On the derivation of the Lorentz-transformation

Johan F Prins

CATHODIXX

8 Portland Place, Northcliff ext. 15, Johannesburg 2195, South Africa

johanprins@cathodixx.com

Abstract

The conventional way to derive the equations of the Lorentz-transformation is done by linearly equating two mathematical expressions which are both equal to zero. If such a derivation could be valid, the Lorentz-transformation should not be a mathematically-isomorphic transformation which maps the coordinates of a single space-time coordinate-point into the coordinates of another unique space-time coordinate-point. Since it is known that the Lorentz-transformation actually does the latter, an alternative derivation for these equations is proposed: Although the Lorentz-equations, derived in the latter manner are mathematically isomorphic, as they must be, it is found that the untransformed space-time coordinate-point and its transformed space-time coordinate-point are not coincident; and thus do not define an invariant space-time point within a four-dimensional space-time manifold. Furthermore, the physics involved restricts this isomorphism to be unidirectional: i.e. the Lorentz-transformation only applies when transforming the three-dimensional (3D) space-coordinates and the time of (what will be called) a primary-event, from within (what will be called) the primary-event's proper inertial reference-frame (IRF), into the space-time coordinates of a concomitant non-primary event within another IRF, relative to which the proper IRF of the primary-event is moving. As required by Galileo's concept of relativity, the the non-primary event is caused by the primary-event and therefore the coordinates of the non-primary event cannot be transformed back into the coordinates of the primary-event which is causing the non-primary event.

PACS numbers: 03.30.+p, 06.30.Ft

1. Introduction and background

The equations, which are known as the Lorentz-transformation, had already been discovered before Einstein formulated his two postulates in 1905 which defined his Special Theory of Relativity [1]. Before then, the Lorentz-transformation had been justified by assuming that a rod contracts in length when moving through the ether; where the latter had been believed to be the stationary medium within which light-waves are formed and through which these waves are propagating. In order to formulate his two postulates, Einstein had to reject the existence of the ether. The latter postulates can be summarized as follows:

(i) First postulate (principle of relativity):

The laws of physics are the same in all inertial reference-frames.

(ii) Second postulate (invariance of light speed c):

The speed of light in free-space has the same value c in all inertial reference-frames.

The first postulate justifies the validity of the second postulate; and the second postulate provides the fundamental reason why the equations of the Lorentz-transformation must be what they are.

In conformation with Einstein's derivation [1], textbooks assume that there are two three-dimensional inertial reference-frames (IRF's): An IRF=K (with Cartesian coordinates x, y, z) and an IRF=K' (with Cartesian coordinates x', y', z'), which have parallel coordinate-axes and which are moving with a speed v along their coincident x- and x'-directions relative to one another. To obtain the Lorentz-equations, the origins 0 and 0' of these coordinate-systems are chosen to coincide at the instant that a single spherical wavefront of light is emitted from this coincident point. At this same instant in time, a perfect clock at 0 within the IRF=K, and another perfect clock at 0' within the IRF=K' are synchronized to both read t=t'=0. Note that this motion is relative, so that either one of the IRF's can be chosen to be the stationary IRF and thus the other IRF to be the moving IRF.

Since, according to Einstein's second postulate, the speed of light must be the same within both inertial reference-frames, the emitted spherical wavefront, from the coincident origins 0 and 0' at the time t=t'=0, must move away from each origin 0 and 0' with the same speed c. Einstein reasoned (and it is still reasoned at present in all text books) that the clocks within the IRF=K and the IRF=K' must, after synchronization, respectively keep time at different rates. It should be noted that this is an *a priori* assumption which does not follow logically from Einstein's two postulates: Even though Einstein subsequently derived a formula for such a time-rate difference from the Lorentz-equations (which he called "time-dilation"), it is circular reasoning to argue that since a time-rate difference can be justified in terms of the Lorentz-equations, this time-rate difference can, in turn, be used as a starting point to derive the Lorentz-equations.

The Lorentz-equations should first have been derived without making this assumption, and only **then** it should have been proved that these equations demand a time-rate difference. Therefore, the assumption of different time-rates within IRF=K and IRF=K', in order to derive the Lorentz transformation, should have been a third postulate by Einstein; and not a subsequent derived-result from these equations. Nonetheless, according to this unpostulated circular-assumption, it has been reasoned by Einstein (and since then by all mainstream physicists) that this spherical wavefront, which manifests

simultaneously around 0 and around 0' respectively, must be given in terms of two different times, t and t', within IRF=K and IRF=K' respectively: So that one can write for each respective manifestation of this wavefront that:

$$x^2 + y^2 + z^2 = (ct)^2 \tag{1a}$$

And

$$(x')^2 + (y')^2 + (z')^2 = (ct')^2 \tag{1b}$$

As can be found in textbooks (see for example [2,3]) it is then reasoned that these two expressions must be linearly proportional to one another; so that one can write that:

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

Eq. 2 has since 1905 been used as a template to derive (or should one rather use the word contrive?) the equations of the Lorentz-transformation. By using the imaginary number $i = \sqrt{-1}$, Eq. 2 can be written as:

$$x^2 + y^2 + z^2 + (ict)^2 = (x')^2 + (y')^2 + (z')^2 + (ict')^2 \tag{3}$$

It is well-known that mathematically one can have a four-dimensional (4D) manifold within which a 4D vector **s** gives the position of a 4D single point relative to the 4D origin 0 of a reference-frame for the manifold. This **same** four-dimensional point can be referenced by two sets of 4D Cartesian coordinate axes: One with an origin 0 and another with an origin 0': The mathematical transformation, from one coordinate-point (x', y', z', u') within a four-dimensional reference-frame (4DRF=K') into its concomitant coordinate point (x, y, z, u) in the reference-frame 4DRF=K, is isomorphic since these points are uniquely related to one another through the transformation-equations. In the case of a 4D manifold this unique relationship is automatically ensured since the two coordinate-points are those for the **same** 4D point within the 4D manifold: i.e. the two 4D coordinate-points **coincide** within the 4D manifold.

When the two different reference-frames, each with Cartesian coordinate axes, are obtained by a rotation within four-dimensions around a coincident 4D origin 0=0', one can write in terms of the magnitude s of the vector **s** of a point, that:

$$s^2 = x^2 + y^2 + z^2 + u^2 = (x')^2 + (y')^2 + (z')^2 + (u')^2 \tag{4}$$

The vector **s** remains the same vector when the coordinates are transformed from one reference-frame into the other reference-frame, and it is thus invariant when the coordinates of a 4D point (x', y', z', u') within 4DRF=K' are transformed into the coordinates (x, y, z, u) within 4DRF=K of the same point in the 4D manifold that is denoted by the invariant vector **s**. Obviously s and s^2 also remain invariant. This invariance is mandatory for a transformation to be a rotational coordinate-transformation in four-dimensions. When the transformation is invariant within four-dimensions, the coordinate transformation-operator is a 4x4 orthonormal matrix which has an inverse matrix. Thus, one can either transform the coordinates (x', y', z', u') of a point within 4DRF=K' into the coordinates (x, y, z, u) within 4DRF=K of the same point, or use the inverse matrix to transform the coordinates (x, y, z, u) within 4DRF=K of a point into the coordinates (x', y', z', u') within 4DRF=K' of the same point.

When the two 4D Cartesian reference-frames have non-coincident origins, the vectors **s**' and **s** within each reference-frame, which reference the same 4D point, are not invariant: However, since they are the position-vectors of the same **coincident** coordinate-points within 4DRF=K' and 4DRF=K, the latter point can be considered as being an "invariant-point" (the same point) within the 4D manifold. It is thus also in this case mathematically possible to have a coordinate-transformation which is isomorphic and which has an inverse transformation.

Owing to the similarity of Eq. 4 to Eq. 3, it has been argued by Minkowski [4] that the Lorentz-transformation is a 4D rotational coordinate-transformation which maps the 4D coordinates (x', y', z', ict') as referenced within a 4D space-time reference-frame STRF=K' (with four orthogonal Cartesian coordinate-axes) in a one-to one manner onto the space-time coordinates (x, y, z, ict) within another 4D space-time reference-frame STRF=K (also with four orthogonal Cartesian coordinate axes). Since the Lorentz-transformation has been interpreted as a rotation within a 4D space-time manifold, it has been concluded that this isomorphism defines invariant vector-positions for each space-time point. Thus, it has been accepted for more than 100 years that the two corresponding sets of coordinates (x', y', z', ict') and (x, y, z, ict) must be the coordinates for the same invariant vector-position of a point within a four-dimensional space-time manifold; and therefore the coordinate-transformation must have an inverse transformation.

Equations have thus also been derived from Eq. 3 for the inverse Lorentz-transformation, which maps the space-time coordinates (x, y, z, ict) within STRF=K, in a one-to-one manner back onto the corresponding space-time coordinates (x', y', z', ict') within STRF=K', which is referenced by the same invariant four-dimensional vector **s** within a space-time manifold. That there must be such an inverse coordinate-transformation, is justified in textbooks by showing that when you use the Lorentz-transformation from (x', y', z', ict') to (x, y, z, ict) in order to replace the coordinates within Eq. 1a, one obtains Eq. 1b, and when using the inverse Lorentz-transformation from (x, y, z, ict) to (x', y', z', ict') in order to replace the coordinates within Eq. 1b, one obtains Eq. 1a. This postulated, four-dimensional space-time is at present known as a Minkowski space-time manifold.

The use of Eq. 1a and Eq. 1b in order to obtain Eq. 2 and Eq. 3 is, however, mathematically suspect, since one is equating two expressions which are each separately, on its own, equal to zero. Equating a mathematical expression which is zero to another mathematical expression which is separately also zero is, in most cases, tantamount to dividing by zero: When doing this, one usually obtains an indefinite result. This can also be seen as follows: Eq. 2 implies that **any** point on the spherical wavefront, as referenced within the (say) IRF=K', corresponds to **any** point on the spherical wavefront, as referenced within the IRF=K. This means that a single point, of all the coordinate-points on the wavefront as referenced around (say) 0' within IRF=K', relates simultaneously, in a one-to-one manner with each and every one of all the points on the wavefront as referenced around 0 within

IRF=K. This, in turn, means that the untransformed coordinates of a single space-time point on the wavefront, as referenced within its corresponding four-dimensional STRF=K', are not restricted to transform into **only one** of the space-time coordinate-points that is on the wavefront, as referenced within another four-dimensional STRF=K. Such a transformation can thus not be an isomorphic transformation.

In contrast, it is known that when using the equations of the Lorentz-transformation to transform an event which is occurring at a time t at a spatial coordinate-point within an IRF into another IRF, relative to which it is moving, the untransformed and transformed space-time coordinates of this event, do actually form a unique pair of space-time coordinates: i.e the transformation **must** be isomorphic. This is strong evidence that Eq. 2 cannot be the "template-generator" for the equations of the Lorentz-transformation. There must be another way to derive the equations of the Lorentz-transformation so that it will be clear from such a derivation that these equations actually do only map the space-time coordinates of a single coordinate-point within one IRF into a unique, single space-time coordinate-point within the other IRF.

Einstein's second postulate clearly states that the speed of light must be the same within all IRF's. This must surely mean that when a spherical wavefront is emitted at the coincident origins 0 and 0' of two IRF's, an observer at 0 (OBS=K) will see this spherical wavefront receding from him/her within his/her IRF=K with a speed c; and an observer at 0' (OBS=K') within his/her IRF=K' will likewise see this **same** spherical wavefront receding from him/her at the same speed c. This logical deduction from Einstein's two postulates **does not** demand that the clocks of the two observers must keep different time-rates. In fact, one rather expects that the clocks should keep the exact same time so that after a time t=t' the distance of this wavefront in any direction, as it manifests within each of the two IRF's, should be exactly the same when measured from each origin. If this is not the case, the physics will be different within these IRF's, and this will be in violation of Einstein's first postulate.

Furthermore, it is also well-known that within a four-dimensional manifold, referenced by two Cartesian coordinate-systems which are rotated relative to one another around the same origin 0=0', the 4D position-vector **s** of an invariant point **can only** be zero when one has that x=y=z=u and x'=y'= z'=u'=0: i.e. in terms of mathematical jargon the coordinates **must** be linearly-independent. In contrast the coordinates (x, y, z, ict) and (x', y'; z', ict') are not each equal to zero for the expressions in Eq. 1 to be valid, even though each quadratic expression, after moving the time-related coordinate to the other side of the equation, is separately zero. This means that the coordinates of a Minkowski space-time manifold cannot be linearly independent, and that therefore the concept of a Minkowski space-time manifold is most probably mathematically, and thus also physically, impossible.

In the exploratory investigation reported here, the opposite *a priori* assumption will be made than the one that Einstein had made in 1905: It will be assumed that the two perfect clocks, after their synchronization, keep simultaneously the exact-same time ever after. If this assumption proves to have merit, the expressions in Eq. 1 must be written for any time t=t'≠0 that:

$$x^2 + y^2 + z^2 = (ct)^2 \tag{5a}$$

And

$$(x')^2 + (y')^2 + (z')^2 = (ct)^2 \tag{5b}$$

To ensure that: $$t = t' \tag{5c}$$

There have been many publications questioning the validity of the interpretation of the Lorentz-transformation in terms of the deductions that Einstein's had made from his Special Theory of Realtivity: Especially the concepts of "time-dilation" and "length-contraction". Many of these publications have been based on wrong logic, and even anti-Semitic, political assaults on Einstein. But some of them, notably those by Dingle [5], have posed dilemmas which have not yet been satisfactorily answered by anybody. Hopefully the alternative derivation of the Lorentz-transformation presented here, even if it could also turn out not to be the best way to derive the Lorentz-transformation, might open up useful new insights when compared to the derivation based on the *a priori* assumption that time-dilation must occur.

2. Emitting a spherical wavefront at the coincident origins

Consider again a spherical wavefront which is emitted at the time t=t'=0 when the origins 0 and 0' of the IRF=K and the IRF=K' coincide. If, as assumed above, both clocks keep synchronous time so that t=t' for all time after their synchronization, this **single** wavefront will at any time t>0 manifest as two separate, but identical wavefronts around 0 and 0'. The **same** wavefront, after an elapse of time t≠0 on both clocks, is shown in Fig. 1 by two dashed circles: Coordinates $r = \sqrt{y^2 + z^2}$ and $r' = \sqrt{y'^2 + z'^2}$ are used in order to emphasise that these spatially non-coincident circles are actually spheres.

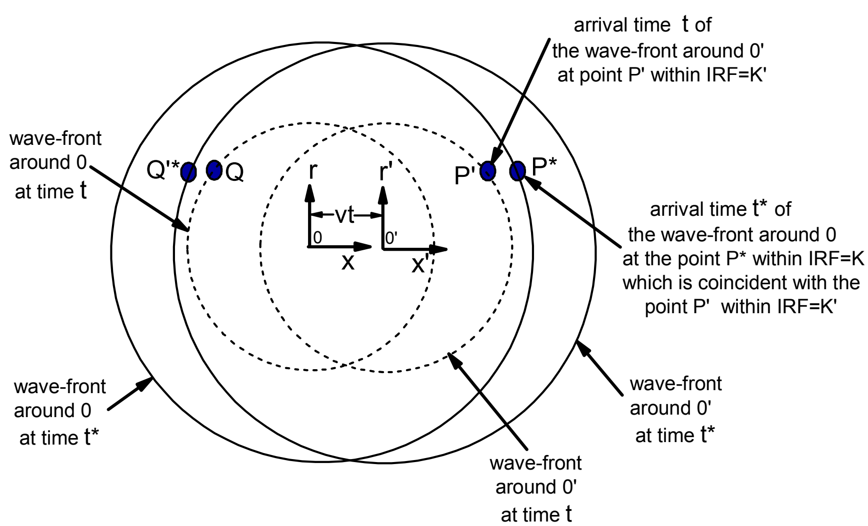

Figure 1: An emitted wavefront (dashed circles) as observed around the origins 0 of an IRF=K and 0'of an IRF=K', after these origins have moved a distance vt apart. Although it seems that it is now two wavefronts, it is actually the same single wavefront that is manifesting within the two separate IRF's. The solid circles are this same wavefront as seen around 0 and 0' at a later time t after the origins 0 and 0' have moved an increased distance vt* apart.*

It must be emphasised that the two dashed-spheres in Fig. 1, which at the same instant in time t are **non-coincident** in space, constitute the **same single** spherical wavefront which manifests within the two different IRF's at the same time t: But since there can only be a single wave-front, the manifestation around 0 within the IRF=K (which will be called the wavefront=K) does not occur within the IRF=K'. Similarly, the manifestation around 0' within the IRF=K' (which will be called the wavefront=K') does not occur within the IRF=K.

Consider a wavefront-detector which is stationary within the IRF=K' at a point P' at a position with coordinates (x', r') within IRF=K': Since this detector is stationary within IRF=K' we will call the latter IRF this detector's proper IRF. Assume that the wavefront=K' reaches the coordinate-point P' of the detector at the time t on both clocks (see Fig. 1). When the time increases further, this wavefront=K' expands further while the detector-position P', with coordinates (x', r'), remains stationary within IRF=K': But the coordinate-position of this detector is not stationary within the IRF=K.

The coordinate-point P(t) within the IRF=K, which is coincident with the stationary coordinate-point P' of the detector within IRF=K', changes with time within the IRF=K in order to stay coincident with the stationary coordinate-point P' within the IRF=K'. It means that there must be a stationary coordinate-point $P_I=(x_I, r_I)$ within IRF=K which is coincident with the stationary coordinate-point P'=(x', r') of the detector within IRF=K', when the wavefront=K' reaches this detector at the instant in time t. From this perspective it means that the arrival of the wavefront=K' at the detector is actually occurring coincidently and simultaneously within both IRF=K' and IRF=K since P' and P_I actually do coincide at the time t: However, since the wavefront=K' does not manifest within IRF=K, this event cannot be recorded within IRF=K at the time t at which it manifests within IRF=K'.

At the instant in time t on both clocks, at which the wavefront=K' reaches the detector within the IRF=K', the wavefront=K within IRF=K has a maximum reach from 0 which is given by the radius ct of this wavefront around 0 at the time t. The event at point P' (see Fig. 1), when the K'-wavefront reaches the detector, can thus not be time-referenced on the wavefront=K at that same instant in time t; since there is no point on the wavefront=K that is in coincidence with the point $P_I=(x_I, r_I)$ within IRF=K. The event can only be time-referenced relative to 0 once a point on the wavefront=K reaches the position-coordinates P*=(x*, r*), where the point P* within IRF=K is coincident with point P' of the detector within IRF=K': And this is only possible at another time t*. Thus, the two manifestations of the same wavefront within IRF=K' and IRF=K reach the same detector at two **separate** times t and t*, each of which is simultaneous on both clocks within IRF=K' and IRF=K.

Another detector can be be chosen to be stationary at a point Q, but now within IRF=K: i.e. IRF=K is now the proper IRF of the latter detector. In Fig.1 this detector has been chosen to be symmetrically situated from the detector at P' within IRF=K' when the origins 0 and 0' coincide: In this case, the wavefront=K around 0 within IRF=K, will reach this stationary detector, at point Q within IRF=K, at the same time t that the wavefront=K' reaches the stationary detector at P' within IRF=K'. In turn, the wavefront=K' will reach the detector which is stationary within IRF=K at a coordinate position Q'*=(x'*, r'*) within IRF=K' at another time t'*. Note that owing to the symmetrical positions of the two detectors, which have been chosen in Fig. 1 to be stationary within IRF=K' and IRF=K respectively, one must have in this specific example that r'*=r* and t'*=t*.

Since the wavefront=K', emitted at the origin 0' within IRF=K', reaches the stationary-detector within IRF=K' at a time t, and the wavefront=K emitted at the origin 0 within IRF=K reaches the same detector at a later time t*, this implies that the same detector should detect the same wavefront at two different times. It is, however, well known that a detector can only detect the same wavefront once; no matter how fast the detector is moving relative to any other IRF.

We also know experimentally that when a source and a detector are co-stationary, the emitted wavefront **must** be recorded by the detector when it reaches the detector. This can be verified by having a detector attached to a recorder, and then afterwards walking from the source to the detector and checking the time at which the event was recorded after the wavefront=K' has been emitted. The wavefront=K' is emitted from 0' which is stationary relative to the detector within IRF=K': The origin 0' thus acts as a stationary source within IRF=K' for this wavefront=K'. Therefore it is compelling to argue that the wavefront=K' which is spreading out from the origin 0' **must** be recorded by the co-stationary detector at point P' at the instant in time t.

This means that when the wavefront=K reaches this detector, which is stationary at point P' within IRF=K', at a later time t*, it cannot be detected by this detector for two reasons: (i) It is the same wavefront that the detector has already detected; (ii) This wavefront is not manifesting within the IRF=K' within which the detector is stationary since it has been emitted from the point 0 which is not co-stationary with the detector within IRF=K': However, an observer within IRF=K, will be convinced that the detector should have detected the wavefront=K at time t*, since according to him/her the wavefront=K only reaches this detector at the time t*.

It is of course possible for the observers to communicate by radio. Assume that OBS=K' reports to OBS=K that the wave-front reached the detector at time t. One can imagine the following conversation if they did not expect this result: OBS=K: It is impossible that you could have recorded the time t since the wavefront only reached the detector at a later time t*: Your clock-rate must thus be slower than mine. OBS=K': That is impossible since we both have the best identical clocks in the universe: Furthermore I have walked to the detector and checked, while you cannot do this: So you must be wrong. OBS=K: Well, by good luck it just happened that I have had a stationary detector that coincided with your detector when the wave-front reached both detectors simultaneously: I walked over to my detector and it recorded t*. Is it maybe possible that, owing to the fact that you are moving away from me, your clock actually keeps time at a slower rate than my clock? OBS=K': Rubbish! Our motion is relative: You are also moving away from me as if I am stationary: This must then surely imply that your clock should also keep time at a slower rate than my clock. Etc. etc. etc. Hopefully (after 100 years?) they will realize that what is really happening is that the positions in space at which the wavefront=K and wavefront-K' reach the detector are not coincident, since the two manifestations of the same wavefront is not simultaneously coincident within IRF=K and IRF=K'. The clocks actually keep the exact same time.

In order to distinguish the real detection-event at time t within IRF=K' from the detection event at time t*, as deduced from within IRF=K, the detection-event at time t will be called a primary detection-event at the position of the detector within its proper IRF=K'. When the wavefront=K reaches this detector, the wavefront=K cannot be detected and recorded by this detector; so that when it arrives at the detector within IRF=K its detection will be a non-event. But this non-event is referenced by the arrival of the wavefront=K at the detector within IRF=K' at the time t*. Thus, the arrival of the wavefront=K' at the detector within IRF=K' is the primary arrival-event of the wave-front at the detector and the arrival of the wavefront=K at the detector is the non-primary arrival-event of the wavefront at this same detector that is moving relative to the emitting point 0 of the wavefront=K.

When, however, the wavefront=K reaches the detector which is stationary at a point Q within IRF=K, it reaches a detector which is stationary relative to the origin 0 at which the wavefront=K had been emitted. Thus, this wavefront will now be detected by this detector within IRF=K, while the K'-wavefront will not be detected when it reaches this detector at point Q'* within IRF=K', even though from the perspective within IRF=K' it should have been detected. Thus, in this case the primary-arrival, which results in an actual detection-event, occurs when the wavefront=K reaches this detector at time t, and the non-primary arrival which results in non-detection occurs when the wavefront=K' reaches this same detector at the time t*.

Does this mean that when a light-source and a detector are not co-stationary, an emitted wavefront will not be detected? We know experimentally that the latter is not the case. The fact is that up to now, the position of the actual light-source when it emits the wavefront at the position where the origins 0 and 0' coincide at time t=0, has not been specified. In fact, in this specific example, it need not be specified since the position of the source, when it emits the wave-front, is instantaneous-simultaneously at the coincident origins 0 and 0'. The actual light-source can thus be stationary within IRF=K or it can be stationary' within IRF=K', without affecting the conclusions which have been reached so far. Therefore, in this specific case, the proper IRF of the light-source, within which this source is stationary, can be either the IRF=K or the IRF=K'.

But this can only be so at the position and time t=0 at which 0 and 0' coincide (see section 4.3). If the source is stationary within IRF=K', this source emits the wavefront=K' within IRF=K', which in turn, causes the non-primary emission of a wavefront=K within IRF=K. The emission of the wavefront=K' within IRF-K', from a source that is stationary within IRF=K', will thus be called a causal event. The concomitant appearance of the K-wave-front within IRF=K, will be called a caused event: The reason is that it will not be emitted within IRF=K when the wavefront=K' is not emitted by the actual source within its proper IRF=K'. Similarly, a source that is stationary within IRF=K can emit a wavefront=K which causes a wavefront=K' within IRF=K'.

The causal emission of the wavefront=K' within IRF=K', is thus a primary-event within the proper IRF=K' of the light-source, which causes the non-primary-emission of the wavefront=K within IRF=K. But although, the emisssion of the wavefront=K within IRF=K is a non-primary-event, the wave-front and its motion within IRF=K are, in this case, not non-events but are just as real within IRF=K as the wavefront=K' and its motion are within IRF=K'. That is why the wavefront=K can, in turn, be responsible for a primary event within IRF=K, when it is recorded by the detector which is stationary at the point Q within IRF=K; which thus, in turn, causes a non-primary arrival-event for the wavefront=K' at the point Q'* within IRF=K'.

3. A possible derivation of the Lorentz-equations

The coordinate axes of the IRF=K and the IRF=K' are shown within Fig. 2 after they have moved a distance vt apart, and also after they have moved a longer distance vt* apart. The IRF=K is assumed to be stationary while the proper IRF=K' of the detector is assumed to be moving with the speed +v along the +x-axis of the IRF=K.

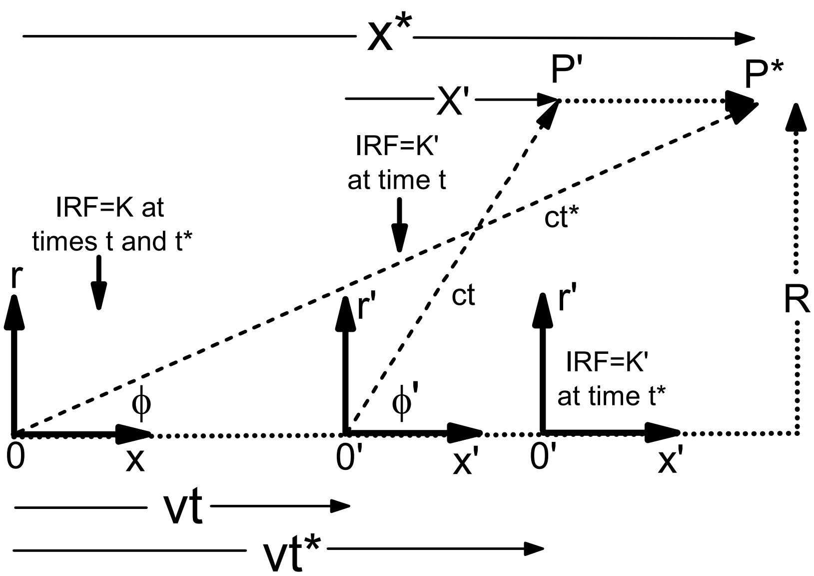

Figure 2: The coordinate axes, at two different times t and t, of a stationary three-dimensional inertial reference-frame (IRF=K) and a three-dimensional inertial reference-frame (IRF=K'), which is moving with a speed +v relative to IRF=K. A primary-event occurs within the moving IRF=K' at a stationary position P' within IRF=K' at the time t. Since the latter coordinate-point is moving within the IRF=K, it has to be referenced by a time-coordinate as measured from the origin 0 within the three-dimensional IRF=K in order for the primary-event within IRF=K' to manifest at a point P* within the IRF=K as a non-primary-event.*

Consider again the primary-event that occurs on the K'-wavefront at a point P' with the coordinates (x', r'=R)=(x',y',z') within the IRF=K', when this wavefront reaches the detector within the IRF=K' at the simultaneous time t on both clocks within the IRF=K' and the IRF=K. As already argued above, the K-wavefront cannot reach the coincident point (x_I R_I) within the IRF=K at the same time t at which the K'-wavefront causes this primary detection-event relative to 0'; since the K-wavefront only reaches a point P* within IRF=K which is coincident with the coordinate-point P=(x', R) within IRF=K', after wavefront=K has moved to reach the point P* with coordimates (x*, r*=R) within the IRF=K: And this non-primary arrival-event can only occur at another, later time t*≠t on both clocks.

The pathlength of the wavefront=K from 0 must thus have a length ct* at the time t* on both clocks within both IRF's when the non-primary arrival-event occurs: It is given by the hypothenuse of the right angle made by R and x: So that from the theorem of Pythagoras one must have that:

$$(x^*)^2 + R^2 = (x^*)^2 + (y^*)^2 + (z^*)^2 = (ct^*)^2 \tag{6a}$$

In turn, the path of length ct within the IRF=K', when the primary arrival-event occurs at the simultaneous time t on both clocks, is the hypothenuse of the right angle made by R and x', so that from the theorem of Pythagoras one must have that:

$$(x')^2 + R^2 = (x')^2 + (y')^2 + (z')^2 = (ct)^2 \tag{6b}$$

When replacing t with t' and t* with t, these expressions seem to be the same as those in Eq. 1. But they are not the same, since they have been derived by assuming that Eq. 5 is valid. The time t* in Eq. 6a is thus not simultaneous with the time t given by Eq. 6b; and the position-coordinates are also not coincident. The untransformed and transformed space-time coordinates do thus not coincide at the position of an invariant 4D position-vector **s** as Minkowski [4] had argued in 1908.

It is now clear why the expressions in Eq. 6a and Eq. 6b, cannot be equated in order to obtain an equation which is concomitant to Eq. 2 and Eq. 3, as had been done for the past 100 years for the expressions in Eq. 1a and Eq. 1b: The expressions 6a and 6b are those for two rectangular triangles that do not have proportional lengths for their sides, and that have different angles ϕ and ϕ' relative to the direction of motion. By using complex-number notation one can, however, rewrite the expresions in Eq. 6 to become:

$$(x^*)^2 + (ict^*)^2 = (iR)^2 \tag{7a}$$

And

$$(x')^2 + (ict)^2 = (iR)^2 \tag{7b}$$

In this case the expressions on the left are not each separately equal to zero, so that they are now mathematically related in a one-to-one (albeit strange) manner: i.e. x'$\rightarrow$x* and time t$\rightarrow$t*; as they should be to form a template from which an isomorphic transformation can be derived for a primary-event within IRF=K' into its non-primary counterpart within IRF=K: One can thus write, without violating the requirement that each space-time point must be mapped in a one-to-one manner, that:

$$(x^*)^2 + (ict^*)^2 = (x')^2 + (ict)^2 \tag{8}$$

This equation, and not Eq. 3, is a more logical template-equation to use in order to derive the Lorentz-transformation for a one-to-one mapping of event-coordinates.

The relationship between the Lorentz-transformed coordinates x'$\rightarrow$x* and t$\rightarrow$t*, of a primary-event within IRF=K' into its non-primary counterpart within IRF=K, must thus be given by a 2x2 matrix, so that one can write that:

$$\begin{bmatrix} x^* \\ ict^* \end{bmatrix} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} \begin{bmatrix} x' \\ ict \end{bmatrix} \tag{9a}$$

From Fig. 2:

$$x^* = x' + vt^* \tag{9b}$$

Replacing x* within Eq. 9a from Eq. 9b leads to:

$$(\alpha_{11} - 1)x' = \alpha_{12}(ict) - vt^* \tag{10a}$$

Eq. 9a also gives that:

$$(ict^*) = \alpha_{21}x' + \alpha_{22}(ict) \tag{10b}$$

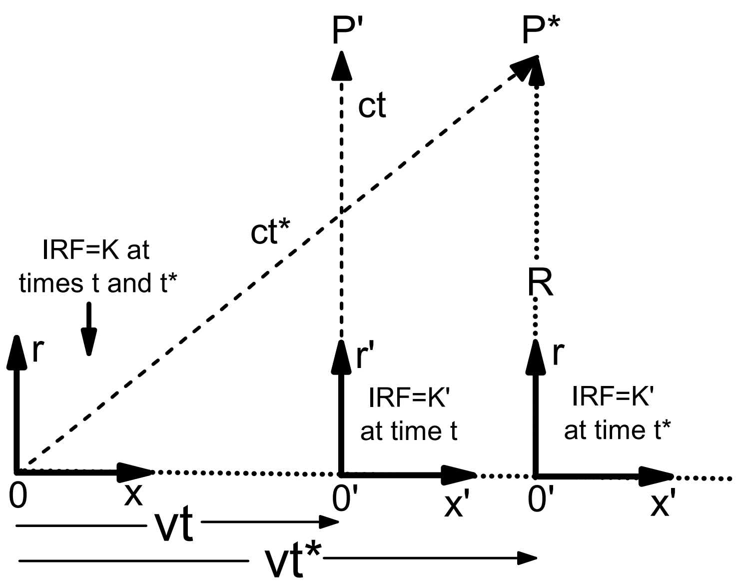

Figure 3: The coordinate axes, at two different times t and t, of a stationary three-dimensional inertial reference-frame (IRF=K) and a three-dimensional inertial reference frame (IRF=K'), which is moving with a speed +v relative to IRF=K'. A primary-event occurs within the IRF=K' at position P' with x'-coordinate x'=0 at the time t. Since this point is moving within the IRF=K, it has to be referenced by a time-coordinate as measured from the origin 0 within the three-dimensional IRF=K in order to manifest as a non-primary event at point P* within the IRF=K.*

It will now be asuumed that these equations must be valid for any position of the stationary detector within IRF=K'. Thus, one can also choose x'=0: The corresponding situation to Fig. 2, is then as shown in Fig. 3. Since R=ct, one obtains for the **two different times on both clocks** from the theorem of Pythagoras that:

$$t^* = \frac{t}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma t \qquad (11)$$

Note that this is the formula has been interpreted since 1905 as proving that time-dilation occurs; so that γ is sometimes called the time-dilation factor. According to the present derivation, it it is the relationship between two **separate times** each of which is recorded simultaneously on the clocks within the IRF=K' and the IRF=K. Since this factor first appeared when Michelson and Morley did their seminal experiments [6], it might be more appropriate to call it the Michelson-factor.

From Eq. 10a one has, for x'=0, that:

$$x^* = \alpha_{12}(ict) \qquad (12a)$$

Combining this result with Eq. 9b, for x'=0, substituting from Eq. 11, and using β=v/c one obtains that:

$$\alpha_{12} = -i\left(\frac{v}{c}\right)\left(\frac{t^*}{t}\right) = \frac{-i\beta}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (12b)$$

And from Eq. 10b that:

$$(ict^*) = \alpha_{22}(ict) \qquad (12c)$$

So that after combining with Eq. 11, one has that:

$$\alpha_{22} = \left(\frac{t^*}{t}\right) = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma \qquad (12d)$$

By now replacing α_{12} in Eq. 10a from Eq. 12b, and replacing α_{12} in Eq. 10b from Eq. 12d, one can solve for α_{11} and $\alpha_{21:}$ The solutions are:

$$\alpha_{11} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma \qquad (12e)$$

And:

$$\alpha_{12} == \frac{i\beta}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (12f)$$

So that

$$\begin{bmatrix} x^* \\ ict^* \end{bmatrix} = \begin{bmatrix} \dfrac{1}{\sqrt{1-\beta^2}} & \dfrac{-i\beta}{\sqrt{1-\beta^2}} \\ \dfrac{i\beta}{\sqrt{1-\beta^2}} & \dfrac{1}{\sqrt{1-\beta^2}} \end{bmatrix} \begin{bmatrix} x' \\ ict \end{bmatrix} \tag{13}$$

Thus, the Lorentz-transformation of the x'-position and concomitant time t **on both clocks** of a primary-event within the IRF=K' into its non-primary counterpart within IRF=K, relative to which the IRF=K' is moving with speed +v, follows from Eq. 11 as:

$$x^* = \frac{x'+vt}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma(x'+vt) \tag{14a}$$

And

$$ict^* = \frac{i\left(\frac{v}{c}\right)x'+ict}{\sqrt{1-\frac{v^2}{c^2}}}$$

Which becomes:

$$t^* = \frac{t+\left(\frac{v}{c^2}\right)x'}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma\left(t+\frac{vx'}{c^2}\right) \tag{14b}$$

Where t* is the **time on both clocks** within IRF=K' and IRF=K when the non-primary event occurs within IRF=K. The y' and z' coordinates are not affected.

During the past 100 years these equations have been applied by assuming that they are valid for **any** coordinate-pair x' and r'=R (also zero) and thus also for any concomitant values of the angles ϕ' and ϕ (also when they are zero so that R is zero): Even when such a coordinate position does not define coordinates (x', r') within the IRF=K' which have ct as their hypothenuse: If this is correct, and it seems from experience that it might be corect, this is quite an amazing result; since, in order to derive these equations, by assuming the emission of a single wavefront from 0' and 0, we had to choose the value of x' and R to define a hypothenuse that is given by ct.

On the other hand, the coordinates of the transformation-matrix have, just now, been derived by assuming that the transformation derived from Eq. 8 must be valid for any value of x' at any time t. Furthermore, after the derivation of the template given by Eq. 8, the distance R, which is required to have a hypothenuse with length ct, does not appear within this equation anymore. It could be that it is for the latter reasons why the coordinates do not have to define a hypothenuse with length ct. It thus seems that the derivation for a specific situation has given a general solution to the problem. It might also indicate that there could be a better template to use when deriving the Lorentz-transformation. A better starting point might be the Doppler-effect (see section 4.3).

It is, however, clear that the derivation presented here, in contrast with the conventional derivation, **does** define a coordinate-transformation which gives a one-to-one relationship between the space-time coordinates of a primary-event within a proper IRF, into a unique single space-time point for the concomitant non-primary event, as referenced within another, non-proper IRF; but the two space-time coordinate-points do not reference coincident coordinate-points within 3D space, and also not within a 4D space-time manifold: i.e. the two times are not **coincident times on their respective clocks**. The untransformed and transformed space-time coordinate-points can thus not be referenced by an invariant space-time vector within a 4D space-time manifold.

There must also be Lorentz-equations for the transformation of a primary-event within IRF=K, into its corresponding non-primary event as observed from within IRF=K'. In this case these equations have to be derived by assuming that IRF=K' is stationary while IRF=K moves away from the origin 0'. This symmetrical situation, shown within Fig. 1, is given by the points Q within IRF=K and Q'* within IRF=K'. Figure 2 and 3 must now be drawn as if it is the IRF=K that is moving relative to the IRF=K': For example, Fig. 3 can be reconstructed to give Fig. 4.

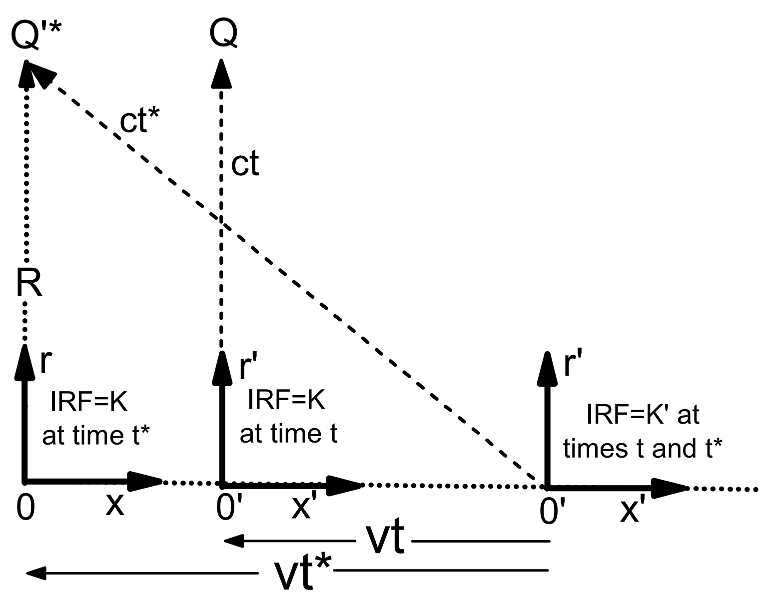

Figure 4: The coordinate axes, at two different time t and t, of a stationary three-dimensional inertial reference-frame (IRF=K') and a three-dimensional inertial reference-frame (IRF=K), which is moving with a speed –v relative to IRF=K'. A primary-event occurs within the IRF=K at position Q with x-coordinate x=0 at the time t. Since this point is moving within the IRF=K', it has to be referenced by a time-coordinate as measured from the origin 0' within the three-dimensional IRF=K' in order to manifest as a non-primary event at point Q'* within the IRF=K'.*

By now following the same route that had been followed above, the Lorentz-transformation of the primary event at point Q within IRF=K into the non-primary event at point Q'* within IRF=K' can be derived. Note, however, that within Fig. 4, the IRF=K is moving with a speed –v relative to the origin 0' of the IRF=K'. Thus, in this case, the equation that is equivalent to Eq. 9b above becomes:

$$x^* = x - vt^* \tag{15}$$

The transformation from the primary coordinate x at the primary time t within IR=K into the corresponding non-primary coordinates x'* and t* within IRF=K', is found to be given in this specific case, by:

$$\begin{bmatrix} x'^* \\ ict^* \end{bmatrix} = \begin{bmatrix} \frac{1}{\sqrt{1-\beta^2}} & \frac{i\beta}{\sqrt{1-\beta^2}} \\ \frac{-i\beta}{\sqrt{1-\beta^2}} & \frac{1}{\sqrt{1-\beta^2}} \end{bmatrix} \begin{bmatrix} x \\ ict \end{bmatrix} \tag{16}$$

Thus, the equations for the latter Lorentz-transformation from IRF=K into IRF=K', follows from Eq. 16 as:

$$x^{*\prime} = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} = \gamma(x - vt) \tag{17a}$$

And:

$$t^* = \frac{t - \left(\frac{v}{c^2}\right)x}{\sqrt{1 - \frac{v^2}{c^2}}} = \gamma\left(t - \frac{vx}{c^2}\right) \tag{17b}$$

The minus sign in Eq. 17 appears since the origin 0 of IRF=K is moving away from the origin 0' of IRF=K' with the speed –v: However, the choice of the positive x-direction is arbitrary. One could just as well have chosen the x- and x'-directions so that the origin 0 of IRF=K is moving with a speed +v from the origin 0' of IRF=K'. The diagram that is then equivalent to the diagram in Fig. 4 is shown in Fig. 5.

If one now derives the Lorentz-transformation for a primary event within IRF=K into its non-primary counterpart within IRF=K' by using Fig. 5, the transformation matrix is not the one in Eq. 16, but it is exactly the same as the one in Eq. 13. Thus, in reality, both matrices only transform a primary event from within such an event's proper IRF unidirectionaly into its non-primary counterpart as referenced within a non-proper IRF relative to which the proper IRF is moving with a positive speed +v. The one matrix is not the inverse of the other in the sense that one matrix transforms a primary event into a non-primary event, while the other matrix then transforms the latter non-primary event back into its primary counterpart. One is transforming the coordinates of primary physics-events, not just mapping coordinates as if they do not have to relate to primary-events.

It should now be crystal clear that the primary-event within its proper IRF, causes the non-primary event within the non-proper IRF relative to which the proper IRF is moving. When the primary-event does not occur, there will not be a concomitant non-primary event within a non-proper IRF. The primary-event is thus a causal-event and the non-primary-event is a caused-event. The transformed space-time coordinates of a causal-event into the event which it is causing, can thus **not** be transformed back into the coordinates of the cuasal event within its proper IRF: This is so since a caused event cannot, in turn, cause the event that has caused the caused event (see also section 4.2).

It has, however, been accepted since 1905 that the coordinates of a non-primary, caused-event can be transformed back into its primary causal-event. This confusion would not have existed if the speed, when two origin's 0' and 0 are moving apart, had been chosen consistently as being positive when measured from either 0 or 0' respectively.

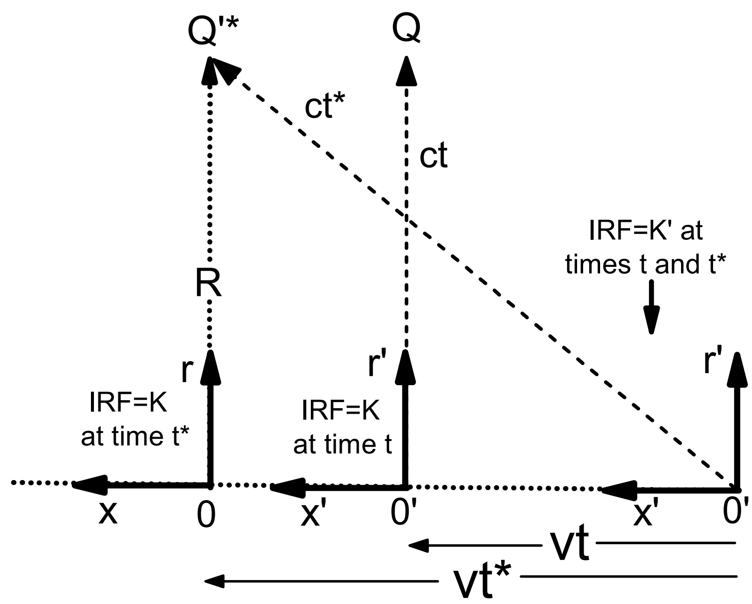

Figure 5: The coordinate axes, at two different time t and t, of a stationary three-dimensional inertial reference-frame (IRF=K') and a three-dimensional inertial reference-frame (IRF=K), which is moving with a speed +v relative to IRF=K'. A primary-event occurs within the IRF=K at position Q with x-coordinate x=0 at the time t. Since this point is moving within the IRF=K', it has to be referenced by a time-coordinate as measured from the origin 0' within the three-dimensional IRF=K' in order to manifest as a non-primary event at point Q'* within the IRF=K'. The only difference, when compared to Fig. 4, is that the positive x- and x'-direction has been chosen to be in the opposite direction than in Fig. 4, so that the speed changes from being negative to being positive.*

4. Consequences

4.1 God's red herring

It is fascinating to note that although the Lorentz-transformation does not have an inverse that makes physics-sense, the matrices in Eq. 13 and Eq. 16 are actually mathematically inverse; even though this is just a fortuitous accident caused by the sign of the speed with which the IRF's move relative to one another. Nonetheless, when one multiplies Eq. 13 with the matrix of Eq. 16, one does get the mathematical result that the coordinates (x*, ict*) of the non-primary event are transformed back into the coordinates (x', ict) of the primary event that causes the non-primary event. Similarly when multiplying Eq. 16 with the matrix of Eq. 13, one gets the mathematical result that the coordinates (x'*, ict*) of this non-primary event are transformed back into the coordinates (x, ict) of the primary event that causes this non-primary event.

We must, however, never forget that mathematics does not determine physics, but that physics determines when and how mathematics must be applied. The classical example that this is so, is the epicycles which had been used in Ptolemy's model of the Universe: In this case, mathematics seems to give the correct solutions for the paths of the planets, but in actual fact it is not modelling the real physics involved.

Thus, although mathematics does give an inverse matrix for the speed –v, to the one in Eq. 13 derived for the speed +v, this is misleading, since one should ask what is the inverse physics that must be valid: And as derived above, the physics clearly demands that the Lorentz-transformation cannot be applied as purely a coordinate-tranformation. The Lorentz-tranformation, which has been interpreted, since 1905, as an inverse coordinate-transformation of an invariant space-time point, is in fact in all cases the very same unidirectional transformation that **only** transforms a primary-event from within this event's proper IRF into another non-proper IRF relative to which the proper IRF is moving with a speed +v. The resultant non-primary-event caused by the primary event cannot be transformed back into the primary-event's proper IRF. In fact, this has been already known for 400 years, after Galileo explained the concept of relativity [7] (see also section 4.2 below).

What is even more intriguing, is that the matrices in Eq. 13 and Eq. 16, are not just mathematically inverse matrices, they are also orthonormal matrices. Mathematically, they can be interpreted as operators which are caused by an actual rotation within a two-dimensional manifold within which the positions of the space-time coordinates are invariant. In his youth Einstein stated that: "God is not malicious, He is only subtle". It seems that when it comes to the Lorentz-transformation God decided to be "subtly-malicious" by deliberately presenting physicists with a red-herring. No wonder that Einstein in his old age stated that "Maybe God is malicious!". It is probaly better not to blame God, but to be honest and to state that we physicists are not as clever as we are pretending to be: We did not succeeed to avoid all the pitfalls we encountered since 1900. In fact, since 1927, we have most probably led physics back into the dark ages of superstition.

4.2 Relativistic reality

Galileo contemplated a ship which is travelling smoothly with a constant unidirectional velocity **v**: He concluded that an observer within an enclosed cabin on such a ship will not be able to do any mechanical experiment from which it can be deduced whether the ship is uniquely stationary in the universe or actually moving [7]. Einstein extended this concept to include the measurement of the the speed of light (see section 1 above).

This concept of Galileo is at present known as inertia. Since the observer must conclude that he/she is uniquely stationary, he/she, when opening a porthole and seeing another ship passing by side-by-side, will conclude that it must be the other ship that is moving. Similarly, an observer within a cabin of the passing ship will, for the same reason, conclude that his/her cabin is uniquely stationary. It is for this reason that such reference-frames have become known as inertial reference-frames (IRF's).

If an experimenter (OBS=K), who believes that his/her IRF=K is uniquely stationary, "looks out" of his/her IRF=K into a passing IRF=K' within which another experimenter (OBS=K') is doing an experiment, OBS=K will not observe the same physics-events that he/she observes for the same experiment when this experiment is being done within his/her own IRF=K. Although the same experiment must give the same identical results within each IRF, what he/she will observe is generated by transforming the primary coordinate-events of the experiment within the moving IRF=K' into his/her stationary IRF=K. What he/she observes when looking into the passing IRF=K' is not caused within his/her own stationary IRF=K, but is caused by the primary-events occurring within the passing IRF=K'. Therefore one cannot transform these caused events back into the IRF within shich they are being caused.

Similarly, what OBS=K' will see when looking into the cabin of OBS=K, is not what is actually happening in the cabin of OBS=K, but will be a coordinate-transformation of the primary physics-events that are actually originating within the cabin IRF=K. To transform these transformed coordinates of the non-primary physics-events within IRF=K' back into the untransformed coordinates of the primary physics-events within IRF=K, which cause the non-primary physics-events, serves no physics-purpose whatsoever. A relativistic coordinate-transformation serves only one physics-purpose, and that is to unidirectionally transform primary-events, which are occurring within a "moving" IRF into a "stationary" IRF relative to which the primary-events are moving: Even when the mathematics is invariant to allow a reverse transformation of the coordinates, the physics-equations cannot be invariant under such a transformation.

Consider the classical example of an aeroplane that drops a bomb. Since the aeroplane moves at a low speed, one can use the Galilean transformation. The primary-event within the IRF=K' of the aeroplane, is to release the bomb from within the aeroplane: This causes the non-primary event that manifests as a horizontal launching of the bomb within the IRF=K attached to earth. The latter can obviously not be a primary event within the IRF=K of the earth, since this launch did not require a horizontal force within the latter IRF. It can thus not be transformed back into the aeroplane as if this horizontal launch is causing what is caused from within the areoplane.

If one, however, has a hovering helicopter which launches a horizontal missile with a speed v, just when an aeroplane passes at the same height with the same speed v, the primary-event will be within the IRF=K of the earth, while the non-primary event will be the downward launching of the missile relative to the aeroplane without having to release it from within the aeroplane. It is thus a non-primary event within the IRF=K' of the aeroplane caused by the primary launching of the missile by the helicopter. Clearly, one can only unidirectionally transform the coordinates of such a primary-event into the coordinates of its concomitant non-primary event that it is causing within another IRF, but not inversely transform the coordinates of the non-primary event back into the coordinates of the primary event without believing that there are "miracle-events" without any cause. Thus also in the case of the Galilean-transformation of coordinates, the physics involved constrain this transformation to be unidirectional even though the mathematics seems to allow an inverse transformation.

The difference between the Lorentz-transformation and the Galilean-transformation is that, for the Galilean-transformation, the untransformed and transformed position-coordinates of a primary-event, and its non-primary counterpart, always coincide in space and time, while for the Lorentz-transformation this coincidence **only** occurs at the origins of the two IRF's when these origins 0 and 0' coincide at time t=0. At any other time, as referenced relative to these origins, which are then not in coincidence, the position-coordinates and time of a non-primary event **do not** coincide with the position-coordinates and time of its concomitant primary event.

It will be seen below (in sections 4.3 and 4.4) that the relationship between a primary-event and its Lorentz-transformed non-primary-event is determined by where in space the coincident origins 0 and 0' are chosen to be at the time t=0. Different choices give different perspectives for the concomitant non-primary event caused by the same primary-event within its proper moving IRF.

Galileo's inertia has been embedded in Newton's first law: According to this law any moving entity with rest mass m_0 has a unique IRF within which it is stationary. Such an IRF will thus be this stationary entity's proper IRF; just as the IRF's, within which a light-source and/or a wavefront-detector are respectively stationary, are the proper IRF for the light-source and the proper IRF for the detector. The motion of a stationary entity with rest mass m_0, when viewed from any other IRF that moves relative to this entity's proper IRF, is not an absolute motion through space, since this same entity is simultaneously moving with different velocities, which are determined by the different velocities of all the other IRF's. The primary-state of a moving entity with rest-mass m_0 must thus be its stationary-state within its proper IRF. Its non-primary state is to move within one of its non-proper IRF's without being propelled by a force, even though the path it follows within the latter IRF is a real path within this IRF. To obtain the latter motion, one must transform the coordinates of the entity's primary stationary-state from its proper IRF into the IRF within which the motion is occurring.

4.3 Moving light sources

4.3.1 Receding light-source

Consider a light-source at the origin 0' within IRF=K': It must have a rest-mass m_0. It emits a wavefront at time t=0 when the source coincides with the origin 0 at which a detector is stationary within IRF=K. This IRF=K' is thus the proper IRF for the source, and the IRF=K is the proper IRF for the detector. We will call the wavefront emitted at time t=0 the zeroth wavefront. Thus, the position-time coordinates within IRF=K', at which the wavefront is emitted, are (x'=0, t=0) and they are at that instant in time coincident with the coordinates (x=0, t=0) of the stationary detector within IRF=K. Thus, the wavefront is in this case emitted by the source within the source's proper IRF, and instantaneously recorded by the detector within the detector's proper IRF.

After a time interval, $\Delta\tau$, the source has moved an actual distance $x_1=v\Delta\tau$ from the detector; as referenced within IRF=K: If it now sends out a consecutive wavefront, numbered as wavefront 1, the coordinates of this primary-event within IRF=K' are $((x')_1=0, t_1=\Delta\tau)$. But the source is moving relative to the detector, so that this emission-event within IRF=K' is a non-primary event within IRF=K; which initiates a wavefront=K within IRF=K that propagates within IRF=K with the speed c. It will now be assumed that to find the the latter non-primary coordinate-position within IRF=K, caused by the primary emission within IRF=K', one must Lorentz-transform the primary-emisson of the wave-front=K' within IRF=K' into its non-primary emission within IRF=K. The latter transformed, non-primary coordinates of the emission-event within IRF=K, follow from Eq. 14 as: $(x^*)_1=\gamma v\Delta\ \tau$ and $(t^*)_1=\gamma\Delta\tau$.

Since the non-primary position-coordinate $(x^*)_1$ is a stationary-coordinate within IRF=K, the wavefront emits from this stationary position within IRF=K in order to follow a path to the co-stationary detector within IRF=K, at which it can thus be detected (see section 2). Since the speed of light is c within all IRF's, the detector will be reached after a time interval $\Delta T=(x^*)_1/c$, when the time at the detector is:

$$t_{D1} = (t^*)_1 + \Delta T = \gamma\Delta t + \frac{v}{c}\gamma\Delta t = \gamma\Delta t\left(\frac{c+v}{c}\right) \qquad (18a)$$

The time t_{D1} is the time-interval $\Delta\tau_D$ that elapsed at the detector between recording two consecutive wavefronts.

The frequency ν with which the wavefronts are emitted at the source is the inverse of $\Delta\tau$, and the frequency ν_D with which these wavefronts arrive at the detector is the inverse of $\Delta\tau_D$, so that Eq. 18a can be written in terms of these frequencies as:

$$\nu_D = \nu\gamma^{-1}\left(\frac{c}{c+v}\right) = \nu\sqrt{\frac{c-v}{c+v}} \qquad (18b)$$

This is the Doppler-shift for a receding light source.

Although the zeroth wavefront is emitted at time t=0, when the light-source is exactly coincident with the detector, the first consecutive wavefront is emitted when the light source is an **actual** distance $x_1=v\Delta\tau$ from the detector as measured within IRF=K. Similarly the second consecutive wavefront will be emitted when the source is an actual distance $x_2=2v\Delta\tau$ from the detector, etc. Obviously, the n^{th} wavefront will be emitted when the light-source is at an **actual** distance $x_n=nv\Delta\tau$ from the detector. The corresponding distances and times at which the corresponding non-primary emissions occur within IRF=K are, however, $(x^*)_n=\gamma nv\Delta\tau$ and $(t^*)_n=\gamma n\Delta\tau$ which, for every value of n, is further away from the detector and occurring at a later time than the actual time t_n at the coincident actual distance x_n that the light-source is from the detector when it emits this wavefront. If the two clocks are keeping synchronous time, then according to the latter equations the light-source is not moving with a speed v relative to the detecttor, but is detected from the origin 0 within IRF=K to be moving with a speed γv.

But since $(x^*)_n/(t^*)_n=v$, this also implies that the light-source must first move from the actual distance x_n at which the primary emission-event occurs to the non-primary distance $(x^*)_n$ in order to emit the n^{th} wavefront=K at the time $(t^*)_n$ within IRF=K: However, although the source, if it keeps on moving along the same psth, will be at the position $(x^*)_n$ when the n^{th} non-primary wavefront=K is emitted within IRF=K, it is also possible that the source might stop moving after it emitted the n^{th} primary wavefront=K' at the distance x_n from the detector, and before it reaches the distance $(x^*)_n$ from the detector. This implies that the non-primary n^{th} wavefront=K might not be emitted, even though the primary n^{th} wavefront=K' has already been emitted.

The latter situation is unlikely: One expects that once the n^{th} primary wavefront=K' has been emitted, an n^{th} non-primary wavefront=K will be detected by the detector. Thus although the non-primary emission of a wavefront=K is caused by the primary emission of its corresponding wave-front=K', the source does not actually emit the non-primary wavefront=K when it recahes a distance $(x^*)_n$ from the detector. The non-primary wavefront=K is the manifestation of the primary wave-front=K' within IRF=K owing to the fact that this wavefront cannot be coincident with itself within IRF=K and IRF=K' (see section 2). Therefore, the causal emission-event and the caused emission-event are separated in time and space: i.e. as already concluded above, the untransformed and transformed coordinates cannot be represented by an invariant vector within either 3D space or within Minkowski's 4D space-time.

The non-primary distance $(x^*)_n$ and time $(t^*)_n$ for the emission of the n^{th} wavefront within IRF=K, cause the Doppler-effect: When the waves are not light-waves but waves which move within a medium (for example, sound through stationary air), the Doppler-effect occurs when either the wave-source, or the detector of these waves, or both the source and detector move relative to the wave-medium. In the case of light, there is no medium (ether), so that the speed of light must always have the same value c relative to both the light-source and the detector; no matter with what velocity they are moving relative to one another.

This means that when the light-source and detector move relative to one-another, the Doppler-effect mandates that the detector cannot detect the actual (primary) position x_n and actual time t_n, which are coincident within IRF=K' and IRF=K; when the light source actually emits a wavefront within its proper IRF=K' at this position and time. It can only detect the n^{th} wavefront when it appears at the non-primary position $(x^*)_n$ (which is stationary within IRF=K) and the non-primary time $(t^*)_n$ within the detector's proper IRF=K. Are these non-primary positions and times real or just apparent? It seems that they must be apparent within IRF=K since they are not the actaul coincident position and time at which the source emits the wavefront; but they cannot be ignored since they cause measurable physics-effects like the Doppler-effect (see also the discussion of the cosmic-ray muon in section 4.6).

Assume that along the x-axis of IRF=K within which the "zeroth"-detector is stationary at the origin 0, one places a row of detectors spaced at distances $\Delta x_D = v\Delta\tau$ apart. Thus, when the zeroth wavefront is emitted, the zeroth-detector at the origin is in coincidence with the source, and it immediately detects the wave-front. When the subsequent first wave-front is emitted, the the source is in coincidence with the first detector at the distance $x_1=\Delta x_D$ from 0 when it emits the first wavefront, and when the second wavefront is emitted the source is in coincidence with the second dectector at the distance $x_2=2\Delta x_D$ from 0, etc. Will these coincident detectors each time instantaneously record the coincident emitted wavefront?

In principle such an experiment can be done so that an observer can afterwards walk from detector to detector to see at what times the detectors have recorded these coincident wave-fronts. I am convinced that such an observer will find that each wavefront has been instantaneously recorded by its coincident detector. But in each case, each detector cannot detect the other wave-fronts to be coincident at the coincident times at which they have been emitted. Each detector thus act as an origin at which the primary wave-front is immediately recorded when it is emitted at its coincident detector: However, according to each detector this is not the case at the positions of the other detectors. Thus each detector gives another perspective on what is happening at positions which do not coincide with its position.

Nonetheles, this means that at any and all times t, the **actual** position of the light-source relative to the detector is given by the Galilean coordinate-transformation, which demands that the distance from the zeroth detector must be x=vt at any time t. Thus, the light source itself is actually following a classical path, while from the perspective at the origin 0 of IRF=K the light-source is moving away from 0 with the speed γv. Which motion is really happening? One has to conclude that both is happening: However, the speed γv cannot be the actual path that the source is following through space since the untransformed and transformed coordinates for this speed are not coincident within IRF=K and IRF=K', as one expects that they must be to model the actual path of an entity with mass through space.

We have, however, concluded above that, according to the Lorentz-transformation, a stationary entity with rest-mass m_0 is a primary-entity within its proper IRF. In other words its motion should be caused by the Lorentz-transformation and not by the Galilean-transformation as the results above seem to demand. This issue will be considered further in section 4.4.

4.3.2 An approaching light-source

Here we will consider an approaching light source: Assume that the light-source is stationary within IRF=K' at a coordinate-position $x' = -L$ from 0'. And assume that a detector is stationary at the origin 0 within IRF.

Assume now that at the time t=0, when the origins 0 and 0' of IRF=K' and IRF=K coincide, the light source emits a wavefront=K' (which in conformation with the notation in section 4.3.1 will be called the zeroth wavefront). The primary-emission of this wavefront within IRF=K' thus occurs at the space-time coordinates ($(x')_0 = -L$, t=0), so that the corresponding non-primary coordinates from which the non-primary wavefront=K is emitted within IRF=K follow from Eq. 14 as:

$$(x^*)_0 = -\gamma L \qquad (19a)$$

And

$$(t^*)_0 = -\gamma\left(\frac{v}{c^2}\right)L \qquad (19b)$$

To reach the detector at x=0, wavefront=K must move within IRF=K from $(x^*)_0$ for a time ΔT_0 given by $\Delta T_0 = |(x^*)_0|/c$. The zeroth wavefront=K will thus reach the detector at the time t_{D0}, where:

$$t_{D0} = (t^*)_0 + \Delta T_0 = -\gamma\left(\frac{v}{c}\right)\left(\frac{L}{c}\right) + \gamma\left(\frac{L}{c}\right) = \gamma\left(\frac{L}{c}\right)\left(1 - \frac{v}{c}\right) \qquad (19c)$$

After a time interval, $\Delta\tau$, the source has moved a distance $v\Delta\tau$ towards the detector, and it then emits its next (number 1) wavefront=K': The coordinates for this event within IRF=K' are thus ($(x')_1 = -L$, $t_1=\Delta\tau$), so that the corresponding non-primary coordinates within IRF=K follow from Eq. 14 as:

$$(x^*)_1 = \gamma(-L + v\Delta\tau) \tag{20a}$$

And:

$$(t^*)_1 = \gamma\left(\Delta\tau - \left(\frac{v}{c^2}\right)L\right) \tag{20b}$$

This non-primary wavefront=K will thus start to move within IRF=K from the coordinate-position $(x^*)_1$ to reach the detector at x=0 after a time-interval $\Delta T_1 = |(x^*)_1|/c$. The time on the clocks t_{D1} when this wavefront reaches the detector is thus given by:

$$t_{D1} = (t^*)_1 + \Delta T_1 = \gamma\Delta\tau\left(1 - \frac{v}{c}\right) + \gamma\left(\frac{L}{c}\right)\left(1 - \frac{v}{c}\right) \tag{20c}$$

The time-interval $\Delta\tau_D$ between the arrival of the zeroth wavefront at the detector and the subsequent wavefront follows from Eq. 19c and Eq. 20c, as:

$$\Delta\tau_D = t_{D1} - t_{D0} = \gamma\Delta\tau\left(1 - \frac{v}{c}\right) \tag{21a}$$

The frequency ν with which the wavefronts are emitted at the source is the inverse of $\Delta\tau$, and the frequency ν_D with which the wavefronts arrive at the detector is the inverse of $\Delta\tau_D$, so that Eq. 21a can be written in terms of these frequencies as:

$$\nu_D = \gamma^{-1}\nu\left(\frac{c}{c-v}\right) = \nu\sqrt{\frac{c+v}{c-v}} \tag{21b}$$

This gives the Doppler-shift for a source that approaches a detector. In contrast to Eq. 18b the frequency is now higher; as it must be. Note that the Doppler-shift of an approaching light-source demands that the wavefront must appear within IRF=K **before** it is actually emitted within IRF=K'. This seems to violate causality, but it cannot do so since the wavefront=K will not appear within IRF=K as a non-primary event, unless it is caused by the primary emission of a wavefront=K' within IRF=K'.

But, eerily. the fact remains that the actual primary-event at time t within IRF=K', appears as a non-primary event within IRF=K **before** it occurs within IRF=K': It can, however, not manifest within IRF=K when it does not occur at all within IRF=K'. This implies that when the non-primary wave-front=K appears within IRF=K, the primary wavefront=K' has not yet been emitted within

IRF=K'. This, in turn, implies that a future primary-event within IRF=K' can be "predicted" by the appearance of its concomitant non-primary event within IRF=K. This situation raises interesting physics-questions which, however, fall outside the scope of this manuscript [8]. In the meantime, I propose that this effect should be called the Nostradamus-effect.

4.4 Relativistic momentum and mass-energy

Consider a point-mass that, in essence, is a centre-of-mass (COM) with rest-mass m_0, which is stationary at the position x' within its proper IRF=K', where the latter IRF is moving with a speed v relative to IRF=K. The Lorentz-transformed coordinates of the COM, are given by Eq. 14a and Eq. 14b. Since the time on both clocks is at every instant in time the same, one can differentiate these expressions with t: And since x' is a constant within IRF=K' it becomes zero when differentiated, so that one obtains that:

$$\frac{dx^*}{dt} = \gamma v \tag{22a}$$

And

$$\frac{dt^*}{dt} = \gamma \tag{22b}$$

Since, as assumed in section 1, the time on both clocks must be simultaneously the same at any instant in time, it seems compelling to conclude from Eq. 22a that the COM must be moving with a speed γv within IRF=K; just as it was found that the non-primary position-coordinate of the light source is moving when judged from the position of the detector that is stationary at the origin 0 of IRF=K: This is, however, not what has been found (just now in section 4.3.1) to be the actual situation for the motion of the light-source. It is only the perception when observed from the origin 0 within IRF=K.

A moving COM has momentum p, which might be obtained by multiplying Eq. 22a with its rest-mass m_0: In which case:

$$p = m_0 \frac{dx}{dt} = m_0 \gamma v = mv \tag{23a}$$

Where m has been interpreted for the last 100 years to be the dynamic mass of the COM, given by:

$$m = \gamma m_0 = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{23b}$$

If this is correct, it means that an entity with rest-mass m_0 does actually follow a classical Galilean-path within any IRF relative to which it is moving: The modification caused by the Lorentz-transformation is an increase in the mass of the entity. That this must be so has been experimentally verified many times. This means that dt* in Eq. 22b serves, in this case, to define the Michelson-factor γ that causes this increase in mass, while the COM of the entity with mass actually follows a primary Galilean-type path within an IRF.

Within textbooks Eq. 23b is derived by making *ad hoc* assumptions (see for example ref [9]). Here, it is derived directly from the Lorentz-transformation by assuming that all clocks keep the exact same time within all IRF's and that therefore an entity with rest-mass must follow a classical path through space, albeit with an increased mass when its relative speed increases.

When a force F acts on such a body with mass m, then, according to Newton's second law, one must have that:

$$F = \frac{dp}{dt} = m\frac{dv}{dt} + v\frac{dm}{dt} \tag{24a}$$

When the force is constant while the body moves a distance ds, the increase in kinetic-energy T of the body must be dT=Fds, so that from Eq. 24a, one must have that:

$$dT = Fds = v^2 dm + mvdv \tag{24b}$$

From Eq. 23b and using $\beta=v/c$, one obtains that

$$dT = (m_0 c^2)\frac{\beta d\beta}{(1-\beta^2)^{3/2}} \tag{24c}$$

By integrating from v=0 to v=v in order to obtain the kinetic energy T, one obtains that:

$$T = mc^2 - m_0 c^2 \tag{24d}$$

This well-known equation proves that the total energy E of the body (with rest mass m_0) when it moves with speed v within free-space must be:

$$E = mc^2 \tag{25}$$

This is what Einstein also deduced, but he did it in an *ad hoc* manner. Here it follows directly from the Lorentz-transformation when assuming that the two clocks within IRF=K and IRF=K' keep the exact same time and that an entity with mass must actually follow a classical path through space.

4.5 Simultaneity

Consider a double-ended laser "point"-source which is stationary at the origin 0' within the IRF=K': Assume that two wavefronts are emitted simultaneously at t=0 (on both clocks within IRF=K' and IRF=K) along the +x'- and the –x'-axes. The wavefronts are thus emitted parallel to, and anti-parallel to the x'-axis. After a time t on both clocks, each of the two oppositely-emitted wavefronts has moved a distance $L' = ct$ from the origin 0' within the IRF=K'. To find the corresponding Lorentz-transformed non-primary positions and times of these wavefronts within the IRF=K, one must use the expressions in Eq. 14.

For the parallel-emitted wavefront along the direction +x’, one has for the Lorentz-transformed coordinate $(L^*)_P$, according to Eq. 14a, that:

$$(L^*)_P = \frac{L+vt}{\sqrt{1-\frac{v^2}{c^2}}} = ct\sqrt{\frac{c+v}{c-v}} \tag{26a}$$

And the Lorentz-transformed time is according to Eq. 14b:

$$(t^*)_P = \frac{t+(v/c^2)L}{\sqrt{1-\frac{v^2}{c^2}}} = t\sqrt{\frac{c+v}{c-v}} \tag{26b}$$

So that $(L^*)_P/(t^*)_P=c$: Just as it must be.

For the antiparallel-emitted wavefront along the direction –x’, one has for the Lorentz-transformed coordinate $(L^*)_A$ according to Eq. 14 that:

$$(L^*)_A = \frac{-L+vt}{\sqrt{1-\frac{v^2}{c^2}}} = -ct\sqrt{\frac{c-v}{c+v}} \tag{26c}$$

And the transformed time is:

$$(t^*)_A = \frac{t-(v/c^2)ct}{\sqrt{1-\frac{v^2}{c^2}}} = t\sqrt{\frac{c-v}{c+v}} \tag{26d}$$

So that $(L^*)_A/(t^*)_A=-c$. Again as it must be, since the light-front is moving with the speed –c within the IRF=K.

It should be noted that the transformed distances and times are determined by the Doppler-factors given by the square-root expressions. It should alo be noted that according to Eq. 26b one must have that $(t^*)_P > t$, while according to Eq. 26d one must have that $(t^*)_A < t$. Thus, along the positive x-direction, the transformed wavefront reaches its transformed path-length $(L^*)_P$ **after** the clocks have simultaneously reached the time t , while along the negative direction, the transformed wavefront reaches its transformed pathlength $(L^*)_A$ **before** the clocks have simultaneously reached the time t . Again the latter result seems to violate causality: But as already pointed out in section 4.3.2 above, it does not do so, since the non-primary event would not have been recorded within the IRF=K at the coordinate $-\gamma L'$, if it had not been a primary-event within the IRF=K’. It is thus again a result of the Nostradamus-effect.

Within the IRF=K', the two separate wavefronts reach the distances L' and –L' simultaneously. These two simultaneous times, at different positions L' and –L' within the IRF=K' are, however, not simultaneous within the IRF=K. Both the transformed distance and transformed time jointly ensure that this is impossible.

Einstein [10] explained non-simultaneity of transformed, simultaneous times at different positions by formulating a thought experiment of a train moving through a station when lightning simultaneously strikes the embankment at the nose of the train and the tail of the train. According to Einstein, an observer sitting in the middle of the train will conclude that the lightning strikes are not simultaneous since "*he is hastening towards the beam of light coming from B* (the nose), *whilst he is riding on ahead of the beam of light coming from A*" (the tail). Therefore he will see the light from the nose before he/she sees the light from the tail. What Einstein thus argued is that the speed at which light approaches the observer from the nose is higher than the speed at which the light is approaching the observer from the tail.

It is amazing that Einstein did not realize that this explanation can only be valid when his second postulate is null and void. Any moving entity with rest mass defines its own proper IRF within which such a body is stationary: Since the observer is stationary within his/her own proper IRF, the magnitude of the speed of light approaching him from ANY source must be c and nothing else but c. The fact is that, no matter where the observer sits on the train, the lightning flash on the embankment at the nose of the train will register at an actual earlier time on the observer's clock than the simultaneous lightning flash on the embankment at the end of the train. An observer need not even be present for this to be so. Thus, the position of the observer on the train has nothing to do with this non-simultaneity. The train can be empty, and the platform deserted, and it will still be the same result. An observer does not create physics by observing what is happening: Physics creates what an observer sees when he/she happens to be present!

4.6 Absolute time

From the analysis above, it is compelling to conclude that the *a priori* assumption that perfect clocks at any position in gravity-free space, whether stationary or moving relative to one another, must keep time at exactly the same time-rate, gives, except maybe for the non-intuitive Nostradamus-effect, self-consistent results: Even so, the Nostradamus effect might turn out to be less paradoxical than the twin-paradox which is caused by the assumption that time-dilation occurs.

The conclusions arrived at so far, might thus be compelling evidence that the time-rate and synchronized time is actually absolute; just as Newton had assumed. This would mean that the difference in time obtained from the Lorentz-transformation for a primary event (which is transformed from its proper IRF into another IRF) is not simultaneously coincident on the two clocks situated within these two inertial reference-frames. Once synchronized, one perfect clock cannot show a different time than another perfect clock at the same instant in time ever again.

The latter possibility places a question mark behind the results that had been measured when flying atomic-clocks around the world [11,12]: These experiments have been repeated with increasing accuracy since they were first done in 1971 and the same result has been extracted every time when analyzing the data. According to these experiments, the flying clocks, when compared to a clock which stayed behind on earth, do actually show a time-decrease as predicted by Einstein from his Special Theory of Relativity, and since, according to the analysis of these results, they did actually lose this time, it must mean that the flying clocks kept slower time purely because they moved with a speed v relative to the clock on earth. If these experimental results are correct, the conclusions reached in this manuscript above must be wrong.

There have, however, been criticisms of the manner in which the flying-clocks experiments had been analyzed and interpreted (see for example [13]). The fact is that the experimental result that the flying clocks kept slower time has not been directly measured, since, during these flights, these clocks had also been affected by other more serious parameters; like the decrease in the gravity-field. The experimenters claim that they took gravity into account. But in addition, aeroplanes are known, for reasons which are not of relevance here, to fly in a special way: Usually they accelerate half of the route while gaining altitude and then decelerate the rest of the route while descending. If Einstein's conclusion is correct that such acceleration and deceleration, caused by an on-board engine, constitutes a gravity-field [14], this effect should have been added to the gravity-part of the analysis.

Since the earth is spherical and spinning around an axis, another effect, which had to be removed from the data, is the Sagnac-effect [15]. This was done in the analysis, but most probably incorrectly. The literature on the Sagnac effect is contradictory and controversial. This effect is experimentally demonstrated for a light-source fastened to the rim of a solid rotating disk. Thus, the circularly-moving reference-frame of the light-source might not be analogous to the case where an aeroplane is flying around the earth.

Furthermore, the effects caused by gravity and the Sagnac effect overwhelmed the data so that the information had to be extracted from a large amount of "noise" to prove "time-dilation" as derived by Einstein from the Lorentz-equations. To be certain that this flight-data do actually prove that clocks will be keeping different time-rates, simply because they move linearly relative to one another, one must first determine whether there is a Lorentz-transformation for circular motion, and if there is such a transformation, what the equations are for such a transformation [8].

It is well-known that the time of a clock on a GPS-satellite has to be adjusted owing to "time-dilation". That this is required owing to the decrease in gravity, as predicted by Einstein's General Theory of Relativity, is probably correct [8]. But in terms of the derivations in this manuscript, time-dilation does not occur in the way that Einstein derived it from the Lorentz-equations: However, there is an actual difference in time owing to the fact that the same wavefront is (at the same instant in time on all the clocks) at different positions within the reference-frame of earth and the reference-frame of the GPS satellite. It is easy to show that to correct for the latter difference, an adjustment in the time on the clock of the GPS-satellite can be made as if there is time-dilation; even though this difference in time is not caused by time-dilation but by the non-coincidence of the primary and non-primary wavefronts.

The longer lifetime of a cosmic-ray muon might thus not be caused by a clock that is keeping slower time, while moving with the muon: Choose the origin 0' of the muon's proper IRF=K' to coincide with the origin 0 at the earth's surface within the proper IRF=K of the earth, at the same time t=0 at which the muon is born high up in the atmosphere. Within the muon's IRF=K', the distance it has to travel to reach the earth is H'. A cosmic-ray muon, which has an average lifetime τ_μ within its proper reference frame, will thus just reach the earth when it forms at a height $H' = v_\mu \tau_\mu$, where v_μ is the actual speed with which the muon approaches the earth along its actual path through space. The non-primary coordinates of the muon's birth as referenced within the IRF=K of earth, however, follow as:

$$x^* = H^* = \gamma H' \tag{27a}$$

And

$$t^* = -\gamma\left(\frac{v_\mu}{c^2}\right)H' \tag{27b}$$

The minus-sign for the transformed time t* is required since the muon is approaching the origin 0 on earth. Relative to earth, the muon thus forms further away at a height H*, and at a time-interval $|t^*|$ before it forms at time t=0 within its own proper IRF=K'. Thus, as measured relative to earth, the muon lives longer before it reaches the earth, since $|t^*|$ must be added to its actual proper lifetime τ_μ which expires while the muon moves along its actual path with speed v_μ to reach the earth. Using two separate detectors along its path to measure the speed of the muon on its way to earth, will give this value for the speed, while from the perspective at the origin 0 on earth the muon is moving with the speed γv_μ. The muon is thus observed to live longer owing to the Nostradamus-effect, not because of time-dilation and length-contraction as is argued in textbooks on modern physics.

4.7 Length-"contraction"

It has already been pointed out in section 1 that, before Einstein postulated his Special Theory of Relativity in 1905, the Lorentz-transformation had been derived and justified in terms of the length-contraction of a rod which is moving through the ether. Einstein's postulates gave a more plausible reason why the Lorentz-transformation must be valid. This must surely mean that the requirement for length-contraction is redundant, and should therefore not be occurring at all. Nonetheless, Einstein went ahead and derived length-contraction from the Lorentz-transformation as if it is not redundant. Einstein thus claimed that this contraction is still real even though it is not required for the Lorentz-transformation to be valid.

What Einstein did not realize is that the proper IRF for the rod is the one in which the rod is stationary and that the Lorentz-transformation of the front-end and the tail-end of the rod can only be transformed from its proper IRF into the non-proper IRF relative to which the rod is moving. In contrast, Einstein assumed that at any instant in time t the the front-end and tail-end of the rod define two instantaneous positions within the rod's non-proper IRF, and he then reversely transformed these non-primary positions from the non-proper IRF into the rod's proper IRF. As already argued above, this is not allowed by the physics involved!

What Einstein should have done was to transform the stationary front-end and tail-end from the rod's proper IRF into the non-proper IRF within which the rod is moving. When one does this by using Eq. 14 for a rod with lenght L' within its proper IRF, the length of the rod within its non-proper IRF actually becomes longer to be given by:

$$L^* = \gamma L' \tag{28a}$$

And a time difference develops **within** the rod between its front-end and its tail-end, given by:

$$\Delta T^* = \gamma \frac{cL'}{v^2} \tag{28b}$$

The rod has a centre-of-mass (COM) situated at the middle of the rod, and according to section 4.4 this COM follows a clasical Galilean-path while having a relativistic mass given by Eq. 23b.

So what does the change in time (Eq. 28b) within the rod, along its increased length mean? Such a change in time can only have physics-meaning when the entity, within which it occurs, is a coherent wave, so that it has a phase-time difference between its front-end and tail-end. If the wave-length of this wave is λ, and its frequency is ν, there must be $n=L^*/\lambda$ wavelenths along its transformed length L^*; so that the corresponding phase-time difference must be:

$$\Delta T_P = \frac{n}{\nu} = \frac{L^*}{\nu\lambda} \tag{29a}$$

Setting ΔT_P equal to ΔT^* in Eq. 28b, one obtains that:

$$\lambda\nu = \frac{c^2}{v} \tag{29b}$$

Multiplying the last term with m/m where m is the relativistic mass of the rod at speed v, and using Planck's relationship, to write that $mc^2=h\nu$, one can write Eq. 29b as follows:

$$\lambda = \frac{h}{mv} = \frac{h}{p} \tag{29c}$$

This is de Broglie's formula for the wavelength of a moving entity with mass m. Thus, if Einstein had not incorrectly derived "length-contraction", he might have discovered the wave-nature of moving matter 20 years before de Broglie postulated it.

Since the de Broglie wavelength seems to follow directly from the Special Theory of Relativity, which in turn, is known to follow directly from Maxwell's wave-equations, the interpretation of quantum mechanics might, and probably must, follow directly from Maxwell's wave-equations. This falls outside the intended scope of the present manuscript: It will therefore be considered in future publications [8].

5. Conclusion

The Lorentz-transformation has been derived by assuming that there is no time-dilation: i.e. that all synchronized perfect clocks, where-ever they are, and with whatever velocity they move relative to one another, must keep the exact same time. From this analysis deductions could be made which differ fundamentally from the traditional viewpoints derived in terms of time-dilation. The following is a summary of the most important deductions when assuming that there is no time-dilation:

1. There is no length-contraction: A moving object with mass is a coherent wave with a de Broglie wavelength along the direction in which it moves: This causes a length-dilation in the direction of motion.
2. The Lorentz-transformation is only valid when it transforms the coordinates of a primary-event from its proper IRF into another IRF, relative to which the proper IRF moves. Such a transformed primary-event is a non-primary event which is caused by the primary-event, and is therefore itself not a primary-event within the IRF into which it has been transformed: It can therefore not, in turn, be transformed back into the primary-event (which caused it) by using an "inverse" Lorentz-transformation. The Lorentz-transformation is unidirectional, just like a relativistic coordinate-transformation **must** be.
3. The concept of Minkowski space-time violates the basic rules of mathematics, since the space-time coordinates are not linearly independent: Minkowski's space-time concept can therefore not be used to model real physics.
4. The Lorentz-transformation is not an invariant coordinate-transformation. Physics-models based on the assumption that all the equations which model physics must be invariant under a Lorentz-transformation, are most-probably totally or, at best, partly flawed.

References:

[1] A Einstein, Zur Elektrodynamik bewegter Körper, Annalen der Physik **17** (1905) 891-921.

[2] H Goldstein, Classical Mechanics, Addison-Wesley, Reading (1959) p. 187.

[3] R D'Inverno, Introducing Einstein's Relatvity, Clarendon Press, Oxford (1992) p. 29.

[4] H Minkowski, Raum und Zeit, Physikalische Zeitschrift **10** (1908/9) 75-88.

[5] H Dingle, The Case against Special Relativity. *Nature* **216** (1967) 119-122.

[6] A A Michelson & E W Morley, On the Relative Motion of the Earth and the Luminiferous Ether, American Journal of Science **34** (1887) 333-345.

[7] Galileo Galilei, Dialogue Concerning the Two Chief World Systems (translated), University of California Press 1953.

[8] J F Prins, Unpublished (2013).

[9] R D'Inverno, Introducing Einstein's Relatvity, Clarendon Press, Oxford (1992) p. 45-49.

[10] A Einstein, Relativity: Special and General Theory, Crown Publishers, New York (1952) p. 35-37.

[11] J C Haefele & R J Keating, Around-the-World Atomic Clocks: Predicted Relativistic Time Gains, Science **177** (1972) 166-168.

[12] J C Haefele & R J Keating, Around-the-World Atomic Clocks: Observed Relativistic Time Gains, Science **177** (1972) 168-170.

[13] W Nawrot, The Haefele and Keating Paradox, Phys. Essays 17 (2004) 518-520.

[14] A Einstein, Relativity: Special and General Theory, Crown Publishers, New York (1952) p. 66-70.

[15] G Sagnac, The demonstration of the luminiferous aether by an interferometer in uniform rotation, Comptes Rendus **157** (1913) 708–710.