

What and how does a Michelson interferometer measure?

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Michelson interferometer is very complicated and capricious instrument. Even more mysterious and difficult to understand the nature of electrodynamic phenomena in moving media, which was studied by rotating the interferometer with two orthogonal coherent beams. Its idea was proposed, as is known, by Maxwell. Undertaking in 1881 the implementation of this idea, Michelson (since then the interferometer bears his name) assumed that the interferometer can measure the shift of the interference fringe when you turn the interferometer in vacuum, in the absence of media in zones of propagation of rays. Not at once there have been comprehended (after 1881 the misunderstanding lasted almost 90 years) that the shift of interference fringe in the Michelson interferometer is absent in vacuum and arises only when light's carriers have the refractive index (n) exceeding unity ($n > 1$). Until now many believe that all known experiments on Michelson interferometer are "negative" conceding the official point of view in SRT that in rotating the interferometer the harmonic shift of the interference fringe is always absent, and fringe shifts observed by some experimenters allegedly are random or systematic errors of the device. In 1968-1975 years I proved experimentally that about 100 years sought for shift of interference fringe when turning interferometer really exists, confidently detecting the absolute motion of the Earth relative to aether at a speed of several hundred km/sec. But this required that processes in the interferometer to be anew and correctly interpreted and be capable to properly extract the main interference process out of the noise and disturbances.

In the present report, I decided to address the root causes of failures of experimental detection of "aether wind" by using a Michelson-type interferometer in order to prevent experimenters from their recurrence. To do this, I will examine the reaction of the Michelson interferometer, which has as light's carrier of orthogonal beams various media. They were the lab vacuum (in evacuated flasks, $n \sim 1$), free air, other gases and liquids in flasks, solid optical-transparent media; with their help I scanned the range of values of refractive indices $1 < n < 1.8$. In the act of measurement light's carriers always remain translationally-fixed relative to the instrument (the rotation of the interferometer by an angle 90° is a locally-methodical process). In the article [Phys.Lett.A **374** (2010) 1110] I reported on the disclosure of some methodological and interpretational artifacts in the performance of the Michelson's experiment, letting me measure the projection (on the plane of the horizon) of the absolute velocity of the Earth relative to the aether at a latitude of Obninsk at different times of day and night as 140 – 480 km/sec.

This version of the paper I supplement with the second method of determining the "aether wind" – from the found by me decrease (by 12%) of the winter interference fringe shift relative to summer one. The estimations obtained agree well with the results of the first method where the velocity of aether wind is determined directly from the shift of the interference fringe.

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1. THE PERIOD 1880 – 1960

The combined interpretation of all key experiments on the Michelson-type interferometer is presented in Fig.1 by four time dependencies $A_m(t_{local})$ of amplitude A_m of the relative shift of interference fringe taken during the full 24-hour cycle of day and night. In this figure the amplitude $A_m = X_m/X_o$ of the relative shift of interference fringe is expressed through the real amplitude of the observed fringe shift in the dimensions of width X_o of the fringe. In my experimental setup the interference pattern was visualized by using a home-made camera and 18 cm kinescope, where the interference fringe had a width of $X_o = 90$ mm.

I managed to reproduce in Fig.1 models of dependencies (1-3), as occurred in the world-famous experiments of Michelson (1881), Michelson&Morley (1887), Miller (1926), which are interpreted as evidence of "negative" Michelson-type experiments. They have been transcribed by me in the form of curves (1-3) after my experiments (1968-1974 period), which only recently became possible to be published [1, 2]. The curve 4 in Fig.1 obtained by me gives the

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answer, why there was ordained for each of these experiments the fate of being "negative". Only when there was obtained the amplitude of shift ($X_m \gg X_{ns}$) of the fringe many times exceeding the level (X_{ns}) of the installation noise, it became clear both the unconditional positiveness of the idea by Maxwell how to observe the reaction of aether, and origins of the failure of the first experiments of Michelson in which the measured parameter X_m turned out to be embraced by all-hiding and suppressing noise $A_{ns} \gg A_m$ (see Fig.1). This became possible only after I managed to understand and divide the response of inertial and non-inertial objects in the interferometer, which Michelson in 1881 did not distinguish.

Indeed, according to proposed in 1881 the theoretical model of the processing of experimental results, based on the classical rule of composition of velocities ($c \pm V$) of the wave of light (c), as non-inertial object, and of the inertial light source and light's carrier moving steadily with velocity V in still aether, Michelson obtained the following formula to determine the speed of "aether wind":

$$V = c[A_m \lambda / L]^{1/2}. \quad (1)$$

In anticipation of the experiment, he estimated from formula (1) the expected value of the amplitude of the relative shift by its reversal relative to A_m :

$$A_{m \text{ expect.}} = LB^2 / \lambda. \quad (2)$$

In (1) and (2) there are accepted: c is the speed of light in vacuum; V the speed of the experimental setup (the light source and light's carrier) relative to aether; $B = V/c$; λ is the wavelength in vacuum, and $A_m = X_m/X_o$. Note that neither the well-known in those years refractive index n of optical medium, whose role in Michelson experiment played the air ($n = 1.0003$), nor less known then permittivity $\varepsilon = n^2$ of the air were not taken into account in formula (1).

Expectations of Michelson in 1881 were optimistic. If $L = 2.4$ m and $B^2 = 10^{-8}$ (i.e. for the linear velocity of the Earth in its orbit around the Sun, ~ 30 km/s), at the beam of visible light he expected to obtain the amplitude $A_{m \text{ expect.}} = 0.04$ [3] corresponding to the shift of the fringe by 1/25 of the bandwidth. In evaluating the resolving power of his interferometer (1/40 of the bandwidth [3]) he was sure that he detects a shift of the fringe (because the ratio signal/noise was expected to be ~ 2). When he made measurements, he found no indications of the shift of interference fringe (i.e., he obtained $A_m = 0$). Therefrom the world-famous "negative" conclusion was drawn that there is no aether.

In fact, this was only the starting point of a complex scientific problem lasting for the period of a century: what and how measure the Michelson interferometer? The real "picture of non-observability" of the amplitude A_m of relative shift of the interference fringe in Michelson's 1881 experiment, from the height of my current understanding of the problem, looked as shown in Fig.1 curve 1, i.e. the sought for in the experiment value of A_m was sunk in the noise, the intensity of which exceeded it hundreds of times.

Perhaps realizing this, in 1887 Michelson&Morley [4] increased the length of the interferometer arms to 22-meters (almost 10 times compared with the experiment of 1881 year). By formula (2) with $L = 22$ m and $B^2 = 10^{-8}$ they expected to obtain $A_{m \text{ expect.}} = 0.4$ [4]. The shift almost 1/2 of the bandwidth is impossible not to be noticed. However, they again found no shift of interference fringe. Actually, this "picture" of non-observability of relative amplitude of the shift A_m of interference fringe was lost in the noise, the only difference that now the noise exceeded the required shift not in the hundreds, but in dozens of times (curve 2 in Fig.1). But neither Michelson&Morley nor other scientists until 1926 year had no idea about this. Experiments of 1881 and 1887, indeed, should be considered as "negative" if interpreted with formulas (1) and (2).

Only by thoroughly cleansing from the noise the curve 4 in Fig.1, I realized that in the experiment of Michelson&Morley only 1 hour per day there evolved signal/noise ratio, which is close to unity ($A_m/A_{ns} \sim 1$), and then in the other 23 hours again decreased tenfold. Despite of these unfavorable conditions, when no one knew the reasons for discrepancies of expectations $A_{m \text{ expect.}}$ due to model (2) and measurements $A_{m \text{ measur.}}$ of the fringe shift in the experiment, Michelson&Morley announced that they were able to briefly record the fringe shift by $\sim 1/30$ of the bandwidth against the background of strong noise [4]. Naturally, this time no one believed it because of the unclear reasons of a multiordinal discrepancy between the expected value of $A_{m \text{ expect.}} \sim 0.4$ according to the model (2) and measured value: $A_{m \text{ measur.}} \sim 0.03$. It was not until 1926 year.

In 1926 Miller recurred the experiment of Michelson using interferometer with greater length of arms ~ 64 m. The picture, which he first observed during almost the whole day and part of the night, presented in Fig.1 curve 3. It was calculated by me (2) from the data of Miller [5] on the velocity of "aether wind" that he obtained processing his measurements by (1). Here we see that the experiment is already comfortable with extracting out of the noise the amplitude of the fringe shift (with the ratio $A_m/A_{ns} \sim 2 - 3$) in a half-day and night. But, since there remained unknown the reason why in the experiment of Miller the anticipated fringe shift by (2) promised to give $A_{m \text{ expect.}} = 1.2$, and in fact at "peak" it gave $A_{m \text{ measur.}} \sim 0.1$, his results were also listed as "negative". Such conclusion was instigated by new knowledge disclosed in twentieth century.

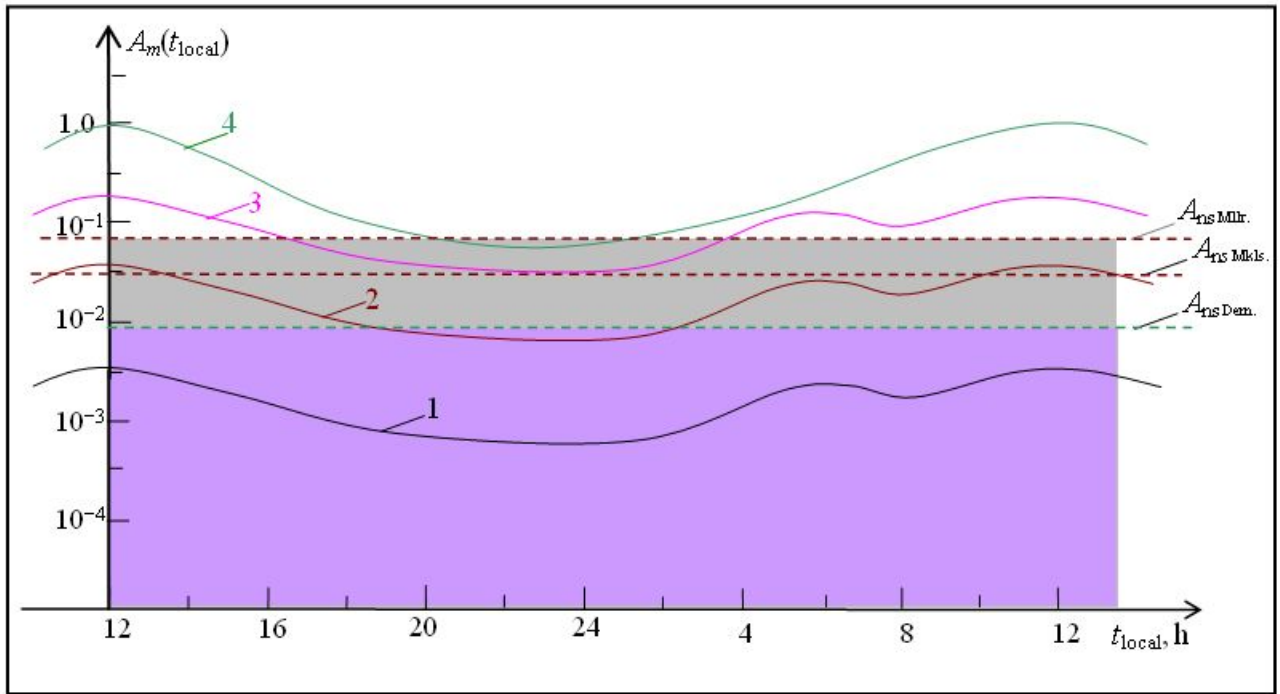


FIG. 1: The time course (during the day and night) of the relative amplitude $A_m(t_{\text{local}})$ of harmonic component $A(\varphi)$ of the shift of interference fringe on the screen of the rotary cross-like interferometer (the local time t_{local}), corresponding to 3rd decade of June: 1 – 1881 year, USA, $\sim 42^\circ$ NL, Michelson [3], $L_1 = L_2 = 2, 4$ m (light's carrier is the air); 2 – 1887 year, USA, $\sim 42^\circ$ NL, Michelson&Morley [4], $L_1 = L_2 = 22$ m (light's carrier is the air); 3 – 1926 year, $L_1 = L_2 = 64$ m, USA, Miller [5], $\sim 42^\circ$ NL (light's carrier is the air); 4 – 1971 year, USSR, $\sim 55, 8^\circ$ NL Demjanov [1], $L_1 = L_2 = 0, 2$ m (light's carrier is the fused quartz). A_{nsi} are estimations of noise level of the experimental installations of Miller, Michelson and Demjanov.

Astronomical observations of those years have demonstrated that the velocity of the Earth in space is determined not only by the linear velocity (~ 30 km/s) of its rotation in its orbit around the sun, but by the order of magnitude greater linear velocity (~ 300 km/s) of its rotation in its orbit around the Galactic center. This corresponds to the parameter $B^2 = V^2/c^2 \sim 10^{-6}$. If Michelson had recognized this in 1881, he would obtain by (2) the estimation of $A_{m \text{ measur.}}$ not 0.04, but 4.0 (i.e. the fringe shift of four bandwidths!). Such a reaction can not be overlooked. To an even greater extent there would alert the discrepancy between the expected fringe shift ($A_{m \text{ expect.}} \sim 40$ for $B^2 \sim 10^{-6}$) and obtained by Michelson&Morley in 1887 experiment value $A_{m \text{ measur.}} \sim 0.1$ (for $L = 22$ m). Overstatement of $A_{m \text{ expect.}}$ in thousand times, that I was capable to communicate only in [1, 2], may have prompted theorists to think over the problem of discrepancies in mathematical processing of the experiment.

In the end, the final sentence of the Michelson experiment as "negative" was contributed by three circumstances. *First*, experiments were not reproducible and were not confirmed by laboratory measurements in vacuum, i.e. for $n = 1$ (even though everyone thought that this is the most sterile conditions to detect the "aether wind"). Now, after the account in [1, 2] of my experiments, it became clear that it was erroneous calculations based on a misunderstanding of the principle of the interferometer. *Second*, the experiments were not reproducible and not confirmed because of the ignorance of how the shift of the fringe (diagnosed at the turn of the optical platform of the device in the horizontal plane) changes depending on the time, the day or night, of shooting (see Fig.2). Only after that to the 1971 year I had found such a relationship by analyzing the patterns of seasonal drift of the curve $A_m(t_{\text{local}})$ during the year (see Fig.2), all measurements at any date and any time of day or night were impeccably played. *Third*, even taking into account all the above-mentioned sporadic cases of detection by experimenters of the relative amplitudes of shift $A_{m \text{ measur.}}$, their treatment by the Michelson formula (1) invariably gave the "aether wind" speed $5 < V < 10$ km/s [4–6]. And this is tantamount to its absence, especially after it became known that the Earth is rushing in space relative to the stars in our galaxy at a speed not less than 300 km/s.

Such were dramatic attempts to measure the speed of "aether wind" with Michelson interferometer to the beginning of 1960. It is indicative that they do not distinguish between measurements on interferometers with air or vacuum atmosphere in the zones of rays, but it was believed that the results from the evacuated zone of propagation of rays should be trusted more. This characterizes the stage of history of science considered as a period of complete lack of

understanding of the physical principle of Michelson interferometer.

2. THE PERIOD OF 1960 – 2010

In 1960th years there appeared first attempts of measuring on Michelson interferometer with high optical density media as light's carriers [1, 2, 6], and in subsequent decades, until now, interest in them is ever growing [8, 9]. My measurements showed (see curve 4 in Fig.1 and curve 1 in Fig.2) the enormous potential of improving the signal (in the interferometer such a signal is A_m) raising over its own noise (δA_{ns}). Their implementation allowed me to respond constructively to the above three questions. Hourly and monthly view of changes in the amplitude of shift of the interference fringe (with turn of the interferometer in the horizontal plane) for the signal/noise ratio not less than 1.5 – 15 during the whole year is shown in Fig.2.

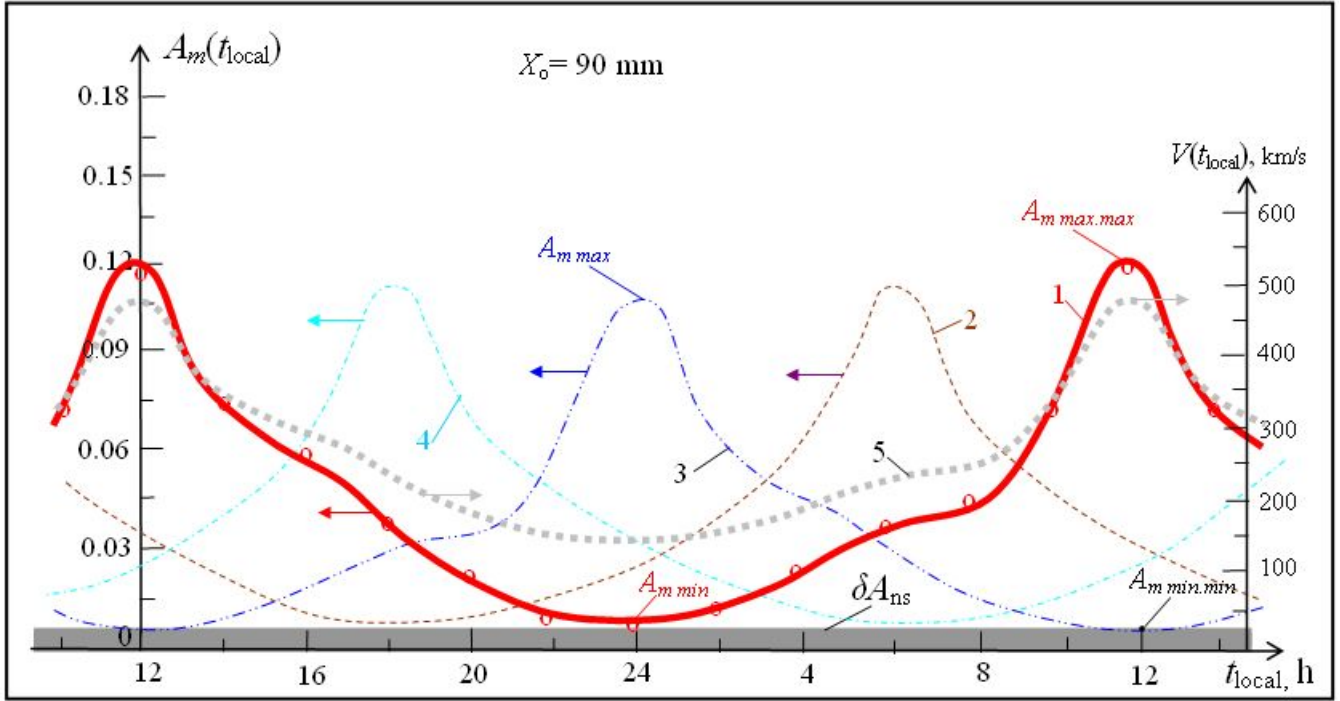


FIG. 2: Patterns (1-4) of the seasonal displacement of the round-the-clock dependencies $A_m(t_{local})$ of the observed relative amplitude A_m of the harmonic component $\Delta A(\varphi)$ of the interference fringe shifts on the kinescope's screen when turning the platform of the rotary cross-like interferometer with water light's carriers only in the horizontal plane, which were measured every two hours during the day and night Moscow time in the third decade of the month: 1 – June; 2 – September; 3 – December; 4 – March (based on measurements in 1969–1971 years); 5 – the velocity of "aether wind", computed from the curve 1 by formula (3). The measurements were performed on water light's carriers (H_2O in glass tubes) with following parameters of the interferometer: $L_1 = L_2 = 0.17$ m, $\lambda = 9 \cdot 10^{-7}$ m, $\Delta \varepsilon_{H_2O} \approx 0.83$; $X_o = 90$ mm is the width of the fringe on the screen of the kinescope; δA_{ns} the level of jitter noise of the interference pattern. $A_m max$ and $A_m min$ is the maximal and minimal amplitude of the fringe shift for 24-hour period of measurement in day and night; $A_m max max$ is the largest (in the year) maximum amplitude of fringe shifts observed from 18 to 25 June each year; $A_m min min$ is the smallest (in the year) minimum amplitude of fringe shifts observed from 18 to 25 December each year (all for the latitude of Obninsk).

It shows the measured by me four dependencies $A_m(t_{local})$ in four characteristic times of the year, specifically referred to the third decade of the month. These data are typical for the latitude of Obninsk ($55,80^\circ$ NL). Curves were obtained: 1 – June, 2 – September, 3 – December, and 4 – in March. Measurements were carried out in 1969 and checked several times until 1974 year. From these dependencies I brought up for the first time the following regularities of the drift of the position of the "peak" of $A_m(t_{local})$ along the axis of the local time:

– maximum maximorum of the amplitude of the relative shift of the fringe $A_m max max$ (at turns of the interferometer in the horizontal plane) is observed in the range $11^{30} - 12^{30}$ o'clock local time from 18th to 24th June each year, minimum minimorum $A_m min min$ is observed in the range $11^{30} - 12^{30}$ o'clock in December each year,

- maximum amplitude of the relative fringe shift $A_{m \max}$ is displaced by two hours in each month in the order of the adopted numeration of months (to the left in Fig.2); thus, the maxima of curves 1, 2, 3 and 4, taken with the step three months, moved relative one to another next to the adjacent curve by 6 hours;
- ratio of the amplitude $A_{m \max}$ of the fringe shift, measured at 12 o'clock June 22, to the amplitude $A_{m \max}$ of the fringe shift, measured at 24 o'clock December 22, was equal to ~ 1.06 (at the latitude of Obninsk);
- calculated from the dependence $A_m(t_{\text{local}})$ by formula (3) the value of the component of the velocity (V) of "aether wind", as shown by curve 5 in Fig.2, changes at the latitude of Obninsk in the range of values $140 < V < 480$ km/s.

Thus, experimental results obtained by me indicate that there exist reliable methods to detect the fringe shift on Michelson-type interferometer with the signal/noise ratio more than 10. With such certainty of execution of experiments on Michelson-type interferometers and those detailed measures of modernization with the help of high optical density media as light's carriers, which I have proposed and experimentally verified [1], it would seem no reason to believe that Michelson-type experiments are "negative". Certainly, in order to confirm it, my measurements and their new interpretation should be revised and reproduced by other researchers.

However, here there may again repeat the story of the previous period. Then a misunderstanding of the true physical principle of Michelson interferometer carried away experimenters on a wrong way of revalidation Michelson&Morley and Miller experiments, held in the air, supposedly in a more "pure" vacuum atmosphere condition of propagation of rays. Naturally, the results obtained in vacuum gave "zero" fringe shifts. This contributed to a denial of the positive results of measurements in air, obtained by Michelson&Morley and Miller. I experimentally disclosed the intrigue of the century-old scientific mistakes and built a theory to explain them [1, 2].

Now that I have described [1, 2] the positive results concerning the sharp increase in sensitivity to "aether wind" of the interferometer with high optical density light's carriers, as I foresee, my results may not be supported by hasty attempts to repeat them in facilities that do not exclude methodological artifacts of spurious interference, noise-polluting fringe shifts. In particular, the monograph [9] reported that in [6] there were obtained zero shifts of the fringe on the interferometer with high optical density light's carriers. Surely, orthodoxies of the official science and its "principle of relativity" believing the "negativeness" of Michelson experiments to be its experimental foundation, enthusiastically greeted reports of experiments which failed to state the shift of interference fringe, and regarded with hostility the reports on any positive results of the experimental registering the finite shift of interference fringe.

Since after 1969 no new information on measurements of the authors [6, 7] appeared, and published by me [1, 2] the positive results of those same years will take a time for them to be rechecked, I will impart to experimenters my experience how to overcome the difficulties of measuring on Michelson-type interferometer with different optical media, including laboratory vacuum. I will describe few methodological artifacts that may lead to a false apparent absence of the sought for shift of interference fringe in the devices, which require the use of optical-transparent containers (for liquids and gases) or optical-transparent rods.

3. POSITIVENESS OF MICHELSON-TYPE EXPERIMENTS

Fig.3 shows my results of measurements on the Michelson interferometer published in [1, 2]. Here refractive index is expressed in terms of the optical dielectric permittivity $\varepsilon = n^2$ as a characteristic of Maxwell's electrodynamics of continuous media. In Maxwell's theory the value $(n^2 - 1)$ got (back in 1870) a clear physical sense of $(\varepsilon - 1) = \Delta\varepsilon$, under which the total permittivity of optical-transparent medium is always composed of the sum of the polarization contribution of aether (**1.**) without particles and contribution of the polarization of particles $\Delta\varepsilon$, always present in aether, i.e. $\varepsilon = \mathbf{1.} + \Delta\varepsilon$. I found that the amplitude of interference fringe depends not on the entire dielectric permittivity of light's carriers of the interferometer, but only on its part $\Delta\varepsilon$, resulted from the polarization contribution of inertial particles of light's carriers, and completely independent on the polarization contribution of non-inertial aether that is equal to **1.**

In Fig.3 the dependence of the fringe shift amplitude $A_m(\Delta\varepsilon)$ is represented on $\Delta\varepsilon$ axis in logarithmic scale. This was done deliberately in order to show the new experimental points obtained not only in the air but also in other gases including laboratory vacuum. It was impossible to show them in the figure of [2], where I applied the linear scale of $\Delta\varepsilon$. The pattern in Fig.3 covers almost the whole area ($1 < \varepsilon < 3$) of known to science optical-transparent media (from a laboratory vacuum and different gases to liquids and solids), which were tested by me as light's carriers in Michelson interferometer. But the main point is not even that.

As will be shown below, the important thing is that the proceeding from measurements of interference fringe shift on Michelson interferometer with an air atmosphere to the interferometer, where in the zone of its orthogonal rays the air is replaced by other media, there are many methodological risks of systematic errors that could give false appearance of the absence of shift of interference fringe. All of them are surmountable. I have no doubt that having

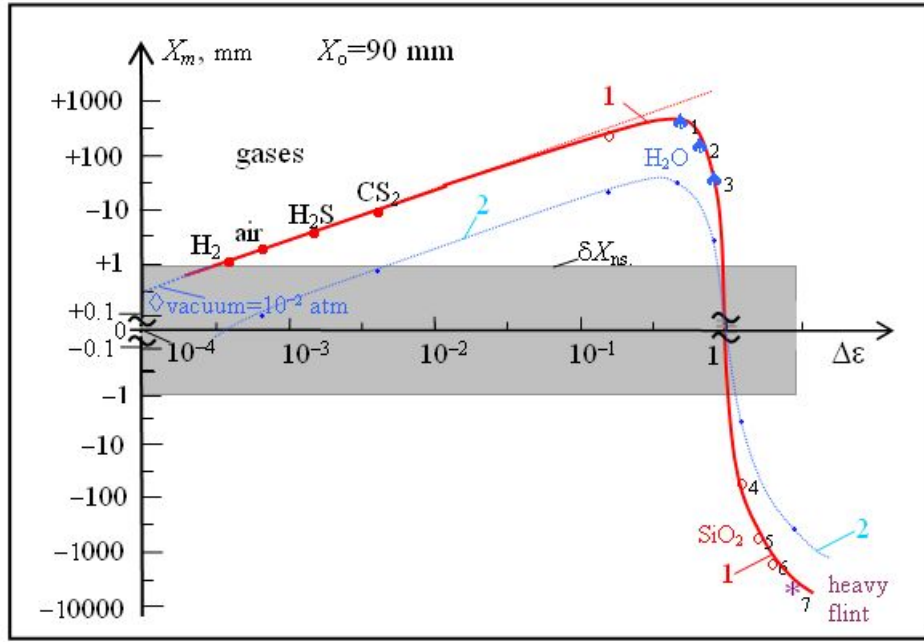


FIG. 3: Dependence $X_m(\Delta\varepsilon)$ of the amplitude X_m of interference fringe shift at the kinescope screen on the contribution $\Delta\varepsilon$ of particles into the full dielectric permittivity ($\varepsilon = 1 + \Delta\varepsilon$) of light's carriers of the interferometer obtained for various light's carriers: \diamond – vacuum, 10^{-1} atm; \bullet gases; \spadesuit_i water; o_j fused quartz; $*_7$ heavy flint glass (F5) at a blue ray (all experimental values are reduced to $L = 6.0$ m and $\lambda = 6 \cdot 10^{-7}$ m). The curve 1 corresponds to $X_m \max$, and curve 2 to $X_m \min$ in the notations of Fig.2; at the local time of observation $X_m \max$ is correspondent by the projections (about 480 km/s) of the "aether wind" velocity on the horizontal plane of the device, and for $X_m \min$ these projections decrease to about 140 km/s (at the latitude of Obninsk). $X_o = 90$ mm is the width of the interference fringe on the screen of the kinescope. δX_{ns} jitter noise of the fringe on the screen of the kinescope.

overcome all methodological difficulties or taking into account my recommendations, or using new methods, that perhaps I do not know, each experimenter will be able to reproduce the dependence $A_m(\Delta\varepsilon)$ disclosed by me in Fig.3.

All the results presented in Fig.3 are reduced intentionally to the data obtained on an interferometer with air light's carrier ($\Delta\varepsilon_{air} = 0.0006$). This is done in order to show the tremendous growth of the resolving power of the interferometer, equipped by light's carriers with much greater magnitude of $\Delta\varepsilon$, than that of the air. In addition, in Fig.3 these results are more fully represented in the range of permeability of optical media $1 < \varepsilon < 1.01$. On the one hand, they clearly show that Michelson interferometer in the absence of material light's carriers (i.e. in vacuum at $\varepsilon = 1$, $\Delta\varepsilon = 0$) is not sensitive to the kinetic interaction with aether. On the other, they completely refute [1, 2] the myth of the "negativeness" of Michelson experiments.

These are the experiments represented by the linear portion of the dependence $X_m(\Delta\varepsilon)$ of amplitude X_m of the fringe shift on the part of the permeability $\Delta\varepsilon$ of light's carriers of the interferometer due to particles, which prove the above conclusions on the loss by the interferometer of the sensitivity to "aether wind" when $\varepsilon \rightarrow 1$, i.e. $\Delta\varepsilon \rightarrow 0$. Thus, in an experiment in Fig. 3 with $L = 6$ m in the air ($\Delta\varepsilon = 0.0006$) in the "rush hour" of the maximum of the observed amplitude of the fringe shift A_m (by Fig.1 this is $t_{local} = 12$ o'clock) there is registered the fringe shift $X_m \sim 2$ mm. When the pumping of the air from the zones of propagation of rays of the interferometer starts, already at the residual pressure ~ 0.1 atm in flasks (i.e. when $\Delta\varepsilon \sim 0.00006$) the fringe shift ceased to be observed (the apperancy is that $X_m \sim 0$), and this is with the resolving power of my unit ~ 0.7 mm. Fig.3 shows by the point \diamond that in reality the fringe shift $\Delta\varepsilon \sim 0.00006$ exists, but it is buried in the noise of the device, the level of which was $\delta X_{ns} \sim 0.7$ mm. Let us turn the variation of $\Delta\varepsilon$ in the opposite direction. Raising the air pressure in flasks up to 3 atm the value of $\Delta\varepsilon$ will rise to about 0.0018, while the shift of the fringe will increase to 6 mm. Replacing the air in flasks by carbon disulfide with the magnitude of optical permittivity $\varepsilon_{CS_2} = 1.0036$, we get almost a sixfold increase in the amplitude of the fringe shift: $X_{mCS_2} \sim 11$ mm (Fig.3). These data constituted the basis for empirical modernization of Michelson formula (1) in the following original form [1]: $V \approx c[A_m\lambda/(L\Delta\varepsilon)]^{1/2}$.

Performing experiments on the interferometer with light's carriers in a wide range of values of dielectric permittivities $1.1 < \varepsilon < 3.0$, I discovered a new effect of changing the sign of the amplitude of fringe shift at $\varepsilon = 2$ ($\Delta\varepsilon = \varepsilon - 1 = 1$), and to the 1971 year have obtained the following formula for determining the velocity of "aether wind" (the details

of its derivation are described in [1, 2]):

$$V = c\varepsilon^{-1/2} \left[\frac{A_m \lambda}{L \Delta \varepsilon (1 - \Delta \varepsilon)} \right]^{1/2} \quad (3)$$

and, accordingly, a new formula to estimate the expected value of the relative amplitude of the shift – resolving (3) with respect to A_m :

$$A_{m \text{ expect.}} = \varepsilon B^2 L \Delta \varepsilon (1 - \Delta \varepsilon) / \lambda. \quad (4)$$

These formulas explain all known since 1881 year results of experiments on Michelson interferometer and all vicissitudes of its misinterpretation:

1) The "lack" of fringe shift in the experiments with interferometers in the normal air pressure with $L_{\parallel} = L_{\perp} = L < 5$ m [3]. With the resolving power of the interferometer $1/40$ of the bandwidth, the expected fringe shift by (4) is obtained much less than $1/40$, i.e. there is a shift, but it is not observed being buried in the noise.

2) Detection of the fringe shift in the experiments with interferometers at normal air pressure with $L_{\parallel} = L_{\perp} = L > 20$ m [4, 5], but the results were processed with the Michelson formula (1). In this case, the speed of "aether wind" is invariably underestimated giving values in the range $5 < V < 10$ km/s. I found that non-accounting in (1) of the dielectric permittivity of the air light's carrier in Michelson interferometer gives hundred-fold underreporting of the velocity of "aether wind" by (1) in comparison with the correct formula (3). Clearly, that obtained by Miller with (1) estimations of the velocity of "aether wind" $5 < V < 10$ km/s were considered as "noise" of the device. Processing of Miller experiments (of the curve 3 in Fig.1) by formula (3) gives the correct estimation of the speed of "aether wind": $200 < V < 400$ km/s.

3) All refutations of finite interference fringe shifts found by [4], Miller [5] and others on air interferometers where the zones of light propagation were vacuumed are based on misunderstanding of the principle of action of the interferometer. I proved that with $\varepsilon \rightarrow 1$ the interferometer loses its sensitivity to "aether wind".

The publication in [2] of my results, obtained on Michelson-type interferometers with liquid and solid media as light's carriers will likely revive attempts of their repetition, checking and rechecking. Formulas (3) (4) provide the necessary basis for a definitive debunking of the myth of "negativeness" of Michelson experiments. However, the experience gained by me in measuring the amplitude of the shift of interference fringe, when installing into the device of light's carriers made from different optical-transparent media, tells me that there may appear "negative" results in the recurrence of my measurements. While I am aware of only two experimental works [6] and W.Lawrence in [9] stating that measurements on Michelson interferometer with solid light's carriers (plexiglas etc.) gave "negative" result (i.e., not gave the expected large shift of interference fringe, which would be many times higher than the noise of the device). Below I will discuss some hidden reasons that can lead to failure of all measurements on interferometers with liquid and solid carriers of light.

4. TWO SECRETS OF THE SUCCESS IN MEASURING ON MICHELSON-TYPE INTERFEROMETER WITH LIQUID AND SOLID OPTICAL-TRANSPARENT MEDIA AS LIGHT'S CARRIERS

I will briefly describe here two probable reasons, the neglect of which may nullify the results of all the expected high sensitivity (by the shift of interference fringes) Michelson-type interferometers with large optical density light's carriers made of optical-transparent liquids or solids. The fact is that in the traditional scheme of the interferometer light's rays propagate in a homogeneous air without encountering any other optical-transparent media with different refractive index. When you install high optical density media across the beam path there arise inevitable unwanted reflections of the part of the beam's energy that may completely disrupt the planned process of basal interference of two main orthogonal beams.

When I built my first interferometer with large optical density light's carriers (initially in the form of cuvettes with water, then the rods of fused quartz), I was shocked, firstly, by a much higher contrast interference fringe on the kinescope's screen than it was in the interferometer with air light's carriers and, secondly, by the dead immobility of the interference fringes. Only after several months of examination it became apparent the reason. It appeared to be the formation in the scheme of the interferometer of the zones of parasitic interference. Below, I consider (in Fig.4) how to construct an optical interferometer scheme that eliminates all possible foci of local zones of extraneous interference while maintaining its core, working, interference of rays that passed through the light carrying medium along *the entire length of the arms* of the interferometer.

Thus **the first cause** of a negative result ("zero" shift of interference fringes) is concerned with disturbances from the foci of parasitic interference in the areas of jumps of the refractive index. In order to overcome it we must find methods to increase the observability of the useful signal of the interferometer and reduce the "parasitic"

interfering signal (as in the classical interferometer with air light's carrier [1, 2]). Fig.4_a represents two zones of the interferometer subjected to the greatest risk of severe parasitic interference from improperly constructed optical scheme of the "normally" (i.e., perpendicular to the plane of the end) entering rays into the butt of the specimen of a given light's carrier.

The ratio of the intensity of useful rays $S_{n\perp}$ and $S_{n\parallel}$ to the intensity of the parasitically-reflected ones $S_{r\perp}$ and $S_{r\parallel}$ (see Fig.4_a), as a rule, even in highly transparent media are $S_{n\perp}/S_{r\perp} \leq 1$ and $S_{n\parallel}/S_{r\parallel} \leq 1$, and in media with damping ~ 0.1 dB/cm and above even with $L \sim 20 - 30$ cm there is at all $S_{n\perp}/S_{r\perp} < 0.1$ and $S_{n\parallel}/S_{r\parallel} < 0.1$. This is a situation almost similar to that occurred 100 years ago, when the results of measuring the shift of interference fringe were buried in the noise of low-sensitivity interferometers with air light's carriers (as shown by me in Fig.1).

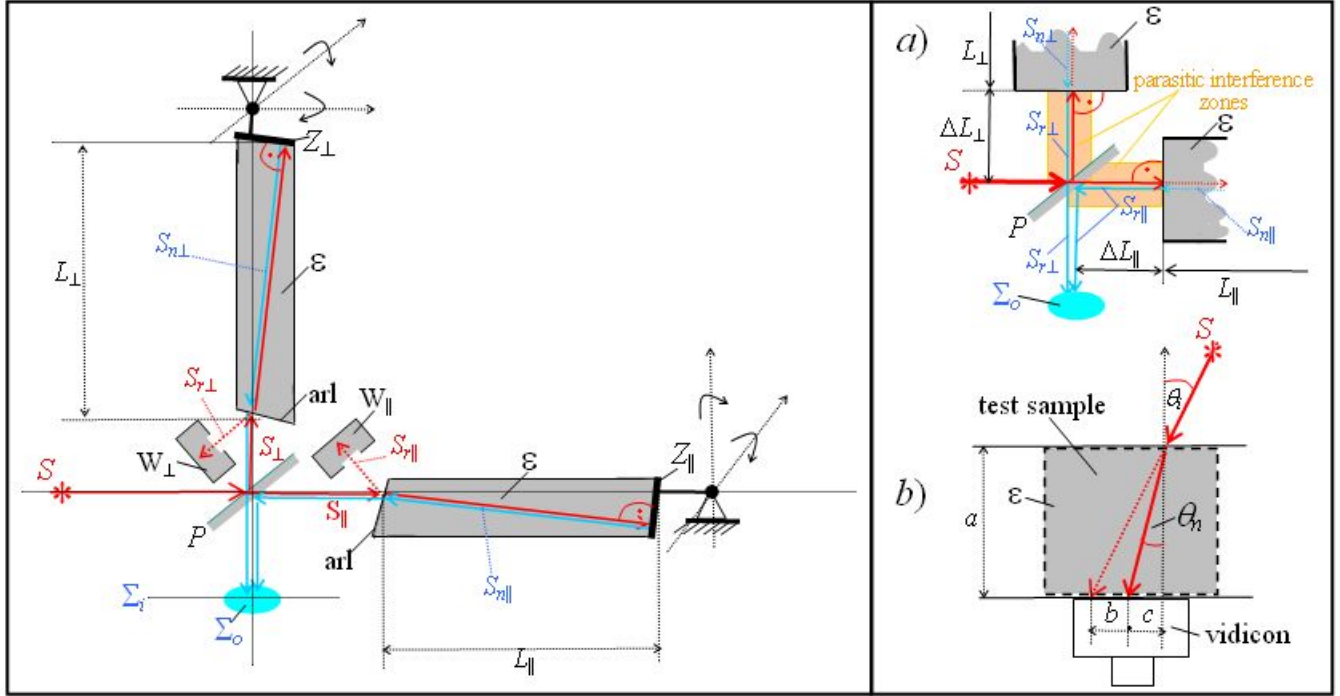


FIG. 4: Optical scheme of formation of rays in a Michelson-type interferometer with light's carriers made of optical-transparent media requiring a cuvette (in case of replacement of air by vacuum, other gases or fluids) or rod design that would eliminate the spurious interference (by means of W – the trap of reflected waves, Z – the mirror, arl – antireflection layer), preventing the monitoring of the base interference of the rays: a) the zone of localization of parasitic interference in the wrong (normal to the rays) orientation of the butt face of the luminiferous cell or rod of improper design; b) the scheme of measurement of the refractive index n or optical permittivity $\varepsilon = n^2$ by the size of the incidence angles θ_i and refraction angle θ_n using the projection on the vidicon's screen of the light's beam used in interferometer.

In the case under consideration when the rays enter from the air into high optical density light's carrying medium by the wrong scheme in Fig.4_a, the interference pattern will be formed by short sections of the air arms of the interferometer ΔL_{\perp} and ΔL_{\parallel} whose length is $\sim 1 - 2$ cm. If Michelson interferometer with $L_{\perp} = L_{\parallel} = 2,4$ m gave the curve 1 in Fig.1, for which the shift was not observed [3] because of the large noise, then in the present Fig.4_a example, when $L_{r\perp} = L_{r\parallel} \sim 2$ cm, the shift of interference fringe will be even 100 times less than it was at Michelson in 1881. There arises the effect of clear-cut, but absolutely "dead immobility" of the interference fringe (I observed this in my experiment). There exist a lot of interpreters, who will consider the experiments on interferometers with high optical density media performed with the methodological error shown in scheme of Fig.4_a, to be "negative".

In section 1 above, I discovered the secret of "negativity" of the experiments on Michelson interferometer with air light's carriers [1, 2]. By this publication I inform the scientific community about the "methodological artifact" which may bury as "negative" all attempts of measuring on interferometers with high optical density light's carriers. I experimentally found the described here effect observed by me in all cases where light's carriers were represented by cells (for gases or liquids) or rods with straight ends perpendicular to rays entering in them.

Fig.4 represents one of the designs excluding zones of parasitic interference which allows to single out the main motive of the interference from the rays $S_{n\perp}$ and $S_{n\parallel}$ through the suppression of spurious radiation $S_{r\perp}$ and $S_{r\parallel}$ by two radical means:

– oblique incidence of the primary partial rays S_{\perp} and S_{\parallel} in the interferometer at appropriately angled butts of high optical density luminiferous element with the directing reflected rays $S_{r\perp}$ and $S_{r\parallel}$ into absorbing traps W_{\perp} and W_{\parallel} (see Fig.4);

– coating angled butts of light's carriers by special quarter-wave enlightening layers (arl), calculated for a given wavelength of light in the beams under the chosen angle of the bevel ends.

In this way I managed to raise the signal/noise ratio $S_{n\perp}/S_{r\perp}$ and $S_{n\parallel}/S_{r\parallel}$ by several hundred times, achieving to perform measurements on the lengths of optical liquid and solid materials up to 1 m, although the sensitivity of the Michelson interferometer with high optical density luminiferous media in the range of permeability $1, 2 < \varepsilon < 3$ (excluding the region of $\varepsilon = 2$) is so high that the length of light's carrying cells with the liquid and rods of solid optical-transparent media may be limited by values $5 \leq L \leq 30$ cm having the signal/noise ratio not less than 10 (if to remove properly all the above described "terminal artifacts of parasitic interference").

The second reason of the negative result, which can give the effect of zero shift of interference fringe, and it must be taken into account, is concerned with discovered by me [1, 2] the phenomenon of complete loss of sensitivity of the interferometer to "aether wind" at the value of optical permittivity of light's carriers equal to 2 (i.e. $\Delta\varepsilon = \varepsilon - 1 = 1$, see Fig.3). I checked the effect of loss of sensitivity of the Michelson-type interferometer with light's carriers having the value of optical permittivity ~ 2 in the following media: water at a blue ray $\lambda \sim 3 \cdot 10^{-7}$ m, plexiglass, polystyrene, transformer and capacitor oils, polyethylene at the ray $\lambda \sim 5 \cdot 10^{-7}$ m. In all these cases the possible values of the dielectric permittivity are in the range of $1.95 < \varepsilon < 2.05$, in which classical linear theory expectations of high sensitivity of the interferometer to "aether wind" are not realized. In this interval, according to my experimental data (see Fig.3) and their theoretical interpretation by formula (4), the shift of interference fringe by the principle of action of Michelson interferometer, operating on the effects of second-order $(V/c)^2$, when $\varepsilon = 2$ passes through zero, changes sign of the shift and certainly sunk in the noise of the device in the neighborhood of $\varepsilon = 2$.

The thing is that there were already proposed erroneous models for interpretation of the expected results for the Michelson interferometer with light's carriers having $\varepsilon > 1$, which assumed the classical scheme of composition of the speed of light in a medium $c_n = c/n$ and speed V of the medium itself in the form: $c_n = c/n \pm V$ [8, 9]. This scheme does not satisfy the principle of Lorentz invariance. However on that grounds there was derived formula for the evaluation of the amplitude X_m of the observed shift of the interference fringe giving a proportional increase $X_m \sim \Delta\varepsilon$. For $\Delta\varepsilon = 1$ this model predicts a huge shift of interference fringe (hundreds of times more than in the interferometer with air light's carrier), which in reality is absent, because $X_m(\Delta\varepsilon = 1) = 0$ (see Fig.3). Proposed by me the theory [2], based on material Maxwell's equations and Fresnel formula, is fundamentally Lorentz invariant. It predicts not linear but a parabolic increase in the amplitude of the fringe shift $X_m \sim \Delta\varepsilon(1 - \Delta\varepsilon)$, that is consistent with the experimental results shown in Fig.3.

It remains for me to draw the attention of experimentalists to yet another simple scheme (it is shown in Fig.4_b) of preliminary testing optical-transparent materials concerning their suitability as light's carriers in Michelson interferometer. It is based on the use of oblique incidence (angle of incidence θ_i) of a laser beam of selected wavelength on the horizontal plane of the vidicon's screen for fixing at it the point of impact (initial test). Once installed on the path of the ray the cell (having parallel edges) with the subject gas or liquid, or after the installation of a solid-state optical-transparent sample (with parallel edges), as shown in Fig.4_b, by the shift (b) of the spot (final test) there is determined the angle of refraction θ_n (hence, the refractive index n or optical permittivity $\varepsilon = n^2$). By the ratio of the brightness of the spot after installing of the test material to the brightness of the spot before the installing there is assessed the optical attenuation (damping) per unit length of the beam in the medium. Errors from the cell sides are accounted for trivially by methods of ray optics. These errors, of course, are reduced to the desired level by thinning-down the walls of the cell.

5. THE SECOND MEANS TO DETERMINE VELOCITY OF "AETHER WIND" – VIA THE WINTER RELATIVE TO SUMMER REDUCTION (BY 12%) OF THE INTERFERENCE FRINGE SHIFT

The first way to determine the horizontal projection of the maximal velocity (designated by V') of aether wind via the maximum amplitude of the interference fringe shift (where A_{mmax} is measured in the course of the round-the-clock observation with the interferometer, as is shown in Fig.2) consists in the calculation of $V' = V$ substituting A_{mmax} in formula (3).

The second method became possible after that there were reliably measured time dependencies $A_m(t_{local})$ of the fringe shift amplitude A_m on the local time t_{local} through the 24-hours cycle of the day and night (see Fig.2). From dependencies $A_m(t_{local})$ in Fig.2 we may monitor the peak value A_{mmax} through all seasons of the year. At the latitude of the city Obninsk the displacement of the $A_m(t_{local})$ peak appeared to be two hours per month (Moscow time). I found that during six months (from 22 June to 22 December) the peak of dependence $A_m(t_{local})$ shifts by 12 hours and attains the maximal ratio $A_{mmax}(22.06)/A_{mmax}(22.12) = 1.12 \pm 0.01$, i.e. this ratio grows by 12%.

Independent astronomical observations of the projection of the sum of the Earth's linear velocity of motion around the Sun and Earth's linear velocity of motion around the center of Galactic show that in summer (22 June) this sum equals to ~ 235 km/s and in winter (22 December) ~ 205 km/s [10]. Thus, if the seasonal increase (from December to June of the next year) of the maximal fringe shift in the horizontal plane of the device (by $\sim 12\%$) is due to change of the sum of the projection on the horizontal plane of the device of the Earth's round the Sun velocity and linear velocity of the Earth's motion around the center of Galactic, equaled to $\Delta V \sim 30$ km/s, then the horizontal projection of the aether wind velocity at summer day-and-night peak (it is designated by V'') can be determined from the ratio of summer V'' and winter $V'' - \Delta V$ velocities of the interferometer, being obtained according to (3):

$$\frac{V''}{V'' - \Delta V} = \left(\frac{A_{m \max \max}}{A_{m \max}} \right)^{1/2} = \sqrt{\xi}. \quad (5)$$

By (5) the peak summer velocity of the Earth relative to aether equals to $V'' = \Delta V / (\sqrt{\xi} - 1) = 30 / 0.06 \sim 500$ km/s. Clearly, the indirect estimating of V'' by the second means, from the maximal shift of the interference fringe in 24-hour cycle of the observation of the dependence $A_m(t_{\text{local}})$ in the realms of summer ($A_{m \max \max}$) and winter ($A_{m \max}$) day-and-night peaks (Fig.2) agrees satisfactorily ($V'' \approx V'$) with the direct measurement of the peak aether wind velocity ($V' = 480$ km/s) performed by the first method in the day-and-night cycle (140 – 480 km/s) [1, 2].

6. CONCLUSION

Thus, if you have already performed experiments on Michelson interferometer with high optical density light's carriers (e.g., [6]), where for one reason or another there has not been recorded the shift of interference fringe, you should not rush to insist on the historically erroneous conclusions of science of early 20th century that Michelson-type experiments are allegedly "negative". Instead you should look for methodical artifacts in the design of your apparatus and remove them. The above described means to eliminate artifacts in Michelson interferometer (Fig.1), my experimental results (Fig.2 and Fig.3) and their interpretation [1, 2] testify to a great potential in increasing the interferometer's sensitivity to "aether wind" enabling us to achieve the "positiveness" of Michelson-type experiments, and thus to prove in principle the possibility to observe absolute motion of inertial bodies.

The described here second method of the indirect estimation of the horizontal projection of the peak velocity ($V'' = 500$ km/s) of aether wind (in the range of the day-and-night measurement of the maximal interference fringe shift at the latitude of the city Obninsk, Fig.2) quite well coincides with the first, direct, way of determining this velocity ($V' = 480$ km/s) by formula (3). Both methods convincingly agree with the mechanics of well-known recent astronomical observations of the Earth's motion at two orbits, around the Sun and around the center of Galactic. All majority of physical experiments on Michelson interferometer, being consistent with measurements in other areas of physics, shows the possibility in principle of observation (by means of this device) of the absolute motion of inertially mobile objects with respect to world aether.

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