Mass and energy in the light of aether theory[1]

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Abstract

The laws of physics dealing with mass and energy are reviewed in the light of the assumption of a fundamental aether frame, relative to which clocks slow down and meter sticks contract, as a function of their speed with respect to this frame. The existence of such a privileged aether frame and of an aether non-entrained by the motion of celestial bodies rely today on weighty theoretical and experimental arguments [1A,1B,1F,1G] and [14-17]. The real physical processes affecting rods and clocks are supported by their ability to rationally account for the *apparent* isotropy of the speed of light. However, the dimension of the rods and the ticking of the clocks being dependent on their absolute velocity, give a distorted view of reality: the physical data are subjected to alterations and need to be corrected. As a result of these corrections, they assume a different mathematical form, which reflects their real value. In the text which follows we propose to highlight the corrected form of the basic laws dealing with mass and energy. This concerns the mass-energy equivalence law and the variation of mass with speed. The real proper mass of moving bodies is shown to vary as a function of their absolute speed, and the kinetic energy is shown not to be observer dependent. The compatibility of special relativity with mass-energy conservation is discussed, and the mass, is shown not to be an intrinsic property of matter, it depends on the presence of the aether. In the appendices, we show by which mechanisms the standard measurement procedures alter the physical data

I. Introduction

In previous publications [1A, 1B] we saw that the measured values of the co-ordinates in the transformations of space and time, result from the distortions caused by length contraction, clock retardation and arbitrary clock synchronization which affect these measurements.

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[1] Revised and updated version of the article published in “Ether space-time & cosmology” volume 3, Apeiron, Montreal, 2009. Further developments and explanations are provided.

Consequently, the expressions of the physical data derived from them are not reliable as such and must be corrected. This point of view, which is developed in the non-entrained aether theory set forth in this article, differs from conventional special relativity for which the laws are reliable as such and need not be corrected. In the developments which follow, we shall study the consequences of this fact as regards the laws dealing with mass and energy and compare them to conventional relativity.

Conventional relativity assumes that, when a body moves from one 'inertial frame' S_1 to another S_2, although its kinetic energy has increased, its rest energy remains unchanged: whatever the 'inertial frame' considered, the energy content of the body, measured by an observer at rest in it, is $E_0 = m_0 C^2$.This condition is also required for m_0, the rest mass, and C, the speed of light, which are the same in S_1 and S_2.

This invariance, which requires that the frames mentioned by relativity (not subjected to perceptible external forces) are really inertial (a fact that will be discussed below), results from the fact that, according to this theory, no physical distinction differentiates two separate 'inertial co-ordinate systems' that could cause actual increase in rest mass and rest energy.

The position taken by relativity is simply untenable. Of course we are aware that, if we use a standard that also moves from S_1 to S_2 to measure the mass of the body by comparison, the rest mass will be (erroneously) found identical in S_1 and S_2. This is because the rest mass of the standard will have changed in the same ratio as the body's rest mass. But the real rest masses in S_1 and in S_2 are different.

The fact can be overcome if one assumes the existence of a fundamental aether frame and of an aether drift which give a physical basis to the increase of kinetic energy, as well as to the increase of rest mass and rest energy which ensues. But this calls into question the character strictly inertial of real platforms not subjected to *perceptible external forces*. These issues will be addressed in detail in the text that follows.

If the conventional space-time transformatons result from measurement distortions, they cannot be used as such to demonstrate the fundamental laws of physics, because, of course, they give a distorted view of reality. Therefore, the laws of physics determined from them, also need a correction. This is the case for the mass variation $m = m_0\gamma$ which is generally derived from the conventional space-time transformations.

We shall nevertheless verify, by means of arguments independent of relativity, that the law $m = m_0\gamma$ applies, but, contrary to relativity, it applies as such only when a body is carried from the fundamental frame to any other frame (case 1). This is because m_0 is the rest mass in the fundamental frame, it is not the real rest mass in other reference frames, even though this seems to be the case.

Insofar as a body is carried from one co-ordinate system, not at rest in the aether frame, to another (case 2), the law will take a different mathematical form contrary to what conventional relativity asserts. But this result requires that the measurement distortions are corrected. *It cannot be obtained with the usual measurement procedures which, in contrast, give rise to the conventional laws.* However, the theory permits to highlight the differences existing between case 1 and case 2, and therefore, enables to correct some illogical consequences of relativity as the examples studied below will show. Some other issues will be addressed showing that the existence of a fundamental frame and of an aether non-entrained by the motion of celestial bodies give rise to a number of significant differences between relativity and aether theory: among them the fact that the mass is not an intrinsic property of matter, it depends on the presence of the aether. The role played by length contraction, clock retardation and arbitrary clock synchronization in the distortion of the measured physical data will be highlighted in the appendices.

In appendix 1 we will show that, assuming the existence of a fundamental aether frame, length contraction is a necessary condition so that the *measured* speed of light along a rigid path assumes the value *C* in any direction of space and independently of the absolute velocity of the 'inertial platform' where it is measured[2]. This *measured* value is actually different from the real one-way speed of light which depends on the angle as the demonstration will show. The issue relative to the synchronization of clocks will be addressed in the appendix 2. This question is often ignored by the physics community. Yet, the usual synchronization procedures play an essential part in the alteration of the measured parameters, in addition to the alterations entailed by length contraction and clock retardation.

II. A classical derivation of mass-energy equivalence in the light of non-entrained aether theory

Let us consider a body at rest in a co-ordinate system S_0 that emits *N* identical photons simultaneously in two opposite directions (+*x* and –*x*,). See Figure1.
We assume that S_0 *is firmly linked to the fundamental aether frame.*
(For this demonstration, we will follow arguments given by Rohrlich, [2] but with different assumptions).

Consider now another system S moving along the *x*-axis at constant speed *v*, (with $(v/C)^2 << 1$). In S_0, the total momentum is conserved, it is null before emission and remains null after emission. The total momentum must also be conserved for any observer moving with respect to S_0. With respect to the system S, we have:

$$P_0 = P_1 + N\frac{h\nu}{C}\left(1+\frac{v}{C}\right) - N\frac{h\nu}{C}\left(1-\frac{v}{C}\right),$$

where P_0 is the initial momentum, and P_1 the final momentum of the body. The other terms are the momenta of the photons altered by the Doppler shift.
(Note that the relation $p=E/C$ which relates the energy and the quantity of motion was known before the formulation of the relativity theory and does not depend on it. The formula can be derived on the basis of classical electrodynamics arguments [3]. Using

[2] Regarding the legitimacy of the use of the concept 'inertial platform', see the section V.2.3.

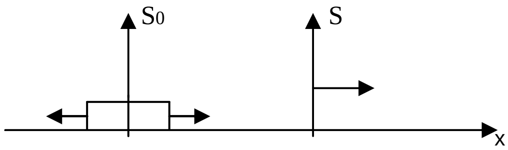

Figure 1. The body at rest in frame S_0 emits N identical photons in two opposite directions.

the relation $E = h\nu$, it is easy to verify that the quantity of motion *p* transmitted to a perfectly absorbing surface by any quantum of light is given by:

$$p = h\frac{\nu}{C}$$

where ν is the frequency of the light quantum).

Since in the system S_0 the speed of ligt is isotropic, the role of the aether is identical in both directions, and therefore it can be ignored. This would be different if the body was standing in a frame different from the aether frame, particularly at high speed, contrary to the assumptions of Rohrlich based on special relativity.
Viewed from the system S, the momentum $\Delta(mv)$ lost by the body will be:

$$P_0 - P_1 = 2N\frac{h\nu}{C^2}v\ .$$

Since, obviously, the source is at rest in S_0 both before and after emission, it is clear that, with respect to the system S, it must have the speed *v* both before and after emission, thus:

$$\Delta(mv) = v\Delta m = \frac{2Nh\nu}{C^2}v\ . \tag{1}$$

Now, according to the energy conservation law:

$$\begin{aligned} E_0 &= E_1 + Nh\nu\left(1+\frac{v}{c}\right) + Nh\nu\left(1-\frac{v}{c}\right) = E_1 + \Delta E \\ &= E_1 + 2Nh\nu \end{aligned} \tag{2}$$

$\Delta E = 2Nh\nu$ is the variation of energy resulting from the emission of the photons. From (1) and (2) we obtain

$$\Delta E = \Delta m C^2\ . \tag{3}$$

In the following sections we shall specify the conditions required so that the mass energy equivalence law applies properly according to non-entrained aether theory.

III. Variation of mass with speed from the fundamental frame

Let us consider a body *initially at rest in the fundamental frame*, which is subjected to a force *F*. The elementary expression of the kinetic energy acquired by the body in the displacement $d\ell$ is:

$$dE_C = Fd\ell = \frac{d(mv)}{dt}d\ell\ , \tag{4}$$

where $Fd\ell$ is the work carried out by the force *F* during the displacement. (We suppose that *F* and $d\ell$ are aligned). Now, the equivalence of mass and energy requires that:

$$E = mC^2 = E_C + m_0 C^2$$

where m_0 is the rest mass assumed by the body in the fundamental frame.
Therefore:

$$dE = dE_C = C^2 dm\,. \tag{5}$$

From equations (4) and (5) we have

$$C^2 dm = (v\frac{dm}{dt} + m\frac{dv}{dt})vdt\,,$$

which gives

$$\frac{dm}{dv}C^2 = \frac{dm}{dv}v^2 + mv\,,$$

and

$$\frac{dm}{m} = \frac{v}{C^2 - v^2}dv\,.$$

Denoting $C^2 - v^2$ as u so that $v\,d\,v = -du/2$, we then find

$$\begin{aligned} Log\ m &= -\frac{1}{2}Log\left(C^2 - v^2\right) + Log\ k \\ &= Log\ k\left(C^2 - v^2\right)^{-1/2} \end{aligned}$$

and

$$m = \frac{k}{C\sqrt{1 - v^2/C^2}}\,.$$

For $v = 0 \Rightarrow m = k/C = m_0$, thus:

$$m = \frac{m_0}{\sqrt{1 - v^2/C^2}}\,. \tag{6}$$

For this result, we have slightly modified a demonstration given by Selleri based on a work by Lewis [4]. As we shall see, in contrast to what conventional relativity asserts, expression (6) is completely exact only if m_0 represents the rest mass of the body in the fundamental frame. But this result can be revealed only after the alterations which affect the measurements have been corrected.

IV. Different conceptions about mass increase with speed

In relativity, since no fundamental frame exists, whatever the ‘inertial frame’ considered, the mass of a body attached to this frame, as seen by an observer at rest in it, is always the same. This mass is defined as the proper mass or the rest mass of the body.

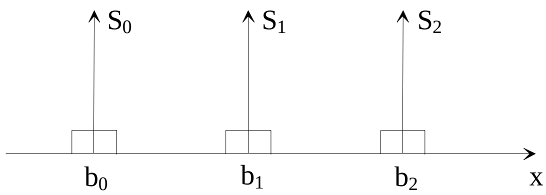

Figure 2. According to relativity, the rest masses of the three bodies are identical. This point of view is not shared by non-entrained aether theory.

If the body moves, with respect to an 'inertial system' S, with velocity v, its mass with respect to S is assumed to be:

$$m = \frac{m_0}{\sqrt{1 - v^2/C^2}}$$

whatever the system S may be. Therefore, the body is supposed to possess at the same time an infinite number of masses different from its rest mass, depending on the speed relative to it of the observer who measures the mass.

The point of view of non-entrained aether theory is quite different. Let us consider a body having mass m_0 in the fundamental system S_0. Since this body needs to acquire kinetic energy E_C in order to go from S_0 to any other system S moving at constant speed, the rest mass of the body in S will be $m_0 + E_C / C^2$. This means that a hierarchy of rest masses exists, each a function of the absolute speed of the body.

(Note that it is necessary to distinguish the real mass from the measured mass, which can be incorrectly determined. If the mass m_0 of a body in the fundamental system S_0 is compared to a standard μ_0 and if both are transported into another system S, they are changed in the same ratio. As a result, the mass m_0 appears not to have changed, which is inexact).

In other words, the real mass m of the body in S, cannot be measured by an observer at rest in this co-ordinate system. In all cases, the measurement gives the value m_0, which is the mass of the body in the aether frame.

-Let us now examine the consequences of these results in the following example. Consider three co-ordinate systems S_0, S_1 and S_2, receding from one-another at constant speed along the common *x-axis,* and let us assume that a body is at rest in each of the three systems. The masses were initially identical in S_0 and equal to m_0, before being transported into their respective reference system. We propose to determine the effect of motion on these masses (See Figure 2).

IV.1. Mass increase with speed according to the conventional theory of relativity

Measured by an observer at rest with respect to one of the bodies, the mass remains equal to m_0 in all cases. Therefore, for observer S_1, we have

$$m_2^1 = \frac{m_0}{\sqrt{1 - v_{12}^2 / C^2}} \tag{7}$$

where m_2^1 refers to the relativistic mass of body b_2 measured by observer S_1, and v_{12} refers to the relative speed of the reference systems S_1 and S_2, (fig 2).

If we suppose that $v_{12} << C$, expression (7) can be written to first order, as follows:

$$m_2^1 \approx m_0 (1 + \frac{1}{2} v_{12}^2 / C^2) .$$

So that, viewed by observer S_1, the energy of body b_2 is:

$$m_2^1 C^2 \approx m_0 C^2 + \frac{1}{2} m_0 v_{12}^2 .$$

(This corresponds to the sum of the rest energy and the kinetic energy needed by b_2 to move from S_1 to S_2). Therefore for observer S_1 the kinetic energy of b_2 is reduced to:

$$(m_2^1 - m_0) C^2 \approx \frac{1}{2} m_0 v_{12}^2 . \tag{8}$$

Given that the usual measurements ignore the absolute velocity and cannot highlight the increase of the rest mass when a body moves from the aether frame to another frame, expression (8) is supposed to be the true value of the kinetic energy acquired by a body which moves from any ‘inertial platform’ to another (when v/C<<1), a fact which *seems* in agreement with the relativity principle, (in contrast, as we shall see, to non-entrained aether theory).

For an observer at rest in the reference system S_0, the energy of b_2 is different. Denoting by m_2^0 the mass of body b_2 measured by the observer at rest in S_0, we have, (for $v_{02} << C$):

$$m_2^0 C^2 \approx m_0 C^2 + \frac{1}{2} m_0 v_{02}^2 ,$$

and the energy of body b_1 is assumed to be

$$m_1^0 C^2 \approx m_0 C^2 + \frac{1}{2} m_0 v_{01}^2 .$$

Thus, for observer S_0 the kinetic energy needed by the body b_2 to move from S_1 to S_2 is:

$$(m_2^0 - m_1^0) C^2 \approx \frac{1}{2} m_0 (v_{02}^2 - v_{01}^2) .$$

This result is different from the measurement made by observer S_1, $m_0 v_{12}^2 / 2$ although, obviously, it should be the same. *This is a serious internal contradiction that affects special relativity.*

IV.2. Mass increase with speed according to non-entrained aether theory

As we shall see, the results below are the results that are obtained *theoretically* in the absence of measurement distortions. (In contrast, the relativity principle *seems* to apply only when the measurements are subjected to distortions and therefore it gives a distorted view of reality).

We now go back to the figure with the three bodies and suppose that S_0 is a co-ordinate system at rest in the fundamental frame and S_1 and S_2 two systems moving away from S_0 at constant speed along the common *x*-axis. As we saw, according to relativity no inertial system has a specific status, so that a body possesses at the same time different masses depending on the system from which the mass is measured. This is not so according to non-entrained aether theory, for which S_0 stands out from the other systems. In other words, the expressions m_1^0, m_2^0 and m_2^1 seen in the section IV.1 have no meaning: a body at rest in one of the three systems seen above has only one real mass. The mass of the body b_0 is m_0, the mass of b_1 is:

$$m_1 = \frac{m_0}{\sqrt{1 - v_{01}^2 / C^2}} \tag{9}$$

and the mass of b_2:

$$m_2 = \frac{m_0}{\sqrt{1 - v_{02}^2 / C^2}} \tag{10}$$

Accordingly the expressions $m_1^0 C^2$, $m_2^0 C^2$ and $m_2^1 C^2$ giving the energies of the bodies b_1 and b_2 measured from non specific inertial systems, are meaningless. The expressions $m_1 C^2$ and $m_2 C^2$ are the only expressions which indicate, no more no less, the total energies of bodies b_1 and b_2 due to their motion with respect to the aether frame.

(These issues will be addressed in more detail in the text which follows and in the following sections).

From (9) and (10) we obtain:

$$m_2 = m_1 \frac{\sqrt{1 - v_{01}^2 / C^2}}{\sqrt{1 - v_{02}^2 / C^2}}, \tag{11}$$

and $$m_2C^2 = m_1C^2 \frac{\sqrt{1-v_{01}^2/C^2}}{\sqrt{1-v_{02}^2/C^2}}.$$

(In the same way, from $\ell_2 = \ell_0\sqrt{1-v_{02}^2/C^2}$ and $\ell_1 = \ell_0\sqrt{1-v_{01}^2/C^2}$ we have:

$$\ell_2 = \ell_1 \frac{\sqrt{1-v_{02}^2/C^2}}{\sqrt{1-v_{01}^2/C^2}}).$$

We see that expression (11), which connects any pair of co-ordinate systems moving at constant speed assumes a mathematical form different from (9) and (10).

If we now suppose that $v_{02} << C$, ignoring terms of fourth and higher order, expressions (9) and (10) reduce to:

$$m_1 \approx m_0(1+\frac{1}{2}v_{01}^2/C^2)$$

and

$$m_2 \approx m_0(1+\frac{1}{2}v_{02}^2/C^2).$$

So that :

$$m_2 \approx m_1 + \frac{m_0}{2C^2}(v_{02}^2 - v_{01}^2) \qquad (12)$$

$$\approx m_1 + \frac{m_0}{2C^2}(v_{12}^2 + 2v_{01}v_{12}).$$

Note that for the small values of v_{01} under consideration, m_1 hardly differs from m_0. Expression (12) is different and obviously greater than the relativistic expression of the mass m_2^1 viewed from observer S_1 which is:

$$m_2^1 = \frac{m_0}{\sqrt{1-v_{12}^2/C^2}} \approx m_0(1+\frac{1}{2}v_{12}^2/C^2).$$

Of course the expressions of the energy differ in the same ratio.

We can also see that, according to non-entrained aether theory, the increase of kinetic energy of the body b_2 in the transfer from S_1 to S_2 is:

$$(m_2 - m_1)C^2 \approx \frac{m_0}{2}(v_{02}^2 - v_{01}^2)$$

$$\approx \frac{1}{2} m_0 (v_{12}^2 + 2 v_{01} v_{12}) \qquad (13)$$

This expression (13) is different from the relativistic expression which is:

$$(m_2^1 - m_0) C^2 = \frac{1}{2} m_0 v_{12}^2 ,$$

Indeed, expression (13) contains a term depending on v_{01} which vanishes when S_1 is at rest with respect to S_0. This result is incompatible with the relativity principle.

We also note that, when $v_{12} \to 0$ or in other words when $v_{02} \to v_{01}$, the terms depending on v_{01} and v_{02} in expression (12) cancel. Thus, m_1 represents the real rest mass assumed by the aforementioned bodies when they are at rest in reference frame S_1. (Actually, there is no distinction between the real mass and the real rest mass.) This is a different result from special relativity.

Nevertheless, we must distinguish the absolute rest mass m_0, from the other rest masses measured in reference frames that are in motion with respect to the aether frame.

We see that the relativity principle, does not apply to real values of the physical variables. But we have shown in ref [1B] that, with the usual measurements which are performed with contracted meter sticks and clocks slowed down by motion synchronized with light signals, the experimental space-time transformations assume a mathematical form identical to the conventional Lorentz-Poincaré transformations and, therefore, with these transformations, the *apparent* laws of physics, (including $m = m_0 \gamma$ and $\ell = \ell_0 / \gamma$ and the expression for the kinetic energy), take an identical mathematical form whatever the platform from which the measurement is made, provided that the platform is not subjected to *perceptible* external forces.

With these measurement distortions therefore, the relativity principle *seems* to apply.

This argument, which enables to surmount the objections raised to the Lorentz approach, merely confirms the coexistence of the Lorentz assumptions and the experimental (apparent) law of mass increase, despite what differentiates them.

(Of course in order to obtain the exact values of the physical data, the experimental results must be corrected in order to suppress the measurement distortions).

Note, however, that when $v_{12} >> v_{01}$, and $v_{01} << C$ expression (11) reduces to:

$$m_2 \approx \frac{m_1}{\sqrt{1 - v_{02}^2 / C^2}} \approx \frac{m_1}{\sqrt{1 - v_{12}^2 / C^2}}$$

and since, $m_1 \approx m_0$ we obtain:

$$m_2 \approx \frac{m_0}{\sqrt{1 - v_{12}^2 / C^2}} .$$

This applies, for example, to particles moving at a significant fraction of the speed of light with respect to the Earth frame, *while the Earth moves at relatively low speed with respect to the aether frame* (a value which is estimated at ≅ 400 km/sec.). In such cases, the Earth can be regarded as almost at rest with respect to the Cosmic Substratum. So, the relativistic approach and the fundamental approach lead to practically equivalent results.

IV.3. Critique of the concept of reciprocity

This question makes a crucial distinction between relativity and fundamental aether theories. According to relativity, when a body is transported from one 'inertial system' S_0 to another S_1, viewed from S_0, its mass is supposed to be

$$m_1 = \frac{m_0}{\sqrt{1 - v_{01}^2 \big/ C^2}} .$$

But conversely, if the body comes back to S_0, viewed from S_1 its mass will also appear equal to m_1.
For the treatment in the fundamental aether theory, let us assume that S_0 is the fundamental frame. If the body is at rest in the system S_1, we also have

$$m_1 = \frac{m_0}{\sqrt{1 - v_{01}^2 \big/ C^2}} ,$$

where $m_1 > m_0$. Indeed we have been compelled to supply energy to the body in order to move it from S_0 to S_1; but if the body returns to S_0, the energy is restored. All observers (including the observer in S_1) will conclude that the real mass in frame S_0 is equal to m_0.

This conclusion is in total contradiction with relativity, but it is the only one in agreement with mass-energy conservation.
Of course this result applies only to real masses whose measurement is not subject to alterations.

Important remark

In the fundamental aether theory, we must distinguish the total available energy of a body (which is equal to the sum of the rest energy $m_0 C^2$ and the kinetic energy with respect to the fundamental frame), from the available energy of the body with respect to any other frame, which is smaller than the previous energy, and takes another mathematical form.
In the example discussed earlier, the total available energy of body b_2 is:

$$m_2\ C^2 = m_0 C^2 \left(1 + \frac{1}{2} v_{02}^2 / C^2\right) + \text{small terms of higher order.}$$

This notion has no equivalent in conventional relativity for which the energy of a body is entirely relative and depends on its speed with respect to another body. For example, viewed by an observer attached to the system S_2, the energy of body b_2 is assumed to be $m_0 C^2$.

In contrast, for non-entrained aether theory the true energy of body b_2 is $m_2 C^2$ for all observers. However, viewed by an observer attached to the system $S_{2,}$ due to measurement distortions it is also found equal to $m_0 C^2$. This is because the mass of the standard used for the measurement is increased, relative to its value in the fundamental aether frame, in the same ratio as the body b_2, and because the speed of light is erroneously found equal to *C* in any co-ordinate system not subject to perceptible external forces (see appendix 1).

Note.
We have compared the laws of relativity as they are understood to those of aether theory. We will see later that in the absence of aether, the very existence of mass is questioned.

V. Mass-energy conservation, inertia and the relativity principle

V.1. Introduction

In contrast to Newtonian physics, special relativity highlighted the fact that the existence of inertial mass does not depend exclusively on the amount of matter, but also on the kinetic and dynamic properties of bodies, a fact which challenges the Newtonian concept of mass. The more recent developments of physics have demonstrated that the critical examination of the old concept of mass could have other important implications as regards the unification of the physical interactions. This is illustrated by the fact that the unification of the electromagnetic interaction and the weak interaction required to explain why the W and Z bosons possess mass while the photon does not.

Two theories have been proposed to explain the origin of inertial mass. Although different, these theories assume that the existence of mass is not an intrinsic property of matter, but rather the consequence of the interaction of matter with a physical medium.

According to the Higgs field hypothesis [5,6], inertial mass results from the interaction of elementary particles with a special kind of field, referred to as the Higgs field, which can be highlighted by the detection of the bosons associated to the field: the Higg's bosons..

In contrast, the speculative theory of Puthoff, Haisch and Rueda (P.H.R) [7], based on stochastic electrodynamics, assumes that "it is the interaction of electric charges and the electromagnetic field that creates the appearance of mass". This theory has little support today.

On 4 July 2012, the CMS and the ATLAS experimental teams at the Large Hadron Collider of CERN, independently announced that they each confirmed the formal discovery of a previously unknown boson whose mass lies between 125 and 127 times the mass of the proton and whose behavior so far has been "consistent with" a Higgs boson.

The CERN indicated however that further studies were needed to determine whether this particle possesses all the features specific of the Higg's boson.

Among the issues addressed in this chapter we will show that, whatever the assumptions made about the nature of its interaction with a substratum, the inertial mass cannot exist without such a mediation.

Although our approach is quite different, we note that the above theories assume some kind of aether, even if they give the concept another appellation. Indeed, in their article Beyond $E=mc^2$ [7], P.H.R conclude: "Even if our approach based on stochastic electrodynamics turns out to be flawed, the idea that the vacuum is involved in the creation of inertia is bound to stay".

(Note also that, in his book "The God particle" [8], Lederman refers to the Higgs field as "new aether").

Our approach does not take sides for one approach or for the other; it does not need to make any hypothesis about the nature of the substratum, it is based exclusively on logical arguments and does not postulate some new assumptions such as the Higgs boson. It should be interesting to investigate to what degree the theories of our predecessors are compatible with ours.

V.2. Critical review of usual definitions

Mass-energy conservation and the unreserved application of the relativity principle to data which are assumed to be measured exactly are regarded today, by almost all the scientific community, as among the most fundamental principles of physics. It is generally accepted that their compatibility does not require specific conditions, and therefore was not called into question at least by the leading members of the discipline.

It is worth asking whether this view is beyond question. Partly addressed in references [1A, 1B, 1F], the subject is of the utmost importance and deserves to be reviewed in more detail in parallel with the role played by a substratum. Its impact on the existence of inertial mass will be studied in the following paragraphs.

V.2.1. Mass-energy conservation

With the advent of Lavoisier, physicists in the 18° century realized that matter cannot be destroyed even if this seems to be the case. Lavoisier expressed the idea in the following terms: "Nothing can be lost, nothing can be created, everything can only be transformed". Later, the idea that energy is also conserved became progressively an acknowledged fact. The energy-conservation law was expressed explicitly and accurately by Helmoltz. The final step was taken at the beginning of the twentieth century when mass and energy were regarded as two aspects of the same reality and the law

E= mc^2 was formulated. The law expresses the fact that mass can be converted into energy and reciprocally. Note that, as we have seen in section II and III the equivalence of mass and energy, as well as the law of variation of mass with speed, can be demonstrated without resorting to the assumptions of relativity [2]. However, as we have shown, the field of application of these two laws in aether theory differs from special relativity.

V.2.2.The relativity principle

Aristotle regarded rest and motion as two states of different nature. The Earth was assumed to be in a state of absolute rest, while the bodies moving with respect to it were considered in a state of absolute motion. According to Aristotle, uniform motion needed a motor to be maintained, although for the philosopher, the origin of the motor was not clear.

The idea of relativity departed completely from this viewpoint, considering that rest and uniform motion are only relative, depending on the position of the observer.

It is difficult to give the exact date of the origin of relativity which interested numerous scientists such as Jean Buridan, rector of the University of Paris (1300 - 1358), Giordano Bruno (1568 - 1600), Descartes (1596 -1650), Leibniz (1646 – 1716) and Newton (1642 -1727) among others. But it is Galileo (1564-1642) who deserves credit for having given the idea a clear formulation. We shall discuss the conclusion of Galileo in the following chapters.

Even if it can be discussed, the approach of Galileo represented a progress on that of Aristotle, because, instead of dogmatic claims, he proposed an explanation based on observation.

With the advent of Poincaré and Einstein, the idea has somewhat evolved. In fact there are at least three formulations of the relativity principle whose meaning is a little different. In the following sections we will review these different approaches and examine whether or not the principle strictly applies in the physical world, or if it is reduced to an approximation whose field of application remains limited.

A. Galileo's original idea [9]

Galileo realized that the uniform motion of a vehicle has no detectable influence on the physical processes occurring in it. For example, a pendulum hung on the ceiling of a ship, sailing uniformly on a calm sea, remains vertical (perpendicular to the surface of the sea), a stone released from the top of the ship's mast falls at the foot of the mast, flies and butterflies move in the same way as they do in their normal conditions, in the Earth frame. According to Galileo, if motion was absolute, in the sense of Aristotle, (i,e essentially different from rest) the stone would fall at a distance from the foot of the mast, the pendulum would adopt a slanting position depending on the speed of the ship etc… Actually, noting that this is not the case, Galileo concluded "…uniform motion is like nothing…," a sentence which can be translated by: there is no absolute uniform motion, rest and uniform motion are only relative, or, in more current terms, a body at rest is in the same time in uniform motion depending on the reference system from which it is observed".

However, even if motion is absolute, it is not clear why there should be a difference between the stone and the ship as regards their motion. In addition, even if a fundamental aether frame exists relative to which absolute motion can be defined, it remains that the stone possesses a momentum which constrains it to continue its horizontal motion at the same speed as the ship, while its vertical motion is determined by the law of gravitation. In other words, like the ship, the stone possesses a kinetic energy which cannot be annulled without the action of an external cause to which this energy is transferred. This is why the stone is constrained to fall at the foot of the ship's mast.
Therefore the observations of Galileo are not enough to corroborate the relativity principle and a principal objection to the existence of absolute motion can be challenged.

(Of course this result would apply only approximately if the ship's velocity was maintained constant while the stone is faced to the atmospheric pressure).

B. Poincaré's Relativity Principle and the Lorentzian aether [10]

If we assume that rest and uniform motion are only relative, it seems a priori obvious that the laws of physics must be the same in all 'inertial platforms' (not subjected to forces external to the platforms). However, under a Galilean transformation $x' = x - vt$ and $t'=t$, the laws of electromagnetism do not meet this requirement, the Maxwell equations taking a different form in the different platforms even if they are not subjected to perceptible external forces. In order to bring the Maxwell equations back into line, Poincaré had recourse to a new set of transformations that he called "Lorentz transformations" which did constitute a group. He expressed his principle in the following terms:

> "It appears that the impossibility of detecting experimentally the absolute motion of the Earth is a general law of nature. We are naturally inclined to admit this law that we shall call the postulate of relativity, and to admit it without restriction". Whether or not this postulate, which up to now agrees with experiment, may later be corroborated or disproved by experiments of greater precision, it is interesting in any case to ascertain its consequences" [10].

We note that, in this sentence, Poincaré did not explicitly deny the idea of absolute motion, he simply questioned the possibility of observing it. Although he placed credit in the postulate of relativity, he did not quite exclude the fact that it could be disproved by experiment. Yet, in other sentences, the rejection of absolute motion and the adhesion to the postulate of relativity were asserted with much more conviction

Before 1900, the opinion of Poincaré about the aether varied. In his essay « La théorie mathématique de la lumière » 1889, he claimed:

> It does not matter to us that the ether exists, it is a question of metaphysics ... A day will come undoubtedly when the ether will be rejected as useless ... These assumptions play a secondary role. One could sacrifice them. One does not usually because exposure would lose clarity, but this is the only reason. H. Poincaré « Preface à la

> théorie mathématique de la lumière », Paris Naud, 1889, reprinted in « La Science et l' hypothese » Editions Flammarion, Paris, 1902 [11]. .

Later, his recognition of the aether proved more assertive: in "La revue des sciences pures et appliqués", 1900, he declared:

> "Does an aether really exist? The reason why we believe in an aether is simple: if light comes from a distant star and takes many years to reach us, it is (during its travel) no longer on the star, but not yet near the Earth. Nevertheless, it must be somewhere, and supported by a material medium". La physique expérimentale et la physique mathématique, « Revue générale des sciences pures et appliquées » 11, 1163-1175. 1900, re-edited in « La science et l'hypothèse », Chapter 10, p. 180 of the French edition [11]. "Les théories de la physique moderne."

And in a lecture given in Lille France 1909 he stated:

> "Let us remark that an isolated electron moving through the aether generates an electric current, that is to say an electromagnetic field. This field corresponds to a certain quantity of energy localized in the aether rather than in the electron" [10].

After 1900 Poincaré no longer rejected the concept of a privileged frame supporting the aether, he shared with Lorentz. His agreement with Lorentz is stated in the following declaration:

> The results I have obtained agree with those of Mr. Lorentz in all important points. I was led to modify and complete them in a few points of detail [10]. .

Yet, Poincaré's discomfort about the absolute motion, that resulted however from the Lorentz postulates, which he admitted, appears obvious in the following sentences which also challenge absolute time and absolute simultaneity. ("La science et l'hypothèse" 1902, chapter VI page 111, [11]).

> There is no absolute space and we only conceive relative motion, nevertheless the mechanical facts are generally expressed as if there were an absolute space to which one could refer.

and,

> There is no absolute time. To say that two times are equal is an assertion which by itself does not have any significance and can only acquire one by convention. Not only do we not have any direct intuition of the equality of two durations, but we do not even have that of the simultaneity of two events.

Besides, even though at first he has expressed a slight hesitation about its application to all orders, Poincaré did not support the idea that the relativity principle could be contingent. His attachment to the principle of relativity was too strong for that, as we can see in the following sentence extracted from "La science et l'hypothèse" 1902, Chapter VII page 129:

> The movement of a system must obey the same laws being related to fixed or moving axes entrained in a rectilinear uniform motion. This is the principle of relative motion which imposes to us for two reasons: first, the most vulgar experiment confirms this, second, the opposite hypothesis would be singularly reluctant to our spirit [11].

This sentence strongly suggests that the principle of relative motion is not for Poincaré a result of distorted measurements. It is rather perceived as something undoubtedly fundamental, (and this, although when the sentence was written, Poincaré had certainly already acknowledged the aether of Lorentz). When he says: "the opposite hypothesis would be singularly reluctant to our spirit", he certainly does not take for granted the fact that, behind the measured values of the variables (apparent), exist hidden variables (real) which obey this opposite hypothesis and do not comply with the principle of relative motion.

But as we saw in ref [1] and as we shall confirm in the following paragraphs, *when the systematic measurement distortions are corrected*, the existence of a fundamental aether frame and of an aether drift which were assumed by Lorentz, prove to be incompatible with the strict applicability of the relativity principle in the physical world.

Even in 1909, long time after the hypothesis of Lorentz contraction (1895), in a conference given in Lille University, Poincaré declared:

> There is no absolute space: all the displacements we can observe are relative displacements [10].

We do not agree with the opinions of Poincaré on this topic. As we saw, absolute displacements exist even if it is difficult to highlight them [1].

We add that, if the relativity principle applied strictly in the physical world, the speed of light would be isotropic because there would be no privileged direction. However, although he assumed the principle without restriction, Poincaré gave credit to the Lorentz assumptions which did not assume light speed isotropy. Actually, light speed anisotropy implies the negation of the principle of relativity as a fundamental principle of physics

As for the simultaneity, it is certain for us that it must be absolute [1A].

C. Einstein's Relativity Principle [12]

In his essay "On the electrodynamics of moving bodies" Einstein expressed his conception of the principle of relativity as follows

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

Despite the similarity of his principle with that of Poincaré, the point of view of Einstein differed in that, unlike him, he never acknowledged the existence of a privileged aether frame. In his early period, he categorically denied the concept of aether, but since 1916, he changed his mind in order to formulate the theory of General relativity.

But Einstein's aether is quite different from the concept of aether previously imagined by Lorentz. This aether is not associated with a fundamental inertial frame. In his essay, "Ether and the theory of relativity" [13], Einstein expressed his idea of the aether in the following terms:

> "According to the theory of general relativity, space is endowed with physical qualities. In this sense therefore, there exists an ether… But this ether must not be thought of as endowed with the qualities of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it."

If the vacuum was empty, the frames associated to moving bodies could be perfectly inertial, and Einstein's relativity principle would strictly apply. But, as we saw in ref [1] and as we shall confirm in what follows, this is an abstraction which does not correspond to reality and which is at variance with the existence of massive bodies.

V.2.3. Further examination of the concept of 'inertial frame'

An inertial co-ordinate system is a coordinate system in which a body at rest relative to it is not subjected to external forces (*no more hidden than apparent*) that can hinder its state of rest or uniform motion.

An inertial body is a body not subjected to such external forces. If such a body is the place for experiments, it can be described as inertial platform. The set of co-ordinate systems at rest with respect to the previous one constitutes an inertial frame of reference.

All inertial frames move with respect to one another with rectilinear uniform motion. The first question worth asking is the following: is the existence of platforms strictly inertial compatible with an aether non-entrained by the motion of celestial bodies? (This kind of aether implies the existence of a drift acting on all bodies except on those standing in the fundamental frame and, as we have seen and as we shall confirm in what follows, weighty arguments in favour of this sort of aether exist, see also Ref [1]and [18]).

We must be aware that the concept of 'inertial frame', which is sanctioned by use, ignores the aether drift. However, except for the fundamental frame, real platforms, not subjected to perceptible external forces, are still subject to the hidden influence of the aether drift whose magnitude depends on the absolute speed of the platform, and therefore are never perfectly inertial.

One can therefore conclude that, real platforms moving with respect to one another are never exactly equivalent for the description of the physical laws. This means that the relativity principle is not compatible in all generality with a non-entrained aether. Actually, it only *seems* compatible, because of the alterations that affect the measurements [1B].

Yet, in practice, the term 'inertial frame' can be used to describe reference frames whose absolute speed is low relative to the absolute value of the speed of light, (v/C<<1) because, as will be explained below, the effects of the aether that result from the pressure exerted on moving bodies, are negligible at low absolute speed..

But, as we shall see, this does not mean that, when bodies are at rest in the fundamental frame, the aether interacts in no way with matter, since its presence can account for the existence of inertial mass, a fact which makes a neat difference between the concept of inertial frame assumed by conventional relativity, and frames surrounded by aether, even at low speed.

Of course, the recognition of an aether endowed with physical properties asks a very fundamental question. If the aether interacts with matter, it should give rise to a resistance to the movement of material bodies. As Einstein said, the planets for example move through the aether without encountering the resistance that such a medium should cause. This is the reason why in his essay, "Ether and the theory of relativity" [13], he envisaged the case of an aether which does not oppose to motion.

However, it is inconceivable that the mass-energy of a body can increase in the absence of a substratum interacting with matter, especially as the absolute velocity of the body increases.

The response to the argument raised by Einstein, as regards a possible resistance exerted by the aether to the motion of material bodies, is that the pressure it exerts at current speeds is negligible. For example even when absolute speeds amount to 10^4 km/sec, the ratio ℓ/ℓ_0 does not fall below 0.9995. They must surpass 10^5 km/sec in order that the ratio falls below 0.95. (However, the absolute speed of the solar system is estimated to about 400 km/sec).

The existence of the aether is supported today by the experimental argument provided by Smoot and his co-workers [14,15] and by several theoretical arguments developed in this text and in [1A,1B,1F1G], and in [16,17]. We have also seen in ref [18] that the concept of aether entrainment is not supported by facts. However some physicists contend that if the aether was not entrained, the slowdown produced would be perceptible. We have already responded to this argument. In addition, if this were the case, the celestial bodies with their crown of entrained aether would not be sheltered from the influence of the aether wind highlighted by Smoot and his team, which would have slowed down them as well.

In the case of the very high velocities assumed by the Big Bang theory the action of the aether should be appreciable, however according to current cosmology, the effect of gravity is masked by the interaction of the celestial bodies with a "dark energy" which exerts an antigravitational effect. Does such an interaction mask the effect of the aether drift highlighted by Smoot as well? If one relies on current cosmology and on the type of reason it invokes, this sort of explanation can be called, since no deceleration of the celestial objects is observed.

However, in this field, the official knowledge based on the Big Bang theory is plagued by much uncertainty and the notions of dark energy or an accelerating universe, not only have not yet found a definitive explanation, but are contested by several authors [17,19,20, 21].

It should be noted that the colossal velocities which affect numerous galaxies in the framework of the Big Bang theory are denied by other authors who, on the basis of a detailed analysis of the ideas supported by the conventional cosmology, claim that the spectra we receive from distant galaxies are not demonstrative of a Doppler effect (see below the section VI).

(We will check in the following sections whether the kind of aether described by Einstein in Ref [13] is (or not) in agreement with other well established laws of physics).

V.2.4. Critique of the conventional concept of kinetic energy

The conventional concept of kinetic energy is closely related to the relativity principle and to the assumed absence of aether drift. Indeed, insofar as there is no privileged frame, the kinetic energy has no absolute character. The following example will put forward the paradoxes raised by this concept of kinetic energy.

When a spaceship travels from one 'inertial system' S_1 to another S_2, a part of its fuel provides the chemical energy which is converted into kinetic energy *K*. According to special relativity, for an observer attached to S_1, this part of chemical energy is used to increase the kinetic energy of the spaceship, and for an observer attached to S_2, the same part is used to decrease it. However, the energy which is provided by the consumption of fuel cannot give rise to a decrease of kinetic energy, contrary to what special relativity asserts. All observers should agree about that.

Such a paradox which affects special relativity, results from the fact that the kinetic energy of a body in relativity is regarded as observer dependent. Indeed, the relativity principle implies that there is no fundamental frame where a body at rest has zero kinetic energy and from which the total kinetic energy of moving bodies should be measured. There is no aether drift and nothing differentiates an inertial frame from another. Therefore, the kinetic energy has no clear physical explanation. If one assumes that the relativity principle applies in all generality in the physical world, any body is viewed as having zero kinetic energy for an observer at rest in the same frame as the body, and therefore, there is no storage of a definite amount of kinetic energy, identical for all observers, when a body moves from one 'inertial system' to another.

There is no paradox any more if we assume that the total kinetic energy of a body is defined with respect to a privileged aether frame in which its value for any body at rest is zero. In this case, the kinetic energy has a well defined value and is not observer dependent. In the above example, the increase of kinetic energy in the transfer from S_1 to S_2 will be absolute, and recognized as the same by all observers. Conversely, in the transfer from S_2 to S_1, the decrease will also be recognized as the same by all. This implies that rest and motion are not only relative and that absolute speeds do exist.

The same considerations can be applied to the mass of a body which is transferred from one system A to another B travelling relative to A at a significant fraction of the speed of light. According to relativity, viewed from A, the mass of the body increases, but viewed from B, it decreases. This conclusion is at variance with logic. If a part of chemical energy has been used to increase the mass of the body, this must be true for all observers.

V.3. Further examination of the relativity principle and mass-energy conservation.

V.3.1. Is special relativity compatible with the mass-energy conservation law?

In this section we shall develop a new direct argument showing that, given the denial of the aether drift, special relativity is unable to be in accordance with the mass-energy conservation law without making irrational assumptions. To this end, we will make use of the criterion expressed in the paragraph V.2.4 which is required by logic and we will reason by contradiction and put forward the consequences of the absence of aether drift. (These arguments examine and clarify some concepts discussed in Ref [1]).

Suppose that two co-ordinate systems perfectly inertial S_1 and S_2 really exist. A spaceship at rest in one of them would not be subjected to any external force (no more hidden than apparent). Now, suppose that the spaceship at rest in the co-ordinate system S_1 leaves S_1 and after acceleration becomes firmly attached to S_2. If we adopt the point of view of special relativity, for an observer at rest in S_1, the initial kinetic energy of the spaceship is zero. The transfer from S_1 to S_2 can be carried out using an amount of fuel *F* capable of supplying the chemical energy *Q*. We assume that the mass of fuel is negligible relative to the mass of the spaceship. (Alternatively nuclear energy can be used). When the spaceship reaches S_2, let us suppose, in accordance with special relativity, that the fuel has been converted, on the one hand into the kinetic energy *K* and, on the other hand, into the heat and exhaust energy *h* which is released in the environment, so that $Q=K + h$.

In S_2, the fuel tank is filled up again. If S_1 and S_2 are assumed to be perfectly inertial (equivalent), they differ from one another only by their relative speed. This means that if there were no aether drift, no difference could be observed in the physical properties of the transfers from S_1 to S_2 and from S_2 to S_1. Therefore, viewed by an observer attached to S_2, the same amount of fuel *F* gives rise to the same distribution of energy, in the transfer from S_2 to S_1, as it did, for an observer attached to S_1, in the transfer from S_1 to S_2, that is: $Q=K + h$
a fact at the origin of the paradox.

(Note that two hypotheses will be formulated about the value of *h*, for one of them this value differs for the observers placed at the origin or at the end of the path, see the discussion below).

Now let us examine how, in the context of special relativity, the energy Q is shared upon the two-way travel of the spaceship. If one assumes that during the transfer from S_1 to S_2 the increase of kinetic energy is K, two working hypotheses can be formulated to this end.
The first hypothesis has been outlined in the previous parts of this text. We shall review it in more detail below.
The second hypothesis assumes that the same energy $Q=K + h$ is consumed whatever the co-ordinate system from which it is observed. Therefore upon a roundtrip the energy $2K + 2h$ is consumed
We will examine the two hypotheses successively.

The first hypothesis states that in the course of the travel from S_1 to S_2, the energy consumed is $Q = K + h1$, for the observer placed in S_1 and $Q + K = h2$ (i.e. $Q = -K + h2$), for the observer placed in S_2.
Conversely, in the course of the travel from S_2 to S_1, the energy consumed is seen to be $Q = K + h1$, for the observer placed in S_2 and $Q + K = h2$ (*i.e.* $Q = -K + h2$), for the observer placed in S_1.
This assumption is the one which is adopted by most supporters of special relativity: They argue that the energy observed in S_1 (the first $K + h$) cannot be added to the energy observed in S_2 (the second $K + h$) contrary to what the second hypothesis asserts.
However if a quantity of fuel is converted into energy, this energy is well defined and cannot be seen differently by different observers. When a certain amount of chemical energy is burned, its power is the same for all. For example if it is used to construct something, it cannot be seen as constructive for an observer and destructive for another. However, according to this hypothesis, the same chemical energy is used simultaneously to increase or to decrease the kinetic energy, depending on the observer.
This is a point which does not affect non-entrained aether theory
Moreover it seems also paradoxical that, according to this hypothesis, the energy released in the environment during the forward trip is viewed quite different by the observers standing in S_1 and S_2 the difference being $h2 - h1=2K$.
This cannot be true, because, as we saw, the true mass-energy of a certain amount of a material element is the same for all observers. It is equal to the sum of the mass-energy it has in the fundamental frame and the kinetic energy it has relative to this frame. If it is estimated differently, this is due to questionable assumptions. Therefore if an amount of fuel is converted into heat and exhaust energy h for an observer, this must be so for all observers.

The second hypothesis takes notice of the symmetry of the transfers, and assumes that the energy consumed should be equal to $Q=K + h$ for both observers, as well in the forward path as in the reverse direction. This is nothing more than a working hypothe-

sis which can be justified by the fact that a certain amount of fuel providing kinetic energy cannot be used at the same time to reduce this energy.
This assumption avoids the difficulties of the previous hypothesis, but unfortunately it is plagued by other difficulties: indeed it supposes that, on a round trip, the spaceship should have used the energy *2Q=2h +2K*. Yet this result is not compatible with the mass-energy conservation law. Indeed, while the heat and exhaust energies have been released in the environment and therefore are conserved, the kinetic energy is not, because a part of the chemical energy has been converted into this energy while the final kinetic energy has not increased.
Yet the mass-energy conservation law is a very basic principle which can in no way be ignored.

V.3.2 Implication on the origin of mass

In order to avoid the difficulties inherent in the absence of aether which have been analysed previously, the only way would be to assume that one can transfer the spaceship from S_1 to S_2 (or from S_2 to S_1) without changing the kinetic energy. Such a paradoxical result can be easily explained when we know that in the absence of aether drift, there is no hierarchy between frames.
Indeed, with this assumption: 1. the mass-energy conservation law is preserved, 2. we are not compelled, to admit that the consumption of a certain amount of energy gives rise to an increase or a decrease of kinetic energy, depending on the observer. Thus the said assumption resolves all the difficulties raised by the hypotheses mentioned in the previous chapters.

Theoretically, *in the absence of aether drift*, the expression of the kinetic energy (due to the consumption of a part of the fuel) gained by the spaceship when it moves from S_1 to S_2 is:

$$(m - m_0)c^2 = m_0 c^2[(1 - v^2/c^2)^{-1/2} - 1], \qquad (14)$$

whatever the 'inertial'system S_1 considered.
Where m_0 is the rest mass of the spaceship, m is the mass in S_2 viewed from S_1, and v the relative speed between S_1 and S_2. However, as the kinetic energy has remained unchanged during the transfer, expression (14) must be null. Noting that v is not null, this result requires that the rest mass be zero: so that $m_0 = 0$.
We therefore conclude that, if there were no aether and if the relativity principle did exactly apply in the physical world, the mass-energy of bodies would be null. Since this is not the case, we must infer that the mass-energy is not an intrinsic property of bodies, it results from their interaction with the aether. The mass is minimum in the fundamental aether frame where there is no drift; it increases with absolute velocity as the aether drift increases.

(This implies that the aether exerts its influence as well inside the bodies as outside of them).

Thus, unlike special relativity, a fundamental theory which assumes a non-entrained aether, implies a different influence of the aether on S_1 and S_2. Let us suppose that the aether drift is greater in S_2 than in S_1. During the transfer of the spaceship from S_1 to S_2, the chemical energy *Q* is converted into kinetic energy Δk and heat and exhaust energy h'. The heat and exhaust energy is released in the environment and therefore conserved. Now, if we suppose that v_1 is the speed of S_1 with respect to the aether frame S_0 and v_2 the speed of S_2 with respect to S_0, the extra kinetic energy acquired by the spaceship when it moves from S_1 to S_2 will be:

$$\Delta k = m_0 C^2 [(1 - v_2^2 / C^2)^{-1/2} - (1 - v_1^2 / C^2)^{-1/2}]. \qquad (15)$$

Upon its return, this extra kinetic energy will be restored to the environment, in agreement with the mass-energy conservation law. We are not constrained to assume that expression (15) is null, and therefore $m_0 \neq 0$. This conclusion does not depend on the observer who draws it, it is the same for all observers.

(The situation is similar to that of a body which, under the effect of an impulse transmitted to it, acquires potential energy E as it moves from one level A to another B. Upon its return to A, the body must give up the same energy E).

Note that the return of the spaceship from a system of low absolute speed (v/C<<1) to the fundamental frame, solely as a result of the interaction with the aether, should take a very long time, because, relative to such a system, the pressure exerted by the aether drift is weak, all the more as it would generally be offset by friction forces. For very low absolute speeds, the slowdown becomes imperceptible as Newton’s first law requires.

However, chemical energy can be used to accelerate the process. Suppose that we use the same chemical energy *Q* as we did previously, the energy conservation requires:

$$Q = \Delta k + h'$$

for the forward path, but:

$$Q + \Delta k = h'' \quad \text{that is} \quad Q = -\Delta k + h''$$

for the return path.

The differences with special relativity, are that, in the return process, $-\Delta k$ is regarded as a real loss of kinetic energy which does not depend on the observer, and for the said chemical energy *Q*, the energy released h'' is the same for all. Besides, the same amount of fuel does not give rise simultaneously to an increase or a decrease of kinetic energy, and the energy released in a one-way travel is not seen different (equal to *h1* or to *h2*) by the observers standing in S_1 or in S_2.

The difference between h' and h'' can be justified because, contrary to special relativity, the forward and the backward travels are not symmetrical, since the aether drift is different in S_1 and in S_2.

It should be also pointed that, unlike the first hypothesis of paragraph V.3.1, the decrease of kinetic energy is not due to the consumption of chemical energy, it only depends on the different magnitude of the aether drift in S_2 and S_1. Chemical energy is only used to accelerate the process, and not to produce it. Once the spaceship has reached S_1, it stops and the energy it has acquired because of the acceleration is released in the environment.

Note also that this result (mass resulting from the interaction of matter with the aether) would not be obtained if we assumed the concept of aether defined by Einstein [13] since, according to Einstein, "the idea of motion may not be applied to this aether", and therefore it does not create an obstacle to the motion of bodies. This concept of aether denies the existence of an aether drift, (and therefore, in this problem, the same conclusions must be drawn as if the aether did not exist).

In practice it is not easy to test the role of the aether drift in the Earth frame where, given that *v* is estimated at 400 km/sec ($v/C \ll 1$), the pressure it exerts must be very low, and given that it is faced to the atmosphere and to the friction forces which oppose a resistance that can hide it.

V.3.3. Consequences

The fact that bodies possess inertial mass, demonstrates that the aether exerts a hidden influence on them. This influence, being dependent on their absolute speed, leads us to conclude that, *provided that the measurement of the space and time coordinates is reliable*, the laws of physics, including electromagnetism, must somewhat vary as a function of this velocity.

Yet the measurements are usually made with contracted standards and with clocks whose ticking is slowed down by motion and which are synchronized with light signals. As we demonstrated in ref [1B], only when these measurement distortions act, the space-time transformations assume a mathematical form identical to the conventionnal transformations and the relativity principle *seems* to apply.

Being established, these facts make it possible to find a solution to the paradoxes generated by the reciprocity of observations, between frames which are supposed to be inertial (even at very high speed), that affect special relativity [1F].

V.3.4. Concluding remarks

I would like to insist on the fact that it is not the validity of the relativity principle as an abstract concept which is called into question. It is clear that if the hidden influence of the aether drift was suppressed, the relativity principle would strictly apply to the true laws of physics (not altered by measurement distortions). But this condition is never exactly fulfilled in the physical world. Only a theoretical study of the cancellation of the drift is possible.

VI. Principle of inertia

The principle of inertia was first anticipated by Galileo and was given by Newton, as the first law of motion, the status of fundamental principle of physics. In his work

“Philosophiæ Naturalis Principia Mathematica” Newton defines the principle as follows:

> The *vis insita*, or innate force of matter, is a power of resisting by which every body, as much as in it lies, endeavours to preserve its present state, whether it be of rest or of moving uniformly forward in a straight line.

In concrete terms this sentence can be translated as: “a body sliding on a perfectly smooth horizontal surface (without any friction) in vacuum, remains perpetually in its state of uniform motion”.

The principle of inertia is closely linked to the Galilean relativity principle. Of course, if rest and uniform motion are only relative, we can view the body as at rest in its reference system and, as a result, it must remain in this state of rest.

So, any objection to the Galilean relativity principle, also challenges the principle of inertia.

But, in the fundamental aether theory proposed here, absolute rest exists and is distinct from motion. The difference results from the existence of the aether. Under the action of the aether, and even if we assume that the friction of the air and of the ground are balanced, the body will experience a gradual slowdown, which at low absolute speed ($v/C<<1$) is imperceptible or hardly perceptible, but which increases with absolute velocity. The Galilean principle of inertia is therefore challenged.

(It is clear that if the pressure exerted by the aether were offset, the principle of inertia would strictly apply, a necessary condition for the mass-energy conservation law to be obeyed).

However, the pressure exerted by the aether at current absolute speeds is extremely low, since, as we saw, even when speeds amount to 10^4 km/sec, the ratio ℓ/ℓ_0 does not fall below 0.9995 and even at 10^5 km/sec it does not fall below 0.95. (However, the absolute speed of the solar system is estimated at only 400 km/sec). Therefore, the obstacle to inertia is negligible.

When the speed of the platform, where it has to be verified, reaches an important fraction of the speed of light, the obstacle to inertia increases significantly. Such important speeds are assigned to distant galaxies by the official astronomy, as the shift of the electromagnetic waves issued from them is attributed in large part to a Doppler effect. However, paradoxically, the astronomical observations have not identified a slowing down of the celestial bodies under the effect of gravity, not any more than to that attributable to any other cause, including the aether. On the contrary the official view is that an acceleration occurs: a process attributed to the presence of a dark energy which opposes an anti gravitational effect to those we just mentioned. Yet, the origin of such an energy remains mysterious.

Other theories less official contest the big bang and do not take for granted the high velocities which are assigned to distant galaxies when the Doppler effect is involved.

The linear relationship of the red-shift with the distance was discovered by Hubble on purely observational grounds, while, unlike what is often believed, the Hubble recession law was a working ad hoc hypothesis, formulated by the author around 1929, which assumed that the red-shift could be interpreted as velocity shift. Its well known mathematical form being:

$$z = \frac{\lambda_{obs} - \lambda_{lab}}{\lambda_{lab}} = \frac{v}{C}$$

where z is the relative red-shift, λ_{obs} is the wavelength of the ray received from the distant source under observation, and λ_{lab} the wavelength emitted by the same source when it is close to the observer, *v* is the speed of the source and C the speed of light.
However not later than 1937, in his book "The observational approach to cosmology" [20] Hubble declared: "The familiar interpretation of red-shifts as velocity shifts, very seriously restricts not only the time scale, the age of the Universe, but the spatial dimensions as well. On the other hand, the alternative possible interpretation that red-shifts are not velocity shifts avoids both difficulties...".
It is regretable that the evolution of the opinion of one of the cosmologists most involved in the theory of the Universe expansion is not better known.
Among the opponents to the big bang theory were also Max Born, De Broglie, Pecker, Vigier and Zwicky.
It is amazing that the Doppler assumption regarding the red-shift supposes that the light can cover extremely long distances without crossing and interacting with gas. However the obstacles are not lacking and large amounts of extra-galactic gas have been detected [21], while, not later than 1896, in the course of the travel of electromagnetic waves across gaseous media, a shift of wavelength toward the red had been observed by Humphreys and Mohler when the pressure is increased. This work which gave rise to several publications was confirmed by Fabry in a note written around 1901 [21].
In an open letter to the scientific community a panel of 33 top scientists declared [20]: "The Big Bang theory relies on a growing number of hypothetical entities, things we have never observed -inflation, dark matter and dark energy are the most dominant examples. Without them there would be a fatal contradiction between the observations made by astronomers and the predictions of the big bang theory. In no other field of physics would this continued recourse to new hypothetical objects be accepted as a way of bridging the gap between theory and observation".
However, as these scientists regret, all peer reviewed committees that control the experimental resources in cosmology are devoted to the big bang studies.

The studies conducted by these authors should be widely spread and known by the experts, in particular as regards the arguments which refute the Doppler approach. In case a consensus was acquired, this would imply that the galaxies do not recede from each other at speeds which in certain cases approximate the speed of light. But this does not exclude local movements at speeds of less value but not null. For the resulting spectra which would not be significantly Doppler shifted, the ratio *v*/C would be very small, in which case, the pressure exerted by the aether on matter assumed by non-entrained aether theory could only be negligible.

As we have seen, it is the interaction of the aether with matter that confers mass. So it is appropriate to ask whether the aether itself possesses mass? Lorentz suggested that it did not. However, one can ask how an aether which should not possess mass can make to exert a pressure on matter? In order to respond to this question, we must realise that, while the existence of mass involves a proportional amount of energy definited by $E=mC^2$, this does not constrain all the energy to assume a massive character. The massive character of energy should only concern the material bodies interacting with the aether. As an example, the electromagnetic radiation possesses energy and momentum although it does not possess mass. These properties can be transmitted to matter as the example of the radiation pressure shows. So that, the pressure exerted to matter by a non massive aether is not a subject of questioning today, even though at low absolute speeds it should be quite small.

(See the discussion in paragraph V.2.3).

VII. Conservation of momentum

Insofar as the particles interacting in a collision are slowed down by the aether drift, their total quantity of motion cannot be the same before and after the collision. A part of the impulse is transferred to the environment. This effect, imperceptible at low absolute speed, should not be ignored if the absolute velocity of the co-ordinate system in which the collision happens, had a significant fraction of the speed of light. (Of course, if the impulse transferred to the environment was taken into account, the total quantity of motion would be conserved).

Note that, as we saw in refs [1A and 1B], in the usual experiments, because of the alterations suffered by the measuring instruments during the movement, the laws of physics *appear* invariant. Therefore, the law of conservation of the relativistic momentum *seems* to apply as such in all frames not subjected to perceptible external forces.

As a result, the apparent relativistic law of variation of mass with speed, which is derived on the basis of the conservation of the relativistic momentum, takes the form conferred by conventional relativity.

In the following appendices, we will show how the alterations of the measuring instruments, as well as the arbitrary synchronization procedures, alter the experimental results.

Appendix I

How Lorentz-FitzGerald's contraction (L.C) explains the *apparent* light speed invariance.

In this appendix we will show that L.C is necessary to account for the invariance of the two way transit time of light along a rigid path, irrespective of its orientation in space, in conformity with the experiment.
But this is not all. Combined with clock retardation, L.C will make it possible to explain why the *measured* value of the speed of light is found isotropic and equal to *C*, whereas its real value is not, and this in any co-ordinate system not subjected to perceptible external forces.

The demonstration is based on Builder and Prokhovnik's studies [22] whose importance is indisputable but, as we shall see, some of the conclusions of Prokhovnik were questionable and could not enable to demonstrate that this *apparent* velocity is found equal to *C*.

Let us consider two co-ordinate systems, S_0 and S. S_0 is at rest in the cosmic substratum (aether frame) and S is attached to a body which moves with rectilinear uniform motion along the x_0-axis of the S_0 system and suppose that a rod AB making an angle θ with the x_0, x-axis, is at rest with respect to the system S (see figure 3).

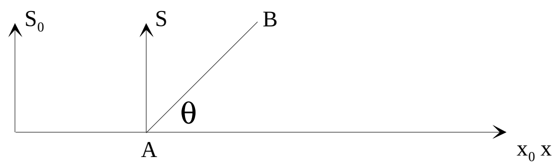

Figure 3. The rod AB is at rest with respect to the system S.

At the two ends of the rod, let us place two mirrors facing one another by their reflecting surface, which is perpendicular to the axis of the rod $\ell = AB$. At the initial instant, the two systems S_0 and S overlap. At this very instant a light signal is sent from the common origin and travels along the rod towards point B. After reflection the signal returns to point A.
We do not suppose a priori that $\ell = \ell_0$ (where ℓ_0 is the length of the rod when it is at rest in the aether system S_0). We remark that the path of the light signal along the rod is related to the speed C_1 by the relation:

$$C_1 = \frac{AB}{t}$$

where *t* is the time needed by the signal to cover the distance AB (see figure 4).
In addition, when the signal reaches point B, the system S has moved away from S_0 to a distance $AA'=vt$, so that:

$$v = \frac{AA'}{t}.$$

Now, with respect to the fundamental frame S_0, the signal goes from point A to point B' (see figure 4).

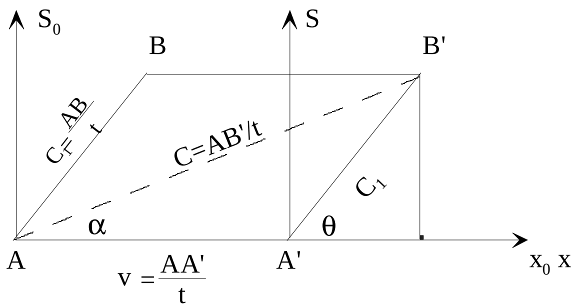

Figure 4. The speed of light is equal to C from A to B', and to C_1 from A' to B'.

C being the speed of light in S_0, we have:

$$\frac{AB'}{t} = C$$

and hence, the projection along the *x*-axis of the speed of light C_1 relative to the system S, will be equal to $C\cos\alpha - v$. So that:

$$C\cos\alpha - v = C_1\cos\theta.$$

The three speeds, C, C_1 and v being proportional to the three lengths AB', AB and AA' with the same coefficient of proportionality, we have

$$C^2 = (C_1\cos\theta + v)^2 + C_1^2\sin^2\theta.$$

Therefore:

$$C_1^2 + 2vC_1\cos\theta - (C^2 - v^2) = 0. \qquad (16)$$

It should be emphasized that, as the same time $t = \dfrac{AB'}{C}$ refers to the three speeds C, C_1 and v, they are determined with clocks not slowed down by motion and exactly synchronized, (while these alterations affect the moving clocks). Of course such a measurement is impossible, but, a theoretical analysis is possible.

The reliability of these speeds is ascertained by their consequences that are described all along the text. In particular they allow explaining why, due to the alterations entailed by length contraction and by clock retardation applied to the two-way light transit time determined from them, the *measured* round trip light velocity is found isotropic and equal to C irrespective of the absolute speed v of the 'inertial system' where it is measured (see below).

For convenience we will use the sentence “clocks attached to S_0” or “clocks not slowed down by motion” in what follows, which means that, if such clocks were attached to the fundamental frame they would indicate the true time.
Resolving the second degree equation, we obtain:

$$C_1 = -v\cos\theta \pm \sqrt{C^2 - v^2 \sin^2\theta}\,.$$

The condition $C_1 = C$ when $v = 0$ compels us to only retain the + sign so:

$$C_1 = -v\cos\theta + \sqrt{C^2 - v^2 \sin^2\theta}\,. \tag{17}$$

Now, the return of light can be illustrated by the figure 5 below:

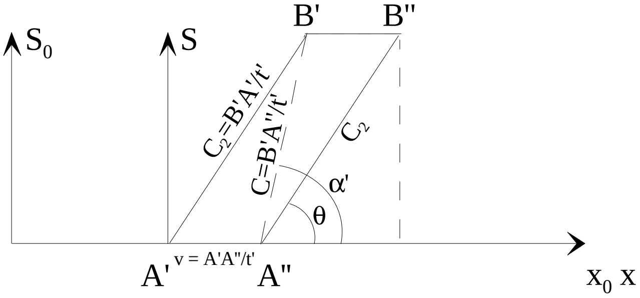

Figure 5.The speed of light is equal to C from B’ to A” and to C_2 from B” to A”.

From the point of view of an observer attached to the system S, the light comes back to its initial position with the speed C_2.
Therefore we can write:

$$C_2 = \frac{B'A'}{t'}\,.$$

With respect to frame S_0 the light comes from B’to A’’ with the speed C, so that:

$$C = \frac{B'A''}{t'}\,.$$

During the light transfer, the system S has moved from A’ to A’’ with the speed v therefore:

$$v = \frac{A'A''}{t'}\,.$$

The projection of the speed of light relative to S along the x-axis will be:

$$C\cos\alpha' + v = C_2\cos\theta\,.$$

We easily verify that:

$$\left(C_2\cos\theta - v\right)^2 + \left(C_2\sin\theta\right)^2 = C^2\,,$$

therefore,

$$C_2 = v\cos\theta + \sqrt{C^2 - v^2 \sin^2\theta}\,. \tag{18}$$

The two-way transit time of light along the rod (which, as the reasoning shows, would be determined with clocks not slowed down by motion and exactly synchronized) is:

$$2T = \frac{\ell}{C_1} + \frac{\ell}{C_2}. \qquad (19)$$

According to the experiment (provided that the vacuum is assured), T must be essentially independent of the angle θ. This is because the *measured* value of the two-way transit time of light in all directions of space is $2\ell_0/C$. Given that in the y direction, as we saw, in ref [1A] the real value of $2T$ is equal to $\frac{2\ell_0}{C\sqrt{1-v^2/C^2}}$ and that the clock retardation factor applies in the same way in all directions, the isotropic character of $2T$ follows.

Therefore, $2T$ must be equal to:

$$\frac{2\ell_0}{C\sqrt{1-v^2/C^2}}$$

which is the two way transit time of light along the y direction calculated above. We can see that, in order for this condition to be satisfied, the projection of the rod along the x-axis must shrink in such a way that:

$$\ell\cos\theta = \ell_0\cos\varphi\sqrt{1-v^2/C^2} \quad \text{(see figure 6)} \qquad (20)$$

where φ was the angle separating the rod and the x_0-axis when the rod was at rest in S_0.

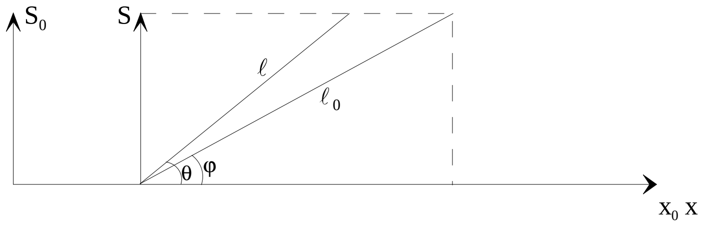

Figure 6. Along the x_0, x-axis, the projection of the rod ℓ_0 contracts, along the y-axis it is not modified.

from:

$$\ell_0\cos\varphi = \frac{\ell\cos\theta}{\sqrt{1-v^2/C^2}}$$

and

$$\ell_0 sin\ \varphi = \ell\ sin\ \theta,$$

we easily verify that:

$$\left(\frac{\ell\cos\theta}{\sqrt{1-v^2/C^2}}\right)^2 + (\ell\sin\theta)^2 = \ell_0^{\,2}.$$

Finally: $$\ell = \frac{\ell_0 \left(1 - v^2/C^2\right)^{1/2}}{\left(1 - v^2 \sin^2\theta/C^2\right)^{1/2}} . \qquad (21)$$

Replacing ℓ with this expression (21) and C_1 and C_2 with their expressions (17) and (18), in formula (19) we obtain, as expected:

$$2T = \frac{2\ell_0}{C\sqrt{1 - v^2/C^2}} . \qquad (22)$$

We conclude that length contraction along the x_0, x-axis is a necessary condition so that the two-way transit time of light along a rod, (given by formula (22)), is independent of the orientation of the rod.

We shall now show that the same conditions, combined with clock retardation, allow to demonstrate why the *'apparent'* average round trip light velocity, is found equal to C in any direction of space and regardless of the speed v.

Clock retardation is an experimental fact. Let us denote by 2ε the *apparent* two-way transit time along the rod, measured with a clock standing in the co-ordinate S. We will have (from (22)):

$$2\varepsilon = 2T\sqrt{1 - \frac{v^2}{C^2}} \qquad (23)$$
$$= \frac{2\ell_0}{C} .$$

Now, the length of the rod, along the y axis is equal to ℓ_0. In all other directions it is different from ℓ_0. However, since it is measured with a meter stick which is contracted in the same ratio, it is systematically found equal to ℓ_0. Therefore, the average two-way speed of light is, *erroneously*, found equal to C in any direction of space and independently of the speed v. This result is highly meaningful, and is a direct consequence of length contraction in the direction of the absolute velocity of the co-ordinate system S and of clock retardation when an aether non-entrained by the motion of celestial bodies is assumed.

Note

In our demonstration, although we are indebted to Prokhovnik, we differ with some of his conclusions [22]; indeed, since $C = AB'/t$ and $C = B'A''/t'$, it is obvious, as we saw, that t and t' are the real transit times of light along the rod.

Now, since $C_1 = \dfrac{AB}{t}$ and $C_2 = \dfrac{B'A'}{t'}$ there is no doubt that C_1 and C_2 are the real speeds. The value of the real two-way light transit time is thus:

$$2T = \frac{\ell}{C_1} + \frac{\ell}{C_2} .$$

Nevertheless, in his book "The logic of special relativity" [22] chapter "The logic of absolute motion", Prokhovnik identifies the time

$$2T = \frac{2\ell_0}{C\sqrt{1-v^2/C^2}}$$

with the two-way transit time of light along the rod, measured with clocks attached to the moving co-ordinate system. This cannot be true for the reason indicated above.
(Note that in our notation the moving co-ordinate system is designated as S, while in Prokhovnik's notation, S denotes the aether system and A the moving system. We will continue the demonstration with our own notation).

In addition, if Prokhovnik's approach were true, the *apparent* two-way speed of light in S would not be *C*. Indeed, since the standard used for the measurement is also contracted, observer S would find ℓ_0 for the length of the rod.
Therefore, the *apparent* (measured) two way speed of light in the system S would have been:

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

which is not in agreement with the experimental facts.

The real two-way transit time of light along the moving rod is actually:

$$2\ell_0/(C\sqrt{1-v^2/C^2}),$$

and the *apparent* two-way transit time, measured with clocks attached to the system S, is $2\ell_0/C$. This corresponds to the experimental facts, since, with these values, the *apparent* average two-way speed of light in S is found equal to

$$2\ell_0\Big/\frac{2\ell_0}{C} = C.$$

Note also that according to aether theory, the real two-way speed of light (measured with non-contracted standards and with clocks not slowed down by the movement) can be easily determined from (21) and (22). Along the x_0, x-axis we obtain:

$$\frac{2\ell_0\sqrt{1-v^2/C^2}}{2\ell_0/(C\sqrt{1-v^2/C^2})} = C(1-v^2/C^2).$$

As expected, this expression tends to 0 when $v \Rightarrow C$.

Appendix 2

Clock Synchronization and Light Velocity

We will now show how the *usual* clock synchronization procedures are affected by *systematic* errors generating a distorted vision of reality. We shall examine successively the Einstein-Poincaré procedure with light signals and the slow clock transport method.

1. Clock synchronization with light signals

In order to measure the speed of light with this method, we can use one or two clocks. When we use one clock, the signal is sent from the clock toward a mirror, and, after reflection, comes back to its initial position. In this case, what we measure in fact is the *apparent* average round trip velocity of the light signal. It is nevertheless this value that is usually identified to the one-way speed of light.

As we saw in the appendix 1 formula (23), even if we subscribe to the Lorentz assumptions, which assume the anisotropy of the one-way speed of light in the Earth platform, the theory demonstrates that this average round trip velocity along a rod is (erroneously) found equal to *C* irrespective of the orientation of the rod. It also appears independent of the speed relative to the aether frame, of the platform in which it is measured. (Its real value along the *x*-axis is derived at the end of appendix 1). (These outcomes follow from the systematic measurement distortions already mentioned).

Therefore, *a priori*, the use of two clocks seems justified in order to accurately measure the one-way speed of light. With this goal in mind, we need first to synchronize two distant clocks A and B.

In the Einstein-Poincaré procedure, this requires two steps. First, we send a light signal from clock A to clock B at instant t_0; after reflection the signal comes back to A at instant t_1. Then we send another signal at instant t'_0. The clocks will be considered synchronous if, when the signal reaches clock B, the display of clock B is:

$$t'_0 + \frac{t_1 - t_0}{2} = t'_0 + \varepsilon$$

where ε is equal to half the *'apparent'* two-way transit time of the signal measured with the clocks slowed down by motion attached to the Earth platform. But this apparent time is usually (improperly) identified with the one way transit time of light.

Therefore both methods are equivalent.

As we saw in formula (23), $\varepsilon = \ell_0/C$ in any direction of space and in any 'inertial frame' and since the distance AB is always found equal to ℓ_0, the speed of light is found equal to *C* in the same way as when we use one clock. Thus, even though the speed of light is given by formulas (17) and (18) of the appendix 1, the measurement by the Einstein-Poincaré procedure yields *C*.

It is therefore justified to test another method, *i.e.*, the slow clock transport procedure.

2. The slow clock transport method

Many physicists believe that an accurate measurement of the speed of light can be obtained by the slow clock transport method. The procedure consists of setting two clocks A and B to the value zero at a point O′ in the Earth platform, and then of transporting

clock B to a distance from A at low speed ($v<<C$). The problem has been envisaged in various ways by different authors [23-31].
We have to realize that in such a procedure, the notion of low velocity has a character strictly relative. For example, 100 Km/sec can be considered very slow since the ratio $\frac{v^2}{C^2}$ yields approximately 0.11×10^{-6}.
A priori, it would appear that, since the transport is very slow, the motion would have no perceptible influence on the time displayed by clock B, and that the two clocks would remain almost synchronized all the time. But is this really the case?

2.1. Point of view of the conventional theory of relativity

If we regard the assumptions of special relativity as indisputable, then absolute speeds have no meaning: only relative speeds exist. On this basis, clock B will display:

$$t' = t\sqrt{1-v^2/C^2} \approx t(1-\frac{1}{2}\frac{v^2}{C^2})$$

where t is the reading displayed by clock A. (Note that for convenience we have supposed that the two clocks display $t_0 = 0$ at the initial instant).
Once clock B has stopped (at point P), its lag behind clock A will remain constant. The synchronism discrepancy between clocks A and B is then, to first order

$$\Delta t = \frac{1}{2}\frac{v^2}{C^2}T$$

where T denotes the time displayed by clock A when clock B reaches point P.

The speed of light will thus appear to be[3]:

$$\frac{O'P}{\tau-\Delta t} \approx \frac{O'P}{\tau} + \frac{O'P\Delta t}{\tau^2}, \qquad (24)$$

where *O'P* refers to the path covered by the light signal.
τ is the apparent time needed by a light signal to cover the distance *O'P*
$\tau - \Delta t$ is the apparent light transit time measured with clock B.
Since v<<C, expression (24) reduces to:

$$\frac{O'P}{\tau}.$$

Note that the value of the speed of light is assumed to be known. The measurement therefore consists in verifying whether the results obtained by this method are in agreement with the premises.
The experimental value of the speed of light obtained is *C*.

[3] With respect to the previous versions of this demonstration, the notations have been changed for clarification.

Since the measurements of $O'P, T\ \Delta t$ and τ are supposed to be exact, special relativity concludes that the method is reliable. Actually if the method gives a value of the speed of light in agreement with the assumed hypotheses, it does in no way enable these hypotheses to be justified**.**

2.2. The fundamental aether theory point of view

It is interesting to see whether the above results can be obtained with basic hypotheses different from those of special relativity. Today, we have strong arguments in favour of the Lorentz assumptions. Several of them have been reviewed in ref [1].

According to Lorentz, the one-way speed of light is constant exclusively in the aether frame. If we denote this speed by *C*, the one-way speed of light in moving platforms is given by the formulas (17) and (18) of the appendix 1. As we saw it depends on the angle.

If the slow clock transport method is reliable, it should give a value for the one-way speed of light in agreement with the assumed hypotheses.

We will see in fact that contrary to what many authors think, the method does not allow synchronizing the clocks exactly. Yet it presents a great interest since it permits to show that, even if we assume the Lorentz postulates, the speed of light is found isotropic and equal to *C* in all 'inertial frames', in contradiction with these postulates but in agreement with the Einstein-Poincaré procedure. It therefore contributes to explain why the experimental results seem consistent with conventional relativity when clocks are synchronized with the usual synchronization procedures.

Two cases will be considered.

2.2.1. The light ray travels in the direction of the absolute velocity of the Earth platform

Consider two co-ordinate systems S_0 and S_1. S_0 is at rest in the Cosmic Substratum, and S_1 is firmly linked to the Earth platform. Initially the two systems overlap. At this instant, a vehicle equipped with a clock starts from the common origin and moves slowly and uniformly along the *x*-axis of S_1 toward a point P of this co-ordinate system. We suppose that during the time of the experiment, the x_0-axis and the *x*-axis are aligned along the direction of the Earth absolute velocity vetor (See Figure 7). v_{01} is the real speed of the Earth with respect to the fundamental frame S_0, v_{02} is the real speed of the vehicle with respect to S_0, and v_{12} the real speed of the vehicle with respect to S_1.

C is the speed of light with respect to S_0.

(Note that, for a short time, the motion of the Earth with respect to the Cosmic Substratum can be considered rectilinear and uniform. If this were not the case, the bodies standing on the Earth platform would be subjected to perceptible accelerations).

The duration of the transport should be short enough so that the orbital and rotational motions of the Earth would not significantly affect the measurement.

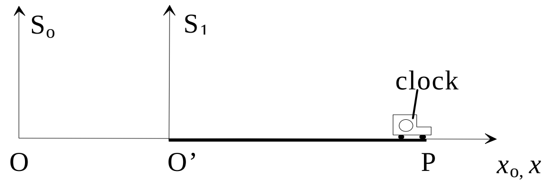

Figure 7. Synchronization of two clocks placed at O′ and P by the slow clock transport method.

When the vehicle reaches point P, it stops. The real time needed to reach point P is given by

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

where ℓ is the length of O′ P (which is contracted because of the motion of the Earth with respect to the Cosmic Substratum), ℓ_0 is the length that O′ P would assume if it were at rest in the aether frame, t_r is the vehicle's real transit time from O′ to P. It is the time that a clock attached to the aether frame, opposite the vehicle at the instant when it reaches point P, would display.
But the clock in the vehicle (B) lags behind the clock attached to S_0, and will display the reading:

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

(Let us recall that, in non-entrained aether theory, real speeds obey the Galilean law of composition of velocities.The relativistic law aplies only to apparent speeds [1]).
Now the clock placed at the origin O′ of the Earth system (A) lags behind a clock attached to S_0 opposite it. When the vehicle reaches point P, it will display the reading:

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

(This implies that, for an instantaneous event occurring at point P, all the clocks attached to the Cosmic Substratum display the same time). Thus, between clock B and clock A, we find a synchronism discrepancy equal to:

$$\begin{aligned}&\frac{\ell_0\sqrt{1-v_{01}^2/C^2}}{v_{02}-v_{01}}(\sqrt{1-v_{01}^2/C^2}-\sqrt{1-v_{02}^2/C^2})\\&\approx\frac{\ell_0\sqrt{1-v_{01}^2/C^2}}{v_{02}-v_{01}}(1-\frac{1}{2}v_{01}^2/C^2-1+\frac{1}{2}v_{02}^2/C^2)\\&\approx\frac{\ell_0}{2C^2}\sqrt{1-v_{01}^2/C^2}(v_{02}+v_{01}).\end{aligned}\tag{25}$$

We can see that, once the vehicle has stopped, the discrepancy will remain constant.

As shown by Prokhovnik [22] the synchronism discrepancy between clocks synchronized by the Einstein-Poincaré method is equal to $v_{01}\ell_0/C^2$. The difference with expression (25) is actually quite negligible if one considers that the transport is very slow and therefore that $v_{02}\approx v_{01}$. As for the gamma factor, for a clock standing in a platform whose absolute velocity is about 300 Km/sec, it differs from 1 by only $\frac{1}{2}10^{-6}$. We can therefore conclude that for the usual measurements, the two methods yield similar results.

Speed of light along *O'P*

If we assume the Lorentz postulates, the real time of light transit along the distance ℓ is theoretically:

$$\ell_0\frac{\sqrt{1-v_{01}^2/C^2}}{C-v_{01}}.$$

We suppose here, *a priori*, that the speed of light with respect to frame S_1 is known and equal to $C-v_{01}$. This is intentional, since we want to check whether the results are in agreement with the premises.

Now, as a result of clock retardation, (and without making allowance for lack of synchronism) the display of a clock in frame S_1 placed at point P when the signal reaches this point should be:

$$\frac{\ell_0\sqrt{1-v_{01}^2/C^2}\sqrt{1-v_{01}^2/C^2}}{C-v_{01}}=\frac{\ell_0}{C-v_{01}}\left(1-v_{01}^2/C^2\right).$$

If, in addition, we take into account the synchronism discrepancy given by formula (25), the apparent (measured) light transit time will be:

$$\frac{\ell_0}{C-v_{01}}\left(1-v_{01}^2/C^2\right)-\frac{\ell_0}{2C^2}\sqrt{1-v_{01}^2/C^2}\left(v_{02}+v_{01}\right).\tag{26}$$

Ignoring the terms of high order, expression (26) reduces to

$$\frac{\ell_0}{C}\left(1+\frac{v_{01}-v_{02}}{2C}\right)=\frac{\ell_0}{C}\left(1-\frac{v_{12}}{2C}\right).$$

Now, since the measured length of $O'P$ is always found equal to ℓ_0, the apparent speed of light will be

$$\frac{\ell_0}{\frac{\ell_0}{C}(1-\frac{v_{12}}{2C})}=\frac{C}{1-\frac{v_{12}}{2C}}\approx C(1+\frac{v_{12}}{2C})=C+\frac{v_{12}}{2}.$$

Since v_{12} is taken as small as possible, the apparent speed of light is found equal to *C*. Therefore, even if the real speed of light is $C-v_{01}$, the slow clock transport method will (erroneously) yield *C* in the same way as the Einstein-Poincaré method.

Therefore the two methods can be considered equivalent.

2.2.2. General case

We now measure the speed of light along a rigid path O′B making an angle θ with the *x*-axis of a co-ordinate system S_1, firmly tied to the Earth frame (See Figure 8). We suppose that during the time of the experiment, the *x*-axis is aligned along the resultant direction of motion of the Earth with respect to the Comic Substratum. For a short period of time this motion can be considered rectilinear and uniform. (Note also that the rigid path is in the *x*, *y* plane, but obviously, provided θ remains the same, the following reasoning would be identical in any plane passing by the x_0, *x*-axis).

We propose to address the case of a system of co-ordinates S_0 in the Cosmic Substratum such that S_0 and S_1 are initially coincident. At this instant, a vehicle leaves the common origin, and moves slowly and uniformly along the rigid path toward point B.

As we saw in formula (21) of appendix 1, due to length contraction along the x_0, *x*-axis, the length of the rigid path is given by

$$\ell=\frac{\ell_0\sqrt{1-v_{01}^2/C^2}}{\sqrt{1-v_{01}^2\sin^2\theta/C^2}},$$

where v_{01} is the speed of the Earth with respect to the fundamental system S_0. We will designate as *v* the real speed of the vehicle with respect to S_1, and *V* its real speed with respect to S_0. (See Figure 8).

The real time needed by the vehicle to reach point B is ℓ/v, but the apparent time, displayed by a clock placed in O' after allowance is made for clock retardation, is:

$$\frac{\ell}{v}\sqrt{1-v_{01}^2/C^2}.$$

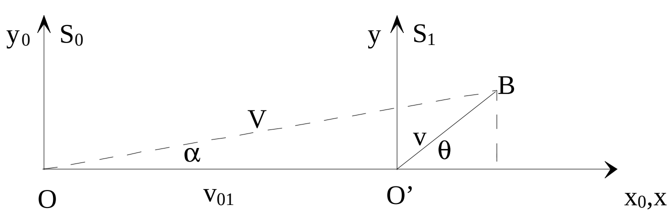

Figure 8. Synchronization of two clocks placed at O′ and B by the slow clock transport method.

The apparent time displayed by a clock inside the vehicle when it reaches point B is:

$$\frac{\ell}{v}\sqrt{1-V^2/C^2}\ .$$

As a result, the synchronism discrepancy between the apparent time displayed by a clock placed at point O′ and the clock in the vehicle when it reaches point B is;

$$\Delta = \frac{\ell}{v}\left(\sqrt{1-v_{01}^2/C^2} - \sqrt{1-V^2/C^2}\right).$$

We easily find that:

$$V^2 = v^2 \sin^2\theta + (v_{01} + v\cos\theta)^2 \tag{27}$$

To first order, Δ reduces to:

$$\Delta = \frac{\ell}{2vC^2}(V^2 - v_{01}^2)\ .$$

From (27), this expression gives:

$$\Delta = \frac{\ell}{C^2}\left(\frac{v}{2} + v_{01}\cos\theta\right),$$

which for θ=0 and the basic hypothesis for which v is taken as small as possible, yields the same result as formula (25).

Speed of light along O′B

Let us now suppose that we place, in O'and B, two clocks that have been (apparently) synchronized by the slow clock transport method. Actually, there is a synchronism error equal to Δ. The real speed of light along the rigid path from O′ to B is (as seen in appendix 1 formula (17)):

$$C_1 = -v_{01}\cos\ \theta + \sqrt{C^2 - {v_{01}}^2\sin^2\theta}\ .$$

As a result of clock retardation, but without the synchronism discrepancy effect, the *apparent* time needed by the light ray to reach point B should be:

$$T_L = \frac{\ell}{C_1}\sqrt{1-v_{01}^2/C^2}\ .$$

However, we must allow for the synchronism discrepancy, so that the '*apparent*' (measured) transit time of light will be:

$$\frac{\ell}{C_1}\sqrt{1-v_{01}^2/C^2} - \Delta\ . \tag{28}$$

Ignoring terms of high order, expression (28) reduces to:

$$\ell_0 \frac{(1-\frac{v_{01}}{C}\cos\theta-\frac{1}{2}\frac{v}{C})}{C(1-\frac{v_{01}}{C}\cos\theta)}.$$

Since the rigid path O′B is measured with a contracted meter stick, it appears equal to ℓ_0.

The apparent speed of light is thus:

$$C_{app}=\frac{\ell_0}{T_L-\Delta}=\frac{C(1-\frac{v_{01}}{C}\cos\theta)}{1-\frac{v_{01}}{C}\cos\theta-\frac{1}{2}\frac{v}{C}}.$$

Since $v \ll C$, C_{app} hardly differs from C.

Therefore, contrary to what is often claimed, the slow clock transport procedure does not allow exact measurement of the speed of light [32]. The method does not provide a result in agreement with the premises, it is approximately equivalent to the Einstein-Poincaré method and even though the speed of light is equal to C_1, it gives the erroneous value C for all measurements.

It is interesting to note that, even if the speed of light is not constant, it is found constant when standard methods of synchronization are used. Consequently, these methods must be seen as inadequate.

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