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E2-94-21

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DOES THE RELATIVITY PRINCIPLE VIOLATE?

Submitted to «Fortschritte der Physik»

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1994

Introduction

It was quite obvious for the Middle Ages scientists that in our World the absolute associated with motionless stars reference frame exists where every motion early or late turns into rest state. First formulated explicitely by Galiley the principle of relativity (all inertial frames are equivalent and theare is no method to ascertain if we are moving or staying at rest) was one of those "mad ideas" which, figuratively speaking, blow up the world outlook of contemporaries.However, as the universally recognized truth, this idea came into beeng quite not at once. Just as some people to-day don't believe Einstein theory of relativity, the principle proposed by Galiley was also criticized severely from theoretical points of view and put to experimental disproofs on the part of those, who were more inclined to the time-tested antique picture of World.

Mathematically the Galilean relativity principle is formulated as the demand of the invariance of all physical laws with respect to the linear coordinate transformation

$$x' = x - vt. \qquad (1)$$

where v is the reference frame relative velocity. Following Evariste Galois and Sophus Lie, one began to name such transformations as group: it contains the identical and inverse elements and, chiefly, two successive transformations could be replaced by a summary one which differs by the velocity $\mathbf{v} = \mathbf{v}_1 + \mathbf{v}_2$ only. Taking into account a rotation, we get a group of transformation

$$G(\mathbf{v}_1; \mathbf{R}_1)\mathbf{G}(\mathbf{v}_2; \mathbf{R}_2) = \mathbf{G}(\mathbf{v}_1 + \hat{\mathbf{R}}_1\mathbf{v}_2; \mathbf{R}_1\mathbf{R}_2), \qquad (2)$$

where $\mathbf{v}_i$ are considered inertial frame velocities, R_i are parameters characterizing the relative orientation of these frames.

While physics delt with the mechanics, mainly, the equations of which are invariant under such transformatoins, the relativity principle possessed a firm basis. However, investigations of electromagnetism gave evidence that the invariance of the describing this phenomenon equations under the Galilean transformation (1), (2) is violated and electromagnetic forces change their form by a transition to a new inertial frame. It is easy, without any calculations, to make sure in this if we remember that a charge at rest doesn't produce a magnetic field, but in a reference frame where it moves, such a field appears without fail. In other words, magnetic forces depend on the choosen frame. And what is more, to explain the phenomenon of electromagnetic waves, one had to suppose the existence of a peculiar medium in Universe, i.e. the world ether. Physicists got the opportunity to assotiate with this all-permeating medium, as early with stars, a preferred, absolute motionless reference frame.

One would think that electromagnetism buried the principle of relativity. However, the idea about the world ether was highly contradictory. Particularly, by explanation of some experiments one had to consider the ether indeed as being completely moutionless and to assume the existence of a ether wind in space slowing down or speeding up the transmited light and other electromagnetic radiation, whereas by an interpretation of other observed phenomena, on the contrary, it was necessary to take into account a dragging of the ether by moving bodies. The famous Michelson-Morley experiment measuring the light speed in two perpendicular directions has shown that the Galilean composition law for light and body velocities $\mathbf{c}_\pm = \mathbf{c} \pm \mathbf{v}$ is not applicable in this case for some reason.

At the boundary of our century two ways to circumvent the difficulties were proposed. The former was worked out by Lorentz, the latter was expressed most clearly by Einstein. Lorents has shown that it is possible to put physics in order if we assume the dependence of body sizes and durations of associated processes on the velocities relative to the motionless ether medium, i.e. if the diameter of every moving clock is decreasing along the velocity vector direction and their time-rate is slowing down. If in the frame assotiated with the world ether some point of a body has been marked by the space-time coordinates $\mathbf{x} = \{x, y, z, t\}$ then in consequence of a inertial motion along x-axis these coordinates get the new values

$$x' = \gamma(x - vt), \quad y' = y, z' = z, \quad t' = \gamma(t - xv/\mathbf{c}^2), \qquad (3)$$

where $\gamma = (1 - \frac{v^2}{\mathbf{c}^2})^{-1/2}$, $\mathbf{c}$ is the light speed in the ether. As long as every uniform rectilinear motion changes all rulers and time standards to the equal degree then all inertial frames are also absolutely equivalent from kinematical point of view. In all these frames the principle of relativity remains valid, only one has to use the Lorentz formulas (3) instead of Galilean one's. According to Lorentz only one single frame, namely the absalute ether frame posesses the peculiar, priviged properties. In this frame physical processes can proceed differently in comparison with other coordinate systems. This circumstance violates the principle of relativity and allowes to determine by means of a comparison with "absolute standards" does the considered frame move or is at rest.

Lorentz had to assume the existence of such absolute motionless frame, since if the alteration of body sizes is due to their deformations, then the coordinate system where these sizes stay undeformed must exist. As the saying does if one had said "a" , he has to say "b" also.

Einstein agreed that the alteration of space-time intervals is real, experimentally measured phenomenon however he considered that it is not a property of the bodies itself, but is a kinematical consequence of the essentially different determination of the simultaneity in reference frames moving with distinct velocities. According to his theory, points which are simultaneous in some frame in other ones have to do with different times and, to measure the length, one needs then to use new points. Such a kinematic distortion is described by the same formulae (3) as in the Lorentz theory and depends on the relative velocity of the considered frames. In other words, Enstein removed the difficulties using the generalization of the principle of relativity. He has spread the application of this law from purely mechanical phenomena to all other physical events.[1]

It looks as that what occured to another gread principle of modern physics — principle of causality a transition to a transient electromagnetic processes demanded the substitution of their classical formulations used in Newton physics for the relativistic ones.

One can say that in the Lorentz theory the relativistic contraction of the size of a clock and its delay are dynamic by nature, in the Einstein theory they are naturally kinematic. In inertial frames the both approaches are identical.

The latter becomes especially obvions if we notice that the Lorentz theoty could be formulate in two ways. First, in the way more precisely expressing its physical meanang when one takes explicitely into account the contraction of lengths $l' = l/\gamma$, time delay $t' = t\gamma$ and adds velocities according to the "orginary rule"

$$v = v_1 + v_2' = v_1' + v_2, \tag{4}$$

where the both terms are expressed in the metric scale of the same

[1]Following strictly to the chronology of publications one has to recognize that the basic suppositions of the theory of relativity,iucluding the generalization of the Galilean principle were formulated for the first time by H.Poincare [1,2]. However, he was convinced that the Lorentz and Galilean transformations are absolute ly equivabut from the princinial point of viev and the use of one or an other is a matter of the covenience and the agreement only. In contrast to Einstein, Poincare ignored the fact that the relativistic invariance is the important physical law, which expresses exactly the essence of the theory of relativity. Therefore, the most physicists are convinced that just Einstein, but not Poincare, is the author of this theory[3,4]. At the same time there is another point of view according to which the principal element of the relativistic theory is the recognition that all elements of our World are plunged into a gravity-free, plane and isotropic (pseudo-Euclidean) four-dimensional space-time, while the relativity principle is only a consequence of this fact [2]. Since Poincare was the first who emphasized the significance of pseudo-Euclideancy, it is lawfully to consider him also as the author of the theory of relativity. However it would be more correct, perhaps, to consider this theory as a collective creation of Lorent, Poincare and Einstein, although below, for short, we shall name it often as "Einstein theory".

frame: $v_i' = \xi_i v_i$ and the equalizing scale coefficients

$$\xi_i = 1/\{[\delta_{i1}\gamma_2^2 + (\delta_{i2} - 1)\gamma_1^2](1 + v_1 v_2/c^2)\}.$$

Second, similar to the Einstein theory, one can express the Lorentz theory by means of transformations (3) when the relativistic alterations of space-time intervals are taken into account automaticly and "relativistic rule"

$$v = (v_1 + v_2)/(1 + v_1 v_2/c^2), \tag{5}$$

for the composition of velocities is used. In inertial frames the both ways are equivalent.

The distinction of the Einstien's and Lorentz's approaehes may become remarkable in some dynamic (noninertial) effects, for example, in the development of deformations in solid bodies (see below); it is essential, of course, when the question is the existence of an absolute system of coordinate. Since there are no sufficiently reliable experiments presently which demonstrate some deviations from Einstein theory, most physicists believe that concepts of the world ether and the absolute frame are temporary, embarrassing their significance "scaffolding" analogous to the old modynamic concepts about phlogiston etc.[2]

Most of scientists believe the relativity principle now so firmly as the arithmetic laws. A large amount of experiments convince us that beeng inside an isolated inertial system we can not acertain the fact of its motion. Nevertheless it happened more than once that a revision of facts which seemed to be long ago established and obvious led to an unexpected results. One can say with certainty that there are no laws of nature, which could be applicable always and everywhere. Especially as the principle of relativity suffered change already by the transition from Galilean transformations to the moderne relativistic theory.

[2] It is well-known that simultaneosly with his ideas on relativity Einstein suggested the photon hypothesis of light. Photons can move in empty space and so the ether medium seemed quite uunecessary also from this point of view.

Lorentz himself, summing up the results of his science activity, recognized an advantige of the Einsteins approach as more transparent from the logical poin of wiev and based, essentially, on only one postulate, i.e. on the principle of relativity. At the same time he emphasized his dissatisfaction by the theory of relativity which consides as a postulate that what Lorentz attempted to draw from some more general physical considerations. In his book[5] he wrote that one had to say some words in favor of the approach whith the help of which he tried to give an account of the ether theory. The ether which can play a part of a carier of the electromagnetic field, of its energy and its oscillations, has to be considered as some substance in spite of his striking distinction from an ordinary matter. From this point of view continued Lorentz -- it seems natural not to introduce the supposition about the relativity at the begiuning but to measure the lengh and time intervals by means of rulers and clocks which are at rest with respect to the ether.

Indeed, being inside the classical physics it is very difficult to reconcile the conclusion on a completely empty, "etherless" space with an intuitive idea that the light wave emitted by a source, but did not yet reach our eyes, is transmitted by an intermediate substratum. The quantum theory convinced us in the existence of a peculiar matter medium consisting of vacuum fluctuations. It could be thought that one can associate with this medium the frame which, according to its determination, is preferred, privileged with respect to all others. This frame could be considered as an absolute one.

The "ether frame" is singlet out also by the experimental fact that the spreading in this frame relict microwave radiation is highly izotropic. This circumstance confirms the hypothesis that exactly the considered frame is the accompanying the "primary blow up" in which our Universe has been created and expands isotropicly now.

As long as 30 years ago, X.Bonndy emphasized that a possibility to choose the accompanying isotropic space expansion privileged coordinate system in every space point contradicts the postulates of the theory of relativity [6]. P.Phillips[7] and P.Bergman[8] expressed the analogous ideas also.

In addition, in presenf there are some theoretical reasons to expect relativistic invariance violations at ultrasmall Plank's scales $\Delta x \sim 10^{-32} cm$[9-11];tails of these effects can become apparent at much larger distances and also at very large cosmic scales carrying traces of the primary cosmological explosion.

These and a number of other samilar reasons impel to ponder over merits and demerits of the Lorentz world ether theory and its connections with the Einstein theory of relativity not only diletantes but also professional physicists. For example, it is sufficient to turn over the pages of a couple of volumes of the international journal "Foundation of Physics" in order to be convinced that the flow of "heretical" papers does not become lower but, sooner, increases. (One can see the bibliography of a considerable part of the latest investigations in this region, for instance, in Corniles essay[12]).

Our aim is to select in this flow and to discuss most interesting, in our opinion, papers, particularly the theoretical and experimental investigations in which some deviations from the Einstein theory are believed to be discovered.

Experimental status of the Lorentz transformations.

As has been mentioned yet above, up till now a large amount of investigations have been carried out, particularly in counection with the studying of elementary particle properties, where the excellent agreement of measurements with formulae (3) was observed up to supersmall intervals $\Delta x \sim 10^{-16} cm$. However, investigations with the expressed purpose to study the accuracy of the Lorentz transformations are rather rare (see a bibliography in papers[13,14]). Their results reduce to the following.

Let us write down the Lorentz transformations in a more general form coinciding with (3) in the small velocity limit $v/c \ll 1$[15-18],

$$\left.\begin{array}{rcl} x' & = & a_1(v)(x - vt) \\ y' & = & a_2(v)y, \quad z' = a_2(v)z \\ t' & = & a_3(v)(t + fx) \end{array}\right\} \qquad (6)$$

where the coefficient f is fixed by a clock synchronization procedure and the expansions

$$a_i(v) = 1 + \alpha_i(v/c)^2 + \ldots, \qquad (7)$$

are valid for function a_i becuse all linear terms $\sim v/c$ vanish due to the supposition of isotropic propagation of light in the initial frame: $c(\theta, \varphi) = c$. (About the validity of this assumption and the possible contribution of linear terms see below).By these conditions the velocity of light emitted ander an angle Θ' in a moving frame

$$c'(\theta') = [1 - (1 + \alpha_3 - \alpha_1)(v/c)^2 +$$

$$+ (1/2 - \alpha_1 + \alpha_2)(v/c)^2 \sin^2\theta'] + \dots \quad (8)$$

It is evident that relations (6) coincide with Lorentz formulae (3) and the light velocity $c'(\theta')$ is isotropic if

$$\alpha_1 = 1/2, \quad \alpha_2 = 0, \quad \alpha_3 = -1/2, \quad (9)$$

The measuraing of elementary particle life times and the most precise interference optical experiments have shown [13]

$$\alpha_1 = 1/2 \pm 7 \cdot 10^{-5}, \quad \alpha_2 = 0 \pm 7 \cdot 10^{-5}, \quad \alpha_3 = -1/2 \pm 10^{-7}, \quad (10)$$

These results are confirmed also by experiments with scattering elementary particles, where relativistic theoretical expressions are compared with measured data. True, the interpretation of these data depends, as a rule, on assumptions about the particle structure and their interaction properties, nevertheless the comparision of a greater amount of the known measured data allows to assert that the theory of relativity agrees with the modern experiment within some hundredths of percents.

One can get essentially a greater accuracy only from measurements of energy levels shifts in atoms moving in electromagnetis fields. This phenomenon is described completely by the well-known relativistic invariant electromagnetic laws. If the observed discrepancy between experimental and theoretical data is attributed to the deviation of the limiting speed of material bodies (i.e.bodies with a nonzero rest mass) from vacuum light velocity c, then the measurements convince that the difference Δc is extremely small: $\Delta c/c \leq 5 \cdot 10^{-21}\%$. In formulae (7) this corresponds to the value $\alpha_3 = -1/2 \pm 10^{-18}$. (A summary of the $\Delta c/c$ values obtained by several authors is presented in the review [14]).

It is very important to note that in all mentioned above experiments the deviations from the Lorentz transformations were investigated in the quadratic terms $\sim (v/c)^2$ only. The linear terms which, generally speaking, may exceed significatly the quadratic ones are left uncertain. In the formulae describing level shifts they, are absent at all, in interference experiments the total compensation of linear terms takes place.

The mechanism of this compensation can be understood by an example of the well-known Michelson-Morley experiment, where one observes an interference of two rays created by the spliting of a primary light beam by means of a semi-transparent mirror M_1 (see Fig.1). These rays propogate in parallels and perpendicularly fo the laboratory (Eearth's) frame velocity **v**. In view of the Lorentz hypothesis about the existence of the motionless ether frame the time of light travel in the direct and opposite directions $t_\pm = l_1/(c \pm v)$. The summary time $t_+ + t_- = 2l_1\gamma^2/c$ does not depend on linear terms $\sim v/c$, the factor γ is compensated by the second Lorentz hypothesis about the contraction of all lengths along the velocity direction. Therefor, the interference picture is not changed by the 90^0-turning of the device. [3]

So, independent of using the Lorentz or Einstein interpretation, one cannot deduce any information about the vector **v** from interfernce experiments where we deal with round-treep velocities. In order to reveal linear terms, one needs experiments where the interfering rays pass their ways partly at least in one direction, when the summation t_+ and t_- is absent.

Clearly, the independent measurement of the one-way light speeds c_+ and c_- demands a preliminary time synchronization at different space points. (At the beginning and at the end of the passed interval). If Lorentz formulae (3) are used for that, then we receive automaticly $c_+ = c_- = c$ since these formulae contain already the

[3]Let us note that in the most precise, using a laser techniques repetition of the Michelson-Morley experiment [19], the equality of the travel times of interfering light rays has been measured with the fractional error $\Delta t/t = \pm 10^{-15}$ what corresponda to the difference of the light velocities in the motionless (preferred) and the moving (Eearth's) frames $\Delta c/c \leq 10^{-7}\%$ and to the difference $\alpha_2 - \alpha_1 = -1/2 \pm 5 \cdot 10^{-9}$[13].

assumption about the equality of the one-way light velocities in direct and opposite directions [1,20]. However, when a sufficiently slow transportation of the clock is used for the time synchronization (with a speed v) then, as it was noted by P.Bridgeman [21], the unknown velocities c_+ and c_- can be measured as the limits by $v \rightarrow 0$.

So long as the immediate measurement of the one-way light velocity is a rather difficult problem even for most length distances available in Earth's conditions, practical determination of linear corrections to the Lorentz formulae became to be possible only later and there are few such experiments yet [22-27].

In all these cases an anisotropy of light velocity c or light frequency ν with respect to the velocity vector of Earth's motion within "gas" of relict photons ($v \simeq 300km/sek$[38]) has been investigated. The most precise measurements of the anisotropy have been done in the Mösbauer rotor experiments measuring Doppler shift for γ-quanta emitted by a source mounted on the rim of a rapidly spinning disc relative to the resonant frequency of an absorber located at the center of the disc: $\Delta\nu/\nu = \varepsilon \mathbf{uv}/c^2$ where $\mathbf{uv} = uv\cos\theta$ is a scalar product of source velocity $\mathbf{u}$ and absolute Eearth's velocity $\mathbf{v}$ relative to the ether frame [22-24]. A specific value of vector $\mathbf{v}$ is not essential because the angle θ changes due to twenty-four-hours Eearth's spinning, and it is sufficient for the measuring of the anisotropy ε. In that way the value $\varepsilon = 0 \pm 1.8 \cdot 10^{-7}$ was obtained.

In works [26,27] the velocity of photons emitted by a excited atom beam and daily variations of the travel velocity of a laser pulse along an 21-km ultrastable fiberoptic link were measured. In the last case the ight velocity $c(\theta)$ has been fixed by an comparison of phases of hydrogen maser clocks on the fiberoptic link ends.One got the values $\varepsilon = 0 \pm 1.4 \cdot 10^{-6}$ and $\varepsilon = 0 \pm 3.6 \cdot 10^{-4}$, accordingly.

Thus, in works [17-20] no deviations from formulae (3), which could violate the principle of relativity and allow to determine the speed of a isolated inertial system, have been observed.

Some doubts

At the same time some papers are known, the authors of which report the discovery of the explicit deviations from transformations (3). First of all, one has to note the comperatively easy from metological point of view Marinovs and Silvertoothese experiments [29–33] where the linear effects $\sim (v/c)$ were investigated.

Marinov used a device with two discs fixed fast on a common axis (see Fig.2) [29]. The intencities I_+ and I_- of the left and right laser rays passing through disposed face to face holes of the discs are measured by the couple of photo-cells Φ_1 and Φ_2. The detector D (a bridge of resistances) allows to measure the summary and differential currents $I_c = I_+ + I_-$ and $I_p = I_+ - I_-$ coresponding to the sum and difference light intencities [4]

In the case of motionless discs the fixed by photo-cells light intencities

$$I_\pm = \alpha_\pm n S$$

where S is the area of the hole, n is a total number of holes on the disc.

If the discs do N revolutions per second, then the alterations of the intencities

$$\Delta I_\pm = \alpha_\pm n N \Delta S_\pm$$

where $\Delta S_\pm = 2\pi(R/l)\Delta t_\pm$ are the alterations of the open for laser rays area, l is the size of a hole, R is the hole distance from the disc centre. $\Delta t_\pm = d/(c \pm v)$ are the times of light travel between two discs, v is Earth's velocity relative to the world ether frame.

[4] The proposed by C.Marinov "Newtonian synchronization" by means of a rigid (nondeforming) revolving axis along which the clock hands are fixed at various distances [29,34] does not differ, as a matter of fact, from the mentioned above Bridgeman's one, since it is possible to neglect axis deformations and to consider the axis as absolute rigid in the limit of very small speeds only. In general, every measurement procedure, even an elementary count of objects,demands some theory. From this point of view the use of the Newtonian mechanics for the aim of synchronization in the region, where this theory proved to be correct, is not a bit worse that the use of the Einstein theory of relativity which, one can formly convinced, is also a particulary case of an yet unknown but more general approach.

It is follows from the expression for $\Delta t\pm$:

$$\frac{v}{c} = \frac{\Delta I_- - \Delta I_+}{\Delta I_- + \Delta I_+} == \frac{\Delta(I_- - I_+)}{\Delta(I_- + I_+} = \frac{\Delta I_p}{\Delta I_c}, \tag{11}$$

i.e. Earth's velocity measured in a isolated from the outside world frame is determined by an alteration of summary and differentiel currents.

In the Silvertoothes experiments (see review [32] and paper [33]) the plotted in the Fig.3 optical system was used instead of hardly controled mechanical device. The splitted by a semi-transparent mirror M_1 laser ray creates a standing wave between mirrors M_1 and M_2. The positions of its maximums and minimums are fixed with the help of a thin semi-transparent (notpreventing light travel) photo-catode detector D. The laser L and mirrors M_1, M_2 are mounted on a mobile platform. By its displacement on a distance Δ the peak of the light intencity at the point D is replaced by the value

$$I \sim cos^2(\Delta/\lambda), \tag{12}$$

where λ is the laser light wave length.

One can see that a interferometer with counter rays is used here instead of a habitual interferometer with parallel rays.

If our laboratory frame moves relatively the motionless ether with a velocity v then an extra phase shift appears. It is easy to prove by the composing two harmonic waves that the intencity of standing waves, if we disregard terms $\sim (v/c)^2$ and higher, is determined by the same expression (12). However, in Silvertooth opinion, the light speed depends on the absolute velocity (relativily ether frame) as $c_\pm = c/(1 \pm v/c)$ and the light wave lenghes $\lambda_\pm = c\pm /\nu$ have the same dependence also while the frequency ν is velocity independent.[5] In this case, in spite of velocity independency of the counter wave phase shift, the wave lengthes $\lambda_\pm$ differ from the wave length λ_1 measured in the ether frame. Experession (12) can be

[5]Certainly, it is very difficult to reconcile the hypothesis about the relativistic invariance of the frequence with the ferm established experimental fact noninvariance of energy (in the case of photon its energy $E = h\nu$).

written in the form

$$I \sim cos^2(\Delta/\lambda + v\Delta/c\lambda), \tag{12a}$$

Using a semi-transparent photo-cathode as a detector, one can measure the term $(v\Delta/c\lambda)$ and, accordingly, the value of velocity v.

In the Silvertoothes experiments [32,33] and in the slightly modified Marinovs measurements [22] the alteration of the length of interfering waves was fixed in the form (12a) indeed.[6]

In view of the mentioned above excellent agreement of relativistic theory with measurements in one-way velocity experiments [22–27], it seems, one may attribute the results of work [29–33] to experimental errors. However, it looks strange that in all experiments [29–33] the discovered value of v is rather near to the deduced from astronomic observations of Earth's velocity.[7]

The measured angles of vector v are also near to the astronomical ones. (In order to measure their quantities, a part of experiments has been performed by means of a rotating platform, other experiments have been done in varions spaces of twenty-four-hours and seasons).

Is it a consequence of an inaccuracy, one of those artifacts which appear sometimes in physical practice, or on the contrary the conclusion deserving the earnest attention?

So long as the described in papers [30–33] optical measurements are comparatively easy, it is worthwhile to repeat them. For the time being, however, amusing reasults [21–25] are discussed mainly from a position of "belive-don't belive" [35–39].

Recently M.V.Liablin and D.E.Shablin at Joint Institute for Nuclear Research in Dubna realized an experiment which is similar to the Silvertoothes one but is something easier methodically. Instead of the used by Silvertooth rather complicated in making semi-tramsparent photo-catode detector, they considered a differential effect

[6] At the same time the monitoring system measuring the round-treep phase shifts by the help of a Michelson-Morley interferometer confirms the expression (12) but not (12a)

[7] One got the values $v = 378 \pm 8, \quad 303 \pm 20, \quad 386 \pm 38, \quad 360 \pm 40$ km/sek.

in a system of two interferometers. The system (see Fig.4) was invented by C.Marinov as one of the way to realize the Silvertoothes idea. We shall not analyse in detail now the phase shifts corresponding to varions light arms (see papers [32,40] about) and note ouly that side by side with an interference of parallel rays, as in the Michelson-Morly experiment (Fig.4a), the interference of light rays propogating a part of their way in opposite directions takes place (Fig.5b). A displacement of the platform with a mounted laser L has to give a rise to a changing the differential current $I_2 - I_1$ disagreement of phases of these rays and, respectively, to a distortion of the interference picture on the oscillograph screen. Up till now the experimenters have not seen anything like that.[8]

Lef us say several words about reference frames linked with quantum vacuum and cosmic microwave background. The theory and the experiment convice us that in modern physics vacuum becomes apparent as a peculiar type of matterial medium but, in contrast to classical ether, bodies moving inside this medium do not experience a matter resistance ("ether wind").As the calculations show, fastening together vacuum parts forces create a negative tension with energy $(-E_{ten})$ which exactly equals to the own-energy dencity of vacuum E, so the summary "wind energy" $E - E_{ten}$ is zero always, therefore moving bodies simply do not fell any "wind". Inside absolutely homogeneous vacuum there is nothing what could be used as a "anchor" in order "to engage" a coordinate system.

As to the reference frame "engaged" to relict microwave bockground, severel authors, as it has been mentioned above, indentify it with the absolutely motionless Lorentz frame. However, one cannot agree with this point of view — the both frames differ essentially. According to the diffinition, the world ether is a practically unavoidable all-penetrating medium, so one can say that there are no completely isolated physical systems and the reference "ether zero point" always is at our service. If an ether medium were to exist then, figuratively speaking, we would be in the position of a passenger of a transparent train car who can recon his speed with

[8]We are obliged to Mr. M.Liablin and D.Shabalin for the permition to tell about their results which are yet incompleted.

respect to ties and wayside objects [9] Conversely, one can shield oneself from microwave electromagnetic and even from neutrino background (technical difficulties are not consided right now) and to bild an absolutels isolated from outer world shelter (so to say, a train car without windows) inside which there is nothing,what could be used in the capacity of a mark for the reading og the frame velocity. Particularly, every absorver finds himself practicly in such a position if he has no devices to record cosmic background.

A some what more complicated case occurs when one dials with the preferred reference frame where our space expands isotropicaly (Hubble swelling of World). If the precision of measurements is sufficiently high, this phenomenon could be observed not only in cosmic space but in every small isolated from outer world volume also. In this case, as in theories with the hypothetic ether, it makes no sense to speak about a completely isolated physical system. In this respect the "Hubble referentide frame" is preferred indeed. However, in this case four-dimensional space-time can not be considered as pseudo-Euclidian, i.e. as quite flat and isotropic.

The last is rather evident if our Universe appertain to the class of the so-called open or closed Fridman worlds. Nevertheless, the pseudo-Euclidicy is violated also in the case if our tree-dimensional World is completely flat (the known now experimental data do not exclude such a possibility) because our time metrics is not uniform due to the Big Bang singularity. In other words, in the Hubble reference frame gravitanion forces act and it cannot be considered as inertial.

Irrespective of the problem of the world curvature, one may raise a question to what extent the preferrebility of the Hubble reference frame is principial in comparison with all other coordinate systems. As it is known, the general theory of relativity assumes the existence of a great number of absolutely equivalent worlds with various properties among which the isotropic Hubble universes may present

[9] By the way, the mentioned above equivalence of the relativity principle and the requirement of space-time pseudo-Euclidecy is true only under the condition that experiment conferms the lack of fact of frame motion in the world with the pseudo-Euclidian metrics also.

also. If it is possible, of course, to place oneself in a position of a detached on-looker who is capable to go out of his own space-time world. However, it is a philosophical problem already...

Nature of Lorentz contraction

As has been said above already, from point of view of the Einstein relativistic theory the contraction of a moving body is a concequence of the change of the time coordinates at the biginning and end points of its length, therefore this phenomenon is purely kinematic by nature and has to proceed with light velocity, i.e. practically instantaneusly since it is unpossible to forestall the light and to fix ("to see") the body ends still corresponding to the old (motionless) reference frame. From point of view of the Lorentz ether theory the contraction of the body length l is its own property, therefore it is dynamic by nature and in a transition to a new frame the contraction process has to proceed with the same speed, with which deformation waves propogate in the body, i.e. during the time $t < l/c$. This quite real physical rebilding process may be observed.

Thus, performing space-time measurements at the accelerating body during a transition from one inertial motion to another one may hope to asertain which one in two of the alternative points of view corresponds to the real physical situation — the consistencely relativistic one or that based on the hypothesis of motionless ether.

Perhaps, the easiest way to do this is the observation of a iniformly rotating body. It experiences a permanent acceleration and the supposed deviation of its form from that predicted by the theory of relativity, is a constant, time independent effect.

As an example, let us consider a cross made of two rods clamped together at their central points. By a rotation the crossarms will pulsate, i.e. contract and lengthen in ratio $1 : \sqrt{1 - v^2/c^2}$, where v is the laboratory frame velocity. So far as all longitudinal scales change quite in the same ratio, the Einstein theory tells that the pulsation is unnoticed for us and the angle between the crossed rods is right always: $\Theta = \pi/2$. (Otherwise, observing a deformation of the cross one could fix, in conflict with the principle of relativity, the laboratory frame motion and measure its absolute velocity v).

The Lorentz ether theory predicts the same result if the tangential velocity $v_T = \omega l$ is smaller than the deformation velocity v_{def} (ω the angular speed of the rotation). However, in the case of a very fast rotating body, when $v_t > v_{det}$, this theory predicts the really observable angular pulsation $\Theta(t) < \pi/2$. True, the velocity of elastic deformations propogating thorugh the rotating body is much greater than the "critical velocity" v_{cr}, by which a disruption of the body occurs. Practically, the disruption happens when the tangential velocity v_t is yet much smaller, then the velocity of elastic deformation waves.

F.Winterberg [41] noticed that in rigid rods side by side with fast elastic deformations the so-called bending waves occur, velocity of which are (r/l)-times smaller (here r is the rotating rod radins). The ratio $l/r > 10$ is sufficient in order the tangential velocity becoms large than the speed of deformations.[10]

Winterbergs calculations show [41] that in the time dependence of the observed angular deviation from value $\pi/2$ predicted by the Einstein theory must be a resonance and at $\omega = \omega_0$, where

$$\omega_0 \simeq 1.76(r/l^2)\sqrt{G/\rho}, \tag{13}$$

the deviation

$$\Delta\Theta(t) = (v/2c)^2[\frac{\omega_0}{2\omega_1}\sin(2\omega t - \pi/2) - \sin 2\omega t] \simeq$$

$$\simeq (v/2c)^2(\omega_0/2\omega_1)\sin(2\omega t - \pi/2). \tag{14}$$

Here ω_1 is the matter dependent constant. Though the quantity $(v/c)^2 \sim 10^{-6}$ and, as a rule, $\omega_0/\omega_1 \ll 1$, the angular deviation $\Delta\Theta(t)$ reaches a great value. For example, if we have a steel cross with $l = 10cm$ and r=0,5 cm then $\omega_0 \simeq 5 \cdot 10^3 s^{-1}$ and the ratio $\omega_0/\omega_1 \simeq 10^{-6}$. Under these conditions the difference of the cross and positions predicted by two considered theories equal to several

[10]The bending wave velocity $v_{ben} \simeq (r/l)\sqrt{G/\rho}$, while the critical velocity of disruption $v_{cr} \simeq \sqrt{G/\rho}$, where ρ is the matter density of the rod, G and σ are the Young and disruption modules, respectively. The condition $v_t \simeq v_{ben} < v_{cr}$ is satisfied if $(l/r) > \sqrt{G/\sigma} \simeq 10$.

mm. The angular speed $\omega \simeq (5 - 10)10^3 s^{-1}$ is not too great for modern engineering.

Clearly, a discavery of the described by formula (14) phenomenon would allow to estimate by means of the measured value of $\Delta\Theta$ the laboratory frame velocity v and, respectively, disprove the principle of relativity.

Thomas rotation

It is easy to satisfy oneself that in the case of rectlinear motion the relativistic transformations (3) constitute a group:

$$\mathcal{L}(v_2)\mathcal{L}(v_1) = \mathcal{L}(v_2 \oplus v_1), \qquad (15)$$

where the compostion $v_2 \oplus v_1$ is defined by rule (5).

A quite different situation occurs when the velocities $\mathbf{v_1}$ and $\mathbf{v_2}$ are non-colinear. In this case the Lorentz transformations may be written in the form

$$\left.\begin{array}{rcl} \mathbf{r}' & = & \mathbf{r} + \frac{(\mathbf{rv})\mathbf{v}}{\mathbf{v^2}}(\gamma - 1) - \gamma\mathbf{v}\mathbf{t} \\ t' & = & \gamma(t - \mathbf{rv}) \end{array}\right\}, \qquad (16)$$

and the velocity composition rule is

$$\mathbf{v_2} \oplus \mathbf{v_1} = \frac{\mathbf{v_1} + \mathbf{v_2}}{1 + \mathbf{v_1 v_2}/\mathbf{c^2}} - \frac{\gamma_2}{\mathbf{c^2}(1 + \gamma_2)} \frac{[\mathbf{v_2} \times \mathbf{v_2} \times \mathbf{v_1}]}{1 + \mathbf{v_1 v_2}/\mathbf{c^2}}, \qquad (17)$$

where $\gamma_2 = (1 - v_2^2/c^2)^{-1/2}$. [11] However, two successive transformations (16) are not equivalent to a Lorentz boost with the summary velocity (17):

$$\mathcal{L}(\mathbf{v_2})\mathcal{L}(\mathbf{v_1}) = \mathcal{L}(\mathbf{v_2} \oplus \mathbf{v_1}),$$

that is in the case of a non-colinear motion the Lorentz transformations do not form any group and the relativistic symmetry is found

[11] It was mentioned above already (see relation (4)) that this rule may beconsidered as the usual composition of two vectors, only one has to express they in the metric scale of any one reference frame.

to be violated [12] The physical (to be precise, the geometrical) cause of this fact is a different space orientation of turning at some angle and linked by transformations (16) reference frames. Performing two successive Lorentz transformation we find oneself in a reference frame with spacial axises rotated relative to the frame, where we would find oneself if only one transition by $\mathbf{v} = \mathbf{v_2} \oplus \mathbf{v_1}$ has been done.

The corresponding rotation angle is named Thomas angle in the name of the physicist who ferstly investigated such phenomenon[43].

It is easy to prove that the group properties are restored if we supplement the space-time transformation (16) with the Thomas rotation and shall characterize the generalized transformation not only by the vector v, but by the space axises orientation $\mathbf{R}$ also:

$$\mathcal{L}(\mathbf{v_2}, \mathbf{R_2})\mathcal{L}(\mathbf{v_1}, \mathbf{R_1}) = \mathcal{L}(\mathbf{v_2} + \hat{\mathbf{R}}_1\mathbf{v_1}, \mathbf{T_{21}R_1R_2}), \qquad (18)$$

where Thomas rotation operator

$$T_{21} = T(\mathbf{v_2}, \mathbf{v_1}) = \mathbf{B}(-\mathbf{v_1} \oplus \mathbf{v_2})\mathbf{B}(\mathbf{v_2})\mathbf{B}(\mathbf{v_1}) =$$

$$= I + a_1\Omega_{21} + a_2\Omega_{21}^2, \qquad (19)$$

and the boosts $\mathbf{B}$ is defined by relation (16a). The matrix

$$\Omega_{21} = \begin{pmatrix} 0 & -\omega_z & \omega_y \\ \omega_z & 0 & -\omega_x \\ -\omega_y & \omega_x & 0 \end{pmatrix}$$

---

[12]The representation of the Lorentz transformation in form (16) violates the explicit space-time symmetly to which we got accustomed using formulae (3). The symmetry is restored if relations (16) are witten down in the matrix form:

$$\mathbf{X}' = B(\mathbf{v})\mathbf{X},$$

where $\mathbf{X} = (ct, x, y, z)^T$ is the transposed matrix,

$$B(\mathbf{v}) = \mathbf{I} + \gamma\mathbf{b} + \gamma^2\mathbf{b}^2(1+\gamma)^{-1}, \qquad \mathbf{(16a)}$$

$b_{k+1,1} = c^2 b_{1,k+1} = v_k$ for k=1,2,3, otherwither $b_{k+1,i} = 0$. I is the 4×4 identity matrix.

with the vector $\omega = \mathbf{v_2} \times \mathbf{v_1}$. I is the 3×3 identity matrix. The coefficients

$$a_1 = \gamma_1\gamma_2(1 + \gamma + \gamma_1 + \gamma_2)a^{-2}, \quad a_2 = \gamma_1^2\gamma_2^2 a^{-1}c^{-4}$$

$$a = (1 + \gamma)(1 + \gamma_1)(1 - \gamma_2), \quad \gamma = \gamma_1\gamma_2(1 + \mathbf{v_1}\mathbf{v_2}/c^2)$$

Relation (18) is analogous to the Galilean transformation (2) but contrary to the last, where the order of velocities $\mathbf{v_1}$ and $\mathbf{v_2}$ does not matter, the relativistic sums differ by the Thomas operator:

$$\mathbf{v_2} \oplus \mathbf{v_1} = \mathbf{T}_{21}\mathbf{v_1} \oplus \mathbf{v_2}, \tag{20}$$

and the Lorentz transformations with the velocities $\mathbf{v_2} \oplus \mathbf{v_1}$ and $\mathbf{v_1} \oplus \mathbf{v_2}$ transfer us to quite different reference frames. [13]

The special rotation by a two-fold transition to a non-colineary moving frame is the qualitative fundamental property of relativistic kinematics analogous the length contraction as clock delay. It should be note, though a violation of group properties and, accordingly, the principle of relativity with respect to transformation $\mathbf{X}' = \mathbf{BX}$ was emphasized in a number of books (see e.g.[43]) nevertheless, this fact remains unknown for some physicists what results sometimes in misundestanding. One of them, for example, is analysed in paper[46], the other concerning a spin precession well be considered in the next section.

Principle of relativity and spin precession experiments

Such experiments are discussed in Neganovs papers [47–50]. As it is generally known (see agein [43]), spin precession in electric and magnetic fulds is just due to a rotation of a spacial frame by two successive Lorentz transformations and, owing to this, can be used as a tool in investigations of possible violations of the known now

[13] One can get to know in detail the group properties of the operators $\mathcal{L}(\mathbf{v})$, $\mathcal{L}(\mathbf{v}, \mathbf{R})$ and a peculiarity of the Thomas operator T in Ungar's papers [44–46]

geometric and kinematic regulaties in regions of order of the electron size $\Delta x \leq 10^{-16}$cm.

An instantaneous electron spin precession speed is described by well-known Bargman-Michel-Telegdy formula

$$\vec{\omega} = \frac{e}{mc}\{(a + \frac{1}{\gamma})\mathbf{H} - (\mathbf{a} + \frac{\mathbf{1}}{\mathbf{1} + \gamma})[\vec{\beta} \times \mathbf{E}\ ]\}. \qquad (21)$$

where **E** and **H** are electric and magnetic fields, a=g/2 - 1 is the electron anamalous magnetic moment, $\gamma = (1 - \beta^2)^{-1/2}$ is the Lorentz factor associated with the electron velocity $\vec{\beta}$. This formula has been deduced by means of apportionment of the tree-dimensional part from the competely Lorentz-covariant four-dimensional expression and can be used in any frame [51,52]. Particularly, in the considered in papers [47-50] "laboratory frame" (i.e.reference frame of the experiment) moving relative to a inertial frame with the velocity β_0, satisfying the condition $\mathbf{E} = -[\vec{\beta} \times \mathbf{H}] = \mathbf{0}$, the precession velocity

$$\vec{\omega}_l = \frac{l}{mc}\mathbf{H}_l(a + \frac{1}{\gamma_l}), \qquad (22)$$

where $\mathbf{H}_l$ and γ_l are the magnetic field and the Lorentz factor in the "laboratory frame".

In papers[47-50] a transition from (21) to (22) has been done directly thrugh the Lorentz transformation.By this in the right part of (22) an additional term

$$\frac{l}{mc\gamma_l}\mathbf{H}_\mathbf{l}(\chi - \mathbf{1}), \qquad (23)$$

with $\chi = (\gamma_l + \gamma_0)/(1 + \gamma)$, $\gamma = \gamma_0\gamma_l(1 + \beta_l\beta_0)$ appeared. The author of these papers contends that the term is a consequence of the violation of Lorentz transformation group properties, therefore a measuring of a spin precession speed in magnetic field allows to manifest the fact of an isolated inertial frame motion what will be an evident violation of the relativity principle.

However, one cannot agree with this conclusion while by the transition from (21) to (22) it is necessary to take into account the time dependent Tomas rotation $T(\vec{\beta}_0, \vec{\beta}_l)$. That results in the compensation of the noncovariant term (23).

To prove that, one has to make a note that the precession speeds in the initial and "laboratory" frames differ, first of all, in factor γ_l/γ [14] and, in the second place, in the additional term $d\Theta_T/dt_l$ (due to the rotation on an angle $\Theta_T(t)$), which is just the Thomas precession speed:

$$\omega = d\Theta/dt = \omega_l\gamma_l/ + \omega_T\gamma_l/\gamma. \tag{24}$$

In Undar's paper[44] it is shown that

$$\sin\Theta = \chi \cdot \sin\Theta_l^0, \tag{25}$$

$$\cos\Theta = \cos\Theta_l + (\gamma_0^2 - 1)^{1/2}(\gamma_l^2 - 1)^{-1/2}(\gamma + 1)^{-1}\sin^2\Theta_l, \tag{26}$$

where $\Theta = \Theta_l^0 + \Theta_T$, Θ_l^0 is the angle of the Larmor precession (rotation of vector β_1 relative to β in the "laboratory frame"). After the differentiation of both parts of this relation and the subsequent division of left and right parts respectively by left and right parts of equallty (26) we get

$$d\Theta/dt_l = \chi d\Theta_l^0/dt_l, \tag{27}$$

that is

$$\omega_T = (\chi - 1)\omega_l^0, \quad \omega_l^0 = d\Theta_l^0/dt_l = \frac{e}{mc\gamma_l}H_l, \tag{28}$$

that is exactly the addition term (23).

One has to make a note that relations (24) and (28) are not adjusted expressions, as it asserted in paper [50], but they are the inescapable consequence of the Lorentz transformations (18).

So, being in an isolated inertial system, it is impossible by means of spin precession experiments to measure its velocity and to ascertain the absolute reference frame. In the describing spin precession formulae there are no velocity dependent terms. If, however erroreous expressions not taking into account the term (28) are used then,

---

[14]One has to take a note that times of initial and "laboratory" frames are linked with the electron rest time by the relations $dt = d\tau\gamma$, $dt_l = dt\gamma_l$, whence, it follows $dt = dt_l\gamma/\gamma_l$

depending on experimental conditions (particularly for different values of the angle Θ), we shall get distinct values of $\mathbf{v}$.

At the same time as it has been already noted above, though the conclusion of papers[47–50] about the contradiction of the Thomas rotation phenomenon to the principle of relativity is not right, the idea and the method of spin precession measurements proposed in these papers are so original that doubtless they are worthy of realization. In experiments with hadron collisions it is difficult to analyse possible violations of known to-day physical and geometical laws against of disguise background of large size of colliding particles ($\sim 10^{-13} cm$), in electron collider experiments one needs particles with very high energies $E \geq 100 GeV$. At the same time measurements of only average precession spin do not reveal any space-time peculiarities. From this point of view the proposed in papers [47–50] experiment gives a new apportunity. In contrary to many other measurements where alterations of already known quantities are investigated in the present case, the question is the new yet unexplored quantity, i.e. an instant precession speed, which has not been measured in a single experiment.

Conclusion

Though there are no doubts that the relativity principle and also the linked with them Lorentz transformations, like all other rules and laws, have a limited range of the applicability and in the future phenomena have to be discovered which well demand a generalization of these regularities. However, in spite of a great number of works critizing and attempting to revise the principle of relativity, at present there are no sufficiently persuasive experimental and theoretical reasons in order to refuse this principle.

Some authors (see i.g. papers [48–49]) express an opinion that the impossibility to answer the question, what is the absolute ("true") velocity of a motion, spells actually a recognition of the existence of quite unknowable Kantean "things in itself" in Nature. One cannot agree with such a point of view. The theory of relativity maintains that the absolute velocity remains unknown for us due not to the impossibility of a measuring but to the fact that such a quantity simply does not exist.

In the last dozens of years one has made a lot attempts to generallize the Lorentz transformations. For example, one can see some of them using complex coordinates $(\mathbf{x}, \mathbf{t})$, higher space-time dimensions, taking into account nonlinear connections of inertial frames etc. in papers [53,54], when they are considered in connection with the discussion of a problem of a faster-then-light velocities. Complicating essentially an interpretation of space-time relations, these generallisations did not give significant results for the time. The Lorentz formulae have been found very steady.

At the same time one can not forget that 90 years ago its itself appears as a result of a more accurate definition and a trying to find the sense of measuring procedures of the "old" physics, which proved to be suitable only for small velocities, but in the other regions are the abstractions. One cannot but take notice that in microscopic intervals Δx and Δt some operations of Einsten theory look to-day again as insufficiently grounded extrapolations of macroscopic analogies. Although physics of microprocesses is a most important region of applications of this theory, the last one maintains to the considerable degree here its macroscopic "clothes". It is vague, for example, what workable procedure could substitute the known now macroscopic way of a clock synchronization using a reflect light signal. It is incomprehensible, in what a sense one can speak about lenghes inside elementary particles where an interpretation of describing internal particle structure form-factors encounters the difficulties and the usual image of a simultaneous at all points tree-dimensional particle bekomes relativistic non-invariant[55]. All these questions demand careful analysis what, it is possible, will result in a more general theory. Perhaps, it is one of the most important conclusions suggested by the modern state of the theory of relativity.

One has to emphasise once more that absolute, applicable for all space-time scales theories are impossible.

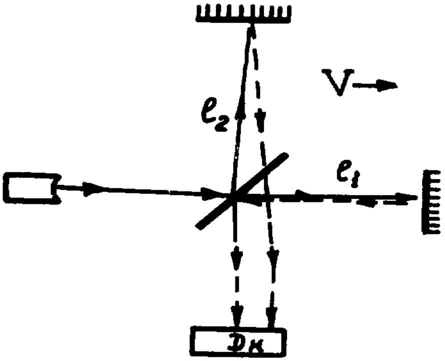

Fig.1. Set-up of principle of the Michelson-Morley and the monitoring interferometers in the Silvertoothes experiments.

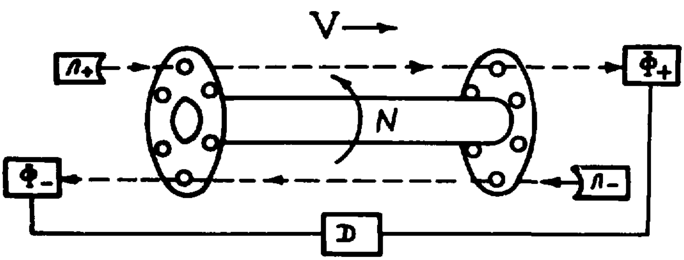

Fig.2. Scheme of principle of Marinovs experiments with discs and two lasers L_1 and L_2. D is the detector of the currents produced by the photocells Φ_1 and Φ_2

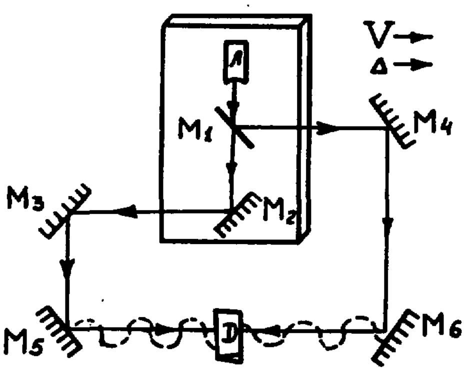

Fig.3. Set-up of the Silvertoothes optical device.

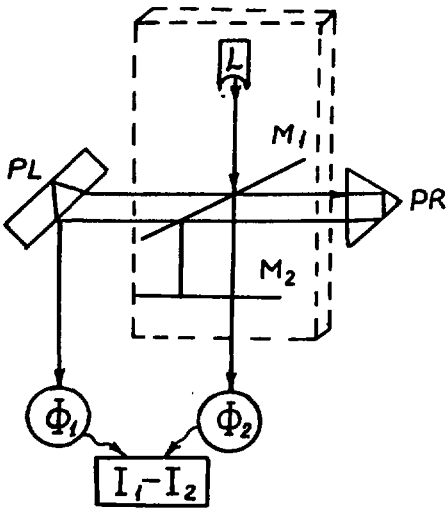

Fig.4. Sheme of M.Liablins and D. Shabalins laser experiment.

a– A semi-transparent mirror M_1 and a prism PR form an interferometer of Michelson-Morly type with parallel rays.

b– Semi-transparent mirror M_2, prism PR and a plane-parallel plate PL form an interferometer with inverse light rays. The time variations of the differential current of photo-detectors Φ_1 and Φ_2 is displayed on the screen of an oscillograph.

References

1. Tiapkin A.A. In book "Principle of relativity". Moscow, Atomisdat, 1973, p.271.
2. Logunov A.A. Lectures on theory of relativity and gravitation. Moscow, Nauka, 1987.
3. Kadomzev B.B. et al. Uspechi Fiz. nauk. **106**, 660 (1972).
4. Molchanov Yu.B. Four conceptions of time in philosophy and physics. Moscow, Nauka, 1977.
5. Lorentz N.A. Theory of electrons. Leipzig, B.G. Teubner, 1907.
6. Bondi N. Observatiry. **82**, 13 (1962).
7. Phillips P.R. Phys. Rev.**146**, 966 (1966).
8. Bergman P.G. Found. Phys. **1**, 17 (1970).
9. Nielsen N.B., Picek N.P. Nucl. Phys.**B211**, 269(1983).
10. Gasperini M. Phys. Lett. **B163**, 84 (1985).
11. De Sabbata V., Gasperini M. -in "Topological properties and global structure of space-time". New-York, Plenum, 1985.
12. Cornille P. Phys. Essays. **5**, 262 (1992).
13. Hils D., Hall J.L. Phys. Rev.Lett. **64**, 1697 (1990).
14. Will C.M. Intern. J. Mod. Phys, **D1**, 13 (1992).
15. Robertson H.P. Rev. Mod.Phys, **21**, 378 (1949).
16. Mansouri H.P., Sexl R.U. J.Gen. Rel. Grav. **8**, 497, 515, 809 (1977).
17. Mansouri R. J. Phys. **A22**, 1589 (1989).

18. Abolghansem G.H., Khagehpour M.R., Mausori R. Phys. Rev. Lett. **A132**, 310 (1988).

19. Brillet A., Hall J.L. Phys. Rev. Lett. **42**, 549 (1979).

20. Tiapkin A.A. Uspeche Fiz. nauk. **106**, 630 (1972).

21. Bridgeman P.W. A sophisticate's Primer of Relativity. Middletown, 1962.

22. Champeney D.C., Isaak G.R., Khan A.M., Phys. Lett. **7**, 241(1963).

23. Turner K.C., Hill H.A. Phys.Rev **B134**, 252 (1964).

24. Isaak G.R. Phys.Bull. **21**, 255 (1970).

25. Kaivola M. et al. Phys.Rev. Lett. **54**, 255 (1985).

26. Riist. et al. Phys.Rev. Lett. **60**, 81 (1988).

27. Krisher T.P. et.al. Phys.Rev. **D42**, 731 (1990).

28. Lubin P. et al. Astrophys. J. **298**, L1 (1985).

29. Marinov S. Czech. J. Phys. **24**, 965(1974).

30. Marinov S. Gen. Rel.Grav.**12**, 57(1980).

31. Marinov S. In book "Progress in space-time physics". 7712 Blumberg, Germany. Benjamin Wesley, 1987, p. 1632.

32. *Wesly J.P. In book "Progress in space-time physics" (see* ref.*31*), p.1 and 11.

33. Silvertooth E.W. Specul. Sc. and Technol. **10**, 3 (1986).

34. Marinov S. Intern.J. Theor. Phys. **13**, 189(1975).

35. Prokhovnik S.J. Found. Phys. **9**, 883(1979).

36. Maddox J. Nature. **311**, 399 (1984).

37. Wesley J.P. Found. Phys.**16**, 817 (1986).

38. Marinov S. New. Scientists. **112**, 48(1986).

39. Maciel A.K.A., Tiomno J. Found. Phys. **19**, 521 (1989).

40. Marinov S. Specul. Sc. and Techn. **12**., 187, (1988).

41. Winterberg F.Zs. Naturforschung. **41**, 1261 (1986).

42. Landau L.D., Lifshitz I.M. Theory of Elasticity. London. Pergamon Press, (1959).

43. Mller M.C. The theory of relativity, Clarendon Press, Oxford, 1952.

44. Ungar A.A. Found. Phys. Lett. **1**, 57 (1988).

45. Ungar A.A. Found. Phys. **2**, 199 (1989).

46. Under A.A. Found. Phys. **21**, 569 (1991).

47. Neganov B.S. Commun. JINR P4-89-827. Dubna, 1989.

48. Neganov B.S. Commun. JINR D1-91-96 . Dubna, 1991.

49. Neganov B.S. Hadr. J. **14**, 377 (1991).

50. Neganov B.S. Commun. JINR D2-92-446. Dubna, 1992.

51. Bargman V., Miechel L., Telegdi V.L. Phys. Rev. Lett.**2**, 435 (1959).

52. Berestetzky V.B., Lifshitz E.M., Pitaevskij L.P. Ouantum electrodynamics. Moscow, Nauka, 1980.

53. Marchildon L., Antippa A.F., Everett A.E. Phys. Rev.D 27, 1740 (1983).

54. Recami E. Rivista del Nuovo Cimento **9**, 1, (1986).

55. Barashenkov V.S. Problems of microscopic space and time. Moscow, Atomisdat, (1978).

Received by Publishing Department on January 26, 1994.