Physical Interpretations of Relativity Theory 2000.
British Society for the Philosophy of Science.

Extended Space-time transformations derived from Galilei's.

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Submitted: February 2000

Abstract

This work (although self-sufficient) continues on the studies previously presented; but in the light of new data, certain commonly accepted views will be re-examined. On the other hand, some notions considered before as controversial, will now appear by far well founded.

In effect, in previous papers (ref.[9-13]), Lorentz assumptions appeared suspicious to us because they lead to space-time transformations reducible to Galilei's and, as a consequence, the law of conservation of the total relativistic quantity of motion could not be used to demonstrate the law $m = m_o\gamma$. But since that time we have become aware that the relativity principle is not an unquestionable concept of physics [13]. This result, in conjunction with the result of Marinov's toothed wheel experiment (described in the text), and some others considerations, demonstrates that all the arguments opposed to Lorentz's assumptions can be overcome.

On the contrary, the said assumptions explain some fundamental experimental results such as the isotropy of the apparent two-way speed of light. So, it appears justified to carry on with our studies on the bases of Lorentz's postulates. *But the Lorentz-Poincaré transformations appear limited to a particular case, and we must try to extend them.*

In ref. [9] we derived the space-time transformations *regarding a light ray* between any couple of inertial frames. We extend here the study to any body moving uniformly. We start from the Galilean relationships, we then demonstrate that the extended space-time transformations derive from them and translate the systematic errors of measurement due to length contraction, clock retardation, and imperfect clock synchronization.

The transformations are demonstrated to be consistent. In particular they are reduced to Lorentz-Poincaré's transformations when one of the inertial frames under consideration is the fundamental frame, and they explain why the apparent velocity of light is always found constant. This approach also permits some obscure points of physics to be explained.

The present manuscript has been registered at the French Society of authors on February 8th 2000.

Foreword

The present reflections derive from those expressed in earlier works [9-13]. They are nevertheless distinguished from them because, in the meantime, we realized that some opinions generally considered as dogmas are for the most part questionable. But, in place of rejecting these earlier reflections, we consider them as the essential of the internal debate which has led to our present views. They shed light on some aspects of these, and can help the reader who refers to them. But this is not absolutely necessary, since we have arranged things so that this text be sufficient unto itself. (Note that these earlier reflections touch also on subjects that will not be treated here.)

I. Introduction

The theory of space-time transformations was the collective work of several physicists. Among the best known we must quote Heaviside [1], Fitzgerald [2], Voigt [3] and Larmor [4]. The principal actors being Lorentz [5], Poincaré [6], Einstein [7] and Minkowski [8]. Although the fact is often ignored among scientists two paths were opposed, a relativist trend and a fundamentalist one. The relativist trend prevailed for a long time, but to day, weighty experimental and theoretical arguments authorize us to reconsider this belief.

The purpose of the present paper is, in the light of this new data, to still examine the Lorentz assumptions, and to verify if they are, then, in agreement with different well established concepts of physics. If this is the case, it should be justified to search for a set of transformations deriving from the postulates of Lorentz, but more general than those of Lorentz-Poincaré, and which could be applied between any couple of inertial frames. (Let us bear in mind that the Lorentz assumptions are: existence of a privileged inertial frame supporting the aether designated as Cosmic Substratum, length contraction, clock retardation, variation of mass with speed, speed of light isotropic and equal to C exclusively in the aether frame.)

Let us briefly remember the reflections to which we devoted our previous papers. In ref. [9-12] we demonstrated, *in the special case of a light signal emitted from an inertial frame different from the fundamental one*, that the space-time transformations bringing into play this reference frame and another, take a different form from the classical ones (i-e Lorentz-Poincaré transformations.) So, the whole of these transformations do not constitute a group and, in consequence, they do not, obey the relativity principle. We also verified that the Galilean law of composition of velocities can be transmuted into the law $v = \frac{v_0 + v'}{1 + v_0 v'/C^2}$ in a simple manner, by introducing the systematic errors of measurement resulting from length contraction, clock retardation and imperfect clock synchronization [10] (Notice that the law takes this form exclusively when one of the frames under consideration is the fundamental frame. In all other cases, as we will see later, it takes another form.)

From these considerations and some others we concluded that the space-time transformations derived from the Lorentz postulates assume the following character:

1. They are reducible to the Galilean transformations after correction of the erroneous measurements just mentioned.
2. They take their usual form (Lorentz-Poincaré transformations, i-e L.P tr) exclusively when one of the frames under consideration is the privileged inertial frame (aether frame).
3. They are in contradiction with the relativity principle (this third statement is a direct consequence of the second statement)

These observations, at first, rendered the assumptions of Lorentz suspicious to us. In effect, in order to demonstrate the law $m = m_0\gamma$, we generally make use (as Einstein did) of the law of conservation of the relativistic quantity of motion in any inertial frame, which applies in relativity theory. If Lorentz's theory is reducible to Galilei's, this law of conservation cannot be called upon to demonstrate $m = m_0\gamma$. So, at first sight, Lorentz (Galilei) theory seemed incompatible with an important experimental fact, i.e the variation of mass with speed.

Finally, the fact that the Lorentz assumptions are not compatible with the relativity principle seemed to us an important objection to this approach. But, since that time, we have become aware that the relativity principle is not an unquestionable concept of physics [13]. So it can really be used, neither to demonstrate the law $m = m_0\gamma$, nor to refute it. In effect, if the laws of physics are not perfectly invariant, then, there is no necessity for the total quantity of motion to be exactly conserved in all inertial frames. (Of course this does not concern the conservation of energy which must be universal.)

So, an important objection against Lorentz's assumptions was removed.

There remained however some points to be clarified:

1. If Lorentz's law of composition of velocities is reducible to Galilei's, is it compatible with the existence of a limit velocity? At first sight this does not seem to be the case!

2. Are there to day some experimental facts which render length contraction obligatory?
3. As far as these experimental bases are proved, is length contraction necessary to explain some other experimental results: for example the apparent (measured) isotropy of the two way speed of light? We will try to answer these three questions.

Suppose two inertial bodies, one having the speed $v_o = 2\ 10^5$ km/sec with respect to the Earth and the other $v = 2\ 10^5$ km/sec with respect to the first, the three bodies being aligned.

According to Einstein's special relativity, the speed of the second with respect to the Earth (v') is

$$v' = \frac{2v}{1+v^2/C^2} = \frac{4\ 10^5}{1+4/9} = \frac{36}{13}\ 10^5\ \text{km/sec} < C$$

In Galilean theory, the total speed would be: $V' = 2v = 4\ 10^5\ \text{km/sec} > C$, which is not agreement with the experiment.

But this obstacle can be overcome. It is sufficient for that, that the speed of a body with respect to the aether frame (V) be limited in such a way that $V < C$.

So that, if a body A moves at speed v_A with respect to the origin O of a system of coordinates at rest with respect to the aether, the speed relative to A of another body B moving along the direction OA will be limited to $v_B < C - v_A$.

Another important point to be examined was the reality of Lorentz Fitzgerald's contraction and its real compatibility with Lorentz's theory if one assumes that it is reducible to Galilei's.

A priori, a number of objections seemed to oppose these two concepts.

1. In Lorentz's theory, length contraction can be justified only if the law $m = m_0\gamma$ applies[14].

   At first sight this looked like an important objection since, as demonstrated previously [9-11], Lorentz's theory seemed incompatible with $m = m_0\gamma$. But, as far as the relativity principle is called into question, the objection no longer holds.

2. Lorentz contraction was never observed experimentally. The classical experiments[15] (Rayleigh, Brace, Trouton and Noble, Trouton and Rankine, Chase, Tomashek, Wood, Tomlison and Essex, etc.) could not demonstrate it but, in ref.[5] paragraph II, Lorentz could explain this negative result by the increase of mass with speed. (See also ref.[14]).

   The more recent experiment by Sherwyn[16] proved also negative : the author considered an elastic rod rotating about one end in the laboratory frame. At low rotation rates, the length of the rod adiabatically follows the length demanded by the equilibrium lengths of the molecular bonds, which obviously cannot be estimated by laboratory meter sticks, since they experience the same dependence of length on angle. However, according to the author, at high rotation rates, when the time required to rotate 90° becomes comparable to the period of vibration of the structure, the macroscopic length would not be able to exactly follow the "bond equilibrium" length.

   This statement appears questionable: if the time required to rotate 90° is comparable to the period of vibration, the adiabatic process should still apply. Probably, only for very high rotation rates the length of the rod would not have enough time to exactly follow the "bond equilibrium" length.

3. The compressibility of matter is limited, and length contraction seems difficult to justify at very high speeds. For example at 0,9999 C the ratio ℓ/ℓ_0 would reduce to 1,4%.

   But we can answer that the law has been proposed following an experiment performed at low speed (Michelson's experiment). It would not adopt the same form at very high speeds.

Today, the author of the present text realizes that, although not observed, there exists some strong arguments lending support to Lorentz-Fitzgerald's contraction. A weighty argument can be derived from the experiment of Marinov (1984)[17] who, by means of a Fizeau's type toothed wheel apparatus, brought to the fore the anisotropy of the one way speed of light. (This kind of experiment does not enter in the category of optical experiments forbidden by the Potier-Veltmann principle [18].)

I would like to express my surprise regarding the ignorance of the physicist's community in what concerns the contributions of Marinov. In the collective book "Open questions in relativistic physics [19]", he is only quoted once by Wesley who is merited with attracting attention to his work. He is not at all quoted by Anderson Vetharaniam and Stedman [20] in their review article of about 100 pages. In his 1998 Apeiron article [21], T. E. Phipps Jr confesses to having had the popular (among physicists) pejorative view of Stefan Marinov, but he continues on: "that opinion I no longer hold since I have been able by my own observation to confirm the operability of one of his inventions... i.e the Marinov Motor".

This prejudicial opinion shared by many, has probably delayed the knowledge of his prominent contribution, and I apologize for my ignorance.

The principle of the toothed wheel experiment was simple. The apparatus consisted of two identical circular steel plates with 40 round holes of diameter = 6 mm. They were mounted on a shaft of length L = 120 cm rotating with angular velocity Ω. An argon laser illuminated the holes of the first plate, and a silicon photocell detected the light passing through the holes of the second plate. At initial instant, the two wheels were aligned with their holes exactly opposite. The transit time Δt for light to travel the distance L, was determined by measuring the amount of light received by the photocell as a function of the rotation rate Ω" (Wesley [36].)

The experiment demonstrated that the absolute velocity (v) of the solar system, is of the order of 360 ± 40 km/sec, and that the speed of light is $C-v$ in the direction of motion of the solar system, and $C+v$ in the opposite direction. (Notice that the orbital motion of the Earth around the sun is far weaker (about 30 km/sec), and that the rotational motion at the latitude of the experiment was of the order of 0,5 km/sec, *for this reason, during a short time, in most cases, the motion of the Earth with respect to the aether frame can be identified with the motion of the solar system*).

As a result of this, it is easy to verify that a rod of length ℓ_0 aligned along the direction of motion of the solar system, contracts in such a way that $\ell=\ell_0\sqrt{1-v^2/C^2}$.

Consider for that a Michelson interferometer whose longitudinal arm slides at speed v along the x_0 axis of a system of coordinates $S_o(O, x_o, y_o, z_o)$ at rest in the Cosmic Substratum. A priori, we do not know if $\ell=\ell_0$ or not. But we know that Michelson's experiment has brought to the fore a displacement of the fringes really too small to explain the existence of an aether wind of about 300 km/sec, and then which can be ignored. (See the review article by Hayden [22].) So, for our purpose, the two way transit time of light in the two arms of the interferometer (t_1, and t_2) can be considered identical. Along the longitudinal arm we have

$$t_1=\frac{\ell}{C-v}+\frac{\ell}{C+v}=\frac{2\ell}{C(1-v^2/C^2)} \qquad (1)$$

Consider now the arm perpendicular to the direction of motion, from Marinov's experiment we know that the speed of light is equal to C exclusively in the aether frame. The signal starts from a point P of this frame towards a point Q at the extremity of the arm and then comes back to point P'. During that time, the interferometer has covered the path vt_2 (see figure 1.)

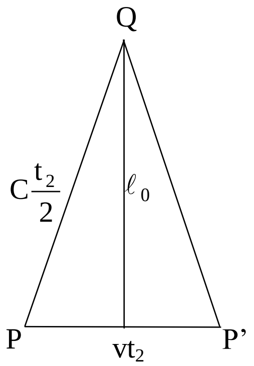

Figure 1

we have $$\left(C\frac{t_2}{2}\right)^2-\left(v\frac{t_2}{2}\right)^2=\ell_0^{\,2} \qquad \Rightarrow \ell_0=\frac{t_2}{2}\sqrt{C^2-v^2}$$

so that $$t_2=\frac{2\ell_0}{C\sqrt{1-v^2/C^2}} \qquad (2)$$

identifying t_1 and t_2 we obtain $\frac{2\ell}{C(1-v^2/C^2)}=\frac{2\ell_0}{C\sqrt{1-v^2/C^2}}$

Hence $\ell=\ell_0\sqrt{1-v^2/C^2}$

Finally length contraction appears as a necessary consequence of both Michelson's and Marinov's results.

Now, with the same standpoint, we will demonstrate that the apparent (measured) two way speed of light along the longitudinal x_0 axis, is equal to C independently of the speed v.

In effect, taking account of clock retardation, the two way apparent (measured) transit time of light (clock display) will be (from formula (2)): $t=\frac{2\ell_0}{C}$.

Since the arm is measured with a contracted meter stick, its length is found equal to ℓ_0 and not to ℓ, so that the apparent average two way speed of light will be found equal to C. (This experimental value is in fact different from its real value which, according to formula (1), is $C(1-v^2/C^2)$). Note also that in absence of length contraction the apparent average two way speed of light (experimental), would have been found different from C in contradiction with the experiment.

So, two meaningful results can be deduced from the toothed wheel experiment of Marinov in conjunction with Michelson's experiment, and the contraction of rods in motion deduced from them.

But this is not all. These two experiments also explain the invariance of the two way transit time of light, not only in two opposite directions, but independently of the angle α and of the speed of the reference frame in which it is measured. (See ref. [11] page 65 to 70 or ref. [23].)

Also the apparent constancy of the two way speed of light in any direction of space and in any inertial frame can be deduced from them [9 11].

These results are highly meaningful.

Notes

1. After having derived the extended space-time transformations, another important consequence will be studied in appendix 2. It deals with Fresnel's "Aether drag formula" and Fizeau's experiment.
2. In place of Lorentz's contraction, the same results could have been obtained in supposing that the speed of light is $(C-v)/(1-v^2/C^2)^{1/2}$ in the direction of motion, and $(C+v)/(1-v^2/C^2)^{1/2}$ in the opposite direction. Let us examine such a hypothesis.

   It is obvious that the factor $1/(1-v^2/C^2)^{1/2}$ would have resulted from the proximity of the celestial bodies. In effect, at a distance from them, in a reference frame not influenced by the presence of matter, there is no possible explanation for the existence of such a term.

   The said factor, being multiplicative, indicates an increase of the speed of light in the neighbourhood of the celestial bodies, which, in turn , implies a partial dragging of the aether.

   Such a hypothesis cannot be justified for the following reasons:
3. The experiment of O. Lodge [24] demonstrated that the speed of light is not changed at the neighbourhood of a rotating wheel.
4. A partial dragging of the aether would have increased the speed of light in the direction of motion, and reduced it in the opposite direction. And the multiplicative factor would have been different in the two opposite directions, which is not the case here.
5. On the contrary there are no logical obstacles for Lorentz contraction. Moreover there are theoretical bases for the process.

   a - Since Marinov's experiment demonstrated the anisotropy of the speed of light, we are limited to two hypotheses (as we have seen in the corpus of the text.) The elimination of the just mentioned hypothesis renders length contraction necessary.

b - According to Wilhelm : "Since matter consists of positive (nuclei) and negative (electrons) charges, the contraction of their equipotential surfaces causes Lorentz-Fitzgerald's contraction".

c - Marinov's experiment gives a physical basis to the theoretical explanations of Larmor [4], Lorentz [5], and Several prominent modern physicists who assume length contraction (see ref. [23] and [25] to [33].) It invalidates the other theories : Ritz theory [34] (ballistic), Einstein theory [7], Stokes theory (completely dragged aether) [35].

We must also note that the compressibility of matter is not infinite and that, most probably, the law $\ell = \ell_0 (1 - v^2/C^2)^{1/2}$ should not apply exactly in the same form at very high speeds. (For example for speeds equal to 0,9999 C, the contraction of matter would be ℓ/ℓ_0 = 1,4%.)

In the light of this new data, the assumptions of Lorentz appear today far better founded than in the past. (Note nevertheless that this statement concerns the Lorentz assumptions and not the Lorentz-Poincaré transformations as will be seen later.)

Let us bear in mind that Lorentz-Poincaré's transformations apply exclusively in a particular case [9-11]. We propose here to derive a set of space-time transformations effective in all inertial frames. This purpose is parallel but different from Selleri's work [27], since, here, we deal with the experimental transformations obtained from the usual Einstein-Poincaré's method of synchronization, or with the slow clock transport's method which is equivalent (and not with the absolute synchronization procedure of Mansouri and Sexl [29], which is theoretical and would be difficult to apply experimentally.)

In addition we demonstrate that the coordinates of these transformations, although experimental, are fictitious and must be corrected in order to obtain the real lengths, speeds, and times. Conversely, in order to derive them we must make use of the Galilean transformations.

We have to specify that these extended space-time transformations, apply to all moving bodies and not exclusively to the special case of a light signal (Like in ref. [9].)

II. Derivation of the extended space-time transformations

Consider three inertial systems S_0 (O, x_0, y_0, z_0), S_1 (O', x_1, y_1, z_1), S_2 (O'', x_2, y_2, z_2), S_0 is at rest in the Cosmic Substratum (aether frame), S_1 and S_2 move along the common x axis with a rectilinear uniform motion (see figure 2.)

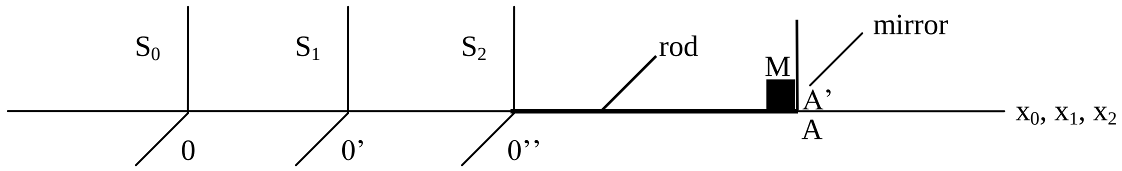

Figure 2

When the body arrives at A it meets a mirror firmly attached to frame S_1.

A long rigid rod at rest with respect to frame S_2 is aligned along the x_2 axis. At initial instant, the origins of the three frames O, O' and O'' are coincident. At this very instant, a body M (coming from the -x_2 region) passes by O'', and then continues on its way along the rod with a rectilinear uniform motion, towards a point A whose distance with respect to O'' is constant.

Let us designate as v_{01} the speed of reference frame S_1 with respect to S_0, v_{02} the speed of S_2 with respect to S_0, and v_{12} the speed of S_2 with respect to S_1. The speed of the body with respect to S_0 will be called V. The length of the rod would be ℓ_0 if frame S_2 were at rest with respect to the Cosmic Substratum. But, as a result of its motion, O''A becomes contracted and assumes the length ℓ such that: $\ell = \ell_0 \sqrt{1 - {v_{02}}^2/C^2}$.

When the body M arrives at point A, it meets a mirror firmly attached to frame S_1 at a point A' of this frame.

In order to synchronize a clock placed at A', with another one placed at O', we send a light signal from O' to A'. After reflection, the signal comes back to O'. We must make the operation in two times : firstly when the body reaches point A, we place the clock at A' (which at this instant coincides with A), then we synchronize the clocks O' and A' by means of the Einstein-Poincaré procedure. Secondly we must start again the experiment from the beginning with the body in exactly the same conditions, but now, the clocks O' and A' are already synchronized.

Let us call t_1 the time needed by the signal to go from O' to A' and $\bar{t}_1$ the reverse time (from A' to O'.) According to Einstein-Poincaré's method, t_1 is supposed to be equal to $\bar{t}_1$, and then the clocks O' and A' are considered perfectly synchronous. (The time needed by the signal to reach clock A', is therefore supposed equal to $\frac{t_1 + \bar{t}_1}{2}$.)

Nevertheless, there are today a number of arguments lending support to the existence of a privileged inertial frame supporting the aether [13,17,23,36] and, therefore, the speed of light must be isotropic exclusively in this aether frame. Thus, the Einstein-Poincaré procedure, introduces a systematic error, which is equal to the difference δ between the real time needed by the light signal to reach point A', and the apparent time $t_{1app} = \frac{t_1 + \bar{t}_1}{2}$ that is: $\delta = t_1 - t_{1app} = \frac{t_1 - \bar{t}_1}{2}$

In absence of clock retardation the value of t_1 would be: $t_1 = \frac{\ell_0 \sqrt{1 - v_{02}^2 / C^2}}{C - v_{02}}$

(See demonstration in appendix 1. For more detailed explanations consult ref. [9-11].) and

$$\bar{t}_1 = \frac{\ell_0 \sqrt{1 - v_{02}^2 / C^2}}{C - v_{02}} \quad \frac{C - v_{01}}{C + v_{01}}$$ (see also the appendix.)

But we must take account of clock retardation, so that the apparent transit times of light in frame S_1 must be equal to the times of frame S_0 multiplied by $\sqrt{1 - v_{01}^2 / C^2}$.

Therefore, the error of synchronism between the displays of clocks O' and A' will be equal to

$$\Delta = \delta \sqrt{1 - v_{01}^2 / C^2}$$

$$\Delta = \frac{1}{2} \ell_0 \sqrt{1 - v_{02}^2 / C^2} \; \frac{C - v_{01}}{C - v_{02}} \left(\frac{1}{C - v_{01}} - \frac{1}{C + v_{01}} \right) \times \sqrt{1 - v_{01}^2 / C^2}$$

$$= \ell_0 \, v_{01} \frac{\sqrt{1 - v_{02}^2 / C^2} \; \sqrt{1 - v_{01}^2 / C^2}}{(C - v_{02})(C + v_{01})}$$

We see that, for $v_{01} = 0$, there is no anisotropy effect since the measurement is carried out in the Cosmic Substratum. So, in conformity with our expectation, $\Delta = 0$.

On the other hand, if $v_{01} = v_{02}$, then, frames S_1 and S_2 always remain coincident, and we are brought back to the case of two reference frames with one them at rest in the Cosmic Substratum (aether frame). In this case, Δ is reduced to $\frac{v_{01} \ell_0}{C^2}$ which is the synchronism discrepancy effect defined by Prokhovnik, see ref.[23]. This is in conformity with our expectations.

The apparent time T_{1app} needed by the body M to cover the distance O'A' in frame S_1, is equal to the difference between $T_{1r} \sqrt{1 - v_{01}^2 / C^2}$ and the error of synchronism Δ, where T_{1r} is the real time given by the clocks of frame S_0, and $T_{1r} \sqrt{1 - v_{01}^2 / C^2}$ is the clock display in frame S_1 resulting from clock retardation (that we would have noticed in the absence of synchronism discrepancy effect.)

$$T_{1app} = T_{1r} \sqrt{1 - v_{01}^2 / C^2} - \Delta \qquad (3)$$

$$\text{where } T_{1r} = \frac{O'A'}{V - v_{01}} \qquad (4)$$

Now, the ratio of the distances covered by the body respectively in frames S_1 and S_2 is equal to the ratio of the speeds with respect to these two frames, that is:

$$\frac{O'A'}{\ell_0\sqrt{1-v_{02}{}^2/C^2}}=\frac{V-v_{01}}{V-v_{02}} \qquad (5)$$

Therefore from (4) and (5):

$$T_{1r}=\frac{\ell_0\sqrt{1-v_{02}{}^2/C^2}}{V-v_{02}} \qquad (6)$$

(we see that this time is equal to T_{2r}.)

From expressions (3) and (6) we finally obtain:

$$T_{1app}=\ell_0\sqrt{1-v_{02}{}^2/C^2}\left(\frac{1}{V-v_{02}}-\frac{v_{01}}{(C-v_{02})(C+v_{01})}\right)\sqrt{1-v_{01}{}^2/C^2} \qquad (7)$$

From expression (5) we easily obtain the apparent distance X_{1app} covered by the body from O' to A' (as measured with the contracted meter stick of observer S_1.) It is equal to O'A' divided by $\sqrt{1-v_{01}{}^2/C^2}$.

$$X_{1app}=\frac{O'A'}{\sqrt{1-v_{01}{}^2/C^2}}=\frac{\ell_0\sqrt{1-v_{02}{}^2/C^2}}{\sqrt{1-v_{01}{}^2/C^2}}\;\frac{V-v_{01}}{V-v_{02}} \qquad (8)$$

(See also later expressions (7 b) and (8 b)

So that, the apparent speed of the body will be:

$$V_{1app}=\frac{\dfrac{V-v_{01}}{V-v_{02}}}{(1-v_{01}{}^2/C^2)\left(\dfrac{1}{V-v_{02}}-\dfrac{v_{01}}{(C-v_{02})(C+v_{01})}\right)}$$

$$=\frac{C^2(V-v_{01})(C-v_{02})}{(C-v_{01})\left[(C-v_{02})(C+v_{01})-v_{01}(V-v_{02})\right]}$$

Expressions (7) and (8) are the extended space-time transformations applicable to any couple of inertial frames receding uniformly with respect to one another along a common axis.

Note that, during a short time, the motion of the Earth with respect to the Cosmic Substratum can be considered as rectilinear and uniform. If this were not the case, the bodies placed on its surface would be subjected to accelerations and would not be steady, which is not the case.

Practically S_1 can be identified with the Earth frame (during a short time), S_2 with a vehicle moving on its surface in the direction of motion of the Earth (for example a ship) and M with a body moving on the surface of S_2 in the same direction. So, v_{01} is the real speed of the Earth with respect to the Cosmic Substratum (S_0), v_{02} is the real speed of the ship with respect to S_0, V is the real speed of the body with respect to S_0, and V_{1app} the apparent (measured) speed of the body with respect to the Earth frame S_1.

Important remark

It is currently asserted that the total quantity of motion is exactly conserved even when collisions occur at very high speeds. This seems eminently questionable to us. In effect, by means of the usual methods of synchronization of clocks, one makes systematic errors in measuring the speeds. One finds the apparent speeds (V_{1app}) in place of the real ones.

III. Consistency of the transformations

The consistency of the transformations can be verified. We need for that to demonstrate their agreement with experimental data and with results already known in particular cases. For example, as we have seen, Δ takes the expected values when $v_{01} = 0$ and $v_{01} = v_{02}$.

In addition, the experimental measurement of the speed of light (apparent) must be found constant, and the equations must be reduced to those of Lorentz when $v_{01} = v_{02}$.

We in effect notice that: $V = C \Rightarrow V_{1app} = C$.

Now, when $v_{01} = 0$, S_1 is at rest with respect to the Cosmic Substratum and then: $V_{1app} = V$.

Suppose now that $v_{01} = v_{02}$. In this case since $S_1$and S_2 were coincident at initial instant, they remain coincident so:

$$V_{1app} = V_{2app} = \frac{C^2 (V - v_{02})(C - v_{02})}{(C - v_{02})\left[(C - v_{02})(C + v_{02}) - v_{02}(V - v_{02})\right]}$$

and $$V_{2app} = \frac{V - v_{02}}{1 - v_{02} V/C^2} \qquad (9)$$

We are brought back (as expected) to the usual law of composition of velocities, (with the additional information that V_{2app} is an apparent speed.)

- Now, for $v_{01} = 0$, expressions (8) and (7) reduce to

$$X_{1app} = X_0 = \ell_0 \sqrt{1 - v_{02}{}^2/C^2}\ \frac{V}{V - v_{02}} \qquad (10)$$

and $$T_{1app} = T_0 = \frac{\ell_0 \sqrt{1 - v_{02}{}^2/C^2}}{V - v_{02}} \qquad (11)$$

where X_0 and T_0 are the real distance and time as measured in the aether frame.

So $$V_{1app} = \frac{X_{1app}}{T_{1app}} = V$$

ℓ_0 is the length of the rod O’’A when it is at rest in the aether frame, but it is also the apparent length X_{2app} as measured with the contracted meter stick of frame S_2.

So from (10) we obtain

$$X_{2app} = \frac{X_0 (V - v_{02})}{V \sqrt{1 - v_{02}{}^2/C^2}} = \frac{X_0 - v_{02} T_0}{\sqrt{1 - v_{02}{}^2/C^2}}$$

In this particular case we are therefore brought back to the Lorentz-Poincaré transformation regarding space.

- We will now derive the synchronism discrepancy effect Δ’ in frame S_2 in order to obtain T_{2app}.

Let us write $$T_{2app} = T_{2r} \sqrt{1 - v_{02}{}^2/C^2} - \Delta' \qquad (12)$$

T_{2r} is the real time needed by the body to cover the distance O’’A. But we must take account of the slowing down of the clocks of frame S_2, so T_{2r} must be multiplied by $\sqrt{1 - v_{02}{}^2/C^2}$.

The error of synchronism δ’ is equal to the difference between the real time needed by a light signal to go from O’’ to A, and the apparent time. The real time is:

$$t_2 = \frac{\ell_0 \sqrt{1 - v_{02}{}^2/C^2}}{C - v_{02}}$$

The apparent time t_{2app} is the average time needed by the light signal that goes from O’’ to A and after reflection comes back to O’’.

$$t_{2app} = \frac{t_2 + \bar{t}_2}{2}$$

where $\bar{t}_2$ is the real time needed by the signal to go from A to O''. (It is equal to $\ell/(C+v_{02})$.)

So: $$\delta' = t_2 - t_{2app} = \frac{t_2 - \bar{t}_2}{2}$$

Taking account of clock retardation, the apparent error of synchronism in frame S_2 becomes

$$\Delta' = \frac{t_2 - \bar{t}_2}{2}\sqrt{1-v_{02}^2/C^2}$$
$$= \frac{1}{2}\ell_0\sqrt{1-v_{02}^2/C^2}\left(\frac{1}{C-v_{02}} - \frac{1}{C+v_{02}}\right)\times\sqrt{1-v_{02}^2/C^2}$$
$$= \frac{v_{02}\,\ell_0}{C^2}$$

On the other hand, the real time needed by the body to cover the distance O''A is:

$$T_{2r} = \frac{\ell_0\sqrt{1-v_{02}^2/C^2}}{V-v_{02}}$$

So, from expression (12), $$T_{2app} = \frac{\ell_0(1-v_{02}^2/C^2)}{V-v_{02}} - \frac{v_{02}\,\ell_0}{C^2} = \frac{\ell_0(1-v_{02}V/C^2)}{V-v_{02}} \qquad (13)$$

Now from expression (11) (assuming $v_{01}=0$)

$$\ell_0 = \frac{T_0(V-v_{02})}{\sqrt{1-v_{02}^2/C^2}}$$

replacing ℓ_0 by its value in formula (13) we easily verify that

$$T_{2app} = \frac{(1-v_{02}V/C^2)T_0}{\sqrt{1-v_{02}^2/C^2}} = \frac{T_0 - v_{02}X_0/C^2)}{\sqrt{1-v_{02}^2/C^2}}$$

So, as expected, we find the Lorentz-Poincaré relationships again (see also ref. [11] p 52.)

- Let us now suppose that $v_{01} = v_{02}$

From equation (7) we obtain:

$$T_{1app} = T_{2app} = \frac{\ell_0(1-v_{01}V/C^2)}{V-v_{01}} \qquad (14)$$

Knowing that the ratio of the distances covered by body M is equal to the ratio of the speeds, the distance from O to A is easily obtained:

$$\frac{X_0}{\ell_0\sqrt{1-v_{01}^2/C^2}} = \frac{V}{V-v_{01}}$$
$$\Rightarrow X_0 = \ell_0\sqrt{1-v_{01}^2/C^2}\;\frac{V}{V-v_{01}}$$

So, the real time needed by the body to cover the distance OA is:

$$T_0 = \frac{\ell_0\sqrt{1-v_{01}^2/C^2}}{V-v_{01}}$$

and $$\ell_0 = \frac{T_0(V-v_{01})}{\sqrt{1-v_{01}^2/C^2}}$$

replacing ℓ_0 by its value in formula (14) gives.

$$T_{1app} = \frac{(1-v_{01}V/C^2)T_0}{\sqrt{1-v_{01}^2/C^2}} = \frac{T_0 - v_{01}X_0/C^2)}{\sqrt{1-v_{01}^2/C^2}}$$

The expression of X_{1app} is obtained by multiplying T_{1app} by V_{1app} (as given by expression (9).)

$$X_{1app} = \frac{X_0 - v_{01}\ T_0 / C^2}{\sqrt{1 - v_{01}{}^2 / C^2}}$$

So, the extended space-time transformations given by (7) and (8) take as expected the form of the Lorentz-Poincaré transformations in the particular cases just studied.

Important remarks

ℓ_0 is not the real coordinate of point A relative to S_2 along the x_2 axis, the real one is ℓ. The fact that people are not aware of this is a source of much confusion.

We also point out that, contrary to what is often believed, X_{1app}, T_{1app} and V_{1app} are all apparent (fictitious) coordinates.

- Inserting expression (13) in (7) and taking account of the identity $\ell_0 = X_{2app}$, T_{1app} can be expressed as a function of T_{2app} as follows:

$$T_{1app} = \frac{T_{2app}\sqrt{1 - v_{02}{}^2 / C^2}}{1 - v_{02} V / C^2} \left(\frac{(C - v_{02})(C + v_{01}) - v_{01}(V - v_{02})}{(C - v_{02})(C + v_{01})} \right) \sqrt{1 - v_{01}{}^2 / C^2} \qquad (7b)$$

and X_{1app}, as a function of X_{2app} in such a way that:

$$X_{1app} = \frac{X_{2app}\sqrt{1 - v_{02}{}^2 / C^2}}{\sqrt{1 - v_{01}{}^2 / C^2}} \ \frac{V - v_{01}}{V - v_{02}} \qquad (8\ b)$$

IV. Conclusion

Starting from the Galilean relationships and assuming the postulates of Lorentz, we obtained a set of transformations applicable to any couple of inertial frames, even if not one is at rest in the Cosmic Substratum (aether frame.) They take a different form from those of Lorentz-Poincaré.

In order to derive them we were compelled to modify the Galilean relationships by taking account of the systematic errors of measurement. The space-time transformations then obtained are equal to the experimental ones.

Conversely, they must be corrected in order to obtain the Galilean transformations, which are the true ones when no error of measurement is carried out.

The consistency of the derivation is verified since the relationships reduce to the Lorentz-Poincaré transformations when one of the frames under consideration is the fundamental inertial frame. They also verify the constancy of the apparent (measured) velocity of light in any inertial frame, (although, after correction of the systematic errors of measurement, they demonstrate that the constancy of the real velocity of light is effective exclusively in the fundamental inertial frame.)

These extended space-time transformations enter in contradiction with the relativity principle, (but, as we have seen in ref. [13], in different usual cases this concept remains practically true.)

The fact that they do not verify the relativity principle does not disprove them, since the principle must be questioned (see also ref. [13]) Now, as we remarked in the introduction, we must point out that the questioning of the relativity principle, compels us to also relativize the law of conservation of the total quantity of motion in any inertial frame. The law exactly applies exclusively in the fundamental inertial frame. It is only approximately true when the center of the collision moves at low speed with respect to it $(v/C << 1)$. (This point of view is also shared by Wesley ref. [36] p17.)

This is not the case in conventional relativity, and this law was used by Einstein to demonstrate the relationship $m = m_0\gamma$.

Note that the transformations just derived have not only theoretical interest, they certainly correspond to our situation in the cosmos since serious arguments demonstrate that the Earth is in motion with respect to the Cosmic Substratum at about 300km/sec, and the frame of the Earth can be identified with S_1 [17].

- Another point of importance should be clarified. We know that in aether theories, contrary to relativity, the kinetic energy presents an absolute character. It is defined with respect to the fundamental frame S_0. So, the increase of kinetic energy of a body which passes from an inertial frame S_1 (different from S_0) to another S_2, is different from the conventional one. Let us calculate it:

When the body passes from S_0 to S_1, the kinetic energy acquired is $(m_1 - m_0)C^2$ (15)

If the speed of the body is weak $(v_{01}/C << 1)$, expression (15) reduces to: $\frac{1}{2} m_0\ v_{01}{}^2$

when the body passes from S_0 to S_2 (with $v_{02}/C << 1$) the kinetic energy acquired is $\frac{1}{2} m_0\ v_{02}{}^2$

So, the increase of kinetic energy from S_1 to S_2 is $\frac{1}{2} m_0 (v_{02}{}^2 - v_{01}{}^2)$ (16)

Since $(v_{02} << C)$, we can write $v_{12app} \approx v_{12} = v_{02} - v_{01}$. So expression (16) becomes

$$\frac{1}{2} m_0 (v_{12}{}^2 + 2 v_{01} v_{12}) \qquad (17)$$

This expression appears different from the conventional one $\frac{1}{2} m_0\ v_{12}{}^2$. In effect, contrary to this, expression (17) depends on v_{01} which is the speed of the Earth with respect to the fundamental frame. In ref.[11] we considered this result as an argument against aether theories, but in the light of the new data which calls into question the relativity principle [13,37], we think that our previous position should be reconsidered .

Analysing expression (17) we notice that when $v_{12} >> v_{01}$, the term depending on v_{01} can be ignored and we are brought back to the conventional expression again. But, very likely, in most cases v_{01} should not be ignored since it is estimated at about 300 km/sec.

N.B-We may notice that in conventional physics, when one assumes the relativity principle, the expression of the kinetic energy is affected by an important internal contradiction. In effect, when a body passes from an inertial system S_0 to another S_1, (assuming that $v_{01} << C$) it acquires the kinetic energy:

$$(m_1 - m_0)C^2 \approx \frac{1}{2} m_0 v_{01}{}^2 \qquad (18)$$

Now when the same body passes from S_0 to S_2, (with $v_{02} << C$) the kinetic energy acquired is

$$(m_2 - m_0)C^2 \approx \frac{1}{2} m_0 v_{02}{}^2 \qquad (19)$$

The difference between (19) and (18) is $\frac{1}{2} m_0 (v_{02}{}^2 - v_{01}{}^2)$

which is different from $\frac{1}{2} m_0 v_{12}{}^2$

(Note that contrary to aether theories, v_{01} is not the speed of the body with the respect to a privileged frame). Suppose that $v_{01} = v_{12} = v$, assuming that v << C, we easily verify that the increase of kinetic energy from S_1 to S_2 is $3/2\, m_0 v^2$. But according to the relativity principle it should be $1/2\, m_0 v^2$ since nothing differentiates the three inertial frames.

This important internal contradiction does not affect the fundamental theories.

The paradox is even more obvious since the energy acquired when a body passes from an inertial frame S_0 to S_1 is not clearly defined, and depends on the frame from which it is measured. Suppose that $v_{01} = 0$ and that S_0 and S_1 coincide, if $v_{12} = 1 \text{km/sec}$ the kinetic energy acquired from S_1 to S_2 will be considered equal to $\frac{1}{2} m_0$. If we measure the same kinetic energy from a frame S_0 moving with respect to S_1 at 10 km/sec we will find

$$\frac{1}{2}m_0(11^2-10^2)=\frac{1}{2}m_0(121-100)=10{,}5m_0.$$

This is in contradiction with the idea that the energy needed to carry out a certain work is well defined and cannot depend on the point from which it is measured.

This paradox is completely foreign to the fundamental theories where the energy is perfectly defined, and depends on the speed of the body with respect to the aether frame.

Appendix 1

Calculation of the real and apparent times needed by a light signal to go from O' to A'.

1. Real time

Let us consider figure1

The ratio of the distances covered by the signal to go from O' to A' and from O'' to A is equal to the ratio of the speeds of the signal with respect to S_1 and to S_2:

$$\frac{x_1}{\ell_0\sqrt{1-v_{02}^2/C^2}}=\frac{C-v_{01}}{C-v_{02}}$$

so:

$$x_1=\ell_0\sqrt{1-v_{02}^2/C^2}\,\frac{C-v_{01}}{C-v_{02}}$$

Therefore the real time needed by the signal to cover the distance x_1 is:

$$t_1=\frac{x_1}{C-v_{01}}=\frac{\ell_0\sqrt{1-v_{02}^2/C^2}}{C-v_{02}} \qquad (20)$$

where $C-v_{01}$ is the real velocity of light in frame S_1.

Let us point out that these lengths, times, and speeds, are not those which are measured experimentally.

2. Apparent time

The experimental (apparent) time can be easily obtained from the real one by taking account of the systematic errors of measurement.

This is also the case for the apparent path. In effect, the distance x_1 being measured with a contracted meter stick, appears longer than it really is, the apparent distance is then:

$$x_{1app}=\frac{x_1}{\sqrt{1-v_{01}^2/C^2}}=\frac{\ell_0\sqrt{1-v_{02}^2/C^2}}{\sqrt{1-v_{01}^2/C^2}}\,\frac{C-v_{01}}{C-v_{02}}$$

As we have seen, the real time needed by the light signal to go from O' to A' is erroneously identified with the average two way transit time t_{1app} (from O' to A' and from A' to O'). In fact

$$\frac{t_1+\bar{t}_1}{2}=t_{1app}$$

t_1 is given by formula (20). We can see that in the reverse direction (A'→ O') the light signal covers with respect to S_1 the same distance as from O' to A', but with the speed $C+v_{01}$.

Thus:

$$\bar{t}_1=\frac{x_1}{C+v_{01}}=\ell_0\sqrt{1-v_{02}^2/C^2}\;\frac{C-v_{01}}{C-v_{02}}\times\frac{1}{C+v_{01}}$$

and:

$$\frac{t_1+\bar{t}_1}{2}=\frac{1}{2}\ell_0\sqrt{1-v_{02}^2/C^2}\;\frac{C-v_{01}}{C-v_{02}}\left(\frac{1}{C-v_{01}}+\frac{1}{C+v_{01}}\right)$$

In fact, as a result of clock retardation, the two way average transit clock display d_{1app} will be equal to the product $t_{1app}\times\sqrt{1-v_{01}^2/C^2}$

so :

$$d_{1app}=\frac{\ell_0}{C}\,\frac{\sqrt{1-v_{02}^2/C^2}}{\sqrt{1-v_{01}^2/C^2}}\,\frac{C-v_{01}}{C-v_{02}}$$

- apparent speed of light

The apparent (experimental) speed of light appears, as expected, equal to $\frac{x_{1app}}{d_{1app}} = C$.

N.B: the concurrent method of slow clock transport also appears affected by similar systematic errors of measurement (consult ref. [11, 23]).

Appendix 2

It is currently asserted that Fizeau's experiment [38] has definitively proved the reliability of Fresnel's formula [39]. This is not exact. As will be seen in the present appendix, although assuming similar mathematical form, Fresnel's and Fizeau's formulas are in fact different. Lorentz-Poincaré's theory was not capable of connecting these two formulas. This can be done by means of the present extended space-time theory.

Fresnel's law states that the velocity of light in the absolute aether frame, in a body of refractive index n, moving with velocity v with respect to the absolute aether, is $C/n \pm (1 - 1/n^2)v$.

The Fresnel aether drag theory is fundamentally wrong because it supposes that the aether is partially dragged by the body, the Fresnel dragging coefficient being $1 - \frac{1}{n^2}$. But obviously, the amount of aether dragged cannot depend on the index n, which is itself a function of the colour of light. Nevertheless, the Fresnel formula appears essentially correct, but the theory that leads to it must be completely re-examined.

The question has been accurately studied by Ockert [40], Marinov [41], Kosowski [42] and Clement [43] who proposed a satisfying explanation. We will briefly expose the theory following Marinov's approach.

The fixed time delay theory, asserts that the speed of light inside a body at rest in the fundamental frame, is equal to C between two molecules. But when a photon meets one of them, it becomes attached to it for a fixed time Δt_0. So that the speed of light inside the body (u) appears different from C.

Let us designate as L_0 the interval separating two molecules, and n the index of refraction of the medium, we have:

$$\Delta t_0 = L_0\left(\frac{1}{u} - \frac{1}{C}\right) \qquad (21)$$

since $u = \frac{C}{n}$, expression (21) becomes: $\Delta t_0 = L_0 (n-1)/C$

For a transparent rod of length L moving along the direction of the light signal, the time delay entailed by the absorption and re-emission of light by the molecules will be independent of the speed of the rod. It will be merely a function of the amount of material encountered.

Thus $\Delta t = \frac{L}{L_0}\Delta t_0 = L(n-1)/C$ in any inertial frame.

Now, let us designate as $v' = C - v$ the speed of light between a molecule and the next one. The time needed to travel between them will be $\Delta t_1 = L_0/(C - v)$

where v is the speed of the Earth with respect to the fundamental inertial frame.

Therefore, the resultant velocity of light in the transparent rod, with respect to an observer at rest in the frame S_1 of the rod, will be. $L_0/(\Delta t_0 + \Delta t_1) = (C - v)\Delta t_1/(\Delta t_0 + \Delta t_1)$

$$= \frac{C - v}{n\left(1 - \frac{v}{C} + \frac{v}{nC}\right)} \text{ which is equal to first order to } \frac{C}{n} - \frac{v}{n^2}$$

with respect to the fundamental frame, the velocity of light will be: $\frac{C}{n} - \frac{v}{n^2} + v = \frac{C}{n} + v\left(1 - \frac{1}{n^2}\right)$

This is exactly the Fresnel Formula which, in fact, does not translate an aether drag, but rather a delay entailed by the absorption and re-emission of light by the molecules of the body.

We must emphasize that v is not the speed of a fluid with respect to frame S_1 (the Earth frame), but rather the speed of S_1 with respect to the fundamental frame S_0.

This distinguishes Fresnel's formula from the experimental one obtained by Fizeau which is

$$\frac{C}{n} + v_{12}(1 - \frac{1}{n^2})$$

Here v_{12} is the speed of the water with respect to the Earth frame. So, the two formulas have been improperly considered as identical.

Now, by means of the extended space-time transformations based on the Galilean velocity addition law $C' = C \pm v$, we will try to connect Fresnel's and Fizeau's laws.

- From Fresnel to Fizeau

In a previous chapter, we demonstrated that the apparent (measured) law of composition of velocities deduced from the extended space-time transformations, was

$$V_{1app} = \frac{C^2(V - v_{01})(C - v_{02})}{(C - v_{01})\left[(C - v_{02})(C + v_{01}) - v_{01}(V - v_{02})\right]} \qquad (22)$$

where V_{1app} is the apparent speed of a moving object with respect to the Earth frame. (The formula can be applied to light).

In place of the transparent rod previously seen, let us consider a fluid moving with respect to the Earth frame at speed v_{12}.

Here, for a question of convenience, it is necessary to use a notation in agreement with formula (22), and to interpret it. V is the speed of light with respect to the fundamental frame, v_{01} is the speed of the Earth frame S_1 with respect to the fundamental frame, $v_{02} = v_{01} + v_{12}$ is the speed of frame S_2 with respect to the fundamental frame. Frame S_2 is a reference system attached to one of the molecules of the fluid, which all move at uniform speed v_{12} with respect to the laboratory.

Let us apply Fresnel's formula to frame S_2; we have: $V = \frac{C}{n} + v_{02}(1 - \frac{1}{n^2})$ (23)

replacing (23) in (22) we obtain

$$V_{1app} = \frac{C^2\left[\frac{C}{n} + v_{02}(1 - \frac{1}{n^2}) - v_{01}(C - v_{02})\right]}{(C - v_{01})\left[(C - v_{02})(C + v_{01}) - v_{01}(\frac{C}{n} - \frac{v_{02}}{n^2})\right]}$$

after simplification the formula reduces to $\frac{C}{n} + v_{12}(1 - \frac{1}{n^2}) + O\,(v^2/C^2)$

This is another illustration of the adequation of the Galilean velocity addition law (disguised), with well established laws and experiments of physics.

We can see that, for a transparent body at rest in the Earth frame, we have: $V = \frac{C}{n} + v_{01}(1 - \frac{1}{n^2})$

but V_{1app} reduces to $\frac{C}{n}$ independently of the speed of the Earth with respect to the fundamental frame. $\frac{C}{n}$ is in fact the speed of light inside the body in the aether frame. In all other frames $\frac{C}{n}$ is an apparent speed resulting from the errors of measurement.

The real speed of light inside the body at rest with respect to the Earth frame is in fact:

$$V - v_{01} = \frac{C}{n} - \frac{v_{01}}{n^2}$$

It is interesting to note that this result is completely in agreement with the theorem of Potier and Veltmann [18], based on Fermat's principle, which asserts that it is impossible by means of an optical experiment to observe a first order aether wind (in v/C).

But we have to be aware that the theorem cannot be applied to all optical experiments. The theorem states that "for arbitrary (notional) path variations in the near vicinity of the physical light path P joining the fixed end points P_1 and P_2, the time of light transit is extremal (least) on the actual path" (Phipps)[44]. So Potier and Veltmann's Principle cannot be extended to the cases where the end points are not fixed.It can no longer be applied to Marinov's experiments, which obviously demonstrated the existence of a first order aether wind.

References

1. O. Heaviside, Phil mag, 27, 324, (1889)
2. G.F Fitzgerald, Science, vol XIII, p 390, (1889)
3. W. Voigt, Nachrichten von der KG d.N zu Gottingen 2, 41, (1887)
4. J. Larmor, Phil trans Roy Soc London, 190-205 (1897), "Aether and matter" Univ. press, Cambridge (1900)
5. H.A Lorentz "Electric phenomena in a system moving with any velocity less than that of light", in "The principle of relativity", collection of original papers on relativity, Dover, New-York (1952)
6. H. Poincaré, "Sur la dynamique de l'électron" in "La mécanique nouvelle" Jacques Gabay Editeur Sceaux (1989)
7. A. Einstein, Annalen der physik 17, 891, (1905), "The principle of relativity", Dover NewYork (1952)
8. H. Minkowski, Space and time, in "The principle of relativity", Dover New York (1952)
9. J. Levy, "Relativity and Cosmic Substratum" Physical interpretations of relativity theory (P.I.R.T) 6-9 September (1996) p 231, M.C Duffy editor, SEAT, University of Sunderland, Chester Road, UK, SR1.3SD. A symposium sponsored by the British Society for the Philosophy of Science. E-mail: michael.duffy@sunderland.ac.uk
10. ibid "Some important questions regarding Lorentz-Poincaré's Theory and Einstein's relativity I". Proceedings of the P.IR.T (1996) Late papers p 158.
11. ibid "Relativité et substratum cosmique" a book of 230 p, Lavoisier Cachan France (1996) E.mail edition@Lavoisier.fr Tel. 01 47 40 67 00.
12. ibid "Some important questions regarding Lorentz-Poincaré's theory and Einstein's relativity II", Proceedings of the P.I.R.T (1996) supplementary papers p 178.
13. ibid "Is the relativity principle an unquestionable concept of physics" Proceedings of the P.I.R.T (1998) late papers, p156.
14. M.A Tonnelat, Histoire du principe de relativité p 99 and p 105, Flammarion Paris (1971)
15. Lord Rayleigh, Phil mag 4, 678, (1902), D.B Brace, Phil mag 7, 317, (1904) F.T Trouton and H.R Noble, Proc Roy Soc 72, 132, (1903) and Phil trans A, 2, 167, (1903) C.T Chase, phys rev 30, 516 (1927), R. Tomashek, ann, d phys 73, 105 (1924) A.B Wood, G.A Tomlison, and L. Essex, Proc Roy Soc, 158, 6061 (1937)
16. C. Sherwyn, Phys rev A, 35, 3650 (1987)
17. S. Marinov, Spec Sci Tech 3, 57 (1980a), "The Thorny way of truth" (East, West, Graz Austria (1984) Gen Rel Grav 12, 57 (1980)
18. W. Veltmann, Astron Nachr vol 76 p 129-144 (1870) A. Potier, Journal de physique, Paris vol 3, p 201-204, (1874)
19. "Open questions in Relativitic physics", F. Selleri Editor Apeiron, 4405 rue St Dominique, Montreal, Quebec H2W,2B2 Canada (1998).
20. R Anderson, I. Vetharaniam and G.E Stedman, Physics reports 295, 93-180, (1998)
21. T.E Phipps Jr, Apeiron, 5, 193, (1998),
22. H.C Hayden, Phys essays, 4, 361 (1991) References to Jaseja et al, Allan et al,Brillet and Hall.
23. S.J Prokhovnik. "The logic of special relativity" Cambridge University press (1967). "Light in Einstein's Universe", Reidel, Dordrecht, (1985) (References to the articles of G Builder) G Builder, Aust J Phys II, 279 (1958a) and 11, 457, (1958b) and Philosophy sci 26, 135, (1959)
24. O. Lodge, Aberration problems, Phil trans roy soc London A, 184, 727, (1893)
25. H.B Ives, J. opt soc Am 27, 263, (1937)
26. J.S Bell, How to teach special relativity in "Speakable and unspeakable in Quantum Mechanics", Cambridge University Press (1987) and George Francis Fitzgerald, Physics world (September 1992)
27. F. Selleri, Phys essays, 8, 342, (1995)
28. F. Tangherlini, suppl nuovo cimento 20, 1, (1961)
29. R. Mansouri, and R U Sexl, General relativity and Gravitation 8, 497, (1977)
30. G. Cavalleri and C Bernasconi, Nuovo cimento, 104, 545, (1989)
31. R. Dishington, in "Advances in fundamental physics" p 187, M. Barone and F. Selleri editors Hadronic press, Palm Harbor FL 34694, USA,(1995)
32. J.P Vigier, Apeiron 4, 71, (1997)
33. H.E Wilhelm, in "Advances in fundamental physics" p 283, M. Barone and F. Selleri editors, Hadronic Press, Palm Harbor FL 34694, USA (1995)
34. W. Ritz, Ann de chim et de phys, 13, 145, (1908)
35. C.G. Stokes, Phil mag, 17 (1845) ; Math and physics papers I (1880)
36. J.P Wesley, "Selected topics in advanced fundamental physics", Benjamin Wesley editor, Blumberg, 7712, Germany (1991).
37. J. Levy, Is simultaneity relative or absolute in "Open questions in relativistic physics" p 39 F. Selleri Editor, Apeiron, 4405 rue St Dominique Montreal, Quebec, H2W 2B2, Canada (1998) E-mail apeiron@vif.com
38. H. Fizeau, CR Acad sci Paris 33, 349, (1851)
39. A.T Fresnel, Ann chim Phys 9, 57, (1818)
40. C.E Ockert, Am J phys 36, 158, (1968)
41. S. Marinov, Epur si muove, (CBDS, Brussels 1977 p84-86)
42. S. Kosowski, Nuovo cimento 46B, 98, (1978)
43. G. Clement, Am J phys, 48, 1059, (1980)
44. T.E Phipps Jr, Galilean Electrodynamics 3, 56, (1992).