Reanalysis of the Michelson’s interferometric experiment in relation to the two swimmers problem

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Abstract: Theoretical basis of Michelson’s interferometer experiment is reanalyzed. Initially we reanalyzed the illustrative model, represented by two swimmers race traversing a river which revealed that the correct transversal trajectory is not an isosceles triangle, but a right triangle and the race ends in a tie. Also, in the interferometer device, the transversal double light path, considering the ether presence and classical geometrical optics together with Huygens principle of light, we found to be too a right triangle instead isosceles one considered by Michelson, which thus is an error. But this new path necessitates zero-time difference, for which fringes displacements are not expected, unlike Michelson’s analysis. So, we found that the light’s double travel times don’t depend on the interferometer arms directions and so the expected by Michelson fringes displacements, must not appear. The above findings are applicable to other similar experiments with ray double travel, including light, lasers, masers, γ-rays, etc. We demonstrated that Michelson’s experiment correct interpretation does not confirm the relativity of the light speed. Consequently, Michelson’s experiment should not be considered negative concerning the presence of ether which must remain the bearer of the E-M phenomena. Consequently, the Special Relativity Theory (SRT) must be reconsidered, based on Lorentz electromagnetic theory from 1895 and the quanta entanglement and E-M field can be physically explained by the ether presence.

1. General presentation of physical models of Michelson’s experiment

While empirically sacrosanct, in this paper we study a putative corrected reanalysis of the two swimmers problem, as frequently correlated with the Michelson interferometry experiment model, demonstrating that the transversal path is not an isosceles, but a right triangle, resulting in the possibility that the analysis contains a misinterpretation, such that an ether or ether-like condition may be possible, warranting further study relative to physics beyond the Standard Model, known to be incomplete.

Many works discuss Michelson’s interferometric experiment (ME) in terms of a mechanical or physical model (PM). A physical model (PM) serves as an analogue to the Michelson’s experiment (ME), which is presented as a (hypothetical) race between two swimmers, Sw1 and Sw2 (alternatively, two boats, two airplanes, two sound signals, etc.).

Both swimmers swim with the same constant speed, c and same distance, l. The swimmers make the distance l, and return to the starting point. The race takes place on a river that flows with speed v. However, the swimmers swim at different directions on the river. The first swimmer Sw1, takes the path or the route
$l_i = l'_i + l''_i$, where the distance $l'_i$ is oriented right (opposite) of the river flow direction, $v$. The second swimmer, Sw2, will take the path $l_2 = l'_2 + l''_2$; the initial distance $l'_2 = l_i$, and is perpendicular to the river flow direction $v$ (Figure 1) and thus also perpendicular to direction $l'_i$.

This orthogonality condition of the two initial paths, $l'_i$ and $l'_i$ (Fig. 2) is mandatory, in order for the two experiments, ME and PM, to be similar. In the ME setup, the two initial light beams, 1’ and 2’, start at orthogonal directions. The beams head toward a semi-transparent splitter P, from which beams 1’ and 2’ egress. Plate P is 45˚ sloped against the incident rays. Direct beam, 2’ permeates the splitter while beam 1’ is reflected by the splitter. The beams then form between them a 90˚ angle, according to the reflection laws of the geometrical optics.

However, it must also be mentioned that none of the physical (in fact mechanical) models (PMs) from the physics literature clearly and precisely establish the reference frame (RF) for the displacements and movements. The chosen RF also essentially depends the accuracy of the analysis itself. This entanglement occurs because at least two local reference frames RF may be considered: the block-start or bank attached frame (BF) (the equivalent of ME interferometric device) or the water-attached frame (WF) (the equivalent of ME ether).

And for the accurate analysis of any model PM, one should specify from the beginning what is the adopted reference frame, RF. In our analysis, we will observe this rule in each and every figure or description.

However, here it must also be mentioned that in any and in all descriptions of the above PMs encountered in the physics literature, one “demonstrates” that the time of swimming the transverse route is shorter than the longitudinal one, and hence Sw2 wins the race. This conclusion has become a myth for many young generations of high school or college graduates.

In the next sections, we will demonstrate that if the race would run “fair-play”, both swimmers Sw1 and Sw2 would reach the start point at the exact same time. This myth would require a correction in this regard, i.e., “the race ends in a tie”.

2. Description of some physical models PMs from literature

We will hereinafter describe details and observations regarding various presentations of the speciality literature for the physical model PM with the two swimmers’ race, which is considered by their authors similar to the Michelson’s interferometric experiment ME.

We have selected from the usual physics literature of average level, few such examples, from the Internet and from works addressed to young people. Young people could be deeply influenced by such examples (as were these authors) that if proven wrong, may have a negative impact with more profound consequences on future physicists.

i). Thus in [1] Jurgen Freund states (referring to a boat, comparable with the swimmer): “When the boat is sailing at right angles to the banks it has to turn its bow slightly upstream and thus reaches the velocity $\sqrt{(c^2 - v^2)}$ relative to the banks”.

But we observe that the mention turn its bow slightly upstream indicates a clear lack of orthogonality in start direction of second boat.

ii). In [2] David Harrison says (referring to a raft and two markers, comparable with two banks): “Now the raft and markers are being towed to the left. In this case, the race will no longer be a tie. In fact is not too hard to show that swimmer 2 wins this race”.

In an Annex the same transversal velocity $\sqrt{(c^2 - v^2)}$ is as in i). above, which indicate a clear lack of orthogonality in the starting direction of second swimmer Sw2, including in an animated presentation of the
race.

iii). Austin Gleeson [3] says: “A stream of width $D$, is flowing with the speed $v_0$ from left to right. A swimmer whose speed is in still water $v$ wants to swim across and back reaching the other bank at a point opposite the starting point. The resultant velocity which is directed across the creek is thus $\sqrt{v^2 - v_0^2}$”.

No mention is made about the orthogonality of $d_1$ and $d_2$ paths, for which this condition is clearly absent.

iv). However, Michael Fowler [4] says: “The swimmer going across the flow is trickier. It won’t do simply to aim directly for the opposite bank, the flow will carry the swimmer downstream (Fig. 1). To succeed in going directly across, the swimmer must actually aim upstream at the correct angle”.

Here we observe a clear mention about the lack of orthogonality of paths $d_1$ and $d_2$ from the text mentioning at the correct angle but Fowler associates the lack of orthogonality with a trick, a situation which is inadmissible in physics.

v). Although in [5] Bernard Jaffe does not specify the conditions in which “boater 2 crosses the water flow” but he chooses for the boater a path after the hypotenuse of the right triangle of the speeds $v$ and $c$.

![Figure 1](image_url)

**Figure 1.** The model PM with the swimmer Sw2 as trickier. (Figure 1 and text extracted from [4]). No mention there about RF frame and about xoy axes attachment.

In Figure 1, in time $t$, the swimmer has moved $ct$ relative to the water, and has been carried downstream a distance $vt$. The swimmer going across the flow is trickier. It won’t do simply to aim directly for the opposite bank - the flow will carry the swimmer downstream. To succeed in going directly across, the swimmer must actually aim upstream at the correct angle (of course, a real swimmer would do this automatically). Thus, the swimmer is going at 5 ft./s, at an angle, relative to the river, and being carried downstream at a rate of 3 ft./s. If the angle is correctly chosen so that the net movement is directly across, in one second, the swimmer must have moved 4 feet across. The distance covered in one second will form a 3, 4, 5 triangle, for at a crossing rate of 4 ft./s, the swimmer gets across in 25 seconds and back in the same time, for a total of 50 seconds. The cross-swimmer wins. (For the swimmer going parallel to the river flow the result is 62.5 seconds).

The figure attached to the text shows that boater 2 runs the 27.5 m of the river width after the hypotenuse. So, his mention “perpendicularly to the water flow…” is clear untrue due to hypotenuse path, and without specifying the reference frame considered there by the author.

vi). However, in [6] George Gamow directly specifies: “In this case, the delay is due (on the transversal route of the river run by a motorboat) to the fact that the boat, in order to go from boat bridge 1 to boat...
bridge 3, it must advance slightly sidewise to compensate the current drift”.

Thus, Gamow admits the path 2’ shows a sidewise advance and this is an acknowledgement that path 2’ is not orthogonal to path 1’.

vii). In [7] D. Ciubotaru e. a. says: “The boat’s movement speed (from which sound signals with sound speed $v_s$ are emitted) may also be determined by having a reflecting area $R_2$, in such a way that the arm $SR_2 = l_2$ is perpendicular to the boat’s movement direction. From Fig. 4, one may determine the time $\tau_2$ in which the sound covers the distance $SR_2 + R_2S \ldots \tau_2 = 2l_2/\sqrt(v_s^2 – v^2)$”.

But in Fig. 4 from [7], the path of the sound is again an isosceles triangle, which indicates a clear lack of orthogonality in the starting direction of the second sound signal (Sw2).

viii). Finally here, according to Thomas D. Le [8]: “To compensate, Boat 2 has to head into the current (upstream from the work) at a certain angle so that the combined effect of $c$ and $v$ would allow it to reach Pier B”. And in Figure from page 23 of [8], the path of the boat is the hypotenuse of the right triangle, which indicates a clear lack of orthogonality in the starting direction of Boat 2 (Sw2).

And such analyses of PM model in which the lack of orthogonality in the starting direction of second swimmer Sw2 may comprises all published works on the above subject about PM models, known by us.

3. Findings and observations on previous PMs

As we further advance, we will show important details and observations regarding some of the physical models PMs previously described in Sec. 2.

We note here that in every previous description of the PM analogues for the ME, the respective authors’ works of description and analysis of the two routes, $l_1$ and $l_2$, contain an error in which the complete similarity between ME and PM is disregarded.

The disregarded similarity refers how the direction of initial path $l_2$ was selected within the PM. We observe that $l_2$ of swimmer Sw2 is allowed to deviate from the orthogonal direction to the water speed direction $v$, because Sw2 starts at a small angle $\beta$ against the exact orthogonal direction. Such a path deviation constitutes a trick and a non-fair play towards Sw1.

Note that $\beta$ is not explicitly stated before swimmer Sw2 starts racing. It is only indirectly mentioned (a trick) because it is said that Sw2 should aim at a point C from the opposite bank, but situated outside the orthogonal direction.

But this inclined aiming of initial path $l_2$ is impossible within the conditions of the interferometric experiment (ME), in which the opposite M2 mirror does not include reference marks for inclined orientation of the light beam, which does not have the sentence in order to consent to a trick and thereby it starts the path $l_2$’ exactly at 90˚.

And in the PM experiment model, no personnel, and no orientation sign for Sw2 is found on the opposite bank that can indicate him the inclination angle $\beta$.

Thus, the PM serving as an analogue of ME may only succeed in practice, as Michelson and authors (mentioned in Sec. 2) proposed, only if somehow Sw2 can benefit from the indication of the inclination angle $\beta$, exactly at the start-up moment. Nevertheless, this would be the case of a trick towards Sw1.

If the PM would be deployed in the conditions of an official race or even of an Olympic contest, the organizers would not allow such deviation from the orthogonality rule of paths $l_1$ and $l_2$ offering to inform Sw2 the angle $\beta$ before starting.

This means that swimmer Sw2 assigned on path $l_2$ should also start orthogonally on block-start, thus perpendicular to path $l_1$, including perpendicular to the water speed direction $v$. This situation obviously is possible, only without indicating to Sw2 an inclined/shifted mark from the opposite bank and without informing him the angle $\beta$. Additionally, the angle $\beta$ also depends on the river flow speed, $v$, which should not be known by any of the contestants.

We notice that Michael Fowler roughly characterizes the swimmer Sw2 as a trickster, and we must agree that M. Fowler is perfectly right. This is because swimmer Sw2 benefits from this information, which is not
allowed in a fair play contest. This means that Sw2 benefits to win from indirect knowledge of the river speed \( v \), and with permission to start at a non-orthogonal direction to \( v \), which is non-orthogonal to the swim direction of contestant Sw1.

The basic rule in such a contest as understood by laymen is that both swimmers must start from the block-start on orthogonal directions between them, just as light beams start from the semi-transparent splitter in ME. Therefore, the correct path in the PM analogue of the ME must take this rule of path-orthogonality into account. In this case, in the WF frame the correct complete crosswise path of Sw2 is a right triangle instead of isosceles triangle as demonstrated in Sec. 5.

Here we define such deviation of \( I_2 \) for Sw2 from orthogonal directions an essential error in the involved analyses.

Fowler’s characterization of swimmer Sw2 as a trickster is perfectly applicable to all the other Sw2 contestants/swimmers in the aforementioned examples and in other works describing PM analogues for ME (including the boaters, airplane pilots, etc.).

We must emphasize that the above-indicated error in the PM, was also taken over, by Michelson in the analysis of his ME experiment as we already presented [9, 10, 11]. But in next three Sections of this Paper, we will limit ourselves to the correct analysis of the swimmers physical model PM only.

4. Correct reanalysis of the two swimmers’ race in the physical model PM

This reanalysis of two swimmers race shall refer to the PM analogue on the ME, model that shall consist, for simplification, of the race between the two swimmers, Sw1 and Sw2.

The following analysis is based on the important observation in Sec. 3., where the start-up mode of Sw2 must observe the rule of fair play. This means that Sw2 should not benefit before start-up of the prior knowledge of angle \( \beta \) or river speed \( v \), nor should he apply \( \beta \) to his start direction \( I_2 \).

Sw2 should start according to the inferred and unanimously accepted rule by the audience in such contests. The two swimmers should start from their block-starts at two orthogonal directions between them.

However, an aspect that should also be specified here is very important to any cinematic analysis: the reference frame (RF) of the space, to which the movements of the relevant bodies or objects are referred to, must be clearly indicated. This means that the object or the body that the RF is attached to should be clearly indicated. In case of the PM of the two swimmers, the most useful reference frames shall be the water-attached frame (moving with the speed \( v \) against the bank) WF, and the block-start or river bank attached frame, BF.

One may notice that all of the previous analyses (considering PMs or ME), do not approach this aspect and thus do not specify clearly the RF adopted, nor include the axes of reference frame WF or BF in the figures of the relevant texts, by the respective authors. For this reason, when both reference frames WF and BF are involved in a model situation, misunderstandings and errors in the analysis of the phenomena may ensue, as the error of the start direction of Sw2 has systematically slipped in.

In this analysis, we will indicate which RF is adopted and even clearly mark it in the attached figures for each every analysis. They will be indicated by the related \( Ox \) and \( Oy \) coordinates.

We would also like to mention here that for the reference frame of time \( t \), RFT, the unique frame with one uniform flow speed of the unique time \( t \), according to classical physics, shall be adopted in all our analyses. The reference moment as \( t = 0 \), could be taken at either moment of the time \( t \) of the experiment, provided to have fulfilled the above condition of uniform time \( t \) flow.

5. Correct reanalysis of the physical model PM of the two swimmers race in the WF frame

5.1. Presentation of the physical model PM of the two swimmers contest

The correct paths or routes in the PM for two boats B1 and B2 was described by us previously in [9, 10, 11] and is presented again in Sec.8. The paths taken by the two boats now apply to the two swimmers Sw1 and
Sw2 contest, and are shown in Fig. 2 and in Fig. 3 and then in Fig. 4. These schematics represent the physical model of the two swimmers race, which shall be analysed.

In Fig. 2 and in Fig. 3, the adopted reference frame is $x_1O_1y_1$, being attached to water, designated as water frame WF, with the axis $O_1x_1$ aimed reversely to water speed $v$. Here, point $O_1$ was taken as the point coinciding with the block-start (BS) right corner, and initial time $t = 0$ is the moment when the race starts.

In this PM, the water flows with speed $v$ towards the left side of observer $O_1$ in Fig. 2. But in the WF selected here (in Fig. 2 and in Fig. 3), the block-start BS and the two river banks RB1 and RB2 will shift to the right side of the drawing with relative speed $v$ while the water remains still.

Figure 2. The PM model with two swimmers Sw1 and Sw2 in WF frame with $x_1O_1y_1$ axes attached to water. The case of Sw2 in crosswise path $2'^{+}2''$ as right triangle.

5.2. Analysis of model PM in case of crosswise direction

In $x_1O_1y_1$ frame at the time $t = 0$, the swimmer Sw2 will leave from point $O_1$ in the direction $y_1$, which is perpendicular to the BS (and to the RB1), and it shall run his initial path $2'$ between the point $O_1$ and the point $A_2$ located oppositely on the opposed bank RB2 located at the orthogonal distance $d_1$ (Fig. 2).

The time needed to cover path $2' = O_1A_2$ shall be $t_2'$, corresponding to running the path $2'$ by the swimmer Sw2 with his own speed $c$ against still water. Note that point $A_2$ does not coincide with point $A_{20}$ that corresponded to time $t = 0$ with the point on the RB2. This point $A_{20}$ is directly opposite to $O_1$ at that time $t = 0$, because the opposite bank shifted to right with the speed $v$ in this timeframe $t_2'$ on a distance $d_1$ (Fig. 2).

At the same time, when Sw2 reaches point $A_2$, he can observe that the BS shifted with distance $d_l$ to the point $O_2$ (the point which is orthogonally opposite to point $A_{20}$) (Fig. 2), and that BS continues to shift in the same direction $x_1$ with speed $v$. Therefore, in order for Sw2 to reach the exact meeting with BS at the return to point $O''$, Sw2 will have to also swim with speed $c$ to the estimated point of meeting $O''$ located at distance $d_2 = d_1$ but still slightly longer than $d_l$ since time $t_2'$ is for return path $2''$ that will be sloped; $2''$ is thus longer than $2'$ path (orthogonally on $l'$ path in the WF, see Fig. 2).

Note that this correct and fair-play route $2'-2''$ of swimmer Sw2 in the WF has the shape of a right triangle $O_1A_2O''$ in Fig. 2 and not of an isosceles triangle as considered by authors from Sec. 2 and by
Michelson.

Now we will determine firstly these two times, \( t'_2 \) and \( t'_3 \). As a reminder, first calculus concerning the two times, \( t'_2 \) and \( t'_3 \), was performed by us in [9, 10, 11]. In those works, \( t'_2 \) and \( t'_3 \) are the times spent by the light beams traveling their two transversal paths in the ME, as right triangle proposed there by us.

In order to better understand the final result of our calculus, i.e., \( t_2 = t_1 \), we will resume here the calculus elaborated in [9, 10, 11] for time \( t_2 = t'_2 + t'_3 \) performed in the transversal path, but applied here to PM of the two swimmers Sw2 and Sw1 in the corresponding PM from Fig. 2 and Fig. 3, in WF frame.

We will improve here, some of our previous calculi, importing the two dedicated paragraphs and equations from [11], into the model PM from Fig. 2 and Fig. 3.

Also the size of small fonts of indices from some formulae from [11], was improved here, compared with [11].

We first determine the two times, \( t'_2 \) and \( t'_3 \) with the geometrical elements of PM in Fig. 2, from which it results:

\[
t'_2 = \frac{l_2}{c} - \frac{O_A}{c}, \quad t'_3 = \frac{A'}{O'} \quad (1)
\]

\[
t_2 = t'_2 + t'_3 = \frac{O}{O'} = vt_2 \quad (2)
\]

From the right triangle \( O_AA'O' \) of Fig. 2 it results:

\[
(O_A)^2 + (O'O')^2 = (A'O')^2 \quad (3)
\]

Introducing (1) and (2) in (3) we obtain:

\[
(t'_2)c^2 + (vt_2) = (t'_3)c^2 \quad (4)
\]

Replacing \( t_2 \) from (2) into (4) we obtain:

\[
(t'_2)c^2 + (v(t'_2 + t'_3)) = (t'_3)c^2 \quad (5)
\]

After making the calculations between the brackets and regrouping the terms we obtain:

\[
(t'_2)^2(c^2 - v^2) - 2v(t'_2t'_3 - (t'_3)^2(c^2 + v^2) = 0 \quad (6)
\]

By solving the second-degree equation of (6) we obtain the result:

\[
t'_3 = \frac{2v^2t'_2 + \sqrt{4v^4(t'_2)^2 + 4(c^2 + v^2)(c^2 - v^2)(t'_3)^2}}{2(c^2 - v^2)} = \frac{v^2t'_2 + t'_3\sqrt{v^4 + (c^2 + v^2)(c^2 - v^2)}}{c^2 - v^2} \quad (7)
\]

Due to the solution \( t_2 = 0 \) obtained for sign (–) in front of the root sign from (7) would be pointless, we have chosen the sign (+) in front of the root sign from eq. (7).

By introducing (1) and (7) in (2) we obtain:

\[
t_2 = \frac{l_2}{c} + \frac{v^2l_2}{c} + \frac{l_2\sqrt{v^4 + c^4 - v^4}}{c^2 - v^2} = \frac{l_2}{c} + \frac{v^2l_2}{c^2 - v^2} + \frac{l_2\alpha^2}{c^2 - v^2} \quad (8)
\]

And from (8) we finally obtain for the time \( t_2 \) of the crosswise route 2'-2" expression:

\[
t_2 = \frac{2l_2c^2}{c(c^2 - v^2)} = \frac{2l_2}{c} \frac{1}{1 - \frac{v^2}{c^2}} = \frac{l_2}{c} \frac{1}{\alpha^2} \quad with \quad \alpha = \sqrt{1 - \frac{v^2}{c^2}} \quad (9)
\]

5.3. Analysis of model PM in case of longitudinal direction
For the longitudinal direction, the path run by Sw1 is shown in Fig. 3. It must also be specified that in Fig. 3, the selected reference frame $x_1O_1y_1$ represents the water frame WF, which is attached to water, and the axis $O_1x_1$ is aimed opposite to water speed $v$. Here we have taken the point $O_1$ of the initial moment $t_0 = 0$ of the race start, coinciding with the same right corner of the block-start BS.

In Fig. 3 at time $t = 0$, swimmer Sw1 will leave from point $O_1$ in the direction reversed to $x_1$ and parallel to block-start BS (and to RB1). His swim time is $t_1$, and his initial path $1'$ is situated between point $O_1$ and the point $A_1$, which is located in the already shifted position of the return wall RW (Fig. 3). We note RW was initially (at $t = 0$) situated on point $A_{10}$ of the same bank RB1 at a distance $l_1$.

The movement distance $b_1$ of RW in time $t_1$ and the movement distance $d_1$ of Sw1 in the same timeframe $t_1$ shall be (Fig. 3):

$$b_1 = vt_1'; \quad d_1 = l_1 - b_1 = l_1 - vt_1'$$  \hspace{1cm} (10)

The time covered by Sw1 when going out and the covered distance shall be from (10):

$$t_1' = \frac{d_1}{c}; \quad d_1 = l_1 - \frac{v d_1}{c};$$  \hspace{1cm} (11)

From (11), after grouping the terms, it results for $d_1$:

$$d_1 \left(1 + \frac{v}{c}\right) - l_1 = 0; \quad \rightarrow d_1 = \frac{l_1}{1 + \frac{v}{c}}$$  \hspace{1cm} (12)

And the time $t_1'$ corresponding to the path $d_1$ run with speed $c$ shall be:

$$t_1' = \frac{d_1}{c} = \frac{l_1}{c + v}$$  \hspace{1cm} (13)

For the return path $t_1^*$ of Sw1, the movement distance $b_2$ of RW and the movement distance $d_2$ of Sw1 shall become (Fig. 3):

$$b_2 = vt_2^*; \quad d_2 = l_1 + b_2 = l_1 + vt_2^*$$  \hspace{1cm} (14)

The time $t_1^*$ covered by Sw1 when returning and the covered distance $d_2$, shall be from (14):

$$t_2^* = \frac{d_2}{c}; \quad d_2 = l_1 + \frac{v d_2}{c};$$  \hspace{1cm} (15)

From (15), after grouping the terms, it results $d_2$:

$$d_2 \left(1 - \frac{v}{c}\right) + l_1 = 0; \quad \rightarrow d_2 = \frac{l_1}{1 - \frac{v}{c}}$$  \hspace{1cm} (16)

And time $t_2^*$ corresponding to returning route $d_2$ covered with speed $c$ becomes:

$$t_2^* = \frac{d_2}{c} = \frac{l_1}{c - v}$$  \hspace{1cm} (17)

Therefore, total time $t_1$ shall be from (13) and (17):

$$t_1 = t_1' + t_2^* = \frac{l_1}{c + v} + \frac{l_1}{c - v} = \frac{2l_1 c}{c^2 - v^2} = \frac{2l_1}{c} \frac{1}{a^2}$$  \hspace{1cm} (18)

Note that in (18) the same result was obtained as in (9) except for lengths $l_1$ and $l_2$. Hence, in case of length equality $l_1 = l_2$, it results from (9) and from (18):

$$t_2 = t_1; \quad \text{and} \quad \Delta t = t_2 - t_1 = 0$$  \hspace{1cm} (19)
Therefore, swimmers Sw1 and Sw2 shall arrive at the same time if at their departure the fair-play rule of orthogonality for their starting direction will be also respected for Sw2. Their race would thus end in a tie as we demonstrated above. No winner yields this race, just a hypothetical race, because there are no data or proofs that such a race would have been practically performed and Sw2 was the winner or the race ended in a tie. But indeed a real such a contest would be clearer for the disputed result.

Moreover, any intermediary starting direction of 1’ path with starting angle $\alpha \neq 0$ of Sw1 may be considered as also obtainable from the overlapping of the two cases of 0˚ and 90˚ analyzed above, but with the results of times $t$ applied in percentages appropriate for $\alpha$. And such one results that the obtained equality of the two times, $t_2 = t_1$ shall be obtained for any pair of paths in which the paths 1’ and 2’ will be aimed at 90˚ between them, independently of the starting angle $\alpha$ for Sw1.

6. Correct reanalysis of the physical model PM in BF frame

6.1. Analysis of model PM in case of transversal direction in BF frame

The paths for the swimmers Sw1 and Sw2 and are shown in Fig. 4. Here, the reference frame is $xOy$, which is attached to the block-start, being a BF frame, with the axis $Ox$ aimed oppositely to water speed $v$. 
Figure 4. The model PM with two swimmers Sw1 and Sw2 in BF frame, with xoy axes attached to block-start. The case of longitudinal path 1’+1” and of the transversal path 2’+2” inclined with β double line.

In Fig. 4, at the time $t = 0$, swimmer Sw2 leaves from point $O$ with his speed $c$ in the direction $y$, perpendicular to the block-start BS (and to the RB1 bank).

As Sw2 swims in the river, he will be carried over by the water with speed $v$. Therefore, the speed of Sw2 swimmer against block-start BS shall be $c'$ inclined with an angle $β$, depending also on the velocity triangle [9, 10, 11]. Sw2 shall cover his initial path 2’ between point $O$ and point $A_2'$, situated on the opposite bank RB2 (Fig. 4) but located at a distance $d_1$ given by angle $β$ in BF, $d_1 = OA_2'$. Swimmer Sw2 shall cover this distance $d_1 = l_2v/c$ within the timeframe $t_2$.

Note that point $A_2'$ does not coincide with point $A_2$ (Fig. 4), which corresponded to initial time $t = 0$ on a point of the RB2 bank, that was directly opposite to point $O$ at that time.

As Sw2 returns from $A_2$ to starting point $O$ (Fig. 4), he swims with his own speed $c$, but angled against axis $Oy$, at an angle $ε$, depending on the velocity triangle [9, 10, 11], as such that under the influence of water speed $v$, the resultant speed $c''$ is aimed toward point $O$.

Sw2 is able to see the point $O$ right from the moment of his return from point $A_2$ (Fig. 4), without breaking any fair-play rule. Hence, Sw2 shall return to point $O$ after the timeframe $t_2'$. The complete transversal/crosswise path in BF frame takes the shape of an incline with angle $β$ double line (Fig. 4).

Because the model PM as physical phenomenon involved, or even because the real contest is unique in reality, then in any selected reference frame WF or BF, the total time $t_2 = t_2 + t_2'$ of running the above path.
2''-2'', (and even the partial times $t_2'$ and $t_2''$) must be equal to the calculated time $t_2$ of eq. (9) and it does not require new calculations here.

It is logical that such calculations performed for the path 2''-2'' from Fig. 4 shall yield for $t_2$ the result of eq. (9). The timeframes $t_2$ and $t_2'$ of the two situations given by frames WF and BF, also must be equal between them.

6.2. Analysis of model PM in case of the longitudinal direction in BF frame

For the longitudinal direction, the path 1'+1'' covered by Sw1 is also shown in Fig. 4. Here, we have taken point $O$ of the initial time $t = 0$ to be the start of the race and have it coincide with the same block-start BS right corner.

When $t = 0$, Sw1 will leave from point $O$ toward a direction opposite to Ox and parallel to the block-start (and to RB1). It shall cover in $t_1'$ time his initial path 1' between point $O$ and point $A_{10}$, which is also located in the initial position of the return wall RW in BF (Fig. 4).

For the return path 1'', Sw1 will start from point $A_{10}$ in the direction of $O$ point, where he will arrive after $t_2''$ time, point which is still the initial position in BF (Fig. 4). His return path to $O$ takes a total timeframe $t_2'' = t_1 + t_1''$.

However, the rule of times $t_2$ discussed the end of Sec. 6.1 shall also apply to this go-return longitudinal path. This is regarding the equivalence also of the times $t_1$ covered in the two reference frames BF and WF. Therefore, the total time $t_1 = t_1' + t_1''$ for running the path 1'-1'' (Fig. 4) must be equal to the calculated time $t_1$ in WF from eq. (18). It does not require new time calculations in BF. Also the partial timeframes, $t_1'$ and $t_1''$, of the two cases WF and BF, must to be equal between them. Neither one of them require a new calculation.

7. Classical conditions of Michelson’s experiment

Now we will reanalyze the correctness of the paths and of the traveling times, of the two orthogonal rays from Michelson’s interferometer experiment, resulted by splitting a light ray and re-encountering them finally.

Michelson’s experiment, which was first carried out in 1881 and repeated with Morley in 1887 [12], is based on Maxwell’s suggestion and aimed to find the speed of the ether wind by “determination of light speeds by measuring the times it needs to travel in two opposite directions a known distance.” [13]. We will prove that the Michelson’s interferometer does not fulfill this suggestion.

The layout of the rotating Michelson’s interferometer device is presented in the same layout in position I (Pos. I), in the majority of works on the subject, while position II (Pos. II), with the arms rotated by 90°, wasn’t analyzed but only was supposed to yield identical results to Pos. I [14-18]. In fact, the two arms formed by the light source (S), the observation telescope (L) and the two mirrors (A1, A2) are disposed at exactly 90° to one another, and the semitransparent plate P is disposed at 45°, as shown in Fig.5. [12,13].

We note that in Michelson’s analysis the geometrical optics theory was admitted as valid, including a hypothetical ether, which must be present also in our analysis.

In reassessments of Michelson’s experiment made over the past few decades, no objection has been expressed about correctness of its theoretical basis, starting from light paths, only putting in discussion other aspects, most regarding the experiment development [19, 20]. And most of these approaches are developed in the SRT assumptions, and not in the classical conditions and analysis as this work does.

For correct analysis of the light path, the reference frame must be clear established. The frame must be attached to the considered immovable part of the experiment, which may be the device (DF frame, corresponding to block-start frame BF, in above swimmers analysis), or the ether (EF frame, corresponding to water frame WF, in above swimmers analysis), by choice. In the next sections of this article the reference frame, will be indicated in each Fig. by (DF, EF), and by the zero speed ($v = 0$) of the immovable part. Both frames have the same value, but the frame (DF) is preferred in this paper for calculations.
However, in almost all precedent works on the subject, including Michelson’s analysis, the EF frame (immovable ether) were tacitly (no such indication was given) adopted [13, 14], in which the correct light path construction is more complicated and ambiguous and maybe it contributed to some errors.

Under these conditions, for the transversal ray 2′–2″ an isosceles path OA′O″ was admitted by Michelson as in Fig.5.(a) in EF frame, path which we will prove to be wrong. The longitudinal path 1′–1″ was admitted to be OA′O″ and then it was considered that the two rays return to the same point O′, and so the interference principal condition was theoretically ensured. So, the two times t₁ and t₂, the light needs to travel the two device arms in Pos. I (Fig.5.(a)) was obtained by Michelson as follows [13]:

For the ray 1′–1″ with the path OA′O″ the time t₁ was given by Michelson as:

$$t_1 = t'_1 + t''_1 = \frac{l}{c+v} + \frac{l}{c-v} = \frac{2l}{c} \frac{1}{1-v^2/c^2} = \frac{2l}{c} \frac{1}{\alpha^2}$$

(20)

We must observe that this simple classic calculation is inconsequent concerning reference frames. The correct t₁ calculation in EF frame was made in Sec. 5.3 but the result from eq. (18) is the same as in (20). We note that calculation in DF frame is more complicated as was shown in [18] but it must give the same result as in (18).

For the ray 2′–2″ with the isosceles path OA′O″ (EF frame) the time t₂ was calculated by Michelson, which obtained:

$$t_2 = t'_2 + t''_2 = \frac{2l}{c} \frac{1}{\sqrt{1-\beta^2/c^2}} = \frac{2l}{c} \frac{1}{\beta}$$

(21)

---

**Figure 5.** Classical arrangement of Michelson’s interferometer. (a). Classic paths in EF frame with movable device. (b). Corrected paths in EF frame with xoy axes attached to water
with: \( 1/\alpha = \frac{1}{\sqrt{1-v^2/c^2}} \)  \hspace{1cm} (22)

Considering \( l_1 = l_2 \) for Pos. I, the time difference resulted for Michelson as:
\[
(t_1 - t_2)_I = \frac{l}{c} \frac{v^2}{c^2}
\]  \hspace{1cm} (23)

By rotating the device counterclockwise by 90° to Pos. II, it was supposed by Michelson and in all precedent classical works, that the two rays \( 1' \) and \( 2' \) return to the same point \( O' \) ensuring the interference. Thus the total time difference due to the device rotation with 90° was obtained by Michelson as follows:
\[
\Delta t = (t_1 - t_2)_I - (t_1 - t_2)_{II} = \frac{2l}{c} \frac{v^2}{c^2}
\]  \hspace{1cm} (24)

This time difference should create a fringe translation \( \Delta N \) which in the experiment from 1887 should have been \( \Delta N = 0.37 \) fringe. However, the value measured by Michelson \([21, 22]\) was much smaller than that calculated and was neglected, whilst the experiment was considered “negative” concerning the presence of ether eliminating it from Physics, and conducting at SRT’s birth.

Here we remark that in Michelson’s analyses, rays \( 1' \) and \( 2' \) were tacitly supposed to start their travel at the same initial moment, and that they would both arrive at the point \( O \) where they interfere, after two different times \( t_1 \) and \( t_2 \).

However, the interference at the \( O \) point is produced only if the following conditions are fulfilled:

i). The two light rays must meet at a certain point in space, \( O \);

ii). The two rays must arrive at \( O \) both at a certain moment, \( t \);

iii). The two rays must be the most coherent;

We see that in Michelson’s analysis condition i). may be fulfilled by a correct geometrical optics construction of the light paths.

In order to fulfill condition ii)., we see that in the case of two different times, with \( t_1 > t_2 \) it is necessary for the ray \( 2' \) to start from the source \( S \) after the ray 1 starts, with a time difference of \( \Delta t = t_1 - t_2 \) but coherence will be worsened.

The condition iii). may be fulfilled conditionally. In interferometer, the rays \( 1'' \) and \( 2'' \) will have maximum coherence when they correspond to a minimum \( \Delta t \), or better to \( \Delta t = 0 \) .

8. Traversing river boat model reanalysis

Here the classic Michelson’s interferometer model, as a boat traversing a river (similar with the swimmer Sw2 from Sec.5.2), as it is presented in Fig.6, will be reanalyzed more closely.

This model, with small adaptations in many works and physics books, was considered to be similar to the light paths in the interferometer placed in the ether wind \([22, 23]\). It was admitted in these works, that the real transversal path of the boat, in EF frame, is the isosceles triangle \( O_A' O' \) (path “a” in Fig.6). In these works the boat’s start direction (given by jetty direction) was admitted to be inclined at 90° as in the device (Fig.5.(a)).

But in Fig.6, based on velocity polygons in EF frame, we observe that the correct jetty launching direction must have an inclination of \( 90° - \beta' \), in order to produce the initial boat velocity \( c \), inclined also by \( 90° - \beta' \)

\[
(\text{where } \tan \beta' = v/c', \text{ with } c' = \sqrt{c^2 - v^2} \text{ or } \beta' = v/c' ).
\]  \hspace{1cm} (25)
Otherwise, with the jetty and boat inclined at 90°, with water immovable, the boat will have the departure path OA₂ and will arrive at the opposite point A₂ by "b" path [24].

But a boat starting with an inclination of 90°, depending on the unknown v, has an unfair advantage, an inadmissible situation, as was also in Sw₂ problem from Sec.5.2.

It is noteworthy that Rosser [22] admits an upstream path inclination of his swimmer, but without considering and drawing the correctly inclined start direction, which is a stolen start in sport, and therefore inadmissible.

The two times, \( t₁ \) and \( t₂ \) for the boat paths \( OA₁ \) and \( OA₂ \) (“a” from Fig.6) resulted in the classic works with the same expressions as for the light in interferometer, given by eqs. (20) and (21).

In Fig.6 a possible correct path “b” in EF frame, is also presented for the jetty inclined at 90°. Consequently, in this situation the boat will start off, in the vertical direction (the path \( OA₂ \)). In this case, in order for the boat to return to the point of appointment with the movable jetty, the returning path must be \( A₂O'' \) (“directed” by its captain, observing the jetty speed). The resulting path in EF frame is a right triangle \( OA₂O'' \).

But in Fig.6, there are a multitude of possible traversing paths like “c” (\( OA₁O'' \)), with \( A₁\) situated anywhere on the opposite shore, while the longitudinal path \( OAO'' \) is unique [24].

But in a “fair contest” of boats or of swimmers along the two orthogonal directions, the transversal departure direction must be at 90°, because the captain or the swimmer does not know the water velocity or the \( β' \) inclination, in advance. However, from opposite shore they can observe the jetty movement and can anticipate the appointment point without fair play violation.
The precedent findings and observations from Secs. 5, 6, 7 and 8, will help us to reanalyze the Michelson's analysis of his experiment.

9. The reanalysis of Michelson’s analysis of his experiment

Now we return to Fig.5.(a) in which the classic light path \( OA' \) is represented in EF frame, and we will compare this path to the similar boat path \( OA' \) from Fig.6.

We notice here the inadvertence between the position of P plate inclined at 45\(^\circ\) (Fig.5) and the position of the boat and jetty, correctly inclined at 90\(^\circ\) (Fig.6). However, both divergent positions of the P plate and of the jetty are the basis for the same isosceles paths \( OA' \) for the EF frame in Fig.5.(a) and respectively \( OA' \) in Fig.6, in Michelson's and in all classical analyses.

Now we can observe that there appears an error in the departure path \( OA' \) of the classical ray path from Fig.5.(a), which does not correspond correctly to the 45\(^\circ\) inclined position of the plate P in Fig.5.

Or for avoiding the error, in geometrical optics one must incline conveniently P plate.

But here in Fig.5 in EF frame, the P plate is inclined at 45\(^\circ\), the interferometer is considered movable with \( v \) speed to right, while the ether is immovable, and for this reasons the correct reflection path must be inclined at 90\(^\circ\) represented by \( OA' \) path in Fig.5.(b) in EF frame.

From speed vectors polygons (simple vectors: \( c \)-up for \( 2' \) path, and \( c \)-down for \( 2'' \) path), the complete correct transversal path in Fig.5.(b) will be \( OA''O \), interrupted at level of \( O'' \) point, due to P plate movement to right. We see here the difficulty of representing graphically this path in EF frame.

In Fig.5(b) is presented also the correct path in DF frame as \( OA''O \).

Under these correct situations from Fig.5(b), the condition i). (Sec. 7) for the interference is not correct fulfilled, because the returning point \( O'' \) of \( 2'' \) ray doesn’t coincide with the \( O \) point where \( 1'' \) ray arrives, and the interference is not assured theoretically [9, 25, 26].

It must be remarked that Kittel et. al. [18] noticed that the two rays \( 1'' \) and \( 2'' \) do not return to the same point, but surprisingly they concluded that this does not affect the analysis and calculations, including the interference conditions, which conclusion cannot be true.

The same device layout in Pos. I, can be better analyzed considering the DF frame as in Fig.7, where the correct paths \( OA''O \) and \( OA'O \) were built by geometrical optics. For this purpose, velocity polygons presented for each direction were used, and here again the points O and \( O'' \) are different and the condition i). (Sec.7) of the interference is not assured.

Here we can make the general observation that in all the situations when the ether is considered movable, in DF frame, with a speed \( v \), one must work with \( c' \) light speed, which is the vector sum of the \( c \) and \( v \) vectors. A reflected ray direction must be obtained, taking into account only the reflection of the light speed \( c \) vector (real speed in ether, and not of the resultant \( c' \) vector) with its real incident direction.

The direction of the light speed resultant vector \( c' \) after an effective reflection must be obtained by composing the reflected \( c \) vector with the \( v \) vector of the ether velocity.

Using this rule, the correct paths \( OA''O \) and \( OA'O \) were obtained, utilizing the velocity polygons, in Fig.7. Here, we observe clearly that the condition i). of interference for rays \( 1'' \) and \( 2'' \) is not assured because O and \( O'' \) points on P plate do not coincide.

We mention here that light paths in the interferometer, but rotated by 90\(^\circ\) to Pos. II, can be easily constructed also in DF frame [10]. And also, in Pos. II, the condition i). of interference of the two light rays will be not assured.

We now conclude that with a classical arrangement in Pos. I of the interferometer, in EF frame with P plate inclined at 45\(^\circ\) (Fig.5(a)), and considering the effects of an ether wind \( v \) like Michelson did, the
transversal path $OA'_1O'$ from Fig.5.(a) as isosceles triangle, as admitted by Michelson, is incorrect.

The corrected path $OA''_1O''$ for the same device arrangement presented in Fig.5.(b) as overlapped paths (or path $OA''_2O''$ from Fig.7 in DF frame), also does not assure theoretically the i). condition of the interference from Sec.7.

10. A possible device arrangement of P plate for obtaining the classical light path.

We now remark that positioning the P plate inclined at $(45^\circ + \beta'/2)$ angle [9, 25, 26], as in Fig.8, appears to exist a method giving the possibility for assuring the concordance of the interferometer arrangement and the Michelson classical ray path, $OA'_2O'$ from Fig.5a. in EF frame, and in Pos.I.

In this new arrangement of the device from Fig.8.(a) in EF frame, the ray $2'-2''$ will have the correct optical geometrical path as the classical path $OA'_1O'$ an isosceles triangle.

Also in this new arrangement of the device from Fig.8.(b) but in DF frame, the ray $2'-2''$ will have the correct optical geometrical path $OA_2O'$, as superposed paths.

While the $1'-1''$ ray, Fig.8.(a), 8.(b), has the paths $OA'_1O'$ in EF frame or $OA_1O$, in DF frame, the same previous paths $OA'_1O'$ and $OA_1O$ from Fig.5.

Figure 7. Corrected light paths in Pos. I. with the device in classical arrangement, in DF frame with immovable device, with xoy axes attached to device.
In this way the two rays $1' - 1''$ and $2' - 2''$ return to the same point $O'$ in EF (respectively $O$ point in DF frame), and such the first condition i). of interference being fulfilled as Michelson theoretically considered for Pos. I, but here in Fig.8 the P plate is inclined at $\left(45^0 + \beta'/2\right)$.

But the condition iii). of coherence is not fulfilled, because the two times are unequal and the coherence will be less good than that of the two rays having the same times.

However, it was necessary also to verify the interference in Pos. II for the same device arrangement as in Fig.8 (P plate at $\left(45^0 + \beta'/2\right)$), operation which was done previously [27].

Also, in the case of Pos. II it resulted from [27] that the interference condition i). of the two rays is not ensured theoretically with P at $\left(45^0 + \beta'/2\right)$. The same negative results will be obtained after two other rotations of $90^0$ to Pos. III and Pos. IV, as can be easily demonstrate [27].

But now we must remark that a ray $2''$ (Fig.8) which starts as in Michelson’s experiment with an inclination $90^0 + \beta'$ depending on the ether wind speed $v$, unknown prior to it, would have to be an “intelligent ray” which is not the case in any interferometer.

Or, the P plate must be inclined by a mechanism with a variable angle $\beta'$ in each moment for assuring the concordance between interferometer arrangement and ray (2’), but this possibility with P plate inclined initially at $45^0$, is not realistic, and must be abandoned.

11. A method to establish an alternative light path ensuring the interference in classic device arrangement.

Figure 8. Corrected light paths in Pos. I, with the device having the P plate inclined at $45^0 + \beta'/2$. (a) In EF frame. (b) In DF frame including speeds polygons, with $xoy$ axes attached to ether, $x_0y_1$ axes attached to device.
In order to find a method of ensuring theoretically the interference in the classical device arrangement and conditions, we can suppose that the transverse returning ray (2'' in Fig. 7) can arrive at O or very closely to point O for assuring the interference, as happened in the experiment. This case of Pos. I is presented in Fig.9.(a), in DF frame.

Fig.9. Reconsidered light paths in Pos. I with the ray 2'' returned to O point, as Huygens-Fresnel reemitted ray, including speeds polygons..(a). In DF frame, axes $x_1o_1y_1$ attached to device (b). In EF frame, axes $xoy$ attached to ether.
For this purpose, it is possible to apply the Huygens-Fresnel undulatory light theory, in which all points of a body surface including mirrors, constitute new secondary light sources that spreads rays in any direction. This hypothesis applied to the A₂ mirror surface touched by a light wave 2′, can give some backward reemitted rays 2″ arriving from point A′ also at O point.

Another possibility for this purpose is to incline A₂ mirror with β′ angle in Pos. I, but in Pos. II the effect is contrary as is easily to demonstrate [10], and this solution must be too abandoned.

This hypothesis and phenomenon of secondary source must be correct for small β′ angles as those corresponding to earth-ether speed. Maybe at greater speeds the interference will be negative affected.

Moreover, the same phenomenon produces in the case of laser devices for measuring distances, when the returning ray is reflected by any separation surface, which is not a mirror, and this ray is received by a lateral lens.

In this way the transversal ray 2″ returns to point O by path A₂′O because c′∥c″, as results from speed polygons in Fig.9.(a). The ray 1″ also returns to point O, theoretically ensuring in this way all the tree conditions of interference from Sec.1.

In Fig.9.(b) in EF frame, one can see that the path of the ray 2′-2″ will be Oₐₛ₂′O, which is exactly the basic right triangle path of swimmer Sw₂ from Fig.2 and of path b) of boat from Fig. 6 [9,10,26,27].

This hypothesis of applying Huygens-Fresnel theory and phenomenon of secondary light source, must be correct also because in swimmer or in boat model, the path is the same a right triangle, and these models correctness can be proved in reality.

By calculating the travel time t₂ necessary for the swimmer Sw₂ to perform such a transversal path Oₐₛ₂′O: from Fig.2. in WF (EF) frame, we obtained finally eqs. (9), (18) which gives:

\[ t₂ = \frac{2l₂}{c\alpha²} \]  \hspace{1cm} (26)

\[ t₁ = \frac{2l₁}{c\alpha²} \]  \hspace{1cm} (27)

We observe that in (26) was obtained for t₂ an expression identical to those found for t₁ in (27).

When the device arms l₁ and l₂ are equal, from (26) and (27), Δt results:

\[ Δt = t₁ − t₂ = 0 \]  \hspace{1cm} (28)

Thus, in this case of Pos. I in Fig.9 (a) or 9 (b), we can say that no time difference exists between the light travel times t₁ and t₂ from the two orthogonal directions.

As result, also the ii). and iii). conditions of interference from Sec. 7 will be fulfilled, because the rays 1″ and 2″ derive from the same initial i ray, assuring the best coherence because of the minimum (zero in fact) time difference Δt.

Hence, the other rays reflected in others points except A′; point, arriving at O point, including the isosceles ray Oₐₛ₂′O′ from Fig. 9.(b), will be stumped by Oₐₛ₂′O″ ray because of their greater time difference, and their worse coherence, and the visible interference fringes will be that produced by rays 1″ and Oₐₛ₂′O″ (Fig. 9.(b), or by 1″ and 2″ rays (Fig. 9 (a).

Here we note that even a isosceles path of Michelson analysis, which may be obtained too by applying Huygens-Fresnel theory in O point for 2′ ray (Fig.5, Fig.7, Fig.9.(b)) will give the same significant Δt ≠ 0 and such a path will be stumped by the right angle path with smaller Δt or even Δt = 0, which will give a
better coherence. The best coherence corresponds to the path which gives real energy transfer between the source and the visible fringe. The energy transfer can take place in a point only once.

In this case the energy transfer for fringes take place by two rays from two paths and will be most favorable in conditions of the best coherence, which is firstly influenced by \( \Delta t \) minim, even zero.

The result given by (13) from Fig. 9.(a). in DF frame for Pos I, will be true also for Pos. II, III and IV of the similar device arrangement and ray paths, due to axial partial symmetry. These situations may be easily verified in Fig. 10 for Pos. II, where the source arm length \( l_s \) was neglected. In Fig.10 we obtained the same transversal and longitudinal paths for \( 1' \) and \( 2' \) rays as in Fig.9.(a), but in changed arms positions and with inversed senses.

With our precedent hypotheses regarding the light paths as right triangle in Michelson interferometer and considering the results of the above analytical demonstration, we get that the fringe displacements are theoretically null because of \( \Delta t=0 \) in any rotated position of the interferometer. And consequently is not justified in such tip of interference experiments, to expect the large values of fringe displacement predicted theoretically by Michelson.

We observe that the path as an isosceles triangle in EF frame from Fig.5, and from Fig.9.(b) proposed by Michelson, represent extreme paths for the \( t_2 \) time (a minimum), and a maximum value for \( \beta \). For these paths, because \( \Delta t \neq 0 \), interference conditions i), ii), iii), from Sec. 7 will not be well fulfilled and these rays will be stomped by other rays arriving at the same point \( O \), with the minimum \( \Delta t \) and better coherence.

Such extreme paths with maximum \( \Delta t \) are unlikely to stay at the origin of the visible interference fringes which necessitate the real energy transfer by best coherence, as was shown above.

Some similar results presented Mark [28] reanalyzing Michelson analysis, concluding that value of \( \Delta t \neq 0 \) obtained by Michelson is not correct deduced and it must be \( \Delta t=0 \). But Mark’s similar theoretical experiment with two balls/light rays, traveling in a moving cubic cabin, differs essential from our case by completely dragged atmosphere.
12. Consideration about observed fringe displacements in interferometer experiments

Some little fringe displacements may appear by rotating the device between Pos. I and Pos. IV because the ether wind influence is real. This wind can influence the $t_1$ and $t_2$ times by at least the four perturbing factors: ray direction, finite width of light ray, source distance, $v$ speed \[25\].

Some paths near the right triangle in EF frame in Fig. 9.(b), or near the $OA_D$O path in Fig. 9.(a) in DF frame giving some non-null $\Delta t$, must be at the origin of such observed little fringes displacements, in most interference experiments.

One can also obtain such small values of $\Delta t$, if the fringes are regarded not as result of a single ray, but as a component of a multitude of rays constituting a light beam with finite width.

In such conditions some small values can be obtained for $\Delta t$, which are not exactly zero but small enough to be observed as in Michelson’s and in other similar experiments, which are probably third order effects of the ether wind.

Under these conditions with the device rotated in Pos. I., II., III and IV. the interference may be only approximately stationary (very small displacements), as in Michelson’s and other experiments.

Our precedent reanalysis and above observations, are in good agreement with the detailed results of Michelson’s experiments, registering some small fringe displacements.

Michelson, \[21\] have reported small fringe displacements in its well-known graphic for 24 hours. Our measurement \[10\] on this graphic, indicated some clear fringe displacements of approximately 0,02$\lambda$, which represent approx. 5% of the expected theoretical movement (0,37$\lambda$), which is not at all negligible, as was considered till now.

Other accurate experiments made later with more improved interferometers have constantly shown however, that in fact some small time differences $\Delta t$ appeared, reaching 1/3 of the classical theoretical time difference \[23\].

Also Miller \[29\] had reported fringe displacements in all of his numerous experiments, which reached even. 20% of the expected theoretical displacement, amount which can be diminished by actual error analysis, but which can’t be considered zero.

These observed small fringe displacements may constitute an argument for the ether wind presence, in the light of our above results.

13. Conclusions and consequences

From the above-presented situations of the physical model (PM), the path taken by swimmer Sw2 in the crosswise direction of the river flow with respect to the water reference frame WF must take the shape of a right triangle. This disagrees with interpretations from many other authors and Michelson himself, who considered the isosceles triangle to be the correct path (probably also in WF).

When considering the right triangle of the path covered by Sw2 in WF, the two times of swimmers Sw1 and Sw2 shall be equal, i.e., $t_1 = t_2$ and their race ends in a tie.

In the BF frame, the transversal path takes the shape of an inclined double line, with an angle $\beta$, but the times $t_1$ and $t_2$ must remain the same as in the WF frame.

As a consequence, utilizing the isosceles triangle for the transversal path from the PM in the WF frame, results in an erroneous analysis.

This context is in the analytical interpretation of the Michelson interferometeric experiment (ME).

Based on similarity between PM and ME, in this article we have demonstrated that the transverse light path in the rotating interferometer, admitted by Michelson as isosceles triangle in EF frame is an error because it is not consistent with a correct analysis when performed under classic conditions of geometrical optics.

We have shown, that the transversal ray path which is an isosceles triangle in EF frame in Michelson’s analysis, must start with an inclination $\beta'$ depending on the ether wind speed, unknown to it before leaving the source, such a ray behavior, implying to be an “intelligent ray”, which is not possible. Except the case of applying Huygens-Fresnel theory, but never invoked by Michelson and his followers, or by his critics.
We were successful in finding, based on geometrical optics and on undulatory Huygens light theory, that a simple transversal ray must start at $90^\circ$ and perform a right triangle path in EF frame, in order to return in the same point with the longitudinal ray, and such resulting equal times, the same moment of returning and the best coherence.

For this transversal right triangle path we calculated a time, longer than that obtained by Michelson, but equal with the time from longitudinal path. In these circumstances are fulfilled also the best interference conditions.

Even if the Michelson isosceles triangle may be constructed by applying Huygens-Fresnel theory at point O, it will give a worse coherence and it will be stumped by the right triangle ray which will give the best coherence and which corresponds to the real energy transport which yields the visible fringes.

And because the time difference $\Delta t$ results zero, no fringe displacement must appear by rotating the device despite Michelson’s expectations.

So the interferometer problem with the supposed ether presence is far from being as simple as it was considered by Michelson in his theoretical analysis, which was incomplete and consequently incorrect.

The Michelson’s experiment, which is based only on the existence of time difference $\Delta t$ for a double light paths, and not on the measurements of simple times for two simple orthogonal paths of light travel, do not correspond to Maxwell’s recommendation for ether wind speed measurements.

And consequently, only other type of experiment based on the simple travel time, are suited for this purpose of establishing the relative movement speed of the earth in ether.

Because of other small dependencies of light paths and travel times, on the ether wind direction in such a complex optical device where the light linear ray is in fact a large beam, as presented in Sec. 9, 10, 11, and 12, it is logical to admit that an absolute stationary interference fringe pattern is practically improbable to persist, when the ether wind direction changes and small $\Delta t'$ will results, compared with $\Delta t$ calculated by Michelson. This $\Delta t'$ can be attributed to ether wind as tertiary effect.

But the interference and small fringe displacement created by $\Delta t'$ may subsist theoretically at relative small ether speed around the earth. Maybe at greater ether-device speed the interference will be more affected.

In fact, only an approximate stationary fringe figure was obtained in Michelson’s experiments in the classic hypothesis of the ether wind influence, when small displacements was also obtained in all similar experiments including Miller’s experiment, for which our above results, confirm as being justified his prolonged experiment efforts.

Present our reinterpretation of Michelson’s analysis does not allow to consider his experiment as a confirmation of relativity of the light speed for a double travel.

And based on our precedent findings we conclude that Michelson’s experiment must be no longer considered as negative concerning the presence of the ether wind.

Under these conditions, the longitudinal arm contraction proposed by Fitzgerald is not necessary, and consequently nor is necessary the SRT proposed by Einstein on the basis of Michelson experiment analysis. Results that Fitzgerald, Lorentz and Einstein were misled by Michelson’s error in his analysis of his interferometer experiment. But Lorentz electromagnetic theory from 1895, actualised, based on an immobile ether, may substitute SRT.

Similar experiments [30, 31] including light, microwaves, masers, lasers, $\gamma$ rays, etc., which are based on the time difference $\Delta t$ calculation and measurements (for the two orthogonal or inclined paths) given by relationships similar to those in equations (20) and (21), which do not correspond to the correct Maxwell suggestion for measuring the ether wind speed, may also be reanalyzed in light of the above findings.

In order to successfully put into evidence the ether wind speed, the correct experiments must actually fulfill Maxwell’s suggestions by measuring the simple times for two orthogonal paths, and such experiments would be possible in the future, including more precise observations of Jupiter satellites eclipses.

A similar situation was happened in antiquity when Ptolemy proposed his functional geocentric planet system, based on apparent planet observed movements, as Einstein did in 1905 for his SRT based on apparent and wrong light path in Michelson experiment, as we demonstrated above. Both these theories can describe the reality only with limited detail, but finally they can be proved to be wrong, because the planets
in reality rotates around the sun as Copernicus demonstrated, and because the light must have a propagation support, a kind of ether, for whose properties discovery, we all must conduct our future efforts.

Based on our above results it is justified in physics, to renounce in future at SRT, and instead to reintroduce a modern real ether in physics, as we already done in two published papers [32, 33], including a new gravitation theory. And so in presence of the ether, many unexplained phenomena, as the atmospheric electricity at earth scale, and so-called dark matter in astrophysics, and others, such phenomena as so called big-bang or black holes, will receive their physical explanation.

The ether presence can also explain physically, the quanta entanglements of atomic microparticles including quarks, consisting in fact as local stationary vibrations/oscillations in the ether components. The ether presence can constitute the physical support of the so called electro-magnetic (E-M) field, consisting in fact of photons transmitted through ether with light sped \(c\), which is a property of the ether and not of the emission source. The ether presence can also explain physically the universal interaction between all bodies and particles by electrical vibrations of ether transmitted through ether with a speed greater then light sped \(c\), constituting in fact the so-called gravitation.

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