EXPERIMENTAL FOUNDATIONS OF THE 2nd PRINCIPLE OF THE THEORY OF RELATIVITY.

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The kinematic relations between Aether and Matter have formed for about a century, one of the most important problems of Physics.

Fresnel conceives the Aether contained in everybody as resultant of two parts: one free, endowed with the same density that the Aether of the void has, which would maintain its position in space unchanged, the other bound to the body, and dragged by it in all its movements, the which would have a density equal to $\frac{n^2-1}{n^2}$ of the total density, where *n* indicates the refractive index of the body.

Stokes raised forward and made a different hypothesis, which managed to explain the modest phenomena considered by Fresnel, i.e., the aberration both in the air and in other bodies, and the negative results of the research done on a possible influence of the terrestrial translation on reflection phenomena, polarization refraction: the total entrainment hypothesis of the Aether, by material bodies in motion.

It had, however, little luck, because, in the field of the doctrine of elastic Aether, bumped against a serious theoretical difficulty that arose from having to admit that the Aether does not present flow with respect to the surface of the bodies in movement; be it because a now classic experience is pronounced clearly against total drag.

This experience, due to Fizeau and then repeated with great care from Michelson, ensures that the speed of light inside two tubes crossed in the opposite direction by a rapid current of water are different, namely date from :

$$c_1 + v\frac{n^2-1}{n^2} \qquad c_1 - v\frac{n^2-1}{n^2}$$

where c_1 is the speed of light in the medium at rest, v of speed of the current, and n the refractive index of water.

This result leads to the conclusion that the moving vehicle it drags the light waves, but the drag is only partial and takes place exactly to the extent proposed by Fresnel.

The electromagnetic theory, in the form elaborated by Hertz, admitted Stokes' hypothesis; it therefore could not explain some of the phenomena mentioned, including this one by Fizeau, which was regarded as *experimentum crucis* against the total entrainment of Aether.

Lorentz, later, admitted the existence of a *Fixed Aether*, but he managed to reconcile this hypothesis with Fizeau's experience - with which it would have been in contrast - by introducing a new concept, that of local time, and for the same away he was able to explain the other researches that seemed to testify in favor of partial entrainment.

Stokes' and Hertz's hypothesis would have merit very great -- only recently come into prominence --that of extending the principle of relativity of ordinary mechanics to the phenomena of optics and electromagnetism.

Lorentz's theory, on the other hand, in its primitive form, it did not admit this principle, that is, it had to predict it a dependence of the laws of optical and electromagnetic phenomena on a constant and common velocity, by which eventually all the parts of the system could be animated in which the phenomena take place.

Thus, it let us foresee that a simple comparison, between the propagation time of light, over a system in motion -- with constant velocity -- is along a path coinciding with the translation, and the propagation time is long an equal path, oriented normally to the first would have was able to give the value of the speed, of the translation of the system with respect to the Aether, i.e., its absolute speed. The first half, according to Lorentz, should have been more larger than the second, and the difference should have depended exclusively from the common length of the paths, L, from speed of light, c, and from the speed, of the translation; and precisely according to the report:

(1) $$\tau = \frac{Lv^2}{c^3}$$

supposed each a path covered twice, i.e., in a sense and in the other.

This result, as is known, could be compared with the experience (the famous experience of Michelson and Morley), then repeated with every care by Morley and Miller [1]) of which the result was clearly negative.

To justify such a result Lorentz and Fitz-Gerald they admitted that, in the sense of translation, bodies undergo a real contraction [2]), of this amount, to be offset by the longer that light should take to travel the path oriented in this direction.

But even the hypothesis of contraction was not admitted therefore composed the disagreement between the theory of Lorentz and the principle of relativity.

The influence of terrestrial translation, excluded in Michelson's experience by such a hypothesis, certainly found still placed in all the phenomena in which the compensation of the contraction could not have intervened.

Thus Raylegh draws attention to birefringence accidental that the transparent bodies should have presented due to the terrestrial translational motion; and this effect was created by Brace (2) but with a negative result. Also negative results had been obtained by some electromagnetic researches by Trouton and Noble and others.

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1) Morley and Miller, "Report of an experiment to detect the FitzGerald, Lorentz effect. " *Phil. Mag*. (6). 9,. p. 680. 1905.

2) On this hypothesis, issued in 1892, see the note on page 362.

To cut short all these attempts aimed at discovering the influence of terrestrial translation on optical and electromagnetic phenomena, attempts which remain unsuccessful cast doubts on the new theory of electrons, Lorentz I try to make it possible for everyone to predict a negative outcome, i.e., try to reconcile his theory with the principle of relativity.

This principle basically says that the equations that describe the phenomena of mechanics do not change their form when changing the reference axis system; provided the new system is not animated by motion varied with respect to the primitive one.

This can also be expressed by saying, that the equations of mechanics do not change, if transformed with the formulas which express a uniform translation.

As is well known, these formulas can be written as follows:

$$x' = x - vt \qquad y' = y \qquad z' = z \tag{4}$$

to which we can also add this ultra:

$$t' = t$$

which expresses that time is the same with respect to any reference system:

Now if in the formulas of the theory of Lorentz, instead of the quantities x, y, z, t, the given x', y', z', t' are introduced from (4) we finally arrive at a system of equations which no longer coincides with the usual system reached by making use of the variables x, y, z, t, which does not mean anything else that Lorentz's theory is not reconcilable with the principle of relativity of classical mechanics of relativity of classical mechanics.

But what was needed for the theory to predict negative result for all research aimed at discovering the influence of translation on observable phenomena, was just this: to obtain that the equations of the theory could be transformed with impunity by means of the formulas of translation, and it was evidently impossible to arrive at this or by either of the following means: either change the equations of the theory or change those expressing the translation.

In this alternative, Lorentz preferred to keep the theory of electrons unaltered and to suitably change the fundamental mechanical concepts so that the formulas, which in new mechanics express translation, could meet to the condition imposed on them: that of not altering the Lorentz equations.

The theory of relativity, expounded by Einstein, coincides essentially with this second form of Lorentz theory, on which it has the advantage of a more direct exposition that it puts in clear light the profound influence, which for necessity of things, the principle of relativity had hello development of the theory.

It is known that Einstein's theory starts from two postulates essential:

1.º The principle of relativity proper.

2.º The principle of the constancy of the speed of light in the void.

These postulates, coupled, lead to the conclusion that if the propagation of the waves in the vacuum is expressed by equation:

$$x^2 + y^2 + z^2 = c^2t^2$$

with respect to a system of axes at rest (c speed of light in vacuum), with respect to a system moving with velocity v, any constant, will be expressed by

$$x'^2 + y'^2 + z'^2 = c^2t'^2.$$

Now the transformation formulas, directly obtainable, which allow us to pass from one to the other of these equations I am:

$$x' = \beta(x - vt) \quad y' = y \quad z' = z \quad t' = \beta\left(t - \frac{vx}{c^2}\right) \tag{5}$$

in which it is placed:

$$\beta = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} .$$

They coincide, except for a common factor, with those of the Lorentz transformation, and therefore lead to the results same: the contraction of the length and of the second time the translation, the variation of the mass, etc.

There is only one difference between the two theories, which is of the highest philosophical interest: While the theory of Lorentz keep the notion of the *Fixed Aether* and therefore consider the motion of a system with respect to Aether -- which acquires value of absolute motion -- Einstein rejects the notion of the Aether and it only takes into account the relative motions of a system to another. From this it follows that the changes over time, in the lengths, in masses, etc., which have the character of reality in Lorentz theory (being the quantities of a system in motion always comparable with the values they assume in an system at rest with respect to the Aether), become purely illusory -- almost psychological, as Lewis puts it and Tolman -- in Einstein's conception; as employees only by the relative position and motion of the observer, and not referable to a system at rest.

The serious consequences that in the field of mechanics and in those of neighboring sciences they brought these new theories they impose the greatest scruples and the greatest demands in the search for the theoretical and experimental foundations of the principles upon which they were raised.

The numerous experiences [1]) undertaken with the aim of revealing an influence of terrestrial translation on various phenomena can actually constitute, with their unanimously negative outcome, a factual basis more than sufficient to allow acceptance with confidence *the principle of relativity properly said*.

[1]) See J. Laub. “Jahrb. d. *Radioakt. u. Elekt*.”. Vol. 7. pg. 405, 1910.

Such foundations cannot be invoked in favour of the 2nd postulate. On the speed of propagation of light in a system in motion with constant velocity, one can only say which must be the same in all directions if the source it is part of the system itself.

This is to satisfy the principle of relativity. But and of great importance to immediately point out that to satisfy to this principle it suffices to admit that such constancy *only exists for an observer belonging to system in motion*; while Einstein's postulate states that *constancy* of the speed of light in a vacuum *also holds for an observer that is not part of the system*, i.e., for an observer in motion with respect to the system; and that the more the value unique of such velocity from these measured in every direction is the same measured by an observer at rest compared to the system.

This second postulate expresses, and raises to a general law, an old concept of the theory of the elastic Aether (by Fresnel); what he considers at the speed of light to be dependent *only* on ownership of the medium, and therefore not subject influenced by the motion of the source.

Now, as it is easy to see, this concept can agree with the principle of relativity only if it is admitted the total dragging of Aether by part of the bodies in motion (the Stokes-Hertz hypothesis). In the other hypotheses (dragging partial, or fixed Aether) the conflict is inevitable, for then the propagation of light must necessarily appear anisotropic to a moving observer (uniform or no) with respect to the medium, even when the source has the same speed of the observer.

From here basically came the contradiction between the principle of relativity of mechanics and the (primitive) theory of Loventz, based on the hypothesis of the fixed Aether. their reconciliation, wanted in the new theory, it was not possible that a price of an audacious hypothesis: the one he attributes to time and to space the anisotropy, which the hypothesis of the non-dragged Aether, necessarily provides for the speed of propagation of light in a system animated by movement. From the in fact, they are the only ones who have matured those changes in concepts of time and space that have had such a large echo in mechanics, physics and allied sciences.

And it is very strange, as Stewart[1]) observes, that the the theory of relativity that begins by denying the Aether comes built on the very essential basis of a concept that is also essential of the theory of Aether; and in my opinion, and also worthy of much consideration the fact, that, after all, it should own arrive at that old hypothesis of total dragging, which alone at first appeared to conform to the principle of relativity; with this one variant, that drag would take place in accordance with the rule of composition of the speed suggested by the new mechanics [2]).

If we wanted to abandon this concept of the independence of the speed of the light from the motion of the source, i.e., abandoning the 2nd postulate of Einstein [3]), one could extend the principle of relativity to optical phenomena and electromagnetism without harming the classy mechanics.

And what some try to do, assuming that the light emitted by a moving source propagates with a constant speed in all directions only with respect to an observer animated by the same speed as the source – accordingly to the 1st principle – but that this isotropy of propagation more does not hold for an observer in motion with respect to the source; and that indeed the speed of light, with respect to these, is equal to the speed that is obtained, composing the one observed in the said direction by an observer at rest, with respect to the people, with the speed that this

[1]) The *Phys. Rev*. XXXII, p. 418. 1911.

[2]) Laue. *Ann. d. Phys*. Vol. 23, p. 989. 1907.

[3]) Einstein and Abraham, on the occasion of some research on propagation of light in the gravitational field have made the hypothesis that in this field this speed is a function of the value of the potential. In this new research, the speed of light thus loses its value of universal constant that the 2nd postulate attributed to it. See *Ann. d. Phys*. Vol. 35, p. 898, 1911 and *Rend. Acc. Lincei*, Vol. XX, p. 678, 1911, (2nd semester).

has with respect to the other observer[1]).

The merit of great simplicity and an adaptation complete with classic mechanics should certainly be kept accountable if a choice were to be made a priori and provisional between the two hypotheses. But just the test of facts can have value in a definitive judgment. Such a test, already attempted, cannot be said to have been achieved yet.

Comstock[2]), and, independently of these, Prof. Castelnuovo[3]), have drawn attention to the possibility of subject the two hypotheses to experimental control, using to the observations of those double stars, which describe orbits lying in planes that roughly pass through the Earth. So, if one of the stars revolves around the other with a speed actual v, it can be assumed that it from the Earth will appear animated by the periodic velocity $v \sin 2\pi \frac{t}{T}$ direct second the visual, assuming that one takes the origin of time the instant in which the star passes through the line joining the center of the orbit with that of the Earth.

Now the instants of three or more consecutive passages through the two positions A and B in which this speed acquires the extreme values $+v$ and $-v$ (which can be considered equally spaced) may appear to a terrestrial observer to be equidistant only if the speed at which light travels in space and independent of the speed of the star that rotates, that is, in Einstein's hypothesis, while in the mechanical hypothesis such intervals as it is evident must appear different.

The results that have so far been obtained by Comstock they appear not to conform to the second hypothesis; but, as it is A himself warns that any conclusion is premature, since the observations -- simple point -- have just begun. On the

[1]) This hypothesis agrees with several concrete images about the nature of the light: p. eg, that of the entrained Aether, that developed ballistics from Ritz, the one proposed by J. J. Thomson of which is made further on a nod.

[2]) *Phys. Rev*. XXX, p. 267, 1910.

[3]) *Science*. IX, p. 64. 1911.

other part of the lack of any detail on the means and the method employed in difficult spectroscopic research, not it allows to form appreciations on the value of the observations.

Tolman [1]) believed he could draw proof to the contrary to the mechanical hypothesis by taking the following path:

He begins by showing that in this hypothesis the length of the wave is independent of the speed of the source, and he concludes that even independent of this speed it must remain the position of a line in the normal spectrum of stars or of the two edges of the solar disk, contrary to how well it is known, from the studies on the Döppler effect in the normal spectra of such bodies.

Such a conclusion, according to an objection that Tolman himself arises, but it would not be decisive. The existence of the effect Döppler in the normal spectra of celestial bodies one could in fact explain by assuming that the light reflected from the lattice, it propagates, not with the speed $c+v$ with which it comes from the source, but with speed c; what is equivalent to consider the reflecting surface as a new source (at rest compared to the terrestrial observer).

This accessory hypothesis was submitted by the same Tolman to experimental control as follows:

A beam of light, coming from one of the edges of the Sun, passed through a narrow fissure, and came to fall in part, with almost grazing inefficiency, above a mirror. The the reflected phase was superimposed on the remaining portion of the primitive beam, and generated a system of interference fringes. If the waves coming directly from the solar edge had the speed $c + v$ (depending on the edge chosen) and those reflected by the mirror the speed c, the system of fringes should have moved, when, in the incoming light from one edge, the one coming had been replaced on the other. However, the experiments carried out in the described way they gave negative results.

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[1]) *Phys. Rev.* XXXI p. 26, 1911

This result, put in relationship with the existence of the Döppler effect in the normal spectra of the light of the stars, would, according to Tolman, provide sufficient evidence against the hypothesis of the composition.

But Stewart [1]) pointed out that it is not correct to consider the reticle as the exclusive measurer of lengths wave, or rather relying on a concrete image of a theory of light founded by J. J. Thomson [2]) on the hypothesis mechanics, shows that the Döppler effect in a spectrum normal should depend on the relative speed of the source and of the lattice; in perfect agreement with the principle of relativity.

About Tolman's interferential experience, Stewart pointed out, that it proves only that the hypothesis made by these, on the speed that the waves acquire after the reflection, was not exact; and more showed that on at this point we can, with better reason, admit that speed of the reflected waves depends on the speed of the image, as that of directed waves depends on the velocity, of the source.

For my part, I can observe that, also wanting to abstract from Stewart's critiques, one might conclude -- as he does the Tolman -- which according to the mechanical hypothesis, the lattice does not can reveal Döppler effect, only if it could be supposed -- as is necessary in ordinary theory -- that the waves that move away from the grid have *in all senses* the same speed. But if we indicate with c the velocity of the waves in a system at rest and with v the velocity of the source which we assume directed from this direction and normally a lattice, the mechanical hypothesis leads, however, to the conclusion that

[1]) L.C.

[2]) According to this image, light waves must be considered, as perturbations that propagate with *constant velocity*, inside I Faraday tubes, of small aperture, (which is attributed to physical reality) which start from each electron; they (waves) thus take a velocity equal to the sum of this characteristic velocity and that of the electron on which the tubes terminate, whenever the electron moves with uniform motion. *Philos. Mag*. XIX, p. 301. 1910.

in a direction that makes the angle *α*, with the direction of *v*, the receding waves have the velocity $c + v \cos \alpha$; and which, therefore, is the position of each line in the normal spectrum is related to the wavelength by *a different law from that given in ordinary lattice theory, which remains valid only if this has the same speed of the source*.

The change of position of the spectral lines of the light of the stars, compared to the terrestrial lights does not seem therefore necessarily contradictory to the mechanical hypothesis.

It would remain to take into account the experiences that are been made to determine the law according to which the mass length of a moving electron depends on the velocity by which you find yourself animated. As is known the various theories on dynamics of electrons lead to different laws, and the particular one of Lorentz-Einstein electrodynamics seems confirmed from Bucherer's experiences.

But the results predicted by the various theories are so few different, and the experiences so delicate, that it was not possible to the valiant physicists who took care of the difficult research, arrive at mutually agreeing conclusions; proof that one hoped to reach by this route -- as the relativists themselves recognize -- it must therefore be considered as also failed [1]).

An easy way, which in my opinion will lead to an experimental judgment on the 2nd postulate of relativity, we can be offered by the Fizeau effect, around which, this postulate and the mechanical hypothesis, leave waiting for different results. Let's examine these results:

The theory of relativity predicts that in an experience analogous to that of Fizeau, -- in which the waves come to propagate in a medium moving with respect to the source -- while an observer at rest with respect to the source sees the waves propagate with a speed different from the one that an observer would have in the

[1]) See Laue. "Das Relativiprinzip." Vieg. Braunschweig 1911 (Wissenseh. Samm.) p. 15 and seq.

middle itself at rest dragged by the medium, it instead sees this propagation take place with the same speed that is valid for the medium at rest compared to the source. In other words, according to the theory of relativity a terrestrial observer sees propagate with the same speed in all directions, both in vacuum and in any material medium, not just the incoming light from terrestrial sources (or rather at rest with respect to location occupied by him) but also that coming from any star.

Ultimately - as has already been mentioned – this theory only arrives at the hypothesis of total dragging in accordance with the speed composition rule given by the new mechanics. The speed of propagation, view from the observer at rest with respect to the source, we obtain, therefore, composing the speed of propagation of the waves in the medium at rest with the speed of the medium with respect to the observer; the result, thanks to the new rule of composition, coincides (end of the 1st order of the ratio $\frac{v}{c}$) with that of Fresnel-Fizeau.

The speed seen by an observer dragged by the vehicle it must then coincide, with the speed of the waves in the middle in stillness; since for such an observer the component is one adds to this speed and nothing.

The same conclusion is also reached with the following reasoning: If, instead of assuming the source at rest, this is supposed to be in motion, with an equal and opposite velocity to that of terrestrial translation, and the Earth at rest, the terrestrial observer will be able to observe nothing but the simple period change due to Döppler effect; with any interferential arrangement, he, measuring speed of propagation times of the waves coming from the source in mote, it will only be able to obtain the same values as obtains for the waves of a terrestrial source. But, since in the theory of relativity, the change of assumption that we have done must not affect the phenomena seen from each observer, it can be deduced that in the projected experience, the terrestrial observer must see the travel waves coming from a star, in any medium, with the same speed with which he sees those that come travelling from a terrestrial source.

The mechanical theory, on the other hand, leads to different consequences.

The simplest mechanical interpretation of experiences of Fizeau, allows us to conclude that if the observer in rest with respect to the source sees the waves traveling in between in motion, with speed

$$c_1 \pm \frac{n^2 - 1}{n^2} v$$

the observer at rest with respect to this must see them travel with the speed:

$$c_1 \pm \frac{v}{n^2} \ .$$

An accurate comparison of the speeds with which in an body whatever, waves from a source propagate terrestrial and those coming from a star should lead to the desired final judgment.

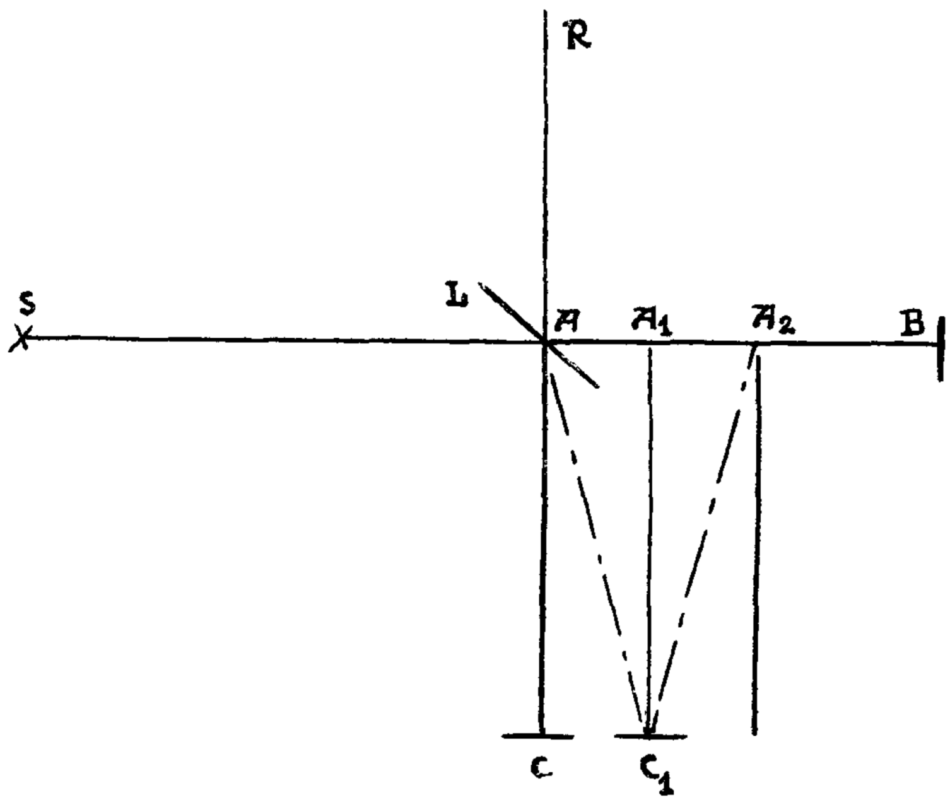
Instead of direct measurements of the speed of light—that are always difficult and not susceptible of great exactitude -- you can resort to interference searches, but in this case being the observations reduced to the comparison between propagation times, should keep in mind that the observable effects depend on the square of the ratio of the speed of translation v and that of propagation in vacuum: for the effects of the first order, the considerations remain, in fact, applicable which make it possible to foresee the remuneration (unless make special hypotheses intervene on the purchased speed by the waves reflected on a moving mirror).

Michelson's arrangement, better than any other can then serve the purpose.

Suppose in the more general case that on arm A B of the Michelson apparatus, of length d_1 find the middle d' index n_1 (at rest); on the other, of length d_2 the middle of index n_2. If there is the speed of light in a vacuum the speeds in the two means, when everything is at relative rest, they are:

$$c_1 = \frac{c}{n_1} \qquad c_2 = \frac{c}{n_2} \ .$$

If v is the speed of the terrestrial translation, and if yes assumes that the first arm is oriented in the same direction of v, an observer 0 not trailed by the Earth



will see the waves propagate along this arm with the speed, $c_1 + \frac{n_1^2-1}{n_1^2} v$, while a terrestrial observer, 0_1, will see them, propagate with speed $c_1 - \frac{v}{n_1^2}$ The propagation time seen from the first will be given by:

$$t_1 = \frac{d_1 + vt_1}{c_1 + \frac{n_1^2 - 1}{n_1^2} v} = \frac{d_1}{c_1 - \frac{v}{n_1^2}}$$

and therefore coincides with the analogous time seen by the entrained observer. Carrying out the division up to the terms of the second degree in the ratio $\frac{v}{c_1}$, and neglecting the remaining ones (due to the smallness of this report) is found:

$$t_1 = \frac{d_1}{c_1}\left(1 + \frac{v}{c_1 n_1^2} + \frac{v^2}{c_1^2 n_1^4}\right).$$

From mirror B, the reflected waves propagate again with the velocity $c_1 - \frac{n_1^2-1}{n_1^2}\, v$, with respect to the observer 0, and with the speed $c_1 + \frac{v}{n_1^2}$ with respect to the observer 0_1. Time taken to return from B to A will therefore be from:

$$t_2 = \frac{d_1}{c_1 + \frac{v}{n_1^2}} = \frac{d_1}{c_1}\left(1 - \frac{v}{n_1^2\, c_1} + \frac{v^2}{n_1^4\, c_1^2}\right).$$

In total the time taken to get there and back and

$$t = t_1 + t_2 = 2\,\frac{d_1}{c_1}\left(1 + \frac{v^2}{c_1^2 n_1^4}\right).$$

Let us now consider the propagation on the normal arm to the translation.

The waves arriving on the plate L at 45°, propagating with speed *c* with respect to 0, they are reflected and penetrate in the middle of index n_2 from which they are dragged in direction normal to that of their propagation, with speed $v\,\frac{n_2^2-1}{n_2^2}$, but the observer 0_1 who runs in the same direction with velocity *v*, you will see the waves lag behind with relative speed $\frac{v}{n_1^2}$.

Because a wave that starts from A can arrive in C and return to A after reflection it is necessary then that it travels the path A C_1 A_2. If we call θ_1 the time that the wave takes to go from A to C_1, one must have:

$$\frac{v}{n_1^2}\theta_1 = AA_1 \qquad c_2\theta_1 = AC_1 \qquad d_2 = A_1C_1$$

and from the figure we get:

$$c_2^2\theta_1^2 = \frac{v^2\theta_1^2}{n_2^4} + d_2^2$$

from which it follows:

$$\theta_1 = \frac{d_1}{c_2\sqrt{1-\frac{v^2}{c_2^2 n_2^4}}}.$$

For propagation along C_1 A_2 it will obviously be necessary a time θ_2 equal to θ_1, so in total, the time employed by the waves that leave and return along the 2nd arm and:

$$\theta = 2\,\frac{d_2}{c_2}\left(1 + \frac{v^2}{2\,c_2^2\,n_2^4}\right)$$

perform root extraction and up division under the terms of the 2nd order in the $\frac{v}{c}$ ratio included.

Assuming that d_1 and d_2 are paths of equal length optics with respect to light from terrestrial sources we have:

$$n_1 d_1 = n_2 d_2 = \delta$$

and therefore $\frac{d_1}{c_1} = \frac{d_2}{c_2} = \frac{\delta}{c}$ is then found as the difference between the times

(6) $$t - \theta = \frac{\delta v^2}{c^3}\,\frac{2\,n_2^2 - n_1^2}{n_1^2\,n_2^2}$$

which is the same as that which results in Lorentz's theory for any two means.

In particular, if the experience were done in a vacuum, yes would have as difference $\frac{\delta v^2}{c^3}$ and as ratio $\frac{t}{\theta} = 1 + \frac{v^2}{2c^2}$ which is that of the Lorentz contraction [1]).

But if Stewart's hypothesis is coupled to the mechanical hypothesis, about reflection in a moving mirror, the consequences which we arrive at are very different from the latter, and from those of the theory of relativity.

For simplicity (and not to introduce other arbitrary assumptions) let's do the calculation for propagation in vacuum.

Let *c* be the propagation speed of the incoming waves from a certain source S seen by an observer at rest compared to it.

Earth observer 0_1 sees the waves traveling along the arm A B of the Michelson apparatus (which with respect to S has the velocity *v* of the direct terrestrial translation for example from A towards B) with the speed *c*-*v*. The time *t* required for the propagation from A to B will be:

$$t_1 = \frac{\delta + vt_1}{c} = \frac{\delta}{c - v}$$

for both the first and the second observer.

As the mirror moves away from the source with the velocity *v*, observer 0 will see the reflected waves recede with velocity *c*-2*v*, while observer 0_1 will see them with the speed *c*- *v*.

The time *t* of the return from B to A will consequently be given by:

$$t_2 = \frac{\delta - vt_2}{c - 2v} = \frac{\delta}{c - v}$$

[1]) In the primitive form of Lorentz theory, the difference *t* - θ is expressed by (6) itself. This proves that the contraction hypothesis, which was issued in 1892 was unacceptable, since, as from (6) it can be easily deduced, the contraction of the arm of Michelson's apparatus, parallel to the terrestrial translation, it should have depended on the index of refraction of the medium placed on the normal arm. This difficulty was surpassed only in the form that the theory took in 1904, thanks to the principle of relativity that was based on it.

that is, it will still be the same, both for the first and for the second observer.

In total the propagation time for the round trip, will be given by:

$$t = 2\frac{\delta}{c}\left(1 + \frac{v}{c} + \frac{v^2}{c^2}\right).$$

We consider the propagation time along the other arm.

The speed of the waves traveling along S A view both from 0 and from 0_1 and c-v. That of the waves reflected in the direction A C, will be, for both observers, also c-v, since for both the image of S on L recedes along A R with the speed v.

Meanwhile, since all the appeased and in motion in the direction A B with the speed v, so that the waves starting from A and go towards C, they can return to A, it is necessary that things are arranged in such a way, that the path actually path both A C_1 A_2, being A A_1 the displacement of A while the waves travel from A to C (which has moved in C_1).

By calling the time of this propagation with θ_1 at the moment you will have:

$$v\theta_1 = AA_1 \quad (c - v)\theta_1 = AC_1$$

and since δ is the length A C = A B, it follows from the figure:

$$(c - v)^2\,\theta_1^2 = v^2\,\theta_1^2 = \delta^2$$

from which

$$\theta_1 = \frac{\delta}{c} \cdot \frac{1}{\sqrt{1-2\frac{v}{c}}}.$$

The waves reflected by C, will have both for one and for the other observer, again the speed c - v, as the new image from the source moves away in the AC, direction, even with the speed v.

The time θ_2 of the return from C to A, and consequently equal to θ_1 so that the total time θ will be given by:

$$\theta \; = 2d \; \frac{1}{\sqrt{1-2\frac{v}{c}}} \, .$$

Extracting the root and performing the division up to the usual order of approximation we get:

$$\theta \; = 2 \; \frac{\delta}{c}\left(1 + \; \frac{v}{c} + \; \frac{3}{2}\frac{v^2}{c^2}\right).$$

if so the difference

$$t - \theta \; = \; - \; \frac{\delta \, v^2}{c^3}$$

it results, that is, equal in value but of opposite sign to that one of the previous case.

From the above it follows that while the 1st postulate of the theory of relativity (the principle of relativity properly said) can now be considered as experimental tried the 2nd one (that is, that of the constancy of the speed of propagation of light in vacuum) cannot so far to boast in its favor any logical evidence, nor any proof experimental.

We then showed that, while according to the theory of relativity, the speed of propagation of waves in a medium in motion with respect to the source, it must appear, to an observer dragged by the medium, independent of the speed of the half, according to the mechanical hypothesis, however, the first must be a fan of the second.

Based on this result, we found that Michelson and Morley's experience, repeated under conditions appropriate, can allow you to decide on the admissibility of the second postulate of Einstein, or of the mechanical hypothesis. We have, in fact, shown, that, while according to the theory of relativity, the propagation times of the waves, along the two arms of the Michelson apparatus must always result equal, whether the waves come from a terrestrial source, from a non-terrestrial one; according to the mechanical hypothesis instead these times are equal, only if the source is participant in the motion of the Earth.

Moreover, we have shown that the difference between such times foreseen by the mechanical hypothesis, results with a different sign, depending on the hypothesis adopted about the speed of the waves reflected on a mirror in motion; is that moreover, this difference must be a function of the indices of refraction of the media found on the two arms of the apparatus by Michelson.

Editor Comment: The author omitted notions of equation numbers for (2) and (3).

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