thus be possible to do a physical measurement within Galileo's "enclosed", inertial reference-frame, which will allow one to determine whether one is moving relative to this substance; and to know whether one is moving or not moving relative to another "outside" body (the ether) which is uniquely stationary within the universe. This can simply be done by measuring the speed of light along different directions within Galileo's "enclosed" inertial reference frame.

Einstein thus postulated that Galileo's inertia should not just be valid for Newton's physics, but also for all physics, including Maxwell's equations[4)] for electromagnetic waves: This would mean that one cannot use the speed of light to determine within an inertial reference frame whether it is uniquely stationary or moving: i.e. the speed of light must always have the exact same magnitude c along any direction within any inertial reference frame. This postulate led Einstein to his Special Theory of Relativity.

Before Einstein postulated his theory of relativity, Michelson and Morley[5)] tried to use light speed to measure the motion of the earth relative to the ether. For this they used an interferometer with two perpendicular arms of equal length L_0: An incoming light-beam is split into two at the junction where the two arms meet: One beam moves along an arm (which will be termed the horizontal arm) and is reflected back by a mirror at the end of this arm, while the other light-beam is moving along an arm which is perpendicular to the horizontal arm and reflected back by a mirror at the end of this arm.

If the whole interferometer is moving relative to the ether with a speed v along the horizontal arm of the interferometer, the two light-beams must expend different times to move along their respective arms to the mirrors (at the ends of the arms) and return to the junction. The formulas for these different times can be found in any elementary text book on modern physics. Along the perpendicular arm, the time is:

$$\Delta t_{perp} = \frac{2L_0/c}{\sqrt{1-\frac{v^2}{c^2}}} \tag{1}$$

In anticipation of the arguments that will follow below, the formula for the time (Δt_{hor}) along the horizontal arm, although already available in elementary text books on physics for more than 100 years, will again be derived here: In this case, the horizontal light-beam, after being split off at the junction, chases the end of the arm with a speed (c-v) and therefore reaches the mirror after a time, Δt_{hor1}, which is given by:

$$\Delta t_{hor1} = \frac{L_0}{(c - v)} \qquad (2)$$

After reflecting at the mirror, the light moves into the speed v of the interferometer, relative to the ether, with a speed (c+v) relative to the junction, and thus reaches the junction within a time-interval, Δt_{hor2}, which can be calculated as:

$$\Delta t_{hor2} = \frac{L_0}{(c + v)} \qquad (3)$$

Thus, the total time for the return trip is:

$$\Delta t_{hor} = \Delta t_{hor1} + \Delta t_{hor2} = \frac{2L_0 / c}{\left[1 - \frac{v^2}{c^2}\right]} \qquad (4)$$

The time intervals, Δt_{perp} and Δt_{hor} are clearly different: Thus, after their respective journeys, the two light-beams should meet up having a phase-difference which can be measured; and from which the speed v relative to the ether can be calculated.

It is well-known that this experiment consistently failed to measure a phase-difference. It might thus mean that the earth is stationary relative to the ether. This is, however, unlikely since the speed-direction of the earth changes relative to the sun when it circles the sun and therefore it must also change direction relative to the stationary ether. It was found that even though such an interferometer is sensitive enough to measure the earth's motion, when it changes direction relative to the ether over a period of one year, no phase-change could be measured. One should note at this point that even though the earth suffered acceleration while moving around the sun, this also did not cause any observable phase change.

It was proposed by both Lorentz[6)] and Fitzgerald[7)] that the null result might be caused by a length-contraction of the horizontal arm when this arm moves along its length with a speed v relative to the ether. Such a contraction will cancel the phase-difference and thus the measurement of the speed v. For this to occur, an arm which has an actual length L_0, must contract to a length L_v when it is moving with a speed v relative to the ether: This contraction is given in terms of the stationary length L_0, speed v, and light speed c, as:

$$L_v = L_0\sqrt{1 - \frac{v^2}{c^2}} \qquad (5)$$

By replacing L_0 in Eq. 4 with this expression for L_v, Eq. 4 becomes the same as Eq. 1. Thus, for such a contraction there will not be a time-difference that can give a phase-difference between the light-beams. Equation 5 has become known as the Lorentz-Fitzgerald contraction: It indicates that the ether might be "viscous" and that, therefore, "ether-drag" might be responsible for the shortening of any object when it moves with a speed v through the ether.

Instead of requiring a length-contraction caused by "ether-drag", Einstein Special Theory of Relativity explains the null result of the Michelson-Morley experiment far more simply: According to his postulate on the speed of light, the two light beams must always be moving with the same speed along both arms of any Michelson-Morley spectrometer; no matter at what speed the spectrometer is moving relative to any other inertial reference frame within the universe. A length-contraction caused by the ether is thus not required to explain the null result. This means that the speed of a body with mass is not absolute, but that the speed of light is absolute when measured relative to **any and all** moving bodies.

Therefore, when flying at an incredible speed in a spaceship, a passenger on such a spaceship will not observe light to move at different speeds when it moves along different directions. According to such a passenger, the spaceship is for all intent and purposes uniquely stationary owing to both its mass-inertial behaviour, as well as the constancy of the speed of light. This implies that when two spaceships move past one another at a relative speed v, one stationary within an inertial reference-frame K' and the other stationary within an inertial reference-frame K, the speed of light must always have the same value c in all directions as measured within either one of these spaceships.

Owing to this requirement, it is found that an event that occurs at a certain position and time within a passing inertial reference frame K', does not necessarily occur at exactly the same time within a reference frame K relative to which it is moving. The motion of K' relative to K causes actual sequential physics events occurring within K', to be distorted in both position and time within K. To distinguish these distorted events within K from the real physics events which actually occur within K' the latter physics events will be called primary physics-events.

In order to derive the concomitant distorted physics-events within the reference frame K relative to which K' is moving with a speed v, one needs to transform the primary physics-events that occur within the inertial reference-frame K', into their concomitant distorted physics-events within the inertial reference-frame K.

Einstein's postulates led him to a set of coordinate transformations from K' to K, which are exactly the same as equations which had been discovered previously by Lorentz[8)]; but which Lorentz obtained by accepting the validity of the Lorentz-FitzGerald contraction: They were therefore, initially, not interpreted as coordinate-transformations. Owing to Lorentz's priority in publishing these equations, they are at present known as the Lorentz-transformation for position and time coordinates.

According to Einstein's Special Theory of Relativity, the Lorentz-transformation "maps" a primary physics-event which occurs at a position x',y',z' at a time t' within an inertial reference-frame K' onto coordinates x,y,z at a time t within another inertial reference-frame K. In order to achieve this mapping, a reference point for time-measurement has to be chosen which is simultaneously valid within both K' and K: It is thus assumed that an ideal, perfect clock within K' must be synchronised with another identical, ideal, perfect clock within K at the very instant in time that the two clocks pass each other at the same position in space.

The general rule is that the two clocks are situated at the two origins $x' = y' = z' = 0$ and $x = y = z = 0$ of the two reference-frames K' and K respectively, and then synchronized so that $t' = t = 0$ at the instant when these origins coincide. With this reference point for time, the following mathematical formulas constitute the Lorentz-transformation from K' to K: i.e.

$$x = \frac{x' + vt'}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (6a)$$

$$y = y' \qquad z = z' \tag{6b}$$

$$t = \frac{t' + \left(\frac{v}{c^2}\right)x'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{6c}$$

2. A Michelson-Morley Spectrometer in Motion

Assume, for the sake of argument, that Michelson and Morley are doing their measurements on the passing spaceship which is stationary within reference-frame K': They will get a null result since, according to Einstein's postulates, light travels with the same speed along both arms within K'.

A question which comes to mind is the following: With what speeds does the horizontal light-beam move from the junction to the mirror and then back when this primary experiment within K' is transformed into its distorted format within K? Since the speed of light is also c in all directions relative to K, the mistake has been made over the past 100 years, and is still being made, to conclude that, since the apparatus is moving with a speed v within K, the horizontal light-beam must move with a speed $(c-v)$ towards the mirror and then with a speed $(c+v)$ back to the junction when observed within K.

The time interval as seen from K must then be the same as given by Eq. 4, and this implies that there must now be a phase shift: However, when the two beams arrive at the same instant at a single point within K', the physics occurring at that point must be the same at the corresponding, distorted coordinates within K. This mandates that when there is no phase-shift within K', there can also not be a phase shift within K. It thus seems compelling that the only way to ensure that there will also not be a phase shift within K, is to again invoke a Lorentz-Fitzgerald contraction of the horizontal arm when the spectrometer moves relative to K; even though there is now not an unique ether which can cause this contraction by means of "ether-drag". This is what Einstein concluded[10)] (see also section 4 below). But, as will now be shown, this conclusion is wrong.

The only acceptable way to really determine what happens within K when the spectrometer within K' moves past with a speed v, is to start off from, and to use the Lorentz-transformation (Eqs. 6): Within K', the spectrometer is stationary, and when light leaves the junction at position $x'=0$ at time $t'=0$, it will reach the mirror at the end of the arm when:

$$x'_m = L_0 \text{ and } t'_m = L_0 / c \tag{7a}$$

It will then reflect and return to the junction, which now has the following position-coordinates and time within K':

$$x'_j = 0 \text{ and } t'_j = (2L_0)/c \tag{7b}$$

At time $t' = 0$, Eqs. 6(a) and 6(c) gives $x = 0$ and $t = 0$ respectively within the outside reference-frame K. When the beam reaches the mirror, these same equations give, in conjunction with Eq. 7a, for x_m and t_m the following:

$$x_m = \frac{x_m^/ + vt_m^/}{\sqrt{1-\frac{v^2}{c^2}}} = L_0 \frac{\left(1+\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \tag{8a}$$

And

$$t_m = \frac{t_m^/ + \left(\frac{v}{c^2}\right)x_m^/}{\sqrt{1-\frac{v^2}{c^2}}} = \left(\frac{L_0}{c}\right)\frac{\left(1+\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \tag{8b}$$

The path-length within K, when the light-beam is moving from the junction to the mirror, is thus $L_{hor1} = x_m$ (Eq. 8a); and concomitant time-interval is thus $\Delta t_{hor1} = t_m$ (Eq. 8b). Thus, the speed of the light-beam observed within K (when the light-beam moves towards the mirror) is $L_{hor1} / \Delta t_{hor1}$; which turns out to be equal to c. It is thus not (c-v)! The speed of light relative to the mirror remains c within both $K^/$ and K. After all, the mirror is in its own right an inertial reference-frame relative to which the speed of light **must** always have the same constant value c!

When, after its reflection and return, the beam again reaches the junction, the Lorentz-transformation, in conjunction with Eq. 7b, gives for the corresponding distance x_j and time t_j within K, the following:

$$x_j = \frac{x_j^/ + vt_j^/}{\sqrt{1-\frac{v^2}{c^2}}} = L_0 \frac{2\left(\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \tag{9a}$$

And

$$t_j = \frac{t_j^/ + \left(\frac{v}{c^2}\right)x_j^/}{\sqrt{1-\frac{v^2}{c^2}}} = \left(\frac{L_0}{c}\right)\frac{2}{\sqrt{1-\frac{v^2}{c^2}}} \tag{9b}$$

The path-length, from the mirror to the junction, is given within K by $L_{hor2} = x_m - x_j$, and the return time is $\Delta t_{hor2} = t_j - t_m$: Thus from Eqs. 8a and 9a:

$$L_{hor2} = L_0 \frac{\left(1-\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \tag{10a}$$

And from Eqs. 8b and 9b:

$$\Delta t_{hor2} = -\left(\frac{L_0}{c}\right)\frac{\left(1-\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \tag{10b}$$

The time interval is now negative: Can time run backwards? Although it is advocated within the mainstream physics-literature that this is possible, so that an electron can supposedly move backwards in time to, in this manner, exist as a positron, it is more probable that it is never-ever physically possible: No matter what! In this specific case, the negative sign is mandated by mathematical self-consistency, since, when now calculating the speed $L_{hor2}/\Delta t_{hor2}$, one obtains $-c$, as one must: The light is moving into the opposite direction after having been reflected.

The simple fact is the following: Whether a time-interval is positive or negative is solely determined by the choice of the coinciding positions within $K^{/}$ and K when synchronizing the clocks within these two inertial reference-frames (see also section 3 below). The latter is an arbitrary choice and the sign of a time-interval does thus not mean that time is changing from the present into the past.

If the magnitude of the speed of light did not remain c, the light would have been observed within K to move on its way back to the junction at a speed $(c+v)$, which would be larger than the speed of light relative to the junction. Such a relative speed for light is, according to Einstein's own postulates, never possible relative to any moving object. Thus, in addition to the fact that the speed of light remains c within any inertial reference-frame, it is also impossible for a light-beam approaching a moving object, or speeding away from such a moving object, to do so with any other speed relative to the moving object than the same constant speed c.

3. Simultaneity and Non-Simultaneity

It is well-known that according to Einstein's Special Theory of Relativity two events which occur simultaneously at two different positions within an inertial reference-frame cannot occur simultaneously within another inertial reference-frame relative to which the first reference-frame is moving. Einstein[9)] explained this effect in terms of a train passing through a station with a speed v at the very instant that two simultaneous lightning-strikes hit the embankment at positions A and B, a distance L_0 apart parallel to the train. He then considered what a person on the train will observe when he/she finds him/herself midway between the two lightning-strikes at exactly the instant when they occur. Quoting Einstein directly: "*..he is hastening towards the beam of light coming from B whilst he is riding on ahead of the beam of light coming from A. Hence the observer will see the beam of light emitted from B earlier than he will see that emitted from A. Observers who take the railway train as their reference body must therefore come to the conclusion that the lightning flash B took place earlier than the lightning flash A*".

To understand how Einstein's physics-logic failed him when he used this argument, we will modernise his explanation of simultaneity by again considering two identical space-ships (both having the same length L_0 (within their respective reference-frames $K^{/}$ and K) which pass each other with a relative speed v along their lengths. We consider the case when, within the spaceship, which is stationary within reference-frame $K^{/}$, a light in its tail and a light in its nose are switched on simultaneously.

Consider a light detector in the spaceship $K^{/}$ which is situated midway between these light-sources: Relative to this spaceship, the fronts of the light-beams coming from the two lights must reach the detector simultaneously. This must be so since the light-fronts, rushing towards the detector from the nose and the tail of the spaceship, both move at the same constant speed c within $K^{/}$, and also cover the same stationary distance $\frac{1}{2}L_0$ to reach the detector.

According to Einstein's train-argument[9)], the lights will not switch on simultaneously within K, since "an observer" in K is moving away from the light-front, rushing towards him from the nose of the moving spaceship with speed c (such that the combined relative speed between the light and this observer is $c-v$) and the "observer" is moving into the light rushing towards him from the tail of the moving spaceship (so that in this case the combined relative speed between the light and the detector is $c+v$): Therefore, Einstein reasoned, the "outside observer" must "see" the light in the tail switching on before he/she "sees" the light in the nose switching on.

The first problem with this argument is that the "outside observer" must be at a position within K that coincides with the detector within $K^/$ when the two lights switch on in order to justify the conclusion that the light in the back switches on before the light in the nose does within K. It is, however, highly unlikely, and most probably impossible, that physics will be determined by the presence and fortuitous position of an observer. If the lights switch on at different times within K, it should not just happen when there is an observer at a specific accommodating position within K; but even when there is no observer present at all. If this is not the case, one is modelling paranormal metaphysics. All the laws of physics must be the same whether there is an observer present or not present at all.

The second, and really major problem with this argument can be seen by revisiting the results which have been derived for the moving Michelson-Morley interferometer in section 2 above: The magnitude of the relative speed of the light coming from the tail as well as the nose must remain equal to the same constant value c within both $K^/$ and K, and relative to the mirror and junction of the spectrometer. It must thus approach the detector within the moving spaceship with exactly the same speed c relative to the detector; even when observed within K. The actual reason why the lights do not switch on simultaneously within K (when they do so within $K^/$) will now be directly derived from the Lorentz-transformation given by Eqs. 6:

Let us assume that the lights switch on at the very instant when a clock in the tail of the passing spaceship within $K^/$ is synchronised with a clock within K: i.e. at this instant, one has that $x^/ = x = 0$ and $t^/ = t = 0$. But at this same instant in time, the time $t^/_N$ in the nose of the spaceship must also be zero, or else the light in the nose of the spaceship (within $K^/$) will not be able to switch on simultaneously with the light in the tail. Relative to $K^/$ this happens at position $x^/_N = L_0$. The corresponding values of x_N and t_N within K then follow from Eqs. 6 as:

$$x_N = \frac{L_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{11a}$$

And

$$t_N = \frac{\left(\frac{v}{c^2}\right)L_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{11b}$$

Thus, just as in the case of the moving Michelson-Morley spectrometer, both the position of the nose and the time that the light in the nose switches on, change when viewed within K. It is important to note that, according to this result, time cannot be the same at every position ("within" the inertial reference-frame $K^/$) when this time is measured within K. At the very instant when an observer in K synchronises his/her clock with a clock in the tail of the spaceship, any point along the spaceship, is situated within the future of the outside clock. All the events occurring simultaneously at that exact instant in time within $K^/$, will only manifest at later times within K: Therefore the light in the nose switches on at a later time t_N within K.

This sounds quite silly: After all, the front of the spaceship should pass by first. How can the nose be in the observer's future when the tail only passes him later? It obviously cannot: It is only in the future of K at the very instant in time that the outside clock is synchronised with a clock situated in the tail of the spaceship! When, in contrast, the outside observer synchronises his clock with a clock in the nose of the passing spaceship, one obtains from the Lorentz-transformation that the coordinate x_T and time t_T in the tail of the spaceship within K are:

$$x_T = -\frac{L_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{12a}$$

And

$$t_T = -\frac{\left(\frac{v}{c^2}\right)L_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{12b}$$

Both have the same magnitudes as their counterparts, x_N and t_N in Eq. 11, but are now negative quantities. The distance must be negative since it is now measured along the negative direction from the origin of $K^{/}$. The negative time in the tail of the spaceship, as well as all points from the outside clock in K towards the tail of the spaceship (and further), are, at that very instant in time, in the past of the outside clock.

When the lights in the tail and nose of the spaceship now switch on exactly at the instant when the outside observer synchronises his clock with the clock in the nose of the spaceship, this observer sees the nose-light switching on at that very instant in time: But from within his/her reference frame K, the light in the rear must already have switched on before he/she synchronized his/her clock with the light in the nose of the passing spaceship.

Does this imply that the light in the tail of the spaceship anticipated the future? If the outside observer is informed by an all-knowing being, who can simultaneously exist within both $K^{/}$ and K, that the two lights have actually switched on simultaneously on the spaceship within $K^{/}$, he/she will be forced to admit that according to his/her clock the light in the tail did anticipate the future. But if he/she really <u>believes</u> that this is possible, he/she needs to go and see a shrink! Minkowski Oh Minkowski!!

The fact is that, even when synchronising his/her clock with the clock in the tail of the spaceship, he/she (when believing the all-knowing being) must conclude that the light in the tail is anticipating the future. This can obviously not be what <u>really</u> happens! A clock in the tail and a clock in the nose of the spaceship must in actual reality be keeping exactly the same time for simultaneity to be possible on the spaceship.

For a passenger within the moving spaceship, the time is exactly the same <u>everywhere</u> within the spaceship: In fact, everywhere within the inertial reference-frame $K^{/}$. Time does not vary from point to point <u>at all</u>; just as Newton had assumed 200 years before Einstein came on the scene. Perfect clocks at any and every position within the spaceship <u>must</u> all keep the same identical time. There is thus not an actual time-coordinate which changes with position within $K^{/}$.

Only within reference-frame K, can an all-knowing being conclude that time is now a function of position along the length of the spaceship: i.e. only under these conditions does time form a "fourth coordinate" according to such a being. But does it <u>really</u> form a fourth coordinate within K? If it could be possible, the two inertial reference-frames would not be equivalent as Einstein has postulated that they must be.

To be equivalent, any two lights which are stationary within either reference-frame $K^/$ or reference-frame K, must be able to switch on simultaneously within their respective inertial reference-frames; no matter at which positions the lights find themselves. This demands that the time must be exactly the same at all positions within both $K^/$ and within K.

Although the time t in Eq. 6c is given "as a function" of position $x^/$ and the time $t^/$, the correct physics-interpretation of this equation is as follows: When, within the reference-frame $K^/$, in which there are identical clocks ticking away at the same rate at any and, in principle, at every position, an event that occurs at position $x^/,y^/,z^/$ at an instant of time $t^/$ (as shown by <u>all</u> the clocks which are stationary at any position within $K^/$) will occur within the reference-frame K at a position x,y,z, when <u>all</u> the clocks, which are stationary anywhere within K, reaches the time t given by Eq. 6c. To re-emphasise: When the clock at x reaches the time t, <u>all</u> the other clocks, at <u>all</u> the other positions within K, will also show this identical time. Thus, time cannot <u>really</u> change with position at all: Not within $K^/$, not within K and not within any inertial reference-frame!

It is, of course possible to switch on the light in the nose of the spaceship $K^/$ before switching on the light in the tail so that the time interval will be such that the lights will switch on simultaneously within K. It is easy to derive this time interval from the Lorentz-transformation and therefore it will not be done here. Thus, actual non-simultaneous events can be observed as occurring simultaneously when viewed from outside the inertial reference-frame in which they actually occur non-simultaneously. This does not mean that that these primary events are actually simultaneous within $K^/$.

4. Length-contraction

Consider again a passing spaceship with a stationary length L_0 as measured within its own inertial reference-frame $K^/$: Within K, the time in the tail of the passing spaceship is ahead of the time in the nose of the spaceship. This means that it is never possible to measure at which positions the nose and the tail are at a single instant in time on any clock which is stationary within K. And this brings us to the most remarkable blunder that Einstein has made more than 100 years ago, and which is still being taught in physics text books as being correct.

After Einstein derived the Lorentz-transformation in terms of his postulates on which the Special Theory of Relativity is based, he immediately went ahead and used the Lorentz-transformation (Eqs. 6) to derive the Lorentz-Fitzgerald contraction (Eq. 1). In order to do so, he had to assume that the front-end (nose) and the back-end (tail) of a passing object with length L_0 can be simultaneously present[10)] within K at a single instant in time on the clocks within K.

As incredible as it may sound, this means that just after Einstein had proved in 1905 that two spatially separated events, which occur simultaneously within a passing inertial reference-frame $K^/$, can never be simultaneous on any of the clocks within the inertial reference-frame K relative to which $K^/$ is moving with a speed v, he used the Lorentz-transformation to map the nose-coordinates and the tail-coordinates within $K^/$ as if they have simultaneous positions within the reference-frame K. He had to do this in order to derive a length L_v within the inertial reference-frame K which is the same as the Lorentz-Fitzgerald contraction (see Eq. 5): And this is still being done in text books to this day.

But, within the reference-frame $K^/$ of the spaceship, passing by with a speed v, the nose and tail are at any instant in time, on any clock travelling with the spaceship, simultaneously a distance L_0 away from each other. Every tick of two clocks (one in the nose and the other in the tail of the spaceship) defines "two events" which occur all the time simultaneously; no matter how small the time-interval between two consecutive ticks is. Only for this reason can the stationary length L_0 be known at a single instant in time on the clocks within the inertial reference-frame $K^{/}$. But this is not the case for the outside observer in reference-frame K.

When applying the Lorentz-transformation, one finds that the transformed length of the spaceship actually increases within the reference-frame K of the outside observer. In fact, the correct transformed length L_v within the inertial reference-frame of the observer when the spaceship moves past with a speed v can be derived from Eq. 6a (as also confirmed by Eq. 11a) and is found to be:

$$L_v = \frac{L_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{13}$$

Thus, if the speed of the spaceship approaches the speed of light relative to the inertial reference-frame of the outside observer, L_v will become very long indeed: However, the apparent time-difference ΔT, between being able to observe the tail and then the nose of the spaceship, will also be very large. By using Eq. 6c, it is derived to be:

$$\Delta T = \frac{vL_0}{c^2\sqrt{1-\frac{v^2}{c^2}}} \tag{14}$$

What does this imply? It can only imply what it is saying: That owing to the relative movement of the spaceship having an actual stationary length L_0 within $K^{/}$, an entity with a longer length L_v is passing by within K, but this length cannot be present at the same instant in time within K, since different positions along this length only manifests at different times on any and all clocks which are stationary at any position within K.

But one might want to stubbornly argue that, even though the front- and rear-ends of the spaceship cannot be simultaneously present within the reference frame K, the spaceship must surely still have, at any instant in time within K, a unique length L_u within the inertial reference-frame K. If one could at any instant in time, stop time, so that all movement halts, the front-end and rear-end of the spaceship must obviously be found at two different space-positions within K. But the fact remains that the nose and tail cannot be simultaneously present within K while there is relative motion, and while it is impossible to stop time.

There is only one way to determine the length of a passing object within K, and that is to measure the time interval Δt that it takes for the object to pass a position within K: i.e. in the case of the spaceship, there must be a stopwatch which starts as soon as the nose passes this point, and then stops as soon as the tail passes the same point. The length L_u must then be equal to:

$$L_u = v\Delta t \tag{15}$$

But let us now consider two identical spaceships, each of length L_0, as measured within their respective inertial reference-frames $K^{/}$ and K, which are passing each other with a relative speed v: As soon as the noses of the two spaceships reach each other, the two captains start their respective stopwatches, thus synchronizing them, and then stop their stopwatches as soon as the tail of the other spaceship passes the nose of his/her space-ship. Now, if the captains measured time intervals Δt and $\Delta t^{/}$ respectively, they will calculate that the lengths of each other's spaceship are $L_u = v\Delta t$ and $L^{/}_u = v\Delta t^{/}$, respectively: But owing to the symmetry involved, one must surely have that $L_u = L^{/}_u$.

Since this is the case, it is highly unlikely, and probably totally impossible, that the lengths $L_u = L^{/}_u$ can be anything else than the actual lengths L_0. Thus there is not an actual contraction of length when an object passes with a speed v as is claimed in text books. Furthermore, this conclusion, in turn, demands that:

$$\Delta t = \Delta t^{/} \tag{16}$$

The clocks of the two captains must keep time at exactly the same rate within their respective spaceships.

5. Time-dilation

What is claimed in the mainstream scientific literature is that, after an outside observer (in the reference-frame K) has synchronized his/her clock with a passing clock moving with a speed v (for example on a passing spaceship), the moving clock actually ticks away at a slower rate than the clock within K. Not to make any errors in the accepted dogma, we will quote Einstein[9)] directly on this issue: "*Let us now consider a seconds clock which is permanently situated at the origin (*$x^{/}=0$*) of* $K^{/}$. $t^{/}=0$ *and* $t^{/}=I$ *are two successive ticks of this clock. The first and fourth equation of the Lorentz-transformation* (see Eqs. 6a and c) *give for these two ticks:*

$$t = 0 \tag{17a}$$

and

$$t = \frac{I}{\sqrt{1-\frac{v^2}{c^2}}} \tag{17b}$$

As judged from K*, the clock is moving with the velocity* v*; as judged from this reference body, the time which elapses between two strokes of the clock is not one second, but* $I/\sqrt{1-v^2/c^2}$ *seconds, i.e. a somewhat larger time. As a consequence of its motion the clock goes more slowly than when at rest."*

But this means that when a time-interval $\Delta t^{/}$ is recorded by the clock in $K^{/}$, then a time interval Δt passes on the clock within K; so that:

$$\Delta t = \frac{\Delta t^{/}}{\sqrt{1-\frac{v^2}{c^2}}} \tag{18}$$

But should this $\Delta t^{/}$ not be the same as $\Delta t^{/}$ in Eq. 16? The same clock can surely not run simultaneously at two different rates!

It is well-known that the time-dilation formula (Eq. 18) can be derived by comparing the different perspectives within K and $K^{/}$ when a light-beam is switched on at time $t^{/}=0$ within $K^{/}$ directed along the $y^{/}$-axis. Within $K^{/}$ the light will reach a height $H^{/} = c\Delta t^{/}$, after a time interval $\Delta t^{/}$, as illustrated by the vertical arrow in Fig. 1(a). Within K, however, the origin of $K^{/}$ has moved through a distance $L = v\Delta t$ while the light moved vertically within $K^{/}$. The light-beam thus moves at an angle to the x-

axis within K: Since the light must also, along this path, move at a speed c, the distance through which the light moves within K is $c\Delta t$. The situation is as illustrated within Fig. 1(b). It is clear that by using the theorem of Pythagoras one obtains Eq. 18.

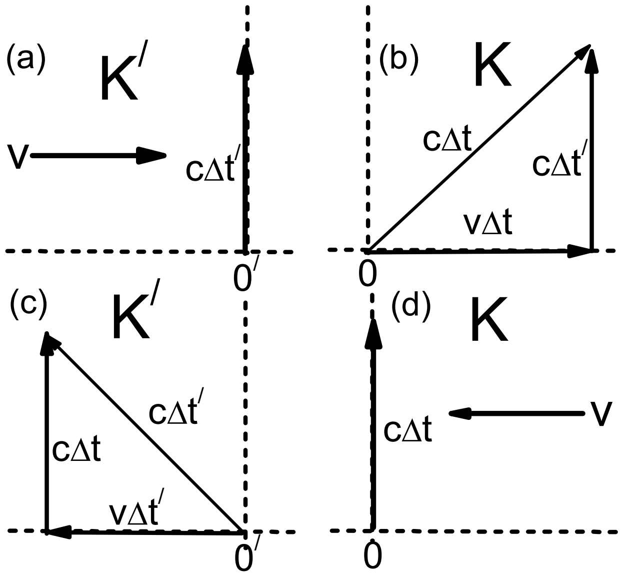

Figure 1: Illustration of time-dilation: (a) A light-beam (vertical arrow) is switched on within the inertial reference-frame K/ which is moving with a horizontal speed v relative to the inertial reference-frame K. (b) The light-beam (inclined arrow) as observed within K. (c) The light-beam (inclined arrow) as observed within K/ when a light-beam is switched on in the vertical direction within K which is moving with a speed v along the negative horizontal direction relative to K/. (c) The vertical light-beam within K.

It is, however, equally possible to switch on a vertical light-beam within K at the same instant in time $t=t^{/}=0$ in the direction of the y-axis. Within K, the light will reach a height $H = c\Delta t$, after a time interval Δt, as illustrated in Fig. 1(d). Within $K^{/}$, however, the origin of K has moved through a distance $L^{/} = v\Delta t^{/}$. The light-beam thus moves at an angle to the negative $x^{/}$-axis. Since the light must also move at a speed c within $K^{/}$, the distance through which it moves within $K^{/}$ is $c\Delta t^{/}$. The situation is as illustrated within Fig. 1(c). It is clear that when using the theorem of Pythagoras one now obtains that:

$$\Delta t^{/} = \frac{\Delta t}{\sqrt{1-\frac{v^2}{c^2}}} \tag{19}$$

Which one of the two equations (Eq. 18 and Eq. 19) is correct? Is the clock within $K^{/}$ slower, or is the clock within K slower? The conclusion is compelling: Clocks do not really keep time at different rates. A clock only keeps time at slower rate within another inertial reference frame within which it is NOT stationary. But, in fcat, both clocks are stationary within their reference frames and MUST thus keep exactly the same time within their respective reference frames.

Eq. 18 applies when the light is switched on within $K^{/}$, while Eq. 19 applies when the light is switched on within K. But can one not argue that the same light has been switched on simultaneously within $K^{/}$ and K at the very instant $t^{/}=t=0$ when the origins of $K^/$ and K coincided? Obviously, this cannot be possible: A single light source cannot be simultaneously stationary within both $K^/$ and K. The source can only be stationary within a single inertial reference-frame (see also the discussion of Minkowski's[11)] space-time in section 6 below).

There have been experiments reported where atomic clocks have been flown around the world and then compared with a clock left behind on earth[12)]: It is claimed that these results prove that time-dilation, as derived from the Special Theory of Relativity, actually occurs on the clocks which had been flown around the earth. It is therefore claimed in text books that a clock on the spaceship moving at a speed v does actually tick at a slower rate, and therefore a person on the spaceship will actually age at a slower rate than an outside observer on earth. But, in view of Eq. 16, it must be impossible that this can be so!

The simplest logical reason why this cannot be so, is that, if the two clocks do not tick at exactly the same rate, the two reference-frames would not be equivalent: The laws of physics must then be different within each one of them. This completely violates Galileo's postulate of inertia, and thus also Einstein's postulates on which he based his Special Theory of Relativity.

The latter would also imply that we cannot allocate a single lifetime to the age of our universe. Relative to which moving, inertial reference-frame must this be done? These inertial reference-frames must all give the same lifetime, or else they cannot be equivalent. Here on earth, we have deduced that the age of the universe is just under 14 billion years. According to a clock on a faraway planet having the same mass as the earth but forming part of a faraway galaxy (moving with nearly the speed of light relative to us) must then imply that the age of the universe is far less: Only 7 days perhaps? It is highly unlikely that our planet required billions of years to form while another similar planet which has since its inception moved at a high speed relative to us, required only 7 days. One is thus forced to conclude that a clock which moves relative to an observer is not actually ticking at a slower rate at all within its own inertial reference frame.

Nonetheless, although time-dilation does not really occur within either $K^/$ or K, it cannot be ignored as being irrelevant: For example, it is found that the lifetime of a muon, formed within cosmic rays that are moving at a high speed relative to earth, is longer when measured by a clock on earth, than when measured by the same clock for another muon that is generated within a laboratory on earth and thus moving at a negligible speed. This does not mean that the clock moving with the muon ticks at a slower rate within the inertial reference frame of the muon.

The deduction that a twin leaving the earth with a speed v will age at a slower rate than a twin staying behind, can thus not be correct. The twin staying behind will have the perception that time is "running slower on the spaceship", just as the twin on the spaceship will have the perception that the "time on earth is running slower" than his/her time on the spaceship. In reality, ignoring gravitational effects, time must be ticking away at exactly the same rate on the spaceship as it does on earth.

It must thus be totally wrong when Stephen Hawking[13)] writes in his book *A Brief History of Time* the following: *"In other words the theory of relativity puts an end to the idea of absolute time! It appeared that each observer must have his own measure of time, as recorded by a clock carried by him, and that identical clocks carried by different observers would not necessarily agree.*" Can this be correct in the case of the Special Theory of Relativity which Hawking is addressing? Although each observer has to deal with the perception that the clock of another observer, moving relative to him/her, does not tick at the same rate as his/her clock, the two clocks (provided they are perfect clocks) must keep time at exactly the same rate; or else their inertial reference-frames cannot be equivalent.

Similarly in his book entitled *Black Holes and Time Warps*, Kip Thorne[14)] writes about a future space trip to the centre of our galaxy as follows: "*The entire trip of 30,100 light years distance will require 30,102 years as measured on Earth; but as measured on the starship it will require only 20 years. In accordance with Einstein's laws of special relativity, your ship's high speed will cause time, as measured on the ship, to "dilate" and this time-dilation (or time warp) in effect, will make the starship behave like a time machine, projecting you far into the Earth's future while you age only a modest amount.*" What he does not mention is that the relative speed between the earth and the starship will dilate the time on earth relative to the time on the starship, thus causing earth to "*behave like a time machine*" relative to the crew on the starship. So who will be in whose future?

Another example is by Lord Professor Martin Rees[15)], Astronomer Royal and President of the Royal Society of London: In his book *Just Six Numbers*, he wrote: "*The speed of light turns out to have very special significance: it can be approached, but never exceeded. But this 'cosmic speed limit' imposes no bounds to how far you can travel in your lifetime, because clocks run slower (and on board time is dilated) as a spaceship accelerates towards the speed of light*".

So what about the results of the atomic clocks which had been flown around the earth[12)]? Firstly the uncertainties in the results were very large, and secondly for the flying clocks the gravitational force changed with height above the earth's surface. Thus the clock on earth was not compared with clocks which moved with a constant, linear speed outside a gravity-field. It can thus not be concluded that the "actual" dilation of time "claimed to have been measured" for these experiments, validates the time-dilation, derived from the Special Theory of Relativity, as being real within the clocks' inertial reference frame. Maybe the results that were found have been what the experimenters wanted to find?

6. Discussion

There is something peculiar about motion: Long before Galileo appeared on the scene, this has been noted by the Greek philosopher Zeno[16)]. Zeno posed paradoxes; all of which led him to conclude that the motion of an object must be an illusion. If motion is an illusion, it is, however, not an ephemeral illusion, since it has real physics-consequences. The latter reality can be painfully tested by jumping in front of a moving train. But when a person is on a hover-board (*a lá* "*Back to the Future*") moving with the same velocity as the train, nothing adverse happens when the hover-board is suddenly manoeuvred into a position in front of the train. Thus, the physical effect of motion is determined by the inertial reference-frame within which it is being observed and measured. Following Zeno, the motion of a body with mass will be classified as being a "relativistic-illusion". This viewpoint dovetails neatly with Galileo's reasoning that a moving object is in essence stationary.

It should be noted that momentum and kinetic-energy can be similarly classified as relativistic-illusions. They do not manifest for a body with mass within its own inertial reference-frame, but only when this body is viewed from another inertial reference-frame. We will classify relativistic-illusions which do not occur within the primary inertial reference-frame, but only when viewed within a reference-frame moving relative to such a primary reference-frame, as Type I relativistic-illusions. Motion, momentum and kinetic-energy are thus, according to this classification, Type I relativistic-illusions.

Zeno has been astute when he proclaimed that motion is an illusion. For example, when an aeroplane, which is stationary within an inertial reference-frame $K^{/}$, flies overhead with a speed v relative to an inertial reference-frame K on earth, and drops a bomb, the bomb will fall straight down within $K^{/}$, but it follows a parabolic path within K; as if it had been projected by a horizontal launch-force: Such a force would have been needed if the bomb were launched by a hovering helicopter that is stationary within K. In the case of the aeroplane, the parabolic path ensues within K, but not within the aeroplane's inertial reference-frame $K^{/}$: The parabolic path is thus clearly a Type I relativistic-illusion within K. In contrast, the horizontal launch-force which is physically mandated by Newton's second law for the parabolic motion to initiate within a primary, inertial reference-frame, does not manifest at all within either $K^{/}$ or K: It will therefore be classified as a Type II relativistic-illusion.

Using the latter classification of relativistic effects, it is argued here that it has all along been wrong to conclude that, according to Einstein's Special Theory of Relativity, time-dilation actually occurs on any clock, other than in the form of a Type II relativistic-illusion. But this illusion can cause Type I relativistic-illusions, like the lengthening in the lifetime of a muon when it moves at a high speed relative to earth (see section 5 above). This is similar to the type II relativistic launch-force being responsible for the Type I parabolic path.

It is thus totally wrong to conclude that at the instant in time at which an outside observer in K synchronises his/her clock with a clock within $K^{/}$, any of the clocks within either $K^{/}$ or K show different times when they are at different positions within their respective inertial reference-frames. Time does not actually change from position to position as if it is a fourth coordinate within either $K^{/}$ or K: The apparent fourth coordinate is a Type II relativistic-illusion which does not manifest directly at all. But, not surprisingly, it does cause Type I relativistic-illusions: For example, when two lights switch on simultaneously within $K^{/}$ but do not switch on simultaneously within K (see also the discussion of the de Broglie wavelength below).

By postulating that two separated events within an inertial reference-frame can occur simultaneously, Einstein unwittingly accepted that, within such a reference-frame, time must be the same at all positions: Just as Newton had assumed in the 1600's. Time must be absolute within any, and all inertial reference-frames within our universe. And since all inertial reference-frames are equivalent, all perfect clocks, whether they are at different positions in gravity-free space, or whether they are moving within gravity-free space relative to one another with a constant speed v, must keep time at exactly the same rate. The clocks of two persons, moving relative to one another, do thus not actually have different time rates at all.

The Lorentz-Fitzpatrick length-contraction is even more misguided: This is so since the derivation of this supposedly "real effect" has all along been just plain wrong. It is nonsensical to use the Lorentz-transformation in order to map two simultaneous positions along a rod which is stationary within $K^{/}$, into two simultaneous positions within K. As long as $K^{/}$ moves with a speed v relative to K, the two simultaneous positions within $K^{/}$ must always map into two non-simultaneous positions within K which are spaced further apart than within $K^{/}$. The Lorentz-Fitzgerald length-contraction does thus not occur: Not in reality and also not even as a Type I or a Type II relativistic-illusion. Contraction just does not happen at all!

The Lorentz-transformation transforms primary-physics, which is allowed according to Galileo's principle of relativity within an enclosed, inertial reference-frame, into relativistic-"illusionary" physics within another, passing, inertial reference-frame: However, owing to the symmetry inherent in the Special Theory of

Relativity, one can also transform primary physics-events within the inertial reference-frame K, to find out how they will be observed within the inertial reference frame $K^{/}$. An observer within $K^{/}$ can obviously also look outside into K. The Lorentz-transformation, when transforming a primary physics-event x,y,z at time t within K, into the concomitant coordinates $x^{/},y^{/},z^{/}$ in $K^{/}$ at time $t^{/}$, are the following:

$$x^{/} = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{20a}$$

$$y^{/} = y \quad \text{and} \qquad z^{/} = z \tag{20b}$$

$$t^{/} = \frac{t - \left(\frac{v}{c^2}\right)x}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{20c}$$

Mathematically these equations are symmetric to those in Eq. 6: For example, when switching on two lights within K at positions $x=0$ and $x=x_N$ at respective times $t=0$ and $t=t_N$; and choosing t_N and x_N as the values given by Eqs. 11a and 11b respectively, one obtains that $x_N^{/} = L_0$ and $t_N^{/} = 0$: Since these are the coordinates within $K^{/}$ when the light in the nose of the spaceship switches on within $K^{/}$, which are then transformed into the values x_N and t_N within K (given by Eq. 11), it seems as if primary events within $K^{/}$ can be transformed into K and that these resultant relativistically-distorted events can then be transformed back into $K^{/}$. But this does not make any physics-sense: In order to "transfer these events back", one requires a light which is stationary within K at the position x_N. If there is not such a light within K, the back-transformation from K to $K^{/}$, although mathematically allowed, is physically meaningless.

In text books the Minkowski space-time manifold is obtained by equating the following two expressions which can be valid within $K^{/}$ and K respectively, since each expression describes the positions of a spherical wave-front around the spatial origins within $K^{/}$ and K, respectively: Within $K^{/}$ one can write for the space-coordinates $x^{/},y^{/},z^{/}$ and the time $t^{/}$ that:

$$(x^{/})^2 + (y^{/})^2 + (z^{/})^2 - (ct^{/})^2 = 0 \tag{21}$$

And within K,

$$(x)^2 + (y)^2 + (z)^2 - (ct)^2 = 0 \tag{22}$$

When one uses the Lorentz transformation (Eq. 6) and replaces x,y,z and t in Eq. 22, one obtains Eq. 21.; and when replacing $x^{/},y^{/},z^{/}$ and $t^{/}$ in Eq. 21 by using the Lorentz transformation (Eq. 20), one obtains Eq. 22. For this reason it is postulated within the presently accepted mainstream physics literature, that one can write that:

$$(x^{/})^2 + (y^{/})^2 + (z^{/})^2 - (ct^{/})^2 = (x)^2 + (y)^2 + (z)^2 - (ct)^2 \tag{23}$$

It is, however, dangerous to equate two expressions which are both zero; as is done in Eq. 23. Generally when doing this, the result obtained is illogical-nonsense. It is thus highly doubtful that it can be correct in this instance. Furthermore, this symmetry is based on mathematical symmetry; and not on the fact that in terms of actual physics the Lorentz-transformation from $K^/$ to K is not the same as the Lorentz-transformation from K to $K^/$.

The argument used in text books to justify Eq. 23, is to postulate that a spherical light-wave is simultaneously emitted within both $K^/$ and K, at the instant $t^/=t=0$, by a single light source at the coinciding origins of the two reference-frames. Inherently it is thus assumed that this light source is simultaneously stationary within both $K^/$ and K. As already pointed out in section 5, this is not physically possible.

Eq. 23 is next invoked to conclude that there exists an actual space-time infinitesimal distance (ds) which can be obtained from the following equation:

$$(ds)^2 = (dx^/)^2 + (dy^/)^2 + (dz^/)^2 - c^2(dt^/)^2 = (dx)^2 + (dy)^2 + (dz)^2 - c^2(dt)^2 \qquad (24)$$

This distance supposedly defines a Minkowski space-time manifold which is then supposedly the physically-real space-time within which we really find ourselves when there is no gravity-field present.

But, all that Einstein added with his Special Theory of Relativity, is the postulate that the speed of light must be the same value c relative to any and all inertial reference-frames; no matter with what speed each is moving relative to the other. This did not make any of these reference-frames non-Newtonian as far as the concept of absolute time is concerned: It is still true that for an observer within any inertial reference-frame, each event occurs at a specific point x,y,z at a specific absolute time-instant t, which is exactly the same at all positions within the inertial reference-frame when this event occurs.

An inertial reference-frame can thus not be a physically-real Minkowski space-time[10)] in which time is an actual fourth coordinate which has actual different values at different positions. The Lorentz-transformation does not transform four actual coordinates $x^/,y^/,z^/,t^/$, from a space-time manifold $K^/$ into another equivalent space-time manifold K with actual coordinates x,y,z,t. It transforms primary physics-events within a Newtonian, inertial reference-frame $K^/$, in which time is the same at each and every position, into another passing, Newtonian, inertial reference-frame K, in which time is also the same at each and every position; and where the time-rates within $K^/$ and K are exactly identical. All that is obtained is that simultaneous events within $K^/$ cannot be observed simultaneously within K. To postulate that this defines an actual "space-time manifold" is daft.

If Einstein would have been alive today, he might have had mixed feelings after reading the arguments in this manuscript: Firstly, he might have been delighted: For many years (from about 1905 to at least 1912) he opposed the idea of a real Minkowski space-time. It probably did not help much that Minkowski called Einstein a "lazy dog" when Einstein studied mathematics under him in Zurich. But eventually, Einstein retreated and decided to base his arguments for developing his General Theory of Relativity, by accepting that Minkowski's space-time manifold really manifests physically.

Einstein should have known that his first instinct told him correctly that mathematics does not determine physics, but that mathematics is only the language used to model physics: Mathematics can lie and therefore it is actually physics that determines the mathematics that should be used. It is dangerous to conclude that when the mathematics is beautiful and "self-consistent", the physics it supposedly describes must be correct. In addition, as proved above, length-contraction does not occur (not even as a relativistic-illusion) and time is absolutely changing at the same rate within all possible inertial reference-frames: This mandates that, many, if not all, of

Einstein's arguments, which he used to extrapolate from Minkowski's space-time to reach the framework of non-Euclidean curved space-time, are wrong.

For example, after invoking his principle that gravitational mass and inertial mass are equivalent, and extending the principle of relativity "*to include bodies of reference which are accelerated with respect to each other*", Einstein considered the behaviour of clocks and measuring rods on a rotating body[17)]. He considered the case where the reference-frame $K^{/}$ is a disc which is rotating around a central axis as viewed from another inertial reference-frame K. The axis of the disc $K^{/}$ does not move in any direction within K.

An observer on the disc will experience a centrifugal force along the radius from the centre of the disc towards its periphery. According to Einstein's principle of equivalence, this observer will interpret his disc as being stationary and will thus have to ascribe this force to a gravity-force being present within his/her reference-frame; even though this "force of gravity" attracts him from the centre towards the periphery of his universe.

We will again quote Einstein directly: "*The observer performs experiments on his circular disc with clocks and measuring rods. In doing so it is his intention to arrive at exact definitions for the signification of time- and space-data with reference to the circular disc $K^{/}$, these definitions being based on his observations. What will be his experience in this enterprise?*"

"*To start with, he places one of two identically constructed clocks at the centre of the circular disc, and the other on the edge of the disc, so that they are at rest relative to it* (the disc). *We now ask ourselves whether both clocks go at the same rate from the standpoint of the non-rotating Galilean reference body K. As judged from this body, the clock at the centre of the disc has no velocity. Whereas the clock at the edge of the disc is in motion relative to K in consequence of the rotation. According to a result obtained in Section XII* (Einstein refers here to the formula for time-dilation), *it follows that the latter clock goes at a rate permanently slower than that of the clock at the centre of the rotating disc, i.e. as observed from K. It is obvious that the same effect would be noticed by an observer whom we will imagine sitting alongside his clock at the centre of the disc. Thus on our circular disc, or, to make the case more general, in every gravitational field, a clock will go more slowly or less quickly, according to the position in which the clock is situated (at rest). For this reason it is not possible to obtain a reasonable definition of time with the aid of clocks which are arranged at rest with respect to the body of reference. ...*"

"*Moreover, at this stage the definition of the space coordinates also presents insurmountable difficulties. If the observer applies his standard measuring rod (a rod which is short as compared with the radius of the disc) tangentially to the edge of the disc, then as judged from the Galilean system, the length of the rod will be less than L_0, since, according to Section XII* (Einstein here refers to the formula for length-contraction) *moving bodies suffer a shortening in the direction of motion. On the other hand, the measuring-rod will not experience a shortening in length, as judged from K, when it is applied to the disc in the direction of the radius. ………….This proves that the propositions of Euclidean geometry cannot hold exactly on the rotating disc, nor in general in a gravitational field…….*".

But are these arguments correct physics?: Firstly, even if one could use the formulas for time-dilation and length-contraction, these formulas had been derived for two inertial reference-frames moving linearly relative to one another: In fact, <u>only in this case</u> do the equations of the Lorentz-transformation actually apply. In contrast, the periphery of the rotating disc $K^{/}$ does not follow a linear path within K. It is thus dubious whether the same formulas will apply. But even more damning, as argued above, the formula derived for length-contraction can never apply, since, even for linear motion, length-contraction does not occur at all: There is no length-contraction whatsoever (not even a relativistic-illusionary one) which will mandate that non-Euclidean geometry must be used to model three-dimensional space.

Let us assume, that in contrast to length-contraction, the formula for time-dilation does apply on the rotating disc, then, in order for an observer in K to conclude that a clock on the periphery of the rotating disc $K^{/}$, is running slower, he/she must first synchronise his/her clock with the clock on the periphery of $K^{/}$ when these two clocks pass each other. At this very instant in time the direction in which the clock, on the periphery of the disc, moves, lies within the future of the observer in K, while the direction along the periphery from which the clock came, lies into the past of the observer in K. (see section 3 above). Thus on the opposite side of the periphery the past and future must meet up. I doubt that this is possible at all.

Thus, it is highly unlikely that these arguments by Einstein can be the reason why time slows down within a gravitational field. There must be another reason than a relativistic effect for this to occur. It can only be the result of the inherent properties of a gravitational field, which Einstein, in the case of the rotating disc, claimed is physically exactly the same as the presence of a centrifugal force.

The fact is that all these arguments were conceived by Einstein with the sole purpose of justifying his subsequent use of curved space-time coordinates to model gravity. Amazingly, it seems as if the complicated equations that he derived in this way, do model many aspects within our universe quite well. But are the arguments that Einstein used, like the rotating disc, really required to arrive at the conclusion that curved space-time must be used to model gravity? Do these arguments really lead logically from the Special Theory of Relativity to a General Theory of Relativity, and then, along this route, to an apparently correct model for gravity?

This brings us to the following question: Is an accelerating reference-frame really equivalent to a gravitational field? In the sense that an observer within the accelerating reference-frame can ascribe the acceleration to being a gravity field, he/she might conclude that his/her reference-frame is stationary; just as the observer within a Galilean reference-frame concludes that he/she is stationary, but without a gravity-field being present. This dovetails neatly with Galileo's original arguments.

Einstein's argument that a reference-frame in free fall is relativistically equivalent to an inertial reference-frame which moves with a constant speed outside a gravity field has merit since, in the this case, both observers do not experience a force, and both conclude that it is the other reference-frame which is accelerating. The situation is physically symmetric as far as the two observers within $K^{/}$ and K are concerned.

Consider again two spaceships passing each other, but in this case the space-ship K is accelerating owing to free fall along the direction $-x^{/}$ relative to $K^{/}$. Although it is the observer in K who is really in free fall, he/she will conclude that it is the spaceship in $K^{/}$ which is in free fall relative to him/her along the x-direction. Let us assume that at the very instant that the two observers within K and $K^{/}$ synchronise their clocks, the reference-frame K starts to accelerate away from $K^{/}$ by going into free fall with an acceleration equal to a; and that also at this very same instant a vertical light-beam is switched on within $K^{/}$ along the $y^{/}$-axis. The light-beam must go straight upwards within $K^{/}$ since $K^{/}$ is an inertial reference-frame which is not accelerating (see Fig. 2a which is identical to Fig. 1(a)). The observer within the free-falling reference-frame K must, however, observe this light to follow a curved path as illustrated in Fig. 2(b).

According to Einstein's postulates for the Special Theory of Relativity, the speed of light relative to K must remain c. As shown in Fig. 2(b), the slope of this path must thus be everywhere proportional to c: i.e. for a time-differential dt, the infinitesimal distance moved by the front of the light-beam along this path must be c(dt). Along the vertical direction the concomitant infinitesimal distance is $c(dt^{/})$ and along the horizontal direction it is, owing to the acceleration a, equal to at(dt). According to the theorem of Pythagoras one must then have that:

$$c^2(dt)^2 - (at)^2(dt)^2 = c^2(dt^{/})^2 \tag{25}$$

which leads to:

$$dt = \frac{dt^{/}}{\sqrt{1-\left(\frac{at}{c}\right)^2}} \tag{26}$$

The free-falling observer in K will conclude that within the non-accelerating, inertial reference-frame $K^{/}$ the light is forming a curved path, and that all the clocks within $K^{/}$ are slowing down with increasing time as measured on the clock within K, until after a critical time t_C, at which $at_C=c$, they all stop completely. As we know, acceleration changes with time when the same force accelerates a body with mass, since the inertial mass of the body within K increases with speed. Nonetheless when the speed of $K^{/}$, as measured within K, approaches the speed of light, the clocks in $K^{/}$ will, according to an observer in K, slow down towards stopping.

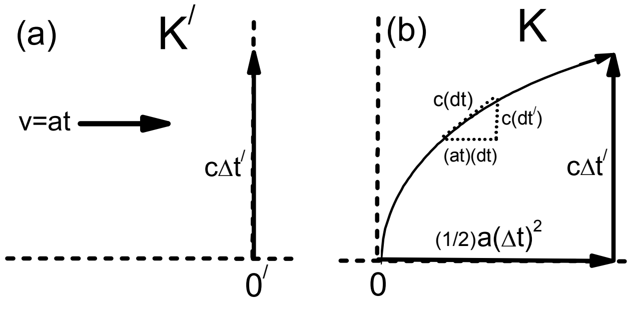

Figure 2: The case where a reference-frame K is accelerating owing to being in free fall relative to an inertial reference-frame $K^{/}$: An observer within K will, however, be of the opinion that it is $K^{/}$ that is accelerating away from him/her: (a) A light-beam is switched on into the vertical direction within $K^{/}$ (see vertical arrow). Since K is accelerating away from $K^{/}$, the relative speed of $K^{/}$ is after a time interval Δt equal to v=a(Δt) , and the distance between the two inertial reference frames is $\frac{1}{2}a(\Delta t)^2$: (b) Within K, the vertical light-beam within $K^{/}$ is thus seen to curve.

Obviously, the curvature and the concomitant, continuously-decreasing time-dilation observed within K cannot be caused by any acceleration of $K^{/}$ itself, since $K^{/}$ is an inertial reference-frame which is not in free fall and is thus not accelerating at all: What is observed within K to occur within $K^{/}$, is actually the result of K being in free fall.

But since an observer within K is of the opinion that it is $K^{/}$ that is in free fall, one expects from relativistic symmetry that an observer within $K^{/}$ will in turn conclude that light is bending and time is rapidly going to zero when a light-beam is switched on vertically within K: If this is the case, and it seems compelling that it must be the case, it implies that even though K is accelerating, light still moves within it as if this reference-frame is uniquely stationary. Furthermore, even when the acceleration of the spaceship K is caused by its engines, one expects the same result as in the case of free fall. In both cases a force is acting on the spaceship within K: The only difference is that the observer within the spaceship K will be either weightless (in free fall) or feeling that he/she has weight (when the spaceship is accelerated by its engines).

It is thus compelling to conclude that the acceleration of an inertial reference-frame does not cause light to bend within such an accelerating reference-frame. This implies that, if Einstein's conclusion that such acceleration is the same as a field of gravity is correct, light should also not bend within a gravitational field: However, all experiments that have been done to date have confirmed that light does bend within a gravitational field. If these experimental measurements hold up, it must mean that Einstein's postulate that inertial acceleration is actually the same as gravity, must be wrong: Although one can argue that an observer within an accelerating reference-frame may conclude that his reference-frame is stationary, and therefore the force he/she feels is a gravity-field; the latter field cannot be identically the same as an actual gravity-field.

There can thus not really be any slowing down of any clock within K which can be caused by the engines of the spaceship within K accelerating this spaceship. Thus, an accelerating clock also does not slow down, but must keep exactly the same absolute time that all clocks are keeping, whether stationary, moving with a constant speed, or even accelerating. Actual time-dilation cannot be caused by any motion of a clock whatsoever. It remains a type II relativistic-illusion, whatever the clock's motion is, or might be.

The curvature observed from K' for light within K (or *vice versa*) is a Type I relativistic-illusion and can thus not be used to explain why light will actually follow a curved path within a gravitational field. Thus, the curving of starlight around the sun cannot be a relativistic effect. In fact, when starlight curves around the sun, then, according to Einstein's equations for gravity, the speed of this light is not constant along the curved path it is following; as it should be if it were a relativistic effect.

If it pans out that Einstein made the correct decision to use curved space-time, then the evidence is compelling that he reached this decision by arguing physics which is not required to reach this conclusion; just as he had done when he explained non-simultaneity. This indicates that curved space-time does not relate to relativistic effects at all; but might be required for another reason when gravitational forces are included.

It might indicate that rigid reference-bodies with mass do not really exist. In this respect, Feynman[18)] made an interesting observation in his famous lectures when he discussed Einstein's General Theory of Relativity: "*Einstein said that space is curved and that matter is the source of curvature. Let us suppose, to make things a bit easier, that matter is distributed continuously with some density, which may vary, however, as much as you want from place to place……*". And then he added a footnote: "*Nobody-not even Einstein-knows how to do it if mass comes concentrated at points.*" So, Einstein's theory of gravity does not tolerate the concept of "particles"! If this is correct, then it is not really surprising that Einstein's gravity and quantum field theory are incompatible.

Add the latter conclusion to another sentence by Einstein[19)]: "*For this reason non-rigid reference-bodies are used, which are as a whole not only moving in any way whatsoever, but which also suffer alterations in form during their motion*", then it seems compelling that matter must consist of matter-fields within which mass is continuously distributed.

Must this then not also be the case for a single electron? The latter can then not be a point of mass: Its mass must then be distributed within a three-dimensional matter-field, which curves space-time. Einstein's theory of gravity might thus be more closely related to Schrödinger's wave-mechanics[20] than to his own Special Theory of Relativity: Provided, of course, that the intensity of a Schrödinger wave is not a probability distribution, as is at present advocated within the mainstream physics literature; but rather a distribution of mass and its concomitant curved space. Waves do "*suffer alterations in form during their motion*". An electron is then, within its primary, inertial reference-frame, a localised, stationary mass-energy field that curves space-time.

It seems reasonable to assume that such a mass-gravity field for a solitary electron within its inertial reference-frame will have a Gaussian-distribution within three-dimensional space: i.e. this intensity-distribution must then be the mass and gravitational curvature around the mass of the electron. The "tunnelling-tails" of a stationary electron-wave probably have nothing directly to do with tunnelling whatsoever, but could be the curvature of space-time.

It is known that a stationary electron-wave, for example an electron orbital around a nucleus, can absorb a light-wave. To achieve this, the light-wave must stop in its tracks in order to entangle with the stationary electron-wave to increase its stationary energy. This mandates that the energy of the light-wave (which has no rest-mass) transmutes into rest-mass energy which adds to the rest-mass energy of the electron. And this might mean that when a light-wave approaches a matter-wave, it slows down within the concomitant gravitational field of the matter-wave as it approaches the interface to form mass-energy. When the speed of light slows down, for example when a light-wave enters a glass block, the light refracts (it bends). Thus, the bending of starlight around the sun is most probably caused by refraction within the gravity-field of the sun: Not by any relativistic effect at all.

There is another interesting possibility to this scenario: As already surmised, one expects that within its own inertial reference-frame (say $K^{/}$) a stationary electron-wave should have spherical, Gaussian-symmetry. This means that the phase angle of this wave-field is at every point within the wave exactly the same at any instant in time. But when, within K, the electron-wave is moving with a speed v, the relativistic-effect of this motion can be derived from the Lorentz-transformation: This means that within K the electron-wave becomes longer along the direction into which it is moving <u>and</u> the time changes with position along this increased length (see section 4 above). This, in turn, means that the phase angle of the electron-wave now changes with position along the direction in which this wave-field is moving within K, so that the electron, although still moving like an entity with a centre-of-mass, develops crests and troughs within K: i.e. it forms a coherent wave along the direction in which it moves. This allows the moving electron to diffract when it encounters suitable boundary conditions. It also means that the de Broglie[21] wavelength is a Type I relativistic-effect. This is not really surprising, since momentum which defines this wavelength is also a Type I relativistic effect.

If the latter deduction is correct, it implies that the de Broglie wavelength does not play any role when the electron-wave is a stationary wave. This possibility is not really surprising since a stationary electron has zero momentum: Zero momentum will require that the de Broglie wavelength must be infinitely long; which is not possible within our universe. This, in turn, implies that Schrödinger's equation for a stationary electron-wave should not be based on de Broglie's momentum-wavelength relationship at all.

One expects that the Schrödinger equation should be amended so that it does not have the rest-mass of the electron as an input, but rather have the rest-mass as the solution for the energy that one obtains when solving such an equation within the primary, inertial reference-frame of the electron: i.e. within the reference-frame within which a solitary electron is stationary. This means that such an equation will not be based on a Hamilton-operator determining the wave-function; since such an operator already contains the rest mass of the electron as an input, instead of rendering it as the solution.

A matter-wave could thus be a "light-wave" which moves at a speed which is less than the speed of light c, so that for this reason it has rest-mass energy in addition to having kinetic energy. This supposition is supported by the fact that a neutrally-charged light wave, which has a suitable energy, can disentangle into an electron (having a negative charge) and a positron (having a positive charge). It might thus be possible to find a more general Schrödinger equation by using Maxwell's equations as a starting point: Such a wave equation should be automatically commensurate with the Special Theory of Relativity without having to take the square root of a Hamilton-operator as Dirac[22)] did when he postulated his relativistic wave-equation for the electron.

7. Conclusion

It has been found in this analysis that, when deriving relativistic effects meticulously from the Lorentz-transformation, it proves that Einstein's own explanation of non-simultaneity violates his own postulates on which his Special Theory of Relativity is based. It also proves that time-dilation is a Type II relativistic-illusion; in the sense that a moving clock does not actually keep time at a slower rate than another clock relative to which it is moving: Time changes at exactly the same rate on all identical clocks at any position within any inertial reference-frame, and even when a clock is accelerating. The results also indicate that Einstein's logic, based on his Special Theory of Relativity, in order to develop his Theory of Gravity, are fundamentally flawed, and that the reason why curved space-time must be used to model gravity is, most probably, mandated by the wave-nature of matter.

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