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1. COORDINATE SYSTEMS

Space is unlimited and man has, since the distant past, had a problem in defining his position or the position of a point in that given infinity. With time he found that space is three - dimensional, and that the position of a point in relation to another point in space can be determined by three length values. This method was first formulated by Descartes, and the first rectangular coordinate system appeared. As is well known, it consists of three axes x, y, z, which intersect at the origin of the coordinates under a right angle. In this rectangular coordinate system the position of each point in space is defined, in relation to the origin, with three lengths, that is, with three coordinate points x, y, z. In Fig. 1.1 the position of the point $A(xyz)$ is shown in space in relation to the origin, and from there we can see that

$$r^2 = x^2 + y^2 + z^2 \tag{1.1}$$

In Fig. 1.2 the position of the point $A(xy)$ in the xy plane is shown and in that case we have

$$r^2 = x^2 + y^2 \tag{1.2}$$

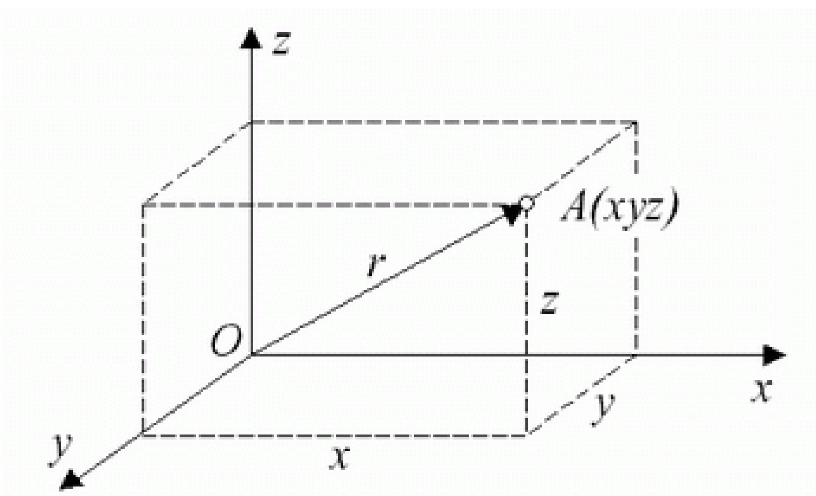

Fig. 1.1

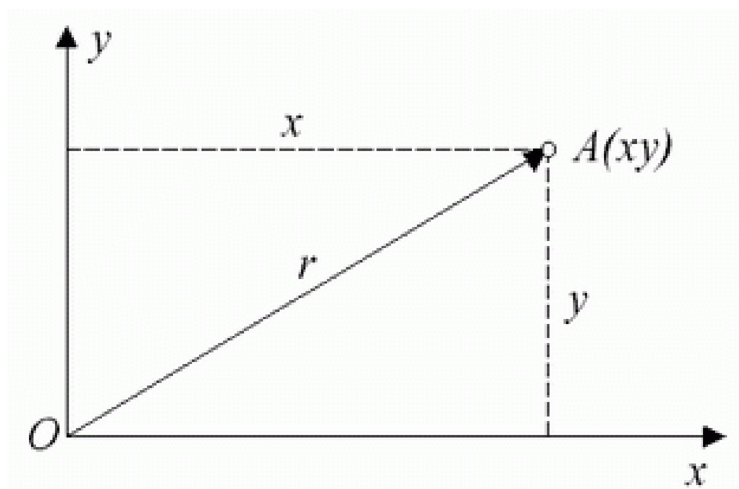

Fig. 1.2

If point A lies on one of the axes of the coordinate system, for example on the x-axis, then $r^2 = x^2$, that is $r = x$. Beside the above mentioned coordinate system there are others such as the polar, the cylindrical, and the spherical etc. They are not important for the further presentation, however.

The coordinate system, besides making it possible to define the position of a body in space, also makes it easier to study its motion in space. The origin of the system is connected to some reference point or body. So, for example, when studying the earth's motion round the sun, the origin is taken to be the center of the sun. A passenger aboard a ship, stands still in relation to the ship, but together with the ship is in motion in relation to the coast. If the coordinate system is connected to the ship then the passenger will be at rest in the given coordinate system. But, on the other hand, if we connect the coordinate system to some point on the coast, then the passenger will move in that new coordinate system. Thus, the passenger can either be at rest or in motion while remaining in the same situation, depending on which body of reference (coordinate system) he uses to define his state of motion. In this way the relativity of motion was recognized. In fact, every motion is relative, something which was known in Aristotle's time.

The theory of relativity is based on the Lorentz transformation of coordinates. In that transformation and in the theory of relativity are used two coordinate systems. One of them is at rest and the other is moved uniformly and translatory relative to the first.

In addition to the relativity of motion there are relativity of time and many other kinds of relativity. Broadly speaking, every measurement or determination of magnitude or quality is relative, that is in relation to some other magnitude or quality that we have defined as absolute or in some other way.

Today the notion of relativity has become connected exclusively with the name of Einstein. Simply said, it became in some way his property. Many indeed believe that Einstein was the first to understand relativity and that it had not been defined correctly before him. This is, of course, a great mistake and an injustice to Galileo, Newton and Lorentz.

When reader read this book, carefully and with the understanding, then, to him will be clear that Einstein's relativity is big illusion, which we should reject and return to Galilean and Newtonian relativity.

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2. TRANSFORMATION OF COORDINATES, THE GALILEAN TRANSFORMATION, INERTIAL SYSTEMS

The position of some point in space can be defined by the coordinates of a coordinate system, which is connected to some other coordinate system, as a reference. For example, in Fig. 2.1 two coordinate systems are shown in a plane - system K and K', whose axes are parallel.

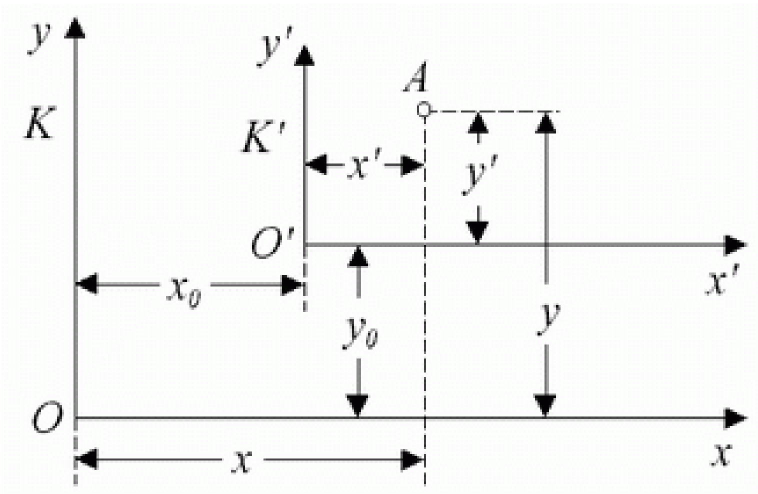

Fig. 2.1

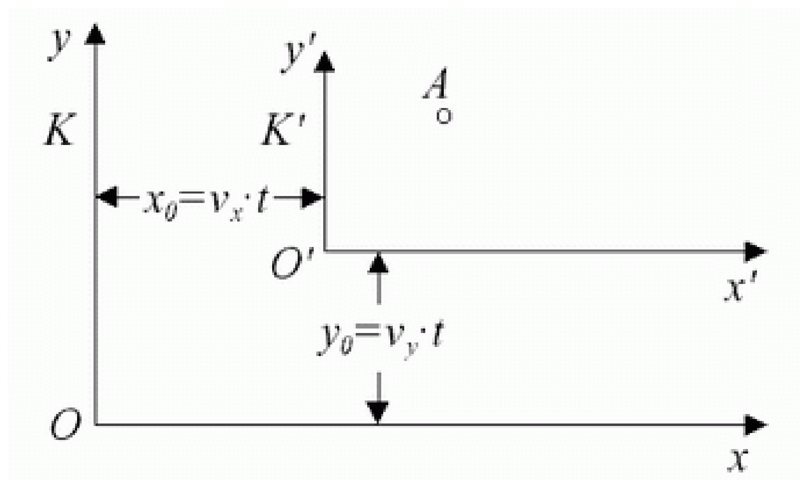

Fig. 2.2

The system K is marked by xy, and the system K' by $x'y'$. The origin of the K' system (point O') is given in the K system with coordinates x_0, y_0. It can be seen in Fig. 2.1 that the coordinates x', y' of the point A in the K' system can be presented as a function of coordinates x, y of the K system by the following relation

$$\begin{aligned} x' &= x - x_0 \\ y' &= y - y_0 \end{aligned} \tag{2.1}$$

Coordinates x, y can also be presented as a function of the coordinates x', y'

$$\begin{aligned} x &= x_0 + x' \\ y &= y_0 + y' \end{aligned} \tag{2.2}$$

A similar transformation can also be derived when the axes of these two systems are at a certain angle, that is when they are not parallel.

The above mentioned transformation is used in cases when the systems have no relative motion.

Let us assume that the K' system is moving translatory and at constant speed v relatively to the K system (Fig. 2.2). In that case the coordinates of the origin O' are $x_0 = v_x \cdot t$ and $y_0 = v_y \cdot t$, where v_x and v_y are the corresponding speed components v, and t is time. The coordinates of a point A in the K' system, can be expressed in terms of the coordinates x, y of the K system in the following way

$$\begin{aligned} x' &= x - v_x t \\ y' &= y - v_y t \end{aligned} \tag{2.3}$$

As in the previous case when the systems had no mutual motion, converse transformation may be used

$$\begin{aligned} x &= x' + v_x t \\ y &= y' + v_y t \end{aligned} \tag{2.4}$$

The same relations are valid for two three - dimensional systems which mutually have translatory motion at constant speed v

$$\begin{aligned} x' &= x - v_x t \\ y' &= y - v_y t \\ z' &= z - v_z t \end{aligned} \tag{2.5}$$

and

$$\begin{aligned} x &= x' + v_x t \\ y &= y' + v_y t \\ z &= z' + v_z t \end{aligned} \tag{2.6}$$

At this transformation time t is the same for both coordinate systems. In classical physics time is the absolute magnitude. It passes evenly and it does not depend upon space, the body of reference, the coordinate system or anything else from the outside.

The above mentioned transformation is called Galilean transformation in honor of the founder of mechanics. It is used for all inertial systems. The inertial system is the system of coordinates, in which inertial law retains its original shape. In connection with that, Newtonian relativity principle says: "There is an infinite number of equivalent systems known to us as an inertial, which have an uniform and rectilinear motion in relation to one another, where the laws of mechanics are fulfilled in the classical form." This means that if one system is inertial so is any other system inertial if, in relation to the first, it moves uniformly and rectilinearly.

Now we examine the case in Fig. 2.2. Let the speed v be constant in the first K system, which means that the acceleration is equal to zero, so inertial law is valid for it, and therefore we say that the system is inertial. We can see from Eq. (2.5) that the moving K' system, which moves rectilinearly and uniformly relatively to K is also inertial because

$$\begin{aligned}
\frac{d^2x'}{dt^2} &= \frac{d^2}{dt^2}\left(x - v_x t\right) = \frac{d^2x}{dt^2} = 0 \\
\frac{d^2y'}{dt^2} &= \frac{d^2}{dt^2}\left(y - v_y t\right) = \frac{d^2y}{dt^2} = 0 \\
\frac{d^2z'}{dt^2} &= \frac{d^2}{dt^2}\left(z - v_z t\right) = \frac{d^2z}{dt^2} = 0
\end{aligned} \tag{2.7}$$

So, at the transformation of coordinates, the equation for the inertial law has remained the same, which means that with Galilean transformation is maintained the invariability of the equation for acceleration in the case of an inertial system.

The invariability of the equation for acceleration does not hold in systems which move acceleratedly or if they rotate one relatively to the other.

Regarding light and sound waves the invariability of the equation for propagation of the same does not hold, even in the case of an inertial system, that is, Galilean transformation.

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3. SIMILARITIES IN PROPAGATION OF LIGHT AND SOUND WAVES

The speed of light is extremely high, and for a long time there was a theory that light could instantaneously reach the most distant points; in a word, it was considered that the speed of light is infinite. Galileo was the first who tried to find it experimentally, but without success. The first person who succeeded in approximately determining the speed of light, by observing the eclipse of the first satellite of Jupiter in 1675, was Olaf Römer.

Because of the high speed of light, it is difficult to follow, examine, and therefore understand all phenomena connected to its behavior. Light's motion is wavelike in nature as is sound. These two natural phenomena have a lot in common, for example: propagation (plane and spherical wave), interference, the Doppler effect, refraction, reflection etc. The speed of sound in the air is about $9{\cdot}10^5$ times lower than the speed of light. That is why it is much easier to perceive, follow and measure certain phenomena present in sound rather than in light. Therefore, in order to understand with ease some phenomena connected with the light and treated by the theory of special relativity it should, at first, to consider the propagation of sound in the air, and to compare it with the propagation of light in a vacuum.

Let us assume that at a point in the homogeneous air environment there is a sinusoidal oscillator whose oscillation generates a spherical sound wave. If the oscillation of the oscillator is given by equation

$$A = A_0 \sin \omega t \tag{3.1}$$

where A is elongation, A_0 is amplitude, ω is circular frequency and t is time, then the sound waves generated, when observed at any point on the sphere with a radius r, is defined by the equation

$$A = A_0 \sin\left(t - \frac{r}{c}\right) \tag{3.2}$$

where r is the radius of the sphere of the observed spherical wave and c is the velocity of sound in the air. If the environment is homogeneous then the propagation of the wave will be equal in all directions, but for the purposes of observation it is enough to take just one direction. Then Eq. (3.2) becomes

$$A = A_0 \sin\omega\left(t - \frac{x}{c}\right) \tag{3.3}$$

Propagation of the spherical sound wave is given by the following equation

$$r^2 = x^2 + y^2 + z^2 = c^2t^2 \tag{3.4}$$

that is

$$x^2 + y^2 + z^2 - c^2t^2 = 0 \tag{3.5}$$

and the propagation of the plane wave along the x-axis by the following equation

$$x - ct = 0 \tag{3.6}$$

The Eqs. (3.2), (3.3), (3.5) and (3.6) can be applied to light waves by the following meaning of the values. The elongation A would present a disturbance of the electric or magnetic waves since they are mutually conjugated. Amplitude A_0 presents the amplitude of the electric or magnetic wave. In this case the circular frequency ω has the same meaning, while c would be the speed of light instead of the speed of sound.

We should pay especial attention to the Eqs. (3.4), (3.5) and (3.6), because they were used to derive the Lorentz transformation whose aim was to prove the contraction of the body moving through an ether and to explain the negative result of Michelson's experiment. Really, the above stated equations were treated as equations which describe electromagnetic wave motion, instead of sound wave motion. In considering the fact that these equations have the same form both for the light and sound wave propagation it is justifiable to state that the special theory of relativity can be derived on the basis of sound propagation instead of on the base of light propagation. In the special theory of relativity it is stated that there is no higher speed than the speed of light, not even the relative speed. It was the same with sound. A lot of time, effort and knowledge were required to break through the "sound barrier". For a long time it was considered impossible. Many had stated that an aircraft would simply fall apart on reaching such a speed. In spite of this many aircraft of different dimensions have broken that sound barrier carrying heavy loads. Now many state that there is no way of breaking through the "electromagnetic barrier", that is to obtain a speed higher than the speed of light in vacuum. It is debatable whether that statement is based upon the facts or incomplete and approximate mathematical equations. Has it not, in fact, been broken by the distant quasars, that, judging by their red shift, are moving away from us at three times the speed of light [16]?

Sound velocity propagation does not depend on the speed of motion of the sound source. The same occurs in the case of the propagation of light. However, in certain circumstances the velocity of sound can be higher or lower than in the open air.

Let us suppose that the sound source is located at the origin of an unmoving coordinate system K (Fig.3.1) and let us say that a closed car moves in a straight line, along the x-axis at speed v. The sound pulse, generated at the origin of the system K reaches the moving closed car after some time and passes trough the back wall into the air inside. From that moment the sound in the car moves from the back of the car to the front at speed c in relation to the back wall of the car. In relation to the sound source in the coordinate system K, from which it originated, this sound is now moving at speed $c + v$, where v is the speed of the car, and with it also the speed of air which carries the sound. In that way the sound velocity in relation to the source can be up to almost two times higher. If the car moves in the opposite direction to that of the sound, then the sound velocity in the car relative to the source would be $c - v$. This occurs because the closed car carries medium - particles of air, whose oscillations transfer sound. If the car is open this phenomenon does not occur, and the sound is propagated at the same speed as in the surrounding open space independently of the speed and direction of motion of the open car. In a closed car or an airplane, whose speed may be higher than the speed of sound, the passengers can have a normal conversation and the speed of motion has no influence on the propagation of the sound inside the car or plane, because the particles, that transfer the sound by oscillation, are carried inside the closed space. If it where an open car traveling at supersonic speed then the particles would not be carried and the sound from the back part of that open car would not reach the front part. For example, it is well known that a sound of a jet stays behind the jet when the speed of the jet is higher than the speed of sound.

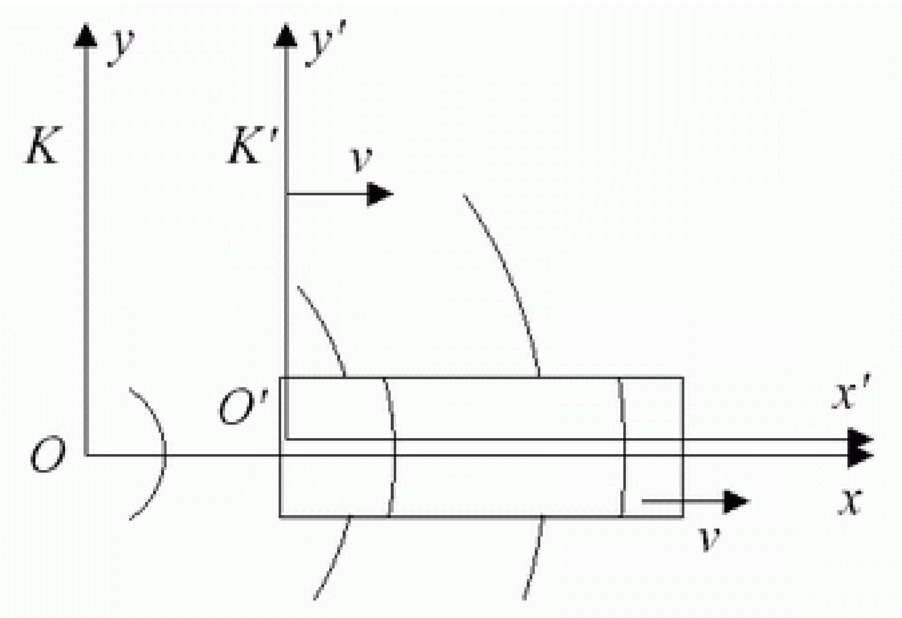

Fig. 3.1

A similar situation could occur with light if there were a medium whose oscillations transfer light, and if this medium could be contained and carried. This medium could, for example, be tied to earth, in which case earth would carry it along, rotate with it on the way round the sun, and move together with the sun through cosmos. This is the case with, for example, the magnetic field of earth. Likewise it could also be the case for the earth's ether. If that where so, then the speed of light in relation to its source (star) could be higher than 300000 km/sec, and many phenomena such as, for example, aberration would be logical and clear. At all events this idea cannot be excluded.

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4. THE ETHER AS A CARRIER OF ELECTROMAGNETIC PHENOMENA

In the middle of the 17th century, Descartes presented the idea of the existence of the ether as a carrier of light. This idea was a predecessor to the wave theory, first proposed by Hook in 1667, but first clearly formulated by Hygens in 1678. Their great contemporary Newton was the author of the opposite doctrine - corpuscular theory. This theory, which dominated for a hundred years thanks to Newtonian authority, claims that glowing bodies radiate tiny particles, corpuscles which move according to the laws of mechanics. The wave theory, however, established the analogy between the propagation of light and wave motion on water or sound waves in the air. Because of that it supposes an elastic medium which fills all the empty space and transparent bodies. special particles of this substance simply oscillate in relation to their balanced position and in such a way make the transfer.

At first it was supposed that there was not only one but a whole series of ethers: optical, thermal, magnetic etc. For each phenomenon a corresponding ether was assumed as a carrier. At the beginning all these ethers had nothing in common. But as time passed a connection was found between phenomena from different areas of physics, phenomena which had not seemed to be related. Finally the ether appeared as a carrier of all physical phenomena, occurring in space without matter. The ether hypothesis was given great support by the revelation that light presents the oscillating electromagnetic process. Keeping in mind, that light as electromagnetic oscillation process comes to us from far away stars, passing through enormous tracts of empty space, and since most physical phenomena and influences propagate throughout the cosmic space, it is quite logical that the hypothesis was reached that this space is not empty, but filled with a fine, weightless substance - called the ether, which is the carrier of all phenomena and influences. Further more, it is assumed that ether is isotropic, absolutely quiescent and can penetrate anywhere and that coarse cosmic bodies and others material bodies move through it. As such, the ether would be suitable for the absolute inertial system, and the coordinate system connected to the ether would be the absolute coordinate system where the velocity of light would be equal in all directions. The presentation of electromagnetic phenomena would be simplified in it. All positions and motions of bodies in the universe could be considered and calculated relatively to that system, which would make the presentation and calculation of motions much simpler.

Einstein was the greatest opponent of the idea of the ether's existence. A large part of his opus is related to the ether.

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5. MICHELSON - MORLEY'S EXPERIMENT

5.1 The performance of the experiment and calculation of the interference shift

Since the existence of an absolute quiescent ether was assumed, it was quite logical to try to measure the speed of the earth's motion and the speed of the whole Solar system relatively to the ether. By measuring the eclipse of the first satellite of Jupiter no reliable proof was obtained about the motion of the entire Solar system relatively to the ether. Even at confining measurement to the earth it was difficult to establish the relative motion of the earth in relation to the ether. Research into the influence of the earth's motion on the speed of light, showed that the time, necessary for a light ray to travel a distance L forward and backward, differed only in a small magnitude of the second order from the value of the time in the case when the earth is at rest relatively to the ether. Thus

$$t_u = \frac{L}{c-v} + \frac{L}{c+v} = \frac{2L}{c}\frac{1}{1-\frac{v^2}{c^2}} \quad \text{and} \quad t_s = \frac{2L}{c}$$

and from there

$$t_u - t_s = \frac{2L}{c\left(1-\frac{v^2}{c^2}\right)} - \frac{2L}{c} \approx \frac{2L}{c}\frac{v^2}{c^2}$$

The experiment had to be accurate enough to register with certainty the small magnitude of the second order. It was believed that this could be achieved by means of an interferometer, because interferometric methods give, with great accuracy, the time difference, necessary for light passing a different and unequal distance between two points.

In this way the famous Michelson experiment of 1881 and the Michelson - Morley experiment of late 1887 were arrived at. The aim of the experiment was to determine the speed of the earth's motion relatively to the ether, that is, to the absolute coordinate system connected to the ether, and also to determine whether the earth in motion draws an ether with it, and to what extent.

Below it is explained how measurements were carried out and how the expected interference shift is calculated.

For the first experiment Michelson used his interferometer a scheme of which is shown in Fig. 5.1. It consisted of two pipes which are placed at a right angle. At the intersection of the pipes axes there was a semi-transparent mirror placed at 45° angle in relation to the incoming radiation. At the end of each pipe there were mirrors M_1 and M_2.

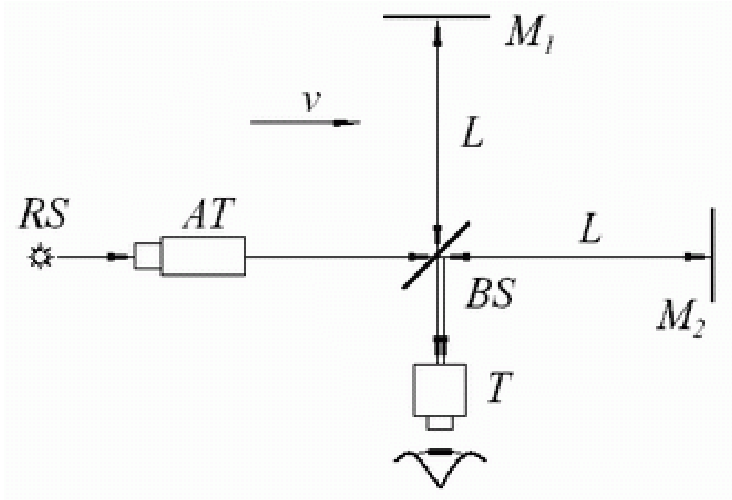

Fig. 5.1

The light is brought from a radiation source RS to the semi-transparent mirror - beam splitter - by means of an astronomic telescope AT, where the interference is observed by telescope T. The collimated beam of light is divided at the beam splitter BS into two beams, which are directed to the mirrors M_1 and M_2 so that after the reflection of the same, they are returned to the splitter where they join again and are directed to the telescope T. In the telescope the interference fringes and their possible shift are observed. The beam of light which is being reflected from the mirror M_2 is parallel to the earth's direction of motion, and the other beam is normal to that direction.

Because of earth's motion in relation to the ether, a displacement of the measuring system arises during the period of time when light travels from the beam splitter to the mirror and back.

The distances from the beam splitter (Fig. 5.1) to the mirrors M_1 and M_2 are equal and amount to L. Looking at Fig. 5.2, we can see that the beam splitter will move from position A to position A' during the time the light from the point A reaches the point A' via mirror M_1. In such a way the light passes the distance $AM_1 + M_1A' = 2a$ at speed c, while the whole system together with the beam splitter passes the distance $AA' = 2b$ at speed v and from there it result

$$t_1 = \frac{2a}{c} = \frac{2b}{v} \tag{5.1}$$

Besides

$$a^2 = L^2 + b^2 \tag{5.2}$$

From Eqs. (5.1) and (5.2) we find that the length S_1, which the first beam passes from the point A to the mirror M_1 and back to the point A', is

$$S_1 = 2a = \frac{2L}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{5.3}$$

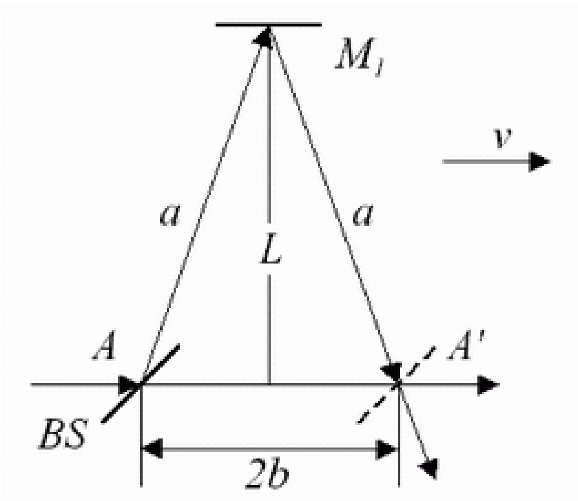

Fig. 5.2

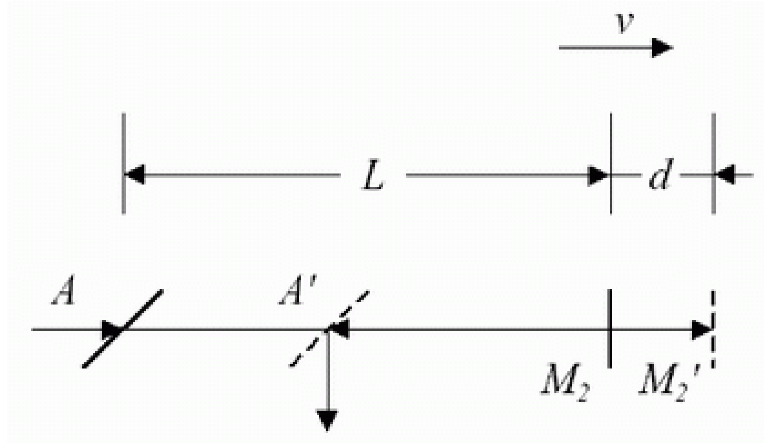

Fig. 5.3

The other light beam, which is directed through the beam splitter towards the mirror M_2, passes the distance AM_2' to the mirror and back to the beam splitter the distance $M_2'A'$ (Fig. 5.3). As can be seen in the figure, while the beam moved from the splitter to the mirror M_2 it also moved for the distance d in the M_2' position. However, while the light moved from the splitter to the M_2 mirror and back, the splitter moved for $2b$ to the A' position, so the other beam passes the total path before joining with the first

$$S_2 = 2(L+d) - 2b \tag{5.4}$$

For a time while this other beam travels the distance $L+d$ at speed c, the mirror M_2 passes the distance d at a speed v, so the following ratio is valid

$$\frac{L+d}{c} = \frac{d}{v} \tag{5.5}$$

The other beam passes the total path $S_2 = AM_2'A'$ at speed c for the same time that it takes the splitter to pass the path $AA' = 2b$ at a speed v. Thus

$$\frac{S_2}{c} = \frac{2b}{v} \tag{5.6}$$

From Eqs. (5.4), (5.5) and (5.6) we obtain that the length of the path of the other beam

$$S_2 = \frac{2L}{1 - \frac{v^2}{c^2}} \tag{5.7}$$

and the differences of the optical paths of these two beams, which join for the sake of interference, is

$$S_2 - S_1 = 2L\left(\frac{1}{1-\frac{v^2}{c^2}} - \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\right) \tag{5.8}$$

For the position of the interferometer which is realized by rotation of the same, round the vertical axis through 90°, Michelson used the same method of calculation and concluded that the shift between the beams would be

$$S_2' - S_1' = -2L\left(\frac{1}{1-\frac{v^2}{c^2}} - \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\right) \tag{5.9}$$

In this way by rotating the interferometer through 90°, the same value of the shift is achieved but with the opposite sign, so the total shift, which should be experimentally established is

$$\Delta S = (S_2 - S_1) - (S_2' - S_1') = 4L\left(\frac{1}{1-\frac{v^2}{c^2}} - \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\right) \approx 2L\frac{v^2}{c^2} \tag{5.10}$$

For, the speed of motion of the earth round the sun, which was known at that time, the shift given by Eq. (5.10) should have been easy to measure. The interferometer was constructed in such a way that it could determine motion up to 30 times smaller than that expected. However the measurement gave a negative result, that is no shift of the interference fringes was perceived.

At the first measurement the length of the branch L of the interferometer was 1.2 meters. The whole system was floating in mercury so it could be turned easily at the speed of one turn in 6 minutes. During the further experiments the length of the interferometer's branch was extended to 30 meters. The sensitivity of the interferometer was also increased by cooling it and by other technical improvements. The experiment has also been made using a laser which considerably increases the accuracy of the measurement. Even with such accuracy the results of the experiment were negative. The importance of this measurement proves the fact that in the first 50 years were carefully prepared and made 16 such complicated measurements in which more than 10 the most famous experimentalist physicists took part.

Michelson's negative result was a great surprise and created confusion in the scientific societies. The existence of an ether was not confirmed, and there were difficulties how this could be explained and brought into conformity with existing theory. These negative results were a total catastrophe for Lorentz theory.

Michelson's negative result is considered one of the most significant in physics, not only of that time but in general, because it is a question of the fundamental understanding not only of light but of the physics field in general.

5.2 The influence of the Doppler effect on the measurement results

In connection with Michelson's experiment, it is interesting to note that none of those who conducted the measurements, analyzed the results and wrote about them, noticed that the influence of the Doppler effect on the magnitude of the interference shift had been omitted. That effect should certainly be taken into account, because it affects the frequency of a radiating source which moves in relation to the ether, and also the frequency of the radiation which falls on a mirror in motion (as a receiver), or is reflected from the mirror (as the source of radiation, since an irradiated place becomes a source of radiation). The magnitude of the interference shift depends, in a certain way, on the frequency as well, that is on the number of wavelengths of the radiation which dispose during the propagation along the branches of an interferometer.

Fig. 5.4 shows the way Michelson's interferometer works when the earth, and the interferometer with it, moves through the ether in the direction of the radiation of the source, and Fig. 5.5 when that motion is normal to the radiation direction, that is when the interferometer is rotated through 90° in relation to the previous condition.

For the case given in Fig. 5.4, the literature usually takes oblique propagation of light towards the mirror M_1, as it is shown in Fig. 5.2. That way of finding the shift does not correspond to the physical process of interference, it is not completely correct and it is unnecessarily complicated. This last is particularly true when in such a condition the interferometer is rotated by 90°, for the purpose of calculating the shift.

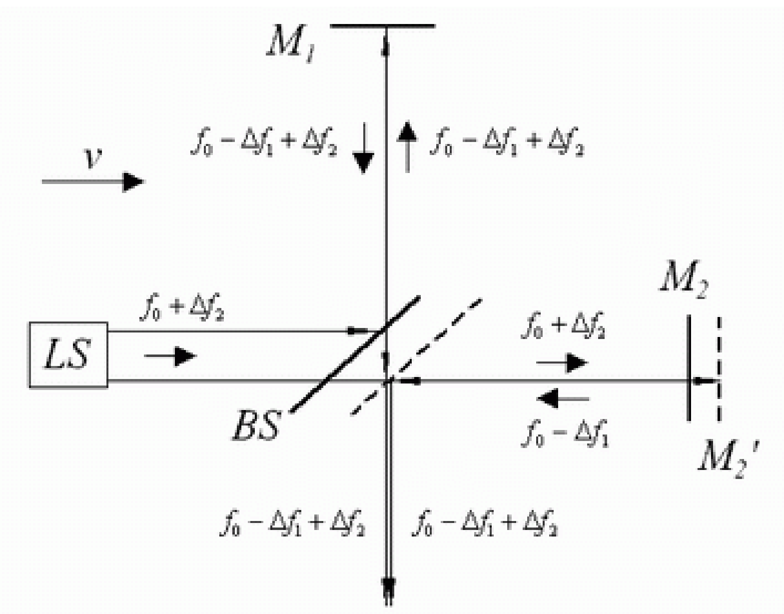

Fig. 5.4

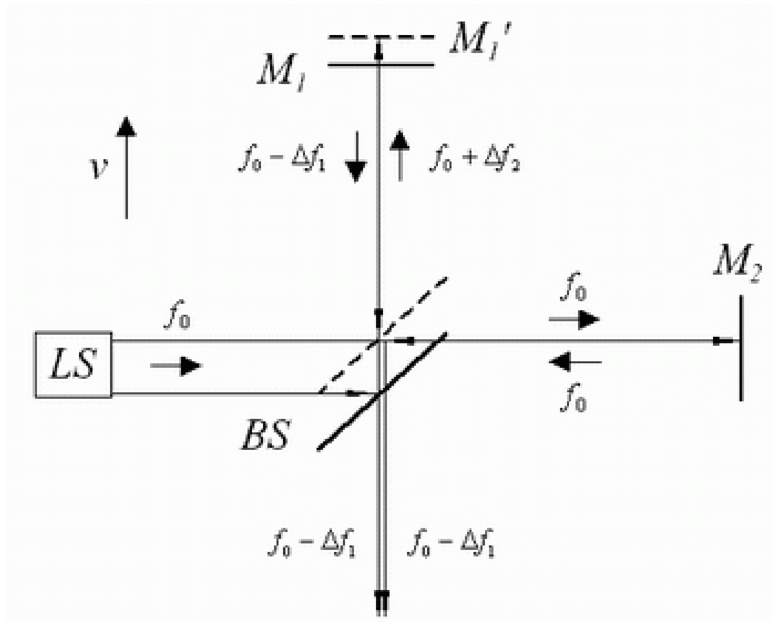

Fig. 5.5

In Figs. 5.4 and 5.5 LS is the source of a collimated beam of light in the form of plane waves, f_0 is the frequency of the source radiation, Δf_1 is the change in frequency of radiation which falls on the mirror in motion, Δf_2 is the change in the frequency of the source of radiation because of its motion, and other symbols are the same as in Figs. 5.1, 5.2 and 5.3.

The analysis of the interferometer function was conducted for only two light rays, whose interference shift is calculated, and which come from the same plane of the plane wave. The other rays from the same plane of the plane wave come into interference in the same way.

The number of waves n of the light radiation at a given moment, which are ranged along some length l, will depend on the length and the size of the wavelength λ or the frequency f of the radiation, so

$$n = \frac{l}{\lambda} = \frac{l}{c} f \tag{5.11}$$

Bearing this in mind, according to the Fig. 5.4, we find that the number of wavelengths of light spread from the beam splitter BS to the mirror M_1 and back to the beam splitter

$$n_1 = \frac{2l + 2l\dfrac{v}{c-v}}{c}\left(f_0 - \Delta f_1 + \Delta f_2\right) = \\ = \frac{2l\dfrac{c}{c-v}}{c} f_0 - \frac{2l\dfrac{c}{c-v}}{c}\Delta f_1 + \frac{2l\dfrac{c}{c-v}}{c}\Delta f_2 \tag{5.12}$$

and the number of wavelengths spread along the second branch of the interferometer from the place where the beam is split to the place where the beams are joined for the purpose of interference

$$n_2 = \frac{l + l\dfrac{v}{c-v}}{c}\left(f_0 + \Delta f_2\right) + \frac{l + l\dfrac{v}{c-v}}{c}\left(f_0 - \Delta f_1\right) = \\ = \frac{2l\dfrac{c}{c-v}}{c} f_0 - \frac{l\dfrac{c}{c-v}}{c}\Delta f_1 + \frac{l\dfrac{c}{c-v}}{c}\Delta f_2 \tag{5.13}$$

The difference in the number of wavelengths on these two branches of the interferometer is

$$n_1 - n_2 = 0 \cdot f_0 - \frac{l\dfrac{c}{c-v}}{c}\Delta f_1 + \frac{l\dfrac{c}{c-v}}{c}\Delta f_2 \tag{5.14}$$

When the interferometer is rotated through 90 degrees, we get the case given in Fig. 5.5, according to which the number of wavelengths spread along the interferometer's first branch is

$$n_1' = \frac{l + l\dfrac{v}{c-v}}{c}\left(f_0 + \Delta f_2\right) + \frac{l - l\dfrac{v}{c+v}}{c}\left(f_0 - \Delta f_1\right) = \\ = \frac{2l\dfrac{c^2}{c^2 - v^2}}{c} f_0 - \frac{l\dfrac{c}{c+v}}{c}\Delta f_1 + \frac{l\dfrac{c}{c-v}}{c}\Delta f_2 \tag{5.15}$$

and the number of wavelengths spread along the interferometer's second branch is

$$n_2' = \frac{2l}{c} f_0 + 0 \cdot \Delta f_1 + 0 \cdot \Delta f_2 \tag{5.16}$$

The difference in the number of wavelengths spread along the interferometer branches, after the interferometer is rotated through 90 degrees, is

$$n_1' - n_2' = \frac{2l\frac{v^2}{c^2-v^2}}{c} f_0 - \frac{l\frac{c}{c+v}}{c}\Delta f_1 + \frac{l\frac{c}{c-v}}{c}\Delta f_2 \tag{5.17}$$

Using Eqs. (5.14) and (5.17) we find that the difference of wave lengths sought, that is the shift of interference fringes, after rotating the interferometer by 90 degrees, expressed in the number of wave lengths of the source of radiation

$$\left(n_1' - n_2'\right) - \left(n_1 - n_2\right) = \frac{2l\frac{v^2}{c^2-v^2}}{c} f_0 + \frac{2l\frac{cv}{c^2-v^2}}{c}\Delta f_1 \tag{5.18}$$

Bearing in mind that $\Delta f_1 = \frac{v}{c} f_0$, finally we find the total shift to be

$$n = \frac{4l\frac{v^2}{c^2-v^2}}{c} f_0 \approx \frac{4l\frac{v^2}{c^2}}{c} f_0 \tag{5.19}$$

or expressed in the same way as in Eq. (5.10)

$$\Delta S \approx 4l\frac{v^2}{c^2} \tag{5.20}$$

which shows the shift to be expected is twice as big as the one that Michelson and Morley calculated.

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6. A NEW INTERFEROMETER FOR MEASURING THE SPEED OF A BODY'S MOTION RELATIVELY TO AN ETHER

In order to measure the speed of the earth or a body's motion in relation to an ether successfully, it is necessary to have an interferometer which would, because of motion, show an easily measurable shift between the parts of a split beam, which interfere. The proceeding analysis shows that this requirement is not fulfilled by Michelson's interferometer or by any other known interferometer. However, it is fulfilled only by my new interferometers, which are much better than they seem at first sight. They are very sensitive, of small dimensions and simple construction. In the first place they are designed to measure the speed of motion relative to the ether, that is to confirm the existence of an ether. Their use also excludes the uncertainty in connection with Lorentz contraction of a body's length due to motion through the ether. With this interferometer the Doppler effect has no influence on the magnitude of the shift of interference patterns.

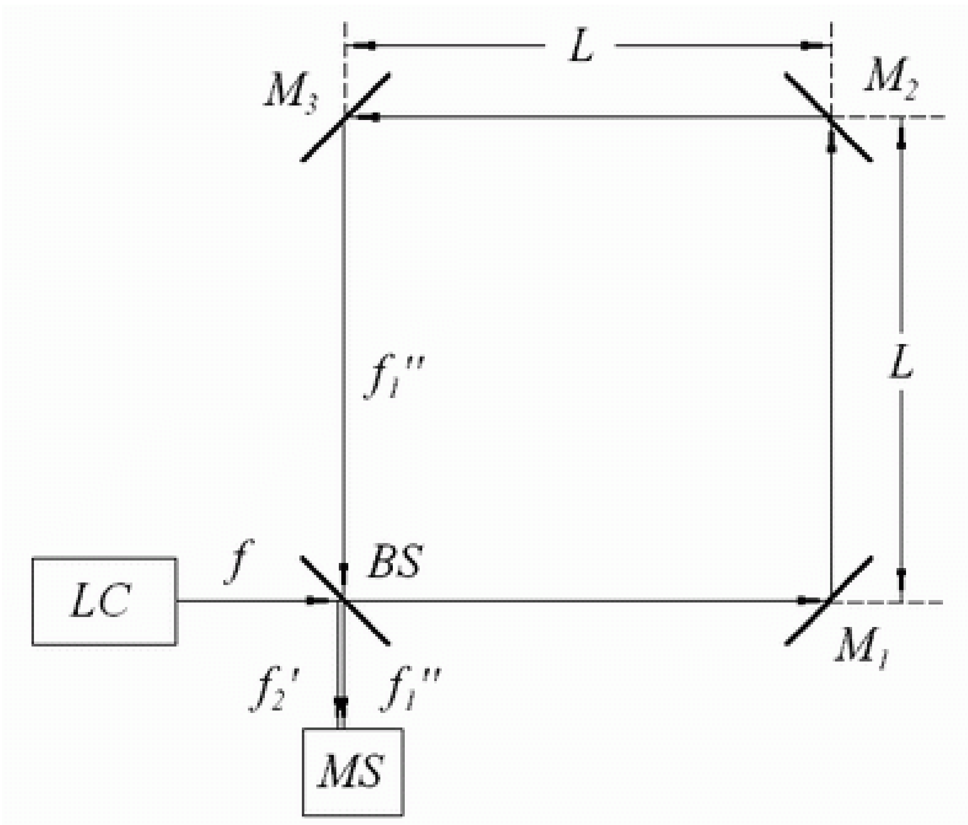

Fig. 6.1

The scheme of one new interferometer is presented in Fig. 6.1 where LC is a laser with a collimator, BS is a beam splitter of the laser light radiation, semi-transparent mirror, placed at an angle of 45° in relation to the direction of the laser radiation; M_1, M_2 and M_3 are a mirrors; f are photons from the collimated laser's source of radiation; f' are photons reflected by the splitter - the reflected part of the radiation beam; f'' are photons passed through the splitter - the passed through part of the radiation beam; MS is a measurer of the shift between the interfered beams or a screen for observation an interference fringes shift and L is a length of the interferometer side.

The extreme coherence of the laser radiation enables this interferometer to function stably.

When the system is at rest relative to the ether, the parts of the beam (photons), which are far from one another for $4L$ or time shifted for $4L/c$, interfere, where L is the length of one interferometer side and c is the speed of light.

In Fig. 6.2, we can see the scheme of interferometer function when it is moving at a speed v through the ether in the direction of the laser radiation and when this motion is taken into consideration. In this figure d is the displacement of the whole system and also of all the parts of the interferometer, while the part of the beam, which has been passed through the splitter, passes from the splitter BS to the mirror M'_1.

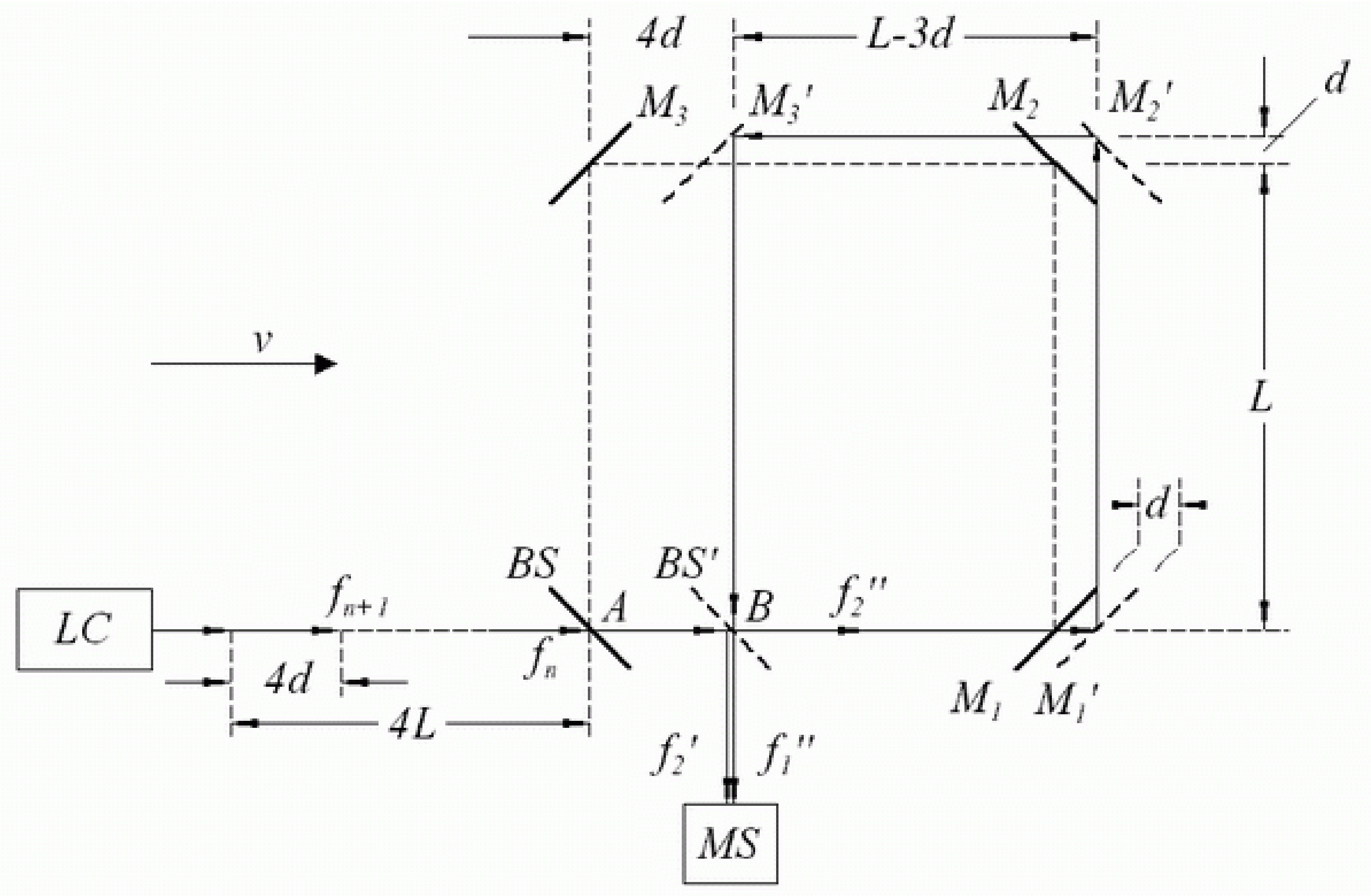

Fig. 6.2

The initial position of the mirrors and the beam splitter is marked with a full line. The position of these components at the moment of the arrival of the studied ray is marked with an interrupted line. So, the mirror M_1 is shifted by d into the position M'_1, the mirror M_2 is shifted by $2d$ in the position M'_2, etc.

For easier explanation of the interferometer's function, the shift d in the figures is considerably increased in relation to the interferometer sides.

When the interferometer starts to function, the part of the beam f_1, is reflected from the splitter in the form of the beam f'_1 which is not an object to be observed or taken into consideration. The other part of that beam f_1

passes through the splitter in the form of the beam f_1'' in the direction of the mirror M_1. During the time it takes that beam to reach the mirror M_1' from the splitter, all mirrors and the splitter shift in the direction of the interferometer's motion for the distance d. While this beam passes from the mirror M_1' to the mirror M_2' all mirrors and splitter move for another distance d. So by the time the beam f_1'' reaches the splitter moving through the interferometer, which is shifted in the direction of the system's motion for the distance $4d$. Inside the interferometer, the beam f_1'' passes the total way

$$S_i = (L+d)+(L+d)+(L-3d)+(L+d) = 4L \tag{6.1}$$

and then a greater part of the beam f_1'' passes through the splitter in the direction of the shift measurer and joins up for the purpose of interference together with the reflected beam f_2' which, at that moment reaches the splitter from the direction of the laser. When there is no motion of the interferometer relatively to the ether, photons from the plane of the wave whose mutual shift is $4L$ interfere because the reflected part of the beam f_2' is late for $4L$ in relation to the transmitted part of the beam f_1''. However, when the interferometer moves in relation to the ether, the beam splitter shifts forward for $4d$ during the time while the beam f_1'' passes all four sides of the interferometer. Because of that the beam f_1'' interferes with the beam f_2' which is late for $4L-4d$. So, that difference of the ways between the two beams, which interfere, is

$$S_1 - S_2 = 4L - 4d = S_i - 4d \tag{6.2}$$

If we rotate the system through 180 degrees, then the interferometer in the ether will move in the opposite direction to the direction of the laser radiation, as it is shown in Fig. 6.3. So, the beam which has been transmitted through the splitter will pass the following way in the interferometer

$$S_i' = (L-d)+(L-d)+(L+3d)+(L-d) = 4L \tag{6.3}$$

and during this time the splitter moves in the direction of the interferometer's motion for $4d$ and the difference of the paths of the interfered beams is

$$S_1' - S_2' = 4L + 4d = S_i + 4d \tag{6.4}$$

From Eqs. (6.2) and (6.4) it works out that by rotating the system through 180° we obtain the difference of the shifts, which is measured by the shift measurer

$$\Delta S = (S_1' - S_2') - (S_1 - S_2) = 8d \tag{6.5}$$

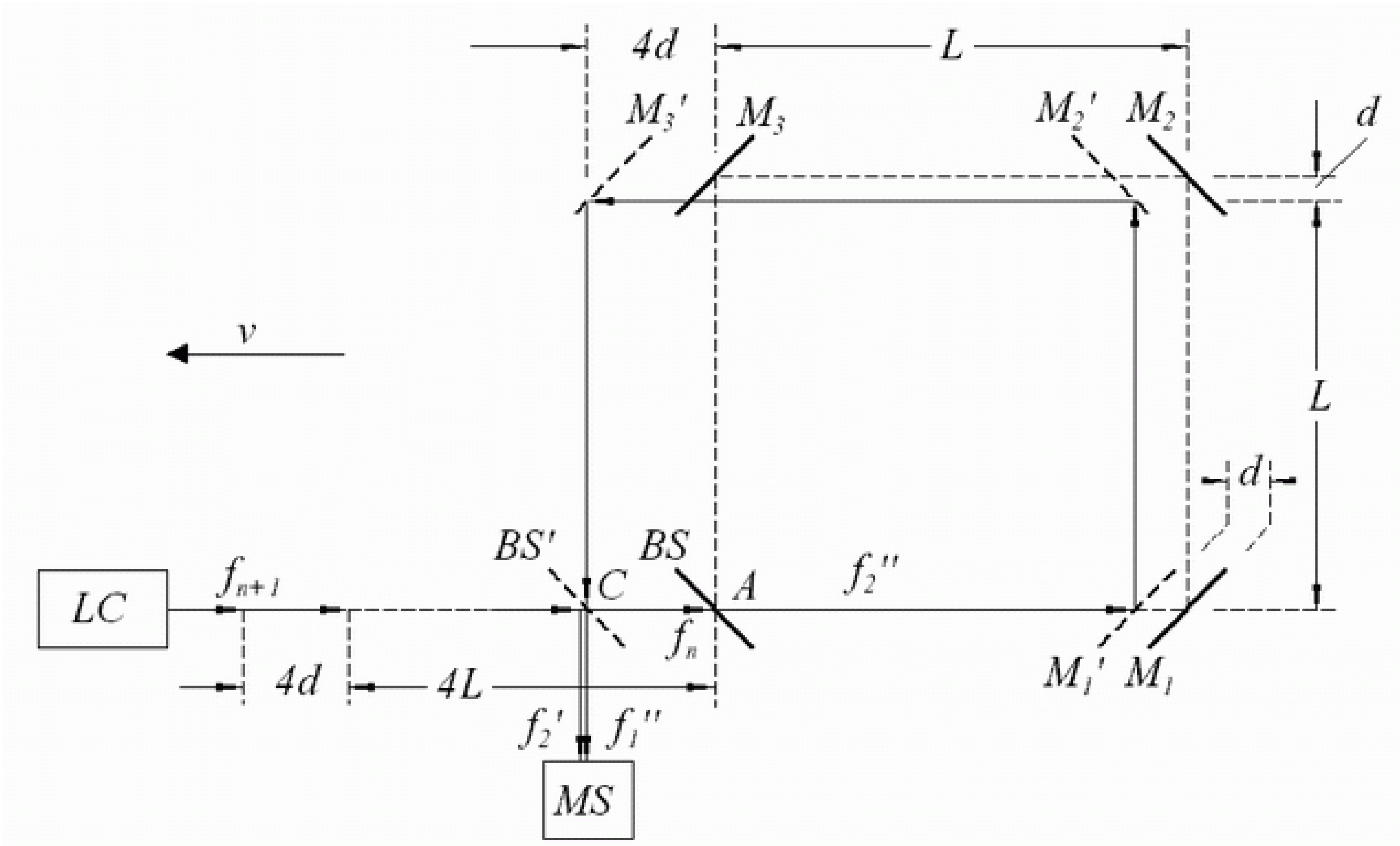

Fig. 6.3

For the time while beam f_1'' travels along path $S_i = 4L$ inside the interferometer at velocity c, the beam splitter passes the way $4d$ at a speed v, so we have the following relation

$$\frac{S_i}{c} = \frac{4d}{v} \tag{6.6}$$

and from there and Eq. (6.5) we obtain

$$\Delta S = 2S_i \frac{v}{c} \tag{6.7}$$

[In consideration we take that $\dfrac{L}{c-v} \approx \dfrac{L-3d}{c+v} \approx \dfrac{L}{c}$. So $d \approx L\dfrac{v}{c}$ and $\Delta S \approx 8L\dfrac{v}{c}$. The exact equation is

$\Delta S = \dfrac{8L\dfrac{v}{c}}{1-\dfrac{v^2}{c^2}}$, but since $v << c$ then we can write $\Delta S \approx 8L\dfrac{v}{c} = 2S_i\dfrac{v}{c}$.]

The shift presented by Eq. (6.7) is rather big and there are no difficulties in measuring its magnitude and also a velocity of a body motion relative to the quiescent ether. This can be done with great accuracy. For example, if v = 30 km/s and L = 0.1 m then ΔS = $8 \cdot 10^{-5}$ m at rotation of the interferometer through 180°. If rotation of the interferometer is just 1°, the mutual shift of the interfered beams would be about $0.444 \cdot 10^{-6}$ m.

As can be seen this interferometer is very sensitive and because of that the L side should be small. For better stability, the interferometer has to be compact, for instance to be made out of glass in the shape of a cube of small dimensions. Three lateral sides of the cube should be mirrors and the fourth should be a semi-mirror, beam splitter.

In order to reduce disturbance arising from repeated returns part of the beam f_1'' into interferometer, and also for the sake of equalizing the intensities of the interfered beams, one mirror at least should be semi-transparent. In conformity with it the beam splitter would transmit more than it would reflect.

Measurements taken with the interferometer like this eliminate any dilemma in connection with questions about the existence of the cosmic absolute quiescent ether and about the contraction of bodies, which move through the ether.

In Fig. 6.4 a new and simpler interferometer is given with the same purpose as the previous one where: LC is a laser with a collimator, BS_1 and BS_2 are a beam splitters, M is a mirror or a beam splitter and S is a screen for observing interference which appears between the laser beams reflected from the beam splitter BS_2 and from the mirror M.

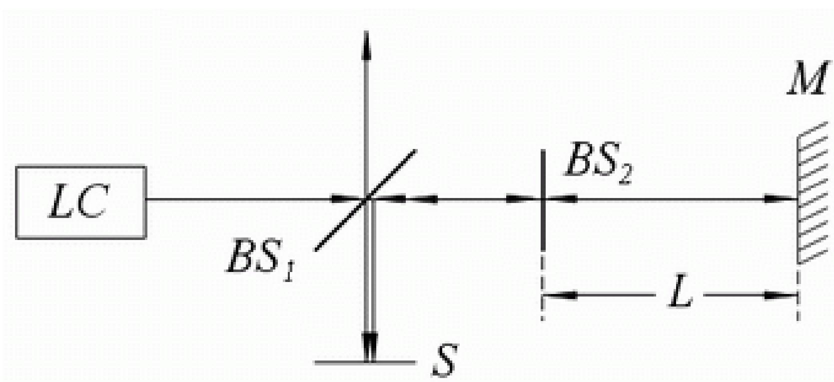

Fig. 6.4

The interference shift caused by interferometer motion in relation to the ether, at interferometer rotation through an angle of 180° is given by

$$\Delta S \approx 4L\frac{v}{c} \tag{6.8}$$

where L is the distance between the beam splitter BS_2 and mirror M, v is a speed of interferometer motion in relation to the ether and c is light velocity.

One side of the BS_1 and BS_2 would be coated with an antireflection coating, and the other side with reflection coating where reflection would be about 50% in case of BS_1 and about 38% in case of BS_2. For the sake of better stability of the interference fringes this interferometer also would be made from glass as a compact interferometer.

The new interferometer is the result of research into the possibilities of constructing a simple interferometer which would be considerably more sensitive than any other already in existence. In fact, my aim was to invent such an interferometer which could confirm my hypothesis on the existence of the earth's ether. As it was earlier shown I realized that aim. The new interferometer has that capacity, primarily, owing to the extraordinary coherence of laser radiation, which is used with that interferometer.

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7. SOME ATTEMPTS TO MEASURE THE EARTH'S MOTION RELATIVELY TO AN ETHER BY MEANS OF THE NEW INTERFEROMETER

If the ether is quiescent and fills up the entire cosmos, it is quite logical to put the following question: "What is the speed of earth's motion through the cosmos, that is, through this ether?" This question is not simple at all. The earth moves round the sun at a speed of 30 km/s. However, the sun moves and with itself pulls the earth around the center of the Galaxy, along an almost circular orbit, at a speed of 220 - 230 km/s. Our Galaxy, together with the local group of Galaxies, moves in the direction of another group of Galaxies in constellation of Virgo at a speed of 410 km/s etc.

The residual background radiation, that is the relict radiation which originated at the time of cosmic expansion (the big bang), discovered by Wilson in 1965, makes possible some special readings, which appear to be general for all parts of the cosmos, like some kind of an ether. For an unmoving observer, in relation to that reading system, the distribution of the relic radiation temperature is isotropic in all directions, only in the system connected to dispersed galaxies. The relict radiation corresponds to a temperature of 2.7 K of the absolute black body, which corresponds to the radiation wavelength of about 1.073 mm. When the observer is in motion, the Doppler effect causes the temperature of the residual background radiation to increase in the direction of the observer's motion, and to decrease it in opposite direction. Because of these characteristics, the absolute coordinate system can be connected to the relict radiation, as was the aim with the ether. The speed of motion of the sun in relation to this radiation is about 410 km/s.

For the above presented, we have anticipated a shift of an interference fringes which would correspond to the speed of the earth's motion through the ether greater than 400 km/s, and not 30 km/s.

The attempt to measure the speed of the earth's motion through the ether by means of new interferometer, was made for the first time at the end of January 1994, for the second time in the second half of May 1994, and for third time in the second half of March 1995.

The scheme of the measurement is presented in Fig. 7.1, where: LC is a helium - neon laser with a collimator, BS is a beam splitter - a glass plate placed at a 45° angle in relation to the incoming laser radiation, M_1 is a semi-transparent mirror with an attenuator of the radiation, M_2 and M_3 are mirrors, S is a screen for observation the interference fringes and OT is an optical table.

The whole system was set up and fastened to a platform, optical bench, which was placed and fastened on the optical table, so that it could rotate through 360°.

The beam splitter reflected about 30% and allowed about 70% of the laser radiation to pass through. This relation is convenient for the sake of the decrease of the disturbance produced by the part of the laser beam which is reflected from the beam splitter to the interior of the interferometer.

Mirror M_1 was a glass plate whose front surface partially reflected the laser radiation towards M_2, and the back side absorbed radiation transmitted through the glass plate. In such a way a part of the laser beam in the interferometer is attenuated.

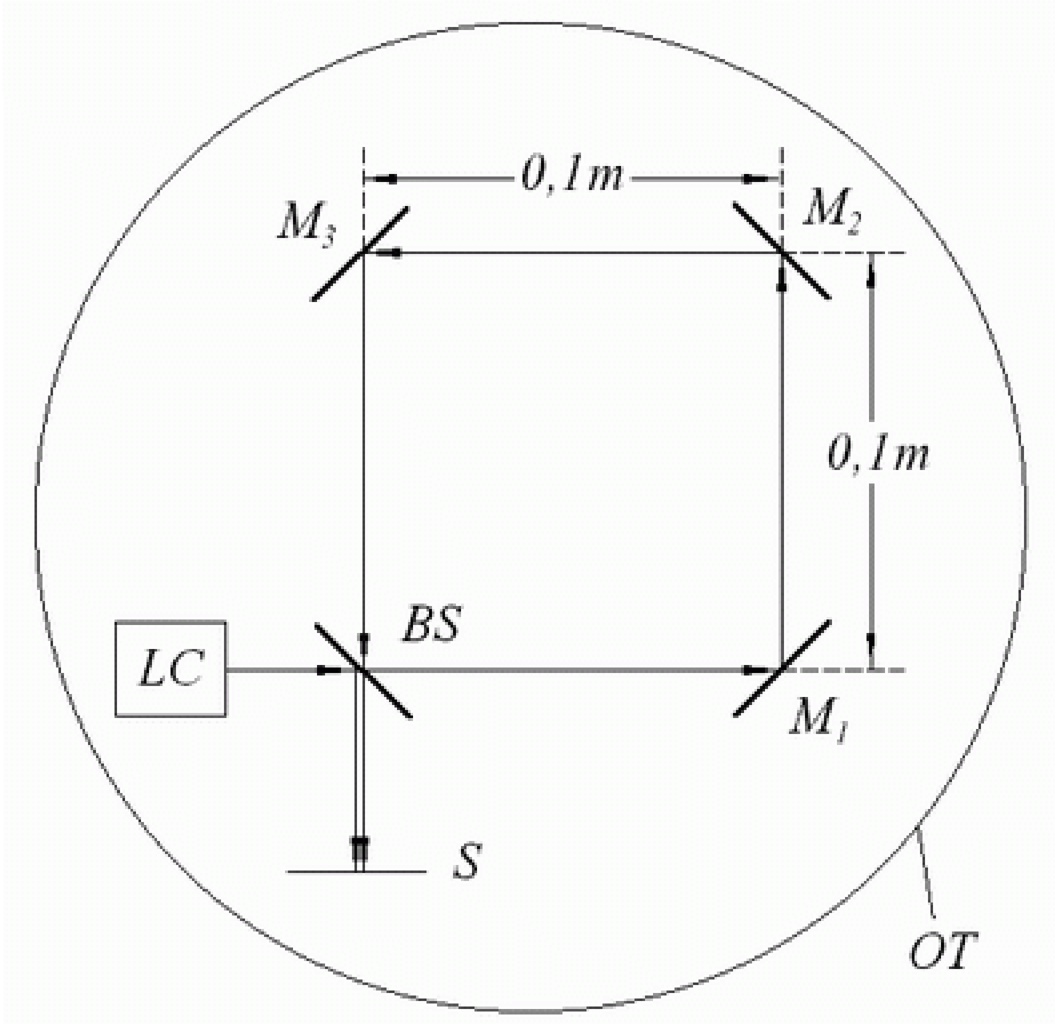

Fig. 7.1

The sides of the interferometer were almost equal and approximately 0.1 m.

It was easy to establish the interference by means of precision laser, mirror and splitter mount, and also it was very simple to follow the interference fringes on the screen.

The experiment was performed many times in a period of 10 - 13 hours, and the interference fringes shift which would arise from a velocity higher than 0.5 km/s when the interferometer was rotated through 360° were not noticed. Minor shifts of the interference fringes occurred, but it was hard to determine with certainty if the shifts arose from instability of the laser function, whose quality was not the best, or because of the mechanical instability of the interferometer parts, caused by rotation of the optical table, or because of motion of the measuring system relatively to an ether.

The system was not conceived to measure velocities less than 0.5 km/s, because, as was mentioned earlier, much higher relative velocities were expected in the case of existence an absolute quiescent and ubiquitous ether, as a carrier of light radiation.

Finally, according to the performed experiment and the given negative results the following conclusion was derived:

1. An absolute quiescent and ubiquitous ether which is a carrier of light radiation, and through which the earth moves does not exist, and

2. The possibility is not excluded that the earth, as well as the other bigger cosmic bodies, carry their

own ether, as it carries its own magnetic field.

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8. EARTH'S ETHER AND THE POSSIBILITY OF ASCERTAINING ITS EXISTENCE

For a long time many scientists have been occupied with the question of the ether's existence as a carrier of electromagnetic radiation, which fills all the cosmos. Thanks to many experiments, although some of them were explained incorrectly, the ether slowly but surely fading away from the science stage. The theory of relativity inflicted a final blow. Thus, such an absolute quiescent ubiquitous ether faded away, but some questions about certain electromagnetic phenomena have been left unanswered. One of those questions is how electromagnetic radiation or the narrower part of that radiation spectrum - light, is transmitted or propagated through the cosmos. The fact that vacuum has electromagnetic characteristics also, in some way, points to the existence of an ether in shape of an electromagnetic field.

The phenomenon of light aberration leads to the idea that the earth could have its own ether, in the way that it has its own magnetic field. What is it really all about? In 1725, Bradley noticed a deflection or an aberration of light while he was observing the stars, which had occurred as a consequence of the earth's motion around the sun.

When we observe a star by means of a telescope, then the telescope is not pointed exactly at the star, but at a small angle β in relation to that direction. The magnitude of that angle β depends on the angle α_s made by the seeming direction earth - star with the direction of the earth's motion. The greatest deflection appears when α_s = 90°. In that case the aberration angle is about 20.496". The effect is such that the light which comes from the stars seems to deflect 20.496" in the direction of the earth's motion. Because of this the telescope should be placed at that angle in relation to the actual direction in order to observe the star. This angle has been defined by the equation

$$\sin\beta = \frac{v}{c}\sin\alpha_s \tag{8.1}$$

where v is the speed of the earth's motion around the sun and c is the velocity of light.

Aberration of light rays, caused by an ether wind, has not been perceived in optical experiments with the earth's light sources. Why? Because there is no cosmic ether on the earth, but only the earth's ether, which moves together with the earth. So, there are no ether winds on the earth and there is no aberration of such light rays.

The theory of relativity explains the phenomenon of aberration in the mathematical way, based on the Lorentz transformation, but doesn't give a satisfactory physical explanation. Because of this, the explanation has been taken with reserve. Especially, when it is known that this transformation, in case of Michelson's experiment, proved contraction of one branch of the interferometer although it didn't exist.

If an analogy is made between deflection of sound waves, due to the motion of the air as the carrier of the sound and the aberration of light then one is led to speculate that there is also a carrier of light, and because of its motion, the light, which propagates within it, is deflected. In other words, the aberration proves the existence of earth's ether which the earth carries with it.

The question now appears to be whether an experiment can confirm or deny the existence of the earth's ether? An old ubiquitous quiescent ether doesn't exist. This has been ascertained by means of the new interferometer. But it is fortunate that with such an interferometer the existence of the earth's ether can be confirmed. The new interferometers give such a big shift of the interference fringes, that, a very small relative velocity can be successfully measured with them.

Michelson wanted to measure the speed of earth's motion relative to the quiescent cosmic ether, in order to prove the ether's existence. In our case let us place a compact new interferometer on an airplane in order to measure the airplane's velocity relatively to the earth's ether. But before that, for any case, we have to use the same interferometer on the earth to see if the earth's ether rotates together with the earth. If it rotates then there cannot be any shift of the interference fringes when measurements are made on the earth. But if it does not rotate, or if earth does not completely pull it at rotation, which is almost impossible there will be a certain shift which also proves the existence of the earth's ether.

Thanks to the new interferometer there are more ways to measure the existence of the earth's ether. Here below are descriptions of the two ways.

Let us imagine that a space ship catches up to the earth at its rotation around the sun, which has a relatively small velocity in relation to the earth. This space ship has to land on earth at some place near the Equator, where the radial velocity on the earth is v_r = 40000 / 86400 = 0.463 km/s or v_r = 1666.67 km/h, due to the rotation of earth. To the observer from the earth it will seem that the space ship flies towards the West at a speed of 1667 km/h. This is so because of the earth rotation towards the East.

Let us suppose that someone on the ship wants to confirm the existence of the earth's ether by using a new interferometer. When the ship was far from the earth, the ether could not be discovered, as would be the case with the earth's magnetic field, but as the ship gets closer to the earth the interferometer would discover the ether at rotation through 180° from the position where the laser radiates in the direction of the earth's rotation to the opposite direction. In both positions the direction of the laser radiation is normal to the direction of the ship's motion, so that this motion has no influence on the interferometer indication.

The above cited procedure would be accomplished with the airplane and interferometer inside it. The interferometer has to be placed in the same position as in the space ship and it has to have the laser radiation in the direction of the earth's rotation and then, after its rotation, in the opposite direction.

The plane would fly along the Equator towards the West at the velocity of 1667 km/h. At that velocity the shift at the interferometer with the side L = 0.1 m, has to be

$$\Delta S \approx 8L\frac{v}{c} = 8\cdot 0.1\cdot\frac{0.463}{3\cdot 10^5} = 1.23\cdot 10^{-6}\ \mathrm{m}$$

which is very close to the double wave length of the *HeNe* laser radiation. If the airplane was flying at a velocity of 840 km/h the shift would be equal to the wave length of the laser radiation, what could be easily measured.

In order to reduce the influence of vibration in the plane on the measurement, it is the best that the interferometer be compact, for example, in a shape of a glass cube whose edges are 10 - 15 cm. Then the shift would be even greater for about 1.5 times.

Of course, the airplane flight may take place at some other place or with other velocity.

Another way of confirming the existence of the earth's ether by use of a new interferometer, is by flying over the South or North pole. The path of that airplane flying over a pole should be the same as the path of space ship at flying over a pole. The beam of laser radiation has to be normal to the direction of the airplane motion. In order to confirm the existence of the earth's ether it is not necessary to rotate the interferometer. Changes in the interference state will appear at flying over the pole, due to the change of the direction of the earth's rotation in relation to the airplane, that is in relation to the interferometer.

If the existence of the earth's ether is confirmed it becomes clear that the light velocity relatively to the source may be greater than the light velocity in the vacuum. This appears, for example, when the earth's ether takes over the radiation from the direction of a star, which coincides with the direction of the earth's motion. Then the light velocity in relation to its source - a star, is equal to the sum of the incoming light velocity and the velocity of the earth motion. If the earth's motion is of opposite direction from the direction of the incoming light, then the light velocity in the earth's ether, in relation to the source of light, will be the difference between these two velocities. In both cases the light velocity in the earth's ether will be 300000 km/s, as if nothing had happened. Actually, the only change that takes place is the change of the light wavelength due to the Doppler shift, as in the case of sound in the closed car discussed in chapter 3. So, if the earth did not have its ether, then the speed of light, in relation to some point on earth, would depend on the direction of the motion of that point in relation to the star, as the source of light. The same is true in the case of a light source on the earth. To make this easier to understand, let us imagine the Michelson - Morley experiment with sound waves in an open wagon and a closed one. In the experiment with the closed wagon we would find out that there is no interference shift, no matter how fast the wagon traveled in relation to the embankment and outer environment. That is so because the environment - air, which carries sound, travels together in the closed wagon. However, on an open wagon there will be interference shift of sound waves, even when the source of sound waves is placed on the open wagon, which we can claim with certainty on the basis of well known experience. Thus, we come to the conclusion that the result of Michelson - Morley experiment proves the existence of the earth's ether.

Confirming the existence of ether has an enormous and multiple significance. Among other things it would present the end of the theory of special relativity, which is based on the constancy of light velocity. If earth's ether exists, then the other ethers of a cosmic bodies exist too. All of them fill up the cosmos and each one has an influence on light which propagates through them.

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9. LORENTZ EXPLANATION OF THE NEGATIVE RESULTS OF MICHELSON'S EXPERIMENT

The negative results of Michelson's experiment were a great surprise to all physicists of that time. There were serious doubts about the result, which is testified to by the persistence with which the experiment was repeated over many years.

Many physicists of that time tried to explain the reason for the negative result. Michelson and Morley concluded, on the basis of the experiments, that the earth, which moves, draws along the ether completely as Stockes's theory and Hertz electromagnetic theory had stated. But that conclusion was in contradiction with many experiments, which tried to prove the hypothesis of the partial drawing of the ether. Lodge, however had shown that the velocity of light does not change near bodies which move fast, even when those bodies carry strong electric and magnetic fields.

A special place in explaining and analyzing the negative result of the experiment, belongs to Lorentz, Fitzgerald and Poincare. Poincare, for example, was one of the greatest mathematicians and theoretical physicists of that time. After analyzing the first and simple experiment performed by Michelson, Lorentz gave a daring and unfounded hypothesis that: "Each body which has velocity v is shorter in the direction of motion for the factor

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

Actually if instead of the length L in Eq. (5.7) we take $L\sqrt{1-v^2/c^2}$ then the length of the optical paths in both branches of Michelson's interferometer will be equal, and the expected shift will not occur, as was the case in the experiment. Fitzgerald and Poincare had the same idea about the shortening. Therefore the contraction hypothesis is also called the Lorentz - Fitzgerald contraction hypothesis. The shortening occurs only in the dimension aligned with the direction of motion, whereas the transversal dimensions do not change. That shortening cannot allegedly be discovered by any kind of Earthly observation because each ruler on the earth shortens in the same proportion. An observer who was at rest position in the ether, and outside earth, would allegedly be able to see this shortening. The whole earth would look flattened in the direction of motion and also all its objects.

Thus, according to Lorentz, the objects which move through the ether, become shorter in the direction of the motion for the contraction factor $\sqrt{1-v^2/c^2}$.

So, if the length of a body is L_0 when it is at rest, then the length of the body in motion is

$$L = L_0 \sqrt{1 - \frac{v^2}{c^2}} \qquad (9.1)$$

L_0 is also called proper length.

Now let us take a look at how the theory of relativity looks at the Lorentz - Fitzgerald's Contraction Hypothesis.

If we connect an unmoving coordinate system to the ether, and a moving system to the earth, then the measuring system in Michelson's experiment, was unmoving in the system which moves and all the measurements were done in that moving system. Accordingly, the shortening of the body originates in the unmoving system in which observed body is at rest. However, according to the theory of special relativity there is no shortening of the objects in the system, in which those objects are at rest. Einstein goes further and says [6]:

Quotation: "According to the theory of relativity there is no any privileged coordinate system which could give a motive for introducing the idea about ether. Consequently, there is no ethereal wind nor any experiment which could show that it exists. Here the contraction of bodies in motion follows, without any particular hypothesis, from both basic principles of the theory. At that for this contraction, the motion only is not competent. For that motion is not able to give any sense, but for the motion in relation to the chosen reference body. Because of this Michelson-Morley's experimental mirror was not shortened in the relative system which moves together with the earth, but only in the relative system which is unmoving in relation to the sun." **End of quotation.**

As we can see from the quoted text, Einstein did not agree with Lorentz's explanation of the negative result of Michelson's experiment, that is he did not accept that the contraction hypothesis could be applied in a system where the body is at rest, but only in a system where the body is moving.

In conclusion, however, it is necessary to repeat that the Michelson - Morley measurement could not give the facts about earth's motion through the ether. Measurements with the new interferometer have also shown that there is no the earth motion, or more exactly the interferometer motion relatively to the ether, and that there was not any contraction. This means that the Lorentz - Fitzgerald contraction hypothesis has no basis, at least as regards the contraction in connection with Michelson's experiment.

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10. THE LORENTZ TRANSFORMATION

In the endeavor to explain the negative results of Michelson's experiment, Lorentz derived the famous transformation which is the predecessor and basis of the special theory of relativity, and was named after him. With this transformation are given the new formulas for the coordinates and time, which are valid for two systems, which mutually move translatory at velocity v and without acceleration. He published these formulas for the first time in 1904 in his work "Electromagnetic phenomena in a system moving with any velocity smaller than that of light".

In the following text the Lorentz transformation is given in the way that Einstein presented it in "The special and general relativity theory" [6]. This is done because the transformation is an important matter upon which the special theory of relativity is based.

Quotation: "The simple derivation of the Lorentz transformation

At the relative position of the coordinate system in Fig. 10.1, the x-axes constantly overlap in both systems. In this case we can divide the problem in such a way, that first of all we will look at events which are located on the x-axis. Such events relative to the coordinate system K are given by abscissa x and time t, but relatively to the K' system is given by abscissa x' and time t'. To find out x' and t' if x and t are given.

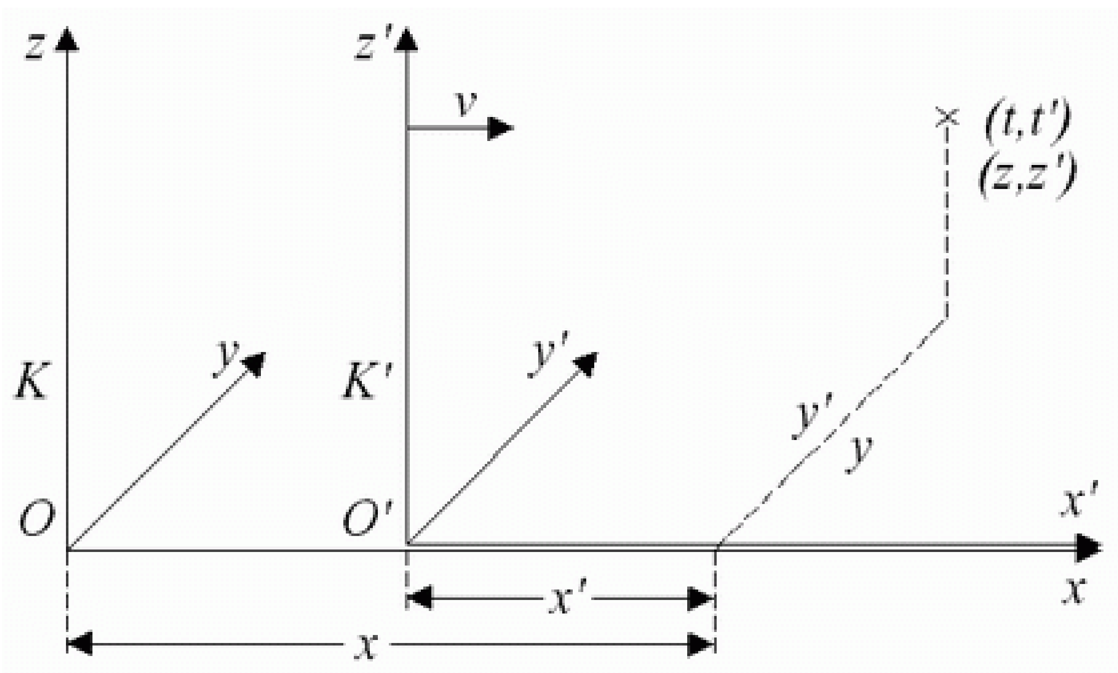

Fig. 10.1

The light signal which moves along the x-axis propagated according to the equation

$$x = ct \quad \text{or} \quad x - ct = 0 \tag{10.1}$$

But since the same light signal has to be propagated at velocity c relatively to K' also, then the propagation toward K' can be expressed by a similar formula

$$x' - ct' = 0 \tag{10.2}$$

The space-time points (events) which satisfy Eq. (10.1) must also satisfy Eq. (10.2). It will be, at all events, when in general is fulfilled the relation

$$(x' - ct') = \lambda (x - ct) \tag{10.3}$$

where λ is a constant, because according to Eq. (10.3) if $x - ct$ is equal to zero, then $x' - ct'$ must be equal to zero too.

A wholly similar consideration applied to light rays which propagate along the negative x-axis gives the following condition

$$(x' + ct') = \mu (x + ct) \tag{10.4}$$

When we add, that is, subtract Eqs. (10.3) and (10.4), to make it simpler, the following constants are introduced instead of constant λ and μ

$$a = \frac{\lambda + \mu}{2} \quad \text{and} \quad b = \frac{\lambda - \mu}{2}$$

we obtain

$$\begin{aligned} x' &= a x - b c t \\ c t' &= a c t - b x \end{aligned} \tag{10.5}$$

With this our task would be solved if a and b were known. These constants we determine by the following consideration.

For the origin of the K' system it is always x' = 0, so, according to the first of Eqs. (10.5) is

$$x = \frac{bc}{a} t$$

[This doesn't function. The coordinates x and x' are coordinates of the light ray (wave) position on the x-axis and x'-axis of the coordinate system K and K' respectively, which has been pointed out by Eqs. (10.1) and (10.2). In the starting position x' = 0 and then it must be t = 0, t' = 0, and x = 0. Remark M.P.]

Let us mark by v the velocity of the origin of the system K' which moves relatively to K, then

$$v = \frac{bc}{a} \tag{10.6}$$

[This doesn't function either. Eq. (10.6) has derived from the previous under the condition that

$$v = \frac{x}{t} = \frac{bc}{a}$$

which can not be correct because it is in accordance to Eq. (10.1) $x = ct$ and from there $x/t = c$, that is not $v = x/t$. Remark M.P.]

The same value for v we obtain from Eq. (10.5) if we calculate, relatively to K the velocity of the second point of the K' system, or the velocity of the point of the system K relatively to K' pointed in the negative direction of x-axis. In short, we can mark v as the relative velocity of both the systems.

Then according to the principle of relativity it is clear, that the unit length of the ruler which is at rest relatively to K', measured in the K system, must be exactly the same as the unit length of the ruler which is at rest relatively to the K system, measured from the K' system. In order to see how the points of the x'-axis look, observed from the system K', it is necessary to make only an "instantaneous photo" of the system K' from the K; this means that we will take for t (the time of the system K) certain value, for instance t = 0. For this value t = 0, from the first of Eqs. (10.5) we obtain

$$x' = ax$$

The two points of the x'-axis, which are measured in the K' system have the distance x' = 1, have, therefore, at our instantaneous photo the distance

$$\Delta x = \frac{1}{a} \tag{10.7}$$

But if we make a instantaneous photo from the system K' (t' = 0), in consideration of Eq. (10.6), we obtain from Eq. (10.5), if we eliminate t

$$x' = a\left(1 - \frac{v^2}{c^2}\right)x \tag{10.8}$$

From this we conclude that the two points of the x-axis with distance 1 (relatively to the K) have the distance at our instantaneous photo

$$x' = a\left(1 - \frac{v^2}{c^2}\right) \tag{10.9}$$

Since, upon above mentioned, both instantaneous photos must be equal, thus Δx in Eq. (10.7) must also be equal to $\Delta x'$ in Eq. (10.9), so that we obtain

$$a^2 = \frac{1}{1 - \frac{v^2}{c^2}} \tag{10.10}$$

Eqs. (10.6) and (10.10) determine the constants a and b. By substitution in Eq. (10.5) we obtain the first and fourth equations which are given in chapter 11

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{10.11}$$

With this we derive the Lorentz transformation for events on the x-axis. It satisfies the condition

$$x'^2 - c^2 t'^2 = x^2 - c^2 t^2 \tag{10.12}$$

The extension of this result on the events being done outside the x-axis, results if, keeping Eq. (10.11), we add equations

$$\begin{aligned} y' &= y \\ z' &= z \end{aligned} \tag{10.13}$$

That the postulate about the constancy of light velocity in a vacuum was also satisfied by this, for rays of light directed in whatever way desired, both for the system K and for system K', can be seen in the following way.

Let the light signal be sent in the moment t = 0 from the origin of the system K. This signal propagates according to equation

$$r = \sqrt{x^2 + y^2 + z^2} = ct \tag{10.14}$$

or squaring, according to equation

$$x^2 + y^2 + z^2 - c^2 t^2 = 0 \tag{10.15}$$

The law about the propagation of light requires, in connection with the postulate of relativity, that the propagation of the same signal, judging from system K', should be done according to an adequate formula

$$r' = ct'$$

or

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = 0 \tag{10.16}$$

In order to be Eq. (10.16) a consequence of Eq. (10.15) it must be

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = \sigma\left(x'^2 + y'^2 + z'^2 - c^2 t'^2\right) \tag{10.17}$$

Since for the points on the x-axis must be valid Eq. (10.12), it also must be σ = 1. It is easily seen that the Lorenz transformation really satisfies Eq. (10.17) with σ = 1, because Eq. (10.17) is a consequence of Eqs. (10.12) and (10.13) and therefore Eqs. (10.11) and (10.13) also. By this the Lorenz transformation has been derived.

Generalized Lorenz transformation can be characterized in the mathematical way as follows:

The Lorenz transformation expresses x', y', z' and t' by means of such linear homogenous functions of x, y, z and t that the relation

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = x^2 + y^2 + z^2 - c^2 t^2 \tag{10.18}$$

is identically satisfied. This means that if on left instead of x', and so on, we place their expression in function of x, y, z and t, then the left side of Eq. (10.18) will identically agree with the right side of the same equation." **End of quotation.**

In order to make the following challenges to some of the assertions made in the theory of relativity easier to understand it is necessary to pay some attention to the following.

The coordinates x', y', z' and t' which, in the case of Lorentz transformation are given by the expressions

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad y' = y, \quad z' = z \quad \text{and} \quad t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{10.19}$$

meet the requirement that the relation (10.18) be identically satisfied.

If the expressions for x', y', z' and t' from Eqs. (10.19) are solved for x, y, z and t then we have

$$x = \frac{x' + vt'}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad y = y', \quad z = z' \quad \text{and} \quad t = \frac{t' + \frac{v}{c^2}x'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{10.20}$$

The transformed coordinates given for x and t in dependence with x' and t' also fulfil the requirement that relation (10.18) also be satisfied identically.

The coordinates of both systems are mutually dependent. That dependence we can determine by using the starting conditions under which the Lorentz transformation is derived and which are given in Eqs. (10.1) and (10.2). According to these equations $x = ct$ and $x' = ct'$. Bearing this in mind we can write

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{ct - vt}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{ct\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{x\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} = x\sqrt{\frac{c - v}{c + v}} \tag{10.21}$$

or

$$x = x'\sqrt{\frac{c + v}{c - v}} \tag{10.22}$$

By the same procedure we get

$$t = t'\sqrt{\frac{c + v}{c - v}} \tag{10.23}$$

or

$$t' = t\sqrt{\frac{c - v}{c + v}} \tag{10.24}$$

From Eqs. (10.21) and (10.24) we get

$$\frac{x'}{t'} = \frac{x\sqrt{\frac{c - v}{c + v}}}{t\sqrt{\frac{c - v}{c + v}}} = \frac{x}{t} = c \tag{10.25}$$

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11. SOME OBSERVATIONS IN CONNECTION WITH THE LORENTZ TRANSFORMATION

Besides the earlier stated remarks, there are some other observations to be made.

In deriving the transformation, Einstein started from an equation for the propagation of a plane light wave [Eqs. (10.1) and (10.2)]. So he derived Eqs. (10.11). After that he demonstrated that the given transformation also satisfies in case of the equation for spherical light wave propagation. And indeed, when we substitute the expression for t' and x' from Eqs. (10.11) in Eq. (10.18) then we obtain identical satisfaction of Eq. (10.18). But if we make substitution in the equation for the plane wave $x - ct = x' - ct'$, then there is no identical satisfaction.

Thus, substitution of the equation for x' and t' from Eq. (10.11) in the equation for the plane wave yields

$$x' - ct' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} - \frac{c\left(t - \frac{v}{c^2}x\right)}{\sqrt{1 - \frac{v^2}{c^2}}} = (x - ct)\sqrt{\frac{c+v}{c-v}}$$

Thus equation $x' - ct' = x - ct$ is not identically satisfied that is, by use of the Lorentz transformation the invariability of equation of the plane wave is not achieved. With that is denied the first principle of special relativity which runs as follows: "Each general law of nature, which is valid relatively to the coordinate system K must be equally valid relative to the coordinate system K', which moves with uniform translation relatively to the system K."

However, in case of a spherical wave by the above substitution the identical satisfaction is achieved.

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = \left(\frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}\right)^2 + y^2 + z^2 - c^2\left(\frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}}\right)^2 =$$
$$= x^2 + y^2 + z^2 - c^2 t^2$$

For the area of the light wave sphere, which moves opposite to the direction of the K' system's direction of motion, we obtain, using transformation, the following equations

$$x' = \frac{x + vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad t' = \frac{t + \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{11.1}$$

In this case the coordinate system K' moves to the left along the negative x-axis at velocity v relative to K and the light wave moves at velocity c to the right, that is in the positive direction of the x-axis. Their relative velocity should be $c + v$, but it is not so. By dividing presented Eq. (11.1) we have $x'/t' = c$. This is mathematically well done. The passed way x'

was increased, and also was increased local time t', so the quotient remained the same, unlike the case given by Eq. (10.11) where the way x' is reduced and also the local time t'. When we substitute x' and t' from Eq. (11.1) into Eq. (10.18) we also obtain the identical satisfaction, which means that the requirement for invariability has been satisfied.

The coordinates x, y, z and x', y', z' are coordinates of the position of the light wave in the unmoving reference coordinate system K, and in the moving coordinate system K' respectively, **and cannot be the coordinates of some other point out of the place of the spherical or of the plane observed light wave.**

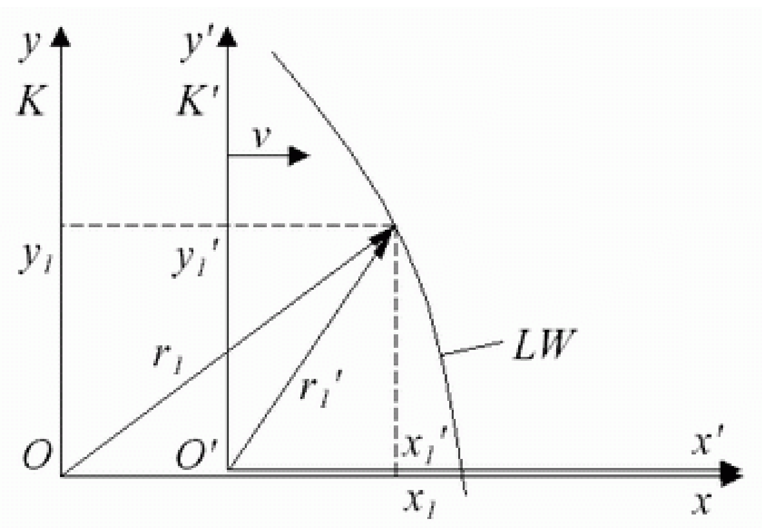

Fig. 11.1

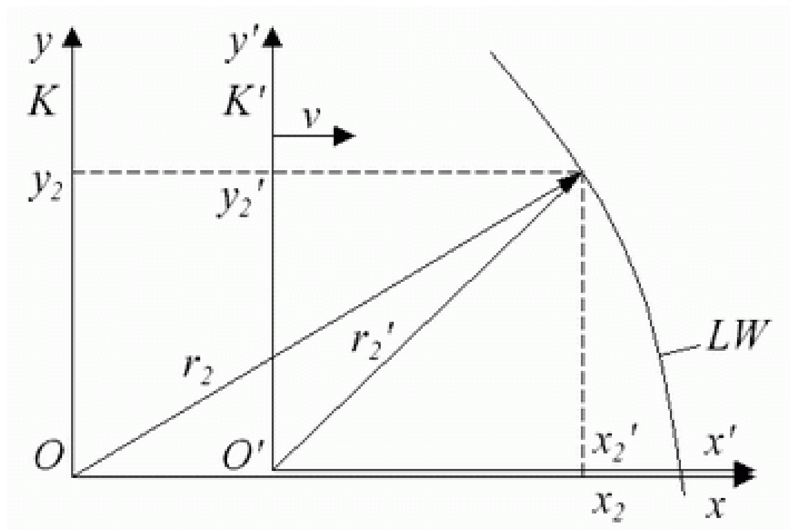

Fig. 11.2

Figs. 11.1 and 11.2 present in the xy and in the $x'y'$ plane the position of the same spherical wave LW in the times t_1 and t_2, that is t'_1 and t'_2. As it can be seen in Fig. 11.1

$$r_1 = c\,t_1 = \sqrt{x_1^2 + y_1^2}$$

that is

$$r_1^2 = c^2\,t_1^2 = x_1^2 + y_1^2$$

and

$$r'_1 = c\,t'_1 = \sqrt{x_1'^2 + y_1'^2}$$

that is

$$r_1'^2 = c^2\,t_1'^2 = x_1'^2 + y_1'^2$$

These relations are also valid for the cases in Fig. 11.2, where the position of the same spherical wave and coordinate system K' in time t_2 is given, so we get from that

$$r_2 = ct_2 = \sqrt{x_2^2 + y_2^2}$$

that is

$$r_2^2 = c^2 t_2^2 = x_2^2 + y_2^2$$

and

$$r_2' = ct_2' = \sqrt{x_2'^2 + y_2'^2}$$

that is

$$r_2'^2 = c^2 t_2'^2 = x_2'^2 + y_2'^2$$

If propagation of the spherical wave is observed only along the x-axis, as it will be further in the text, then the above given equations will take the following form

$$x_1 = ct_1 \quad \text{and} \quad x_1' = ct_1', \quad \text{but also} \quad x_2 = ct_2 \quad \text{and} \quad x_2' = ct_2' \tag{11.2}$$

so that

$$x_2 - x_1 = c \cdot (t_2 - t_1) \quad \text{and} \quad x_2' - x_1' = c \cdot (t_2' - t_1') \tag{11.3}$$

We will come back to these equations later on, when we will consider the contraction of space and dilatation of time, where it was wrong taken that $x_1 = vt_1$ and $x_2 = vt_2$.

The initial state is the moment when the spherical or the plane light wave and the moving coordinate system K' begin to move from the origin of the unmoving reference coordinate system K. Then it is x = 0, x' = 0, t = 0 and t' = 0. If this phenomenon is observed in the space then also are r = 0, r' = 0, y = y' = 0 and z = z' = 0.

So, the coordinates of the origin in the systems K and K' cannot be coordinates x, y, z and x', y', z' except in the initial state, and because of that it may be said that the Lorenz transformation in regard to the determination of coefficients a and b in Eq. (10.5) has not been derived correctly.

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12. DERIVING THE TRANSFORMATION OF COORDINATES BASED ON THE SATISFACTION OF THE REQUIREMENT FOR INVARIABILITY

As was mentioned before, the Galilean transformation maintains the invariability of equation of the basic laws of mechanical motion in inertial systems. However, this is not the case for equation of the laws in electromagnetism, so new transformations have to be found, which are derived from the condition of invariability of certain equations in the given area. Some of these examples will be treated in the further text.

The propagation of the spherical electromagnetic (or sound) wave has been given in a system K by the following equation

$$x^2 + y^2 + z^2 - c^2 t^2 = 0 \tag{12.1}$$

If we suppose that the system K' moves continuously and translatory in relation to K so that its x'-axis moves along the x-axis, whereas the y'-axis remains parallel to the y-axis and the z'-axis parallel to the z-axis, we obtain the transformational formulas as in one-dimensional case.

The invariability of Eq. (12.1) for the propagation of an electromagnetic spherical wave requires that the propagation of the given wave can be presented by the same equation in a system K' as well, which would then be as follows

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = 0 \tag{12.2}$$

Let the transformational formula for the coordinate x' be

$$x' = a(x - vt) \tag{12.3}$$

where is a coefficient which is determined by the comparison.

For the coordinates y' and z' the transformational formulas are

$$\begin{aligned} y' &= y \\ z' &= z \end{aligned} \tag{12.4}$$

Let the transformational formula for time t' be

$$t' = mt - nx \tag{12.5}$$

where m and n are the coefficients which are also determined by the comparison.

When the substitution of the expression for x', y', z' and t' is done in Eq. (12.2) we obtain

$$a^2 (x - vt)^2 + y^2 + z^2 - c^2 (mt - nx)^2 = 0$$

or

$$\underbrace{\left(c^2 n^2 - a^2\right)}_{1} x^2 + y^2 + z^2 - \underbrace{\left(c^2 m^2 - a^2 n^2\right)}_{c^2} t^2 + 2xt \underbrace{\left(a^2 v - c^2 mn\right)}_{0} = 0 \tag{12.6}$$

Comparison of the coefficients of t^2, x^2, y^2 and z^2 in Eqs. (12.1) and (12.6) gives

$$\begin{aligned} c^2 n^2 - a^2 &= 1 \\ c^2 m^2 - a^2 n^2 &= c^2 \\ a^2 v - c^2 mn &= 0 \end{aligned} \tag{12.7}$$

Solving Eqs. (12.7) we obtain the coefficients

$$\begin{aligned} a = m &= \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \\ n &= \frac{\frac{v}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} \end{aligned} \tag{12.8}$$

Substitution of these expressions in Eqs. (12.3) and (12.5) gives relativistic formulas for the coordinates and time which Lorentz derived

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$
$$y' = y$$
$$z' = z \qquad (12.9)$$
$$t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Thus, we obtained the same equations for a case of propagation of the spherical wave as in case of Lorentz transformation, but in a more correct mathematical way.

This does not exclude the possibility of deriving the other transformations as well. For the need of further consideration we will derive two new transformations for the case of spherical wave propagation and two for the case of plane wave propagation. As before, for the spherical wave we will use Eqs. (12.1) and (12.2) and the following transformational formulas

$$x' = mx - vt$$
$$t' = at - bx \qquad (12.10)$$
$$y' = y$$
$$z' = z$$

In the same way, as in previous case, in obtaining Eqs. (12.9) we find expressions for coefficients m, a and b

$$a = m = \sqrt{1 + \frac{v^2}{c^2}} \qquad (12.11)$$
$$b = \frac{v}{c^2}$$

so that

$$
\begin{aligned}
x' &= x\sqrt{1+\frac{v^2}{c^2}} - vt \\
y' &= y \\
z' &= z \\
t' &= t\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x
\end{aligned}
\qquad (12.12)
$$

As in case of relativistic Eqs. (11.1) it is also obtained that

$$
\begin{aligned}
x' &= x\sqrt{1+\frac{v^2}{c^2}} + vt \\
y' &= y \\
z' &= z \\
t' &= t\sqrt{1+\frac{v^2}{c^2}} + \frac{v}{c^2}x
\end{aligned}
\qquad (12.13)
$$

In Eqs. (12.12) and (12.13) the velocity v is not limited to the velocity c, so, it is allowed to be $v > c$.

We obtain the fifth transformation of coordinates on the basis of the requirement of invariability for the equation of the plane wave so that the relation

$$x - ct = x' - ct' \qquad (12.14)$$

is identically satisfied, and transformational equations

$$
\begin{aligned}
x' &= x - vt \\
t' &= at - bx
\end{aligned}
\qquad (12.15)
$$

As before we determine coefficients a and b by the comparison using Eqs. (12.14) and (12.15) which gives

$$a = 1 - \frac{v}{c}$$
$$b = 0 \tag{12.16}$$

so that

$$x' = x - vt$$
$$t' = \left(1 - \frac{v}{c}\right)t \tag{12.17}$$

In these equations the velocity v is also not limited, so it can be $v > c$.

Eq. (12.17) most clearly describes the propagation of a light plane wave (or a sound plane wave) in an inertial system. In them lengths are "clear", which means that they are not multiplied by any coefficient. The times are given by simple formulas. Time t' is smaller than time t for a coefficient ($1 - v/c$), which is, from the standpoint of a light waves propagation, clear in the sense of physics, if the flow of the events is observed in the direction of a wave motion. For example, if the system K' is moved at velocity $v = c$ then its origin would always be at the same light wave (x' = 0). Then the time would stop flowing in that coordinate system, because there would be no change in the electromagnetic situation. From the direction of the origin of the system K no electromagnetic phenomena, such as a light pulse, succeeds in reaching that system and they always stay at the same distance, like the others in front of them. Under these conditions it seems that everything has stopped, in a sense of propagation of the electromagnetic waves in the direction of motion.

For example, if $v = 0.5c$ then the number of electromagnetic waves which pass through the origin of the system K' are two times smaller than it would be if the system K' were at rest in relation to the system K. Because of this the number of events is two times smaller, so it seems as if time passes more slowly. This can be of great significance in regard to the life time of some phenomena or things.

For example let us suppose, that a rocket starts to fly from a point A at speed $v = 0.5c$ toward a point B, with the intention of destroying some target. Let the system in the rocket be programmed to activate an explosive when it receives 20 radio pulses from the earth, which are sent there every second. The question is: What is the life time of the rocket from the moment it receives the first pulse at point A, till the explosion and its destruction? Counting the pulses we could say that it is 20 seconds, since 20 pulses altogether are sent from the earth, that is, one pulse per second. However, since the rocket flies at speed $v = 0.5c$ it will receive 20 pulses and activate the explosive, only, after 40 seconds. According to the rocket's clock, which is synchronized with the radio pulse receiver, and which is programmed to count time according to received number of pulses on the earth at rest, the life time of the rocket is 20 seconds. But, naturally, if the clock was set to work independently, that is at its own speed, it would show the actual life time, which would be, as we said 40 seconds.

If the rocket flew in the opposite direction, from the point B towards the point A, at the same speed as in the previous case, then the actual life time of the rocket would be 13.3 sec, and the counter - synchrony clock in the rocket would again show 20 seconds.

The second Eq. (12.17) can show the time of the past. So if $v > c$, the coordinate system K' goes in front of the light wave (in the same way as the supersonic airplane flies in front of the sound). In its way it catches up with and outruns the waves had started earlier, and gives the picture of the past. In such a way, for example, it could reach the rays of sun's light reflected from a warrior's armor at the Battle of Kosovo in 1389, making possible for the observer in that coordinate system to see the battle but in reverse, as when we rewind a film tape. This is the sense of the negative time in Eq. (12.17).

The following transformation number six, is also derived by using Eq. (12.14) of the plane wave propagation and transformational formulas

$$\begin{aligned} x' &= ax - avt \\ t' &= at + bx \end{aligned} \tag{12.18}$$

After determining the coefficients a and b by comparison we obtain

$$\begin{aligned} x' &= \frac{x - vt}{1 + \frac{v}{c}} \\ t' &= \frac{t - \frac{v}{c^2}x}{1 + \frac{v}{c}} \end{aligned} \tag{12.19}$$

Besides the given transformations, others of a similar form can be derived as well. Lorentz gave one coordinates transformation. However, as it has been shown, there are the other transformations with which is achieved an identical satisfaction of relation connected with propagation of a spherical light wave

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

or relation connected with propagation of a plane light wave

$$x' - ct' = x - ct$$

when left instead of x', y', z' and t' we put their expression depending on x, y, z and t.

This requirement for an identical satisfaction was emphasized by Einstein himself in the earlier quoted citation "The simple derivation of Lorentz transformation". All transformations which achieve the invariability of equation of propagation of the spherical or of the plane wave are of the same validity.

With the transformed coordinates in case of a spherical wave, there is no identical satisfaction of relation $x' - ct' = x - ct$ connected with the plane wave propagation. Also with transformed coordinates in case of a plane wave, identical satisfaction of relation

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

connected with the spherical light wave propagation cannot be obtained.

A spherical wave appears in case of radiation sources of very small dimensions, and the plane wave appears at a collimated radiation. Michelson and Morley's experiment and Fizeau's test were performed by using plane waves. All interferometric measurements are made by use of plane waves, because for a such measurements it is necessary to have a collimated radiation.

Finally, before we consider the basic characteristics of the derived transformations, we present them together, for the sake of easier comparison.

a) **Lorentz transformation**

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad x = \frac{x' + vt'}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad t = \frac{t' + \frac{v}{c^2}x'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{12.20}$$

b) The new transformation, in the further text **transformation No. 1**

$$x' = \frac{x + vt}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad t' = \frac{t + \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad x = \frac{x' - vt'}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad t = \frac{t' - \frac{v}{c^2}x'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{12.21}$$

c) The new transformation, in the further text **transformation No. 2**

$$x' = x\sqrt{1+\frac{v^2}{c^2}} - vt, \quad t' = t\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x$$
$$\text{and} \quad x = x'\sqrt{1+\frac{v^2}{c^2}} + vt', \quad t = t'\sqrt{1+\frac{v^2}{c^2}} + \frac{v}{c^2}x' \tag{12.22}$$

d) The new transformation, in the further text **transformation No. 3**

$$x' = x\sqrt{1+\frac{v^2}{c^2}} + vt, \quad t' = t\sqrt{1+\frac{v^2}{c^2}} + \frac{v}{c^2}x$$
$$\text{and} \quad x = x'\sqrt{1+\frac{v^2}{c^2}} - vt', \quad t = t'\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x' \tag{12.23}$$

e) The new transformation, in the further text **transformation No. 4**

$$x' = x - vt, \quad t' = \left(1-\frac{v}{c}\right)t \quad \text{and} \quad x = x' + \frac{vt'}{1-\frac{v}{c}}, \quad t = \frac{t'}{1-\frac{v}{c}} \tag{12.24}$$

f) The new transformation, in the further text **transformation No. 5**

$$x' = \frac{x-vt}{1+\frac{v}{c}}, \quad t' = \frac{t-\frac{v}{c^2}x}{1+\frac{v}{c}} \quad \text{and} \quad x = \frac{x'+vt'}{1-\frac{v}{c}}, \quad t = \frac{t'+\frac{v}{c^2}x'}{1-\frac{v}{c}} \tag{12.25}$$

The Lorentz transformation and transformation No. 1, which has been derived from the Lorentz transformation, exclude the possibility that velocity v of the coordinate system K' can be greater than the speed of light and all other transformations allow that possibility.

Transformation No. 2 has one paradox. The origin of the system K' even at velocity v higher than the velocity of light, stays inside the sphere formed by the spherical wave, which propagates at the velocity of light from the origin of the system K. This means, for example, that the light wave moves at the velocity of light in the positive direction of the x-axis, and after it the origin of system K' moves in the same direction, at a much higher velocity than that of light, but for all that never reaches that light wave. So, the origin of the system K' cannot go out of the sphere of that spherical light wave, in spite of its own so high velocity.

Transformation No. 3 contains another paradox. The origin of system K' can leave the sphere, formed by the spherical light wave, if it moves in the negative direction of the x-axis and with higher velocity than the velocity of light. Naturally, for that, the light wave observed moves in a positive direction of x-axis. When $x' > 2x$ the origin of system K' has left the sphere, but backwards.

Another paradox is that the relative velocity, between the light wave and the origin of system K', which move in opposite directions, is equal to the velocity of light even when system K' moves at an unlimited velocity v, that is

$$\frac{x'}{t'} = \frac{x\sqrt{1+\frac{v^2}{c^2}}+vt}{t\sqrt{1+\frac{v^2}{c^2}}+\frac{v}{c^2}x} = \frac{c\left(t\sqrt{1+\frac{v^2}{c^2}}+\frac{v}{c^2}x\right)}{t\sqrt{1+\frac{v^2}{c^2}}+\frac{v}{c^2}x} = c$$

In fact, this paradox occurs with all transformations, but with some, for example with the Lorentz transformation, the speed v is limited to a value v less than c. Thus, according to Einstein, it turns out that the relative speed of a light ray apex and the origin of the system K' do not depend on the system's direction of motion relatively to the ray's direction of motion. That is in conflict with common sense and human experience. In nature there are no such paradoxes, so we can put the question whether the theory with such paradoxes and postulates can describe and interpret physical processes. The answer to this question is certainly negative.

From the examples given above we can see that it is not the physical process of motion in question, but pure mathematics, where the variables, time and length, are defined and changed in case of necessity without any relation to real space and time, with the exception of transformation No. 4 where this connection can be established in some way.

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13. THE INFLUENCE OF WATER MOTION ON THE SPEED OF LIGHT (FIZEAU'S TEST)

The results of Fizeau's test are cited as the strongest proof of the correctness of the special theory of relativity, something that Einstein persistently asserted personally. Therefore, the method with which test was performed and the application of that test's result as confirmation of the theory of special relativity should be carefully analyzed.

This test is of fundamental importance, one of the most important tests performed in the 19th century. The results of the test have remained unexplained to date and the consequences are far-reaching. The aim of the test was to find out how water motion influences the velocity of light propagating through it. It was closely connected with research into the characteristics of the ether and its connection with moving transparent bodies.

Fizeau was the first to perform the test in 1851. It was later repeated by Michelson and others. The measurement was based on measurement of the interference shift between two light beams transmitted through unmoving water and moving water. A scheme of the experiment is given in Fig. 13.1.

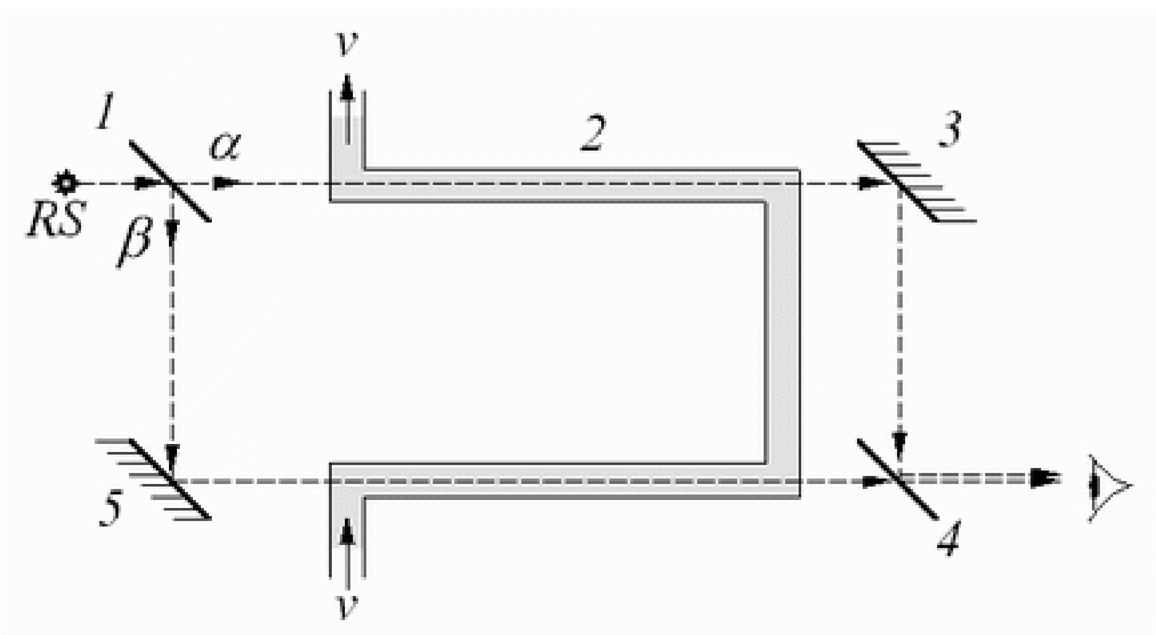

Fig. 13.1

The beam of light comes from the radiation source RS to the semi-transparent mirror 1, and there it is split up into two identical beams according to intensity. One beam (α) goes through the pipe 2 with water, in the direction of mirror 3, where it is reflected to another semi-transparent mirror 4 and after reflection on it reaches the eye of the observer. The other beam (β) goes toward mirror 5 where it is reflected and passes through the water in pipe and semi-transparent mirror 4 towards the eye of the observer. In such a way the observer can see an interference image in the shape of fringes, whose initial state of position and distance is established through unmoving water. After that water is brought to a state of motion and the shift of the interference fringes is established.

In one variant of the test, the length of the pipe was 1.5 m and the speed of the water motion in the pipe was 7 m/s.

The expected shift of the interference fringes would be easy to calculate, if a simple assumption of the mutual relation between the ether and the water is made. The velocity of light in unmoving water is smaller than the velocity of light in the ether, that is in vacuum. This decrease is determined by the index of water refraction $n = c / c_w$ or $c_w = c / n$ where c_w is the light velocity in water and n is the index of water refraction.

In relation to the coordinate system connected to the unmoving pipes and mirrors, the light velocity will be equal on the paths α and β if the ether is not drawn by the water and different if the ether is drawn in by the water. In the second case the rays α and β will have different passing times through the water, t_1 and t_2, because the velocity of light in relation to the pipe is ($c_w + v$) and ($c_w - v$), where v is the speed of the water motion. Thus

$$t_1 = \frac{L}{\frac{c}{n} + v} \quad \text{and} \quad t_2 = \frac{L}{\frac{c}{n} - v} \tag{13.1}$$

and the time difference of the light passing through the water

$$\Delta t = \frac{L}{\frac{c}{n} - v} - \frac{L}{\frac{c}{n} + v} = \frac{2lvn^2}{c^2 - n^2 v^2} \approx \frac{2\,Lvn^2}{c^2} \tag{13.2}$$

This difference of time corresponds to the difference of the wave paths of the two beams

$$\Delta S = \Delta t c \approx \frac{2\,Lvn^2}{c} \tag{13.3}$$

or expressed by a wave length

$$\frac{\Delta S}{\lambda} = \Delta_\lambda = \frac{\Delta t c}{\lambda} \approx \frac{2\,Lvn^2}{\lambda c} \tag{13.4}$$

If the water does not draw the ether, then we have Δ_{λ} = 0 because $t_1 = t_2$. In that case there is no shift in the interference fringes. If the ether is wholly drawn by the water then that shift should have to be Δ_{λ}. If the water only partially draws in the ether then the light velocity in relation to the pipe would be $c/n \pm kv$, where k is a coefficient of the drawing of the ether by the water. Then the shift would be

$$\Delta_{k\lambda} = \frac{c}{\lambda}\left(\frac{L}{\frac{c}{n} - kv} - \frac{L}{\frac{c}{n} + kv}\right) \approx \frac{2Lvn^2 k}{\lambda c} \tag{13.5}$$

Fizeau, Michelson and others discovered that shift, but its magnitude was about two times smaller than expected, that is, it was k = 0.46 by Fizeau's measurement and k = 0.434 ± 0.02 according to [12] at considerably later measurement. In case of water we have

$$k = \left(1 - \frac{1}{n^2}\right) = 0.4375$$

On the basis of that experimental result Fizeau then came to an important conclusion: it seems that the ether is partially drawn by the moving water, where the pulling coefficient k with a great degree of accuracy is equal to ($1 - 1/n^2$). As has been said, n is the index of light refraction in water. Thus

$$\Delta_F \approx \frac{2Lvn^2}{\lambda c}\left(1 - \frac{1}{n^2}\right) \tag{13.6}$$

So, the velocity of light through moving water in the direction of water motion is

$$c_{w1} \approx \frac{c}{n} + v\left(1 - \frac{1}{n^2}\right) \tag{13.7}$$

and the light velocity in the opposite direction

$$c_{w2} \approx \frac{c}{n} - v\left(1 - \frac{1}{n^2}\right) \tag{13.8}$$

Fresnel supposed that the ether passes through a body, and that it is denser inside the body than outside. According to Fresnel ρ is the density of an ether in vacuum, and ρ_1 is its density in the body, so

$$\frac{c}{c_1} = \sqrt{\frac{\rho_1}{\rho}} = n$$

The ether is treated as a fluid, and light according to the laws of mechanical motion. On that basis, in a complicated manner, he derived equations for the velocity of light in moving bodies, which indicated that such bodies partially drag the ether with them. The magnitude of that drag is given as a coefficient whose value is the same as Fizeau's ($1 - 1/n^2$).

On the other hand, Hertz stated that bodies completely draw the ether along with them. This notion was disproved by experiment. However, the assertions about a partial pulling of an ether also fail, since one material can have different light refraction indexes for different light wave lengths and because of that for each wave length the ether would be drawn to a different degree, which is clearly not acceptable.

According to the theory of relativity, the velocity of light in a body which moves at speed v in relation to an observer, is determined according to the relativistic principal on the addition of speeds. Relativistic equation for the addition and subtraction of speeds w and v, which will be analyzed in detail later (chapters 19 and 20), in the general form reads

$$W = \frac{w \pm v}{1 \pm \frac{wv}{c^2}} \tag{13.9}$$

So if $c/n = w$ is the light velocity in unmoving water, then the relativistic sum of speeds c/n and v of the same direction is

$$V_{r1} = \frac{\frac{c}{n} + v}{1 + \frac{v\frac{c}{n}}{c^2}} = \frac{\frac{c}{n} + v - \frac{v}{n^2} - \frac{v^2}{nc}}{1 - \frac{v^2}{n^2c^2}} \approx \frac{c}{n} + v\left(1 - \frac{1}{n^2}\right) \tag{13.10}$$

and the speeds difference, when this water motion is in the opposite direction of the light motion direction

$$V_{r2} = \frac{\frac{c}{n} - v}{1 - \frac{v\frac{c}{n}}{c^2}} = \frac{\frac{c}{n} - v + \frac{v}{n^2} - \frac{v^2}{nc}}{1 - \frac{v^2}{n^2 c^2}} \approx \frac{c}{n} - v\left(1 - \frac{1}{n^2}\right) \tag{13.11}$$

which comes very close to the Fizeau's result. However, relativistic equations for the addition and subtraction of speeds in the given shape are not valid in this case, because they are derived for vacuum, and here the mediums in the coordinate systems K and K' through which the light wave propagates are different. In those mediums the light velocity is different even under the condition of relative rest. Because of this the relativistic equations for addition and subtraction of speeds cannot be applied to Fizeau's test, that is, to explain Fizeau's results. This problem will be considered later on, in detail in chapter 19.2.

Many eminent scientists offered a great number of explanations. However the right explanation has not yet been given, an explanation without any remarks based on already known facts.

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14. A NEW EXPLANATION OF FIZEAU'S TEST RESULT

As is well known light moves at a lower velocity through transparent bodies than through vacuum. The velocity of light decreases in inverse proportion to the index of refraction, and is expressed in the following way

$$c_1 = \frac{c}{n} \tag{14.1}$$

The question is: "Why does light propagate more slowly through a material environment than through a vacuum?" The following may be an answer to this question.

During motion through a transparent substance photons are absorbed by that substance (atom or molecule), to be emitted later on, after a very short time, and after some time they are absorbed again, and so ceaselessly, until they leave the environment. The emission of a photon is stimulated by another photon, which comes across an excited atom or molecule. In this way the direction of motion of the emitted photon and the photon which stimulates this emission is the same. Because of this the direction of radiation through transparent substances does not change. This phenomena is well known in the case of lasers as a stimulated emission of radiation.

The total period of time the photon spends in the states of absorption is proportional to the index of refraction of the body. The total period of time the photon takes to pass through the transparent body is the sum of the time of the photon motion through that body at a velocity which is equal to the velocity of light in vacuum and the time of the photon's detention in a state of absorption. From there we have

$$t_u = t_c + t_a = \frac{L}{c_1} = \frac{nL}{c} \tag{14.2}$$

where t_u is the total period of time that the photon needs to pass through the transparent body, t_c is the time that the photon needs to pass through the body at the velocity of light in vacuum, t_a is the total period of photon detention in a state of absorption and L is the length of the photon's path through that body.

Using Eqs. (14.1) and (14.2) we obtain

$$t_a = \frac{nL}{c} - \frac{L}{c} = \frac{L}{c}(n-1) \tag{14.3}$$

$$t_c = \frac{L}{c} \tag{14.4}$$

What happens to the velocity of light in a transparent body when it is in motion? In order to give an answer it is necessary to analyze the process of the photon's motion through a moving body.

Fig. 14.1 shows a photon's motion through water which moves at speed v. For a greater part of the way, the photon passes as in a vacuum in the form of radiation and at a velocity which is equal to its velocity in vacuum. On the other considerably shorter part of the way, the photon is carried in an absorbed state at speed v, that is, at the speed of the water which carries it. As can be seen in Fig. 14.1, the photon P is carried in the direction of the water's motion from position 1 (the position of photon absorption) to position 2 (the position of photon emission). This process is repeated until the photon leaves the pipe.

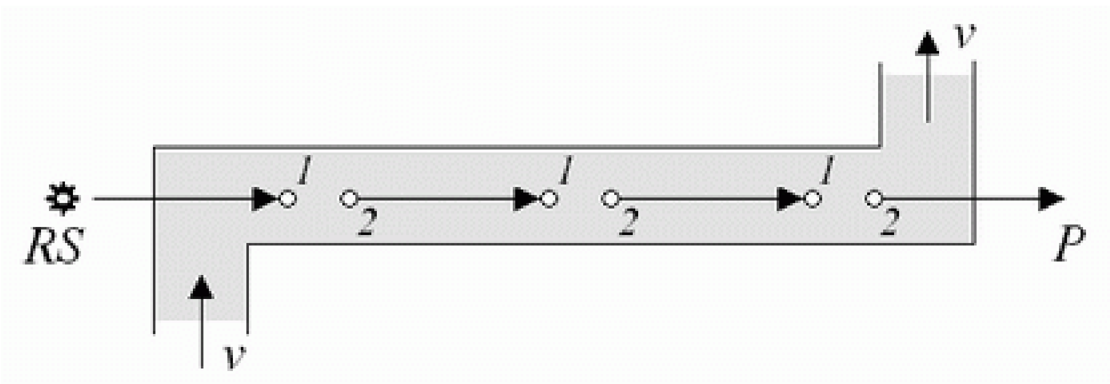

Fig. 14.1

During the photon motion through the pipe containing water the layer of the water, whose thickness ΔL_1, flows out in a lateral direction, and the photon does not succeed in reaching and passing trough it, so the shortening of the path on which the process of absorption and emission will not happen is given by equation

$$\Delta L_1 = v t_{u1} = (t_{a1} + t_{c1}) v \tag{14.5}$$

For the same reason there is a shortening of the absorption time Δt_{a1}. This shortening of the absorption time is proportional to the thickness of the out flowing water layer ΔL_1, like the total absorption time t_a is proportional to the total length L of the water column, that is, the pipe length containing water through which light rays pass, so we have

$$\frac{\Delta t_{a1}}{\Delta L_1} = \frac{t_a}{L} \tag{14.6}$$

From Eqs. (14.3), (14.4), (14.5) and (14.6) we have

$$t_{a1} = t_a - \Delta t_{a1} = t_a\left(1 - \frac{\Delta L_1}{L}\right) = \frac{L}{c}\frac{(n-1)\left(1-\frac{v}{c}\right)}{1+\frac{v}{c}(n-1)\left(1-\frac{v}{c}\right)} \tag{14.7}$$

and

$$t_{c1} = t_c - \Delta t_{c1} = \frac{L - t_{a1}v}{c} = \frac{L}{c}\frac{1}{1+\frac{v}{c}(n-1)\left(1-\frac{v}{c}\right)} \tag{14.8}$$

From Eqs. (14.1), (14.3), (14.5), (14.6) and (14.7) it follows that

$$\Delta t_{a1} = \frac{Lv}{c^2}(n-1)\frac{1+(n-1)\left(1-\frac{v}{c}\right)}{1+\frac{v}{c}(n-1)\left(1-\frac{v}{c}\right)} \tag{14.9}$$

During the free motion through the water the photons (from emission - the position 2 in Fig. 14.1, to repeated absorption - the position 1 in Fig. 14.1) do not pass the way they passed in the absorbed state. Because of this, the time shortening of the free passing Δt_{c1} in a form of radiation is proportional to the way ΔL_{a1}, into which the photons have been carried in an absorbed state. This means that it is proportional to the total period of time that the photons spend in an absorbed state and to the speed at which they are carried - the water speed. So from Eqs. (14.4) and (14.8) we have

$$\Delta t_{c1} = \frac{Lv}{c^2} \frac{(n-1)\left(1-\frac{v}{c}\right)}{1+\frac{v}{c}(n-1)\left(1-\frac{v}{c}\right)} \tag{14.10}$$

The total shortening of time that the photon takes to pass through the water, which moves in the direction of the photon motion, on the way length L is

$$\Delta t_{u1} = \Delta t_{a1} + \Delta t_{c1} = \frac{Lvn^2}{c^2} \frac{\left(1-\frac{1}{n^2}\right)-\left(1-\frac{1}{n}\right)\frac{v}{c}}{1+\frac{v}{c}(n-1)\left(1-\frac{v}{c}\right)} \tag{14.11}$$

Fig. 14.2 shows the motion of a photon through water flowing in the opposite direction to the motion of the photon.

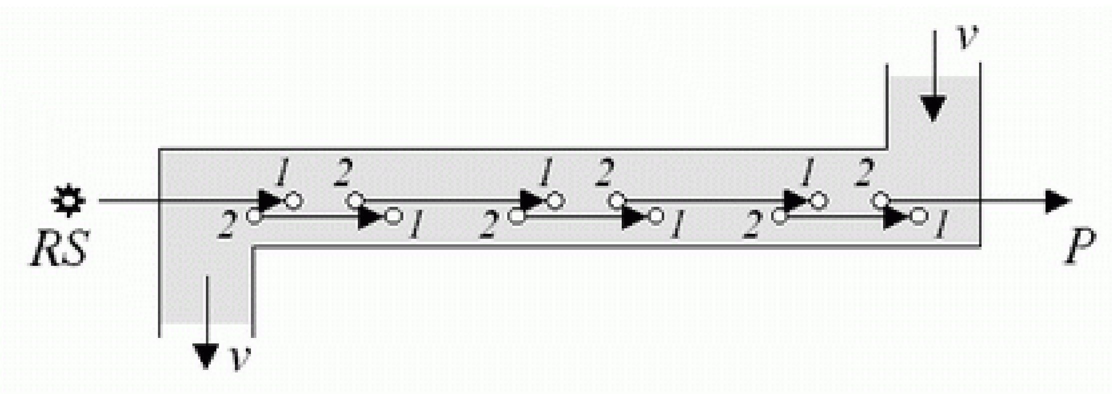

Fig. 14.2

We can see that, in this case, the time t_{a2} is increased for Δt_{a2}, in which the photon is in an absorbed state, due to the arrival of a new water layer during the time the photon passes through the pipe containing water. Also the time t_{c2} of the photon's free passage through the water in the form of radiation is increased for Δt_{c2}. This appears due to an increase in the length of the photon's path through the water, because of its return, in an absorbed state, in the direction of the water's motion. Because of this, the photon must once again travel this additional distance, which has already been passed.

So, the time taken by a photon, to pass downstream, through the pipe with water, is shortened and the time needed to pass upstream is increased.

The increasing of times passing Δt_{a2}, Δt_{c2} and Δt_{u2} are calculated in a similar way to the shortening of times Δt_{a1}, Δt_{c1} and Δt_{u1}, in the previous case. At that it is taken

$$\Delta t_{a2} = t_{a2} - t_a, \quad \Delta t_{c2} = \frac{v}{c} t_{a2} \quad \text{and} \quad \frac{\Delta t_{a2}}{\Delta L_2} = \frac{t_a}{L}$$

In this way we get

$$\Delta t_{a2} = \frac{Lv}{c^2}(n-1)\frac{1+(n-1)\left(1+\frac{v}{c}\right)}{1-\frac{v}{c}(n-1)\left(1+\frac{v}{c}\right)} \tag{14.12}$$

and

$$\Delta t_{c2} = \frac{Lv}{c^2}(n-1)\frac{1+\frac{v}{c}}{1-\frac{v}{c}(n-1)\left(1+\frac{v}{c}\right)} \tag{14.13}$$

and from there

$$\Delta t_{u2} = \Delta t_{a2} + \Delta t_{c2} = \frac{Lvn^2}{c^2}\frac{\left(1-\frac{1}{n^2}\right)+\left(1-\frac{1}{n}\right)\frac{v}{c}}{1-\frac{v}{c}(n-1)\left(1+\frac{v}{c}\right)} \tag{14.14}$$

Using Eqs. (14.11) and (14.14) we find that the ray, which propagates downstream, reaches the interference shift measurer before the ray which moves up stream for the time

$$\Delta t_u = \Delta t_{u1} + \Delta t_{u2} = \\ = \frac{Lvn^2}{c^2}\left[\frac{\left(1-\frac{1}{n^2}\right)-\left(1-\frac{1}{n}\right)\frac{v}{c}}{1+\frac{v}{c}(n-1)\left(1-\frac{v}{c}\right)}+\frac{\left(1-\frac{1}{n^2}\right)+\left(1-\frac{1}{n}\right)\frac{v}{c}}{1-\frac{v}{c}(n-1)\left(1+\frac{v}{c}\right)}\right] \tag{14.15}$$

Considering that $c >> v$ we can write

$$\Delta t_u \approx \frac{2Lvn^2}{c^2}\left(1-\frac{1}{n^2}\right) \tag{14.16}$$

This time difference corresponds to the shift of the ray α relative to the ray β which is measured by the interferometer

$$\Delta S = \Delta t_u c \approx \frac{2Lvn^2}{c}\left(1-\frac{1}{n^2}\right) \tag{14.17}$$

From this it results that the speed of light in water, which is moving in the same direction as that of the light is defined by the equation

$$c_{w1} = \frac{c}{n} + v\left(1-\frac{1}{n^2}\right) \tag{14.18}$$

and the speed of light travelling in the opposite direction to the water flow is defined by the equation

$$c_{w2} = \frac{c}{n} - v\left(1-\frac{1}{n^2}\right) \tag{14.19}$$

So, according to the given postulate Eq. (14.17) has been derived in order to calculate the interference shift. Fizeau's test completely confirmed the correctness of that shift calculation by using Eq. (14.17). This is the confirmation of the correctness of the previously given hypothesis that light propagates more slowly in a transparent body than in a vacuum, because of the time which the photons spend in the state of absorption on their way through that body, when their motion in the form of radiation is stopped.

The new hypothesis about light propagation through moving transparent bodies and this calculation which proves the correctness of that hypothesis, exclude any connection of the ether with the speed of light in moving transparent bodies, as Fizeau, Fresnel and Hertz asserted.

In estimating the reliability of the given hypothesis we should bear the following in mind. The law on the conservation of momentum is not satisfied when considering the transition of a photon from air (n = 1) to water (n = 4 / 3) and vice versa

$$P = \frac{E}{c} \neq \frac{E}{\frac{c}{n}} = \frac{hf}{\frac{c}{n}} \tag{14.20}$$

because the speed of the photon changes on transition from one substance to the other but its frequency remains the same.

If we treat the photon as a corpuscle then the law on the conservation of energy cannot be satisfied either, since the kinetic energy of the corpuscle is proportionate to the second power of the corpuscle's velocity.

However, according to the hypothesis given above about light propagation through a transparent substance, both the above laws are satisfied in the transition of a photon from one transparent substance to another. In this hypothesis the speed of the photon in every transparent substance, while the photon is not absorbed, is equal to the speed of light in a vacuum. The satisfaction of these two laws is one more proof of the correctness of the given hypothesis.

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15. THE PRINCIPLES OF THE THEORY OF RELATIVITY

Einstein says that the theory of relativity is the theory of principles. In order to understand it one must be acquainted with the principles it is based on.

Further on in the text we will present those principles, as well as the comments which Einstein made himself.

The first principle is: "Each general law of nature, which is valid relatively to the coordinate system K must be equally valid relative to the coordinate system K', which moves with uniform translation relatively to K".

The second principle upon which the special theory of relativity is based is "The constancy of the velocity of light" which reads as follows: "Light always has one definite velocity of propagation in a vacuum, which is independent of the condition of the light source's motion", and also "The speed of light is the same in all systems whose mutual motion is with uniform translation".

The third principle is the principle of relativity in relation to the direction which is: "All directions in space or all configurations of the Cartesian (Descartes) coordinate system are physically equivalent".

The first principle goes one step further in relation to the principle of relativity in a narrow sense, which refers to Galilean (inertial) coordinate system, saying: "If K is a Galileo (inertial) coordinate system, then any other coordinate system K' will also be a Galileo system, if relatively to K moves with uniform translation. For both these Galilean systems, Newtonian law of mechanics is valid". Generalizing further Einstein says: "If K' is a coordinate system, which relatively to K moves uniformly and without rotation, then natural phenomena relative to K' and relative to K, happen according to exactly the same general laws".

The Galileo transformation did not satisfy the requirement for invariability of equations for laws in the field of electromagnetism, in other words the first principle was not valid for the field of electromagnetism. This is why a solution for that field was searched for as well. This solution was found by Lorentz using a coordinate transformation, where time became the fourth coordinate. For that, he introduced a new comprehension of space and time by denying the hypotheses of classical mechanics which are:

a) The spatial distance between two points of a rigid body, does not depend on the state of motion of a reference body, and

b) The time interval between two events is independent from the state of motion of a reference body.

Simply said, in the coordinate system K' which moves with uniform translation relative to the coordinate system K, Lorentz introduced a new time which he called "**the local time**". But in reference to the distance between two points of the same rigid body he applied the hypothesis of the body's contraction in the direction of motion. The magnitude of that contraction depends on the speed of the body's motion relative to the ether. In this way he made it possible for the first principle to be universal, and applicable to all natural laws. Einstein accepted the Lorentz transformation, but made a change in the understanding of contraction of the body. According to him, the contraction is in the coordinate system in which the body moves. According to Lorentz, the contraction is in the coordinate system in which the body is at rest, and appears due to the body's motion relative to ether.

The second relativity principle was the result of the Lorentz transformation and here is what Einstein said about it [6]:

Quotation: "In the following example we can clearly see that the law on light propagation in vacuum is satisfied by the Lorentz transformation, as for the body of reference K, so for the body of reference K'. Let the light signal be sent along the positive x-axis and let the light propagation be according to equation

$$x = ct \qquad (15.1)$$

consequently at speed c. According to the Lorentz transformation this simple connection between x and t conditions the connection between x' and t' too. Really, the first and fourth equation of the Lorentz transformation give the following when we place ct instead of x

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{c\left(1 - \frac{v}{c}\right)t}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{\left(1 - \frac{v}{c}\right)t}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (15.2)$$

Thus, by division arrives directly

$$x' = ct' \qquad (15.3)$$

According to this equation, light is propagated relative to the system K'. The result is that the velocity of light relative to system K' is also equal to c. It is similar with the light rays which move in any other direction. Naturally, one should not wonder at this, because the Lorentz equations were derived on just that hypothesis." **End of quotation.**

With the second principle of relativity we have two different cases. The first case is about the motion of a light source and the speed of light and it is said that the speed of light propagation does not depend on the speed of the light source motion. This is a correct claim if that speed of light does not in relation to the moving source of light. The same case is also valid for the case of propagation of sound waves. Of course, it would be different if light had corpuscular nature. Then ballistic laws would be valid, and the speed of light propagation would depend on the speed of the light source.

In the second case it is claimed that the speed of light is the same in all inertial systems which move relatively. So, the speed of light in the system which moves relatively to the light source is the same as in the system which does not move relatively to that source. Here is what Einstein says in reference to that [6]:

Quotation: "It is natural that this process of light propagation, as with any other, must be put in relation to some reference rigid body (coordinate system). As a reference body we will choose again a railway embankment. We will imagine that the air above the embankment has been evacuated. One ray of light is sent along the embankment, whose wave front relative to the embankment will move at velocity c. Let our railway wagon travel along the track at speed v and in the same direction in which the light ray propagates, but of course much more slowly. We put the question: "What is, relative to the wagon, the velocity of the light propagation?" W is the required light velocity relative to the wagon and for it is valid

$$W = c - v$$

It results that the velocity of the light ray propagation relative to the wagon is lower than c.

This result is contradictory to the principle of relativity. According to the principle of relativity, the law on light propagation in vacuum has to be equally read as any other law of nature, as relative to the wagon so relative to the embankment. It seems, by our consideration, impossible. Since the ray moves at velocity c relatively to the embankment, it seems that relative to the railway wagon the propagation must be different, against the principle of relativity.

In consideration of this dilemma, it seems inevitable that we must surrender either the relativity principle or the simple law of light propagation in vacuum." **End of quotation.**

So, for the sake of the principle of relativity, Einstein also rejects the well known law on light propagation. In relation to that, let us examine the next case more closely.

Let us suppose that the wagon moves at speed $c/3$. In one second the light pulse passes 300000 km and the wagon following it passes 100000 km, so the distance between them is 200000 km, and not 300000 km, as the special theory of relativity states. If the speed of the wagon is almost equal to the velocity of light, then the wagon and the light pulse would move along together. Then the speed of the light pulse relative to the wagon would be almost equal to zero.

What is the solution to this obvious disagreement? The solution lies in mathematics, that is, in the transformation of the coordinates and time. By accepting the fact that the propagation time and the coordinates of the position of the light wave in system K' depend on its velocity v, Lorentz made it possible to take the velocity c instead of a real relative velocity $c - v$. For this, it is enough simply to make time t' dependent on speed v, which can be seen in the previously presented transformation No. 4, in case of a plane wave given in Eq. (12.24). This t' time is not the actual time, it is a kind of "local time", as Lorentz treated it.

If after some time the distance between the wagon and the apex of the light ray is S, and if the wagon is at rest, then the apex of the light ray moves away from the wagon at speed $c = S/t$, so we have $c \cdot t = S$. However, if the wagon moves at speed v following the light pulse then the wave front or apex of that ray moves away from the wagon at speed $c - v = S/t$ so that $(c - v)t = S$. But because of the insistence that, in this case, c must be substituted for $c - v$, then time has to change. Therefore it must be

$$(c-v)t = ct' \qquad (15.4)$$

and from there

$$t' = \left(1 - \frac{v}{c}\right)t \qquad (15.5)$$

which is the same as in Eq. (12.17) of transformation No. 4.

So, in the new coordinate system K' a higher relative velocity was taken than the actual, but for that a shorter time than the actual was taken, so the final result [$ct' = (c-v)t = S$] remained the same.

At the end it is very important to emphasize and not to forget, because it will be necessary to later consideration, that Einstein himself emphasized that light propagates along the x-axis according to equation $x = ct$. In other words the coordinate x is the coordinate of the light ray apex, but not some point between the origin and the light ray apex or the front of the light wave propagation. In Eq. (15.2) he substituted x by ct. Also, it should be emphasized and not forgotten that he did the same for the coordinate system K', namely he took that $x' = ct'$, so, from there

$$c = \frac{x}{t} = \frac{x'}{t'} \qquad (15.6)$$

which is correct and in accordance with the second principle of the special theory of relativity.

The third principle requires the existence of homogenous and isotropic space, because only in that case are all directions equivalent and there is invariability of equations of the laws of mechanical motion in the inertial systems and with the Lorentz transformation, also invariability of equations of the laws in the sphere of electromagnetism.

Later on we will see that Einstein did not respect the third principle in application of his equation for addition and subtraction of the speeds in order to explain the result of Fizeau's test. In general he did not respect the other principles and postulates which he had himself declared.

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16. THE HIGHEST POSSIBLE VELOCITY

In regard to the maximum possible velocity, Einstein says:

Quotation: "In the theory of relativity the velocity c has the role to be the ultimate speed, which cannot be reached, let alone exceeded by any real body.

This role of the velocity c, as the ultimate speed, results, already, by itself, from equations of the Lorentz transformation. And actually they lose their sense if v is chosen so to be higher than c. For the speed $v = c$ it would be $\sqrt{1 - v^2 / c^2} = 0$, and for a higher speed the square root would be imaginary [6]." **End of quotation.**

So, according to Einstein, the velocity c plays the role of an unreachable velocity because of equations of the Lorentz transformation. He did not give any other reason. However, we shall see later on that he did not respect this postulate about maximum speed.

In order to come to a real conclusion about justification of the quoted assertion it is necessary to carry out analysis of equations of Lorentz and others (new) transformations from the standpoint of maximum possible velocity.

Equations of the Lorentz transformation (12.20) and the transformation No. 1 (12.21) derived from Lorentz, exclude the possibility of the existence of a velocity higher than that of light. According to them, the speed v can only be lower than the velocity of light in vacuum. On the contrary, but in consideration of the square root in the denominator of quoted equations, an unreal situation would arise, because, there is no real number as a result of the square root of the negative number. As we have seen, Einstein applied this to all phenomena in nature, stating that in nature there are no higher speeds than the velocity of light. It has become the fundamental principle in the theory of relativity. The basis for such a firm attitude is the square root in the denominator of equations which in that case really limits the speed v to the value of the velocity of light. However, a question is put: "Can this square root, which is only a mathematical magnitude, in the given case, be the reason for attributing such serious limitations to nature?" The answer to this question is given by analyzing the following equations of transformations.

The equations of the transformation No. 2 (12.22) did not put any limitations in regard to the maximum possible speed v, which means that it can be higher than the velocity of light, that is, it allows $v >> c$.

The equations of the transformation No. 3 (12.23) which are similar to the equations of transformation No. 2, also has no limitation to the maximum possible speed, so it is possible that $v >> c$.

The equations of the transformation No. 4 (12.24) and No. 5 (12.25) derived from the condition given for the invariability of the equation for propagation of the plane light wave also has no limitations of the maximum possible speed v, so they also allow $v >> c$. In the equations of these two transformations at $v = c$ is $t' = 0$ and $x' = 0$, while x and t are not defined magnitudes and can be any real number, because they are the result of the division of zero by zero.

Thus, according to the above presented, it cannot be concluded that there are real reasons for the hypothesis that the highest speed in nature is the velocity of light in vacuum. It would be more realistic to lead out the conclusion that greater speeds are possible, both in the macro and micro world. However, the characteristics of the equations which are derived by transformations cannot be proof for the first nor for the second assertion.

As regards relative speeds higher than the velocity of light, for example, the speed between the wagon and a light wave, when they move in the opposite direction, they exist at all events in spite of the opposite assertion by the special theory of relativity. After all, in his first paper on relativity [2] Einstein used the expression $c+v$ in the third equation of the paper ($t'_A - t_B = \frac{r_{AB}}{c+v}$), and thus, at the very beginning of his work on the theory of relativity he himself negated his postulate that the speed of light in vacuum is the maximum possible speed in nature.

At the base of transformation No. 2 it could be, for example, taken that the body mass in motion is given by formula

$$m = m_0 \sqrt{1+\frac{v^2}{c^2}} = m_0\, K_N \tag{16.1}$$

instead of the already very well known Lorentz formula which many people wrongly ascribe to Einstein

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = m_0\, K_{Ei} \tag{16.2}$$

with remark that the electron mass, calculated according to the first formula, better agrees to the electron mass calculated by formula M. Abraham [M. Abraham, Ann. d. Physik 10, 105, 1903.], K. Schwarzschild [K. Schwarzschild, Göttinger Nachr. 245, 1905.], A. Sommerfeld [A. Sommerfeld, Göttinger Nachr. 303, 999, 1904.], derived on the base of the electronic theory

$$m = m_0 \frac{3}{4}\frac{c^2}{v^2}\left[\frac{c^2+v^2}{2cv}\ln\left(\frac{c+v}{c-v}\right)-1\right] = m_0\, K_T \tag{16.3}$$

as also with experimentally established electron mass at motion by W. Kaufmann. [W. Kaufmann, Gessel, Wise, Gött. Nachr. 143, 291, 1901.; Ann. d. Physik 19, 487; 20, 639, 1906.]

Calculated values of the coefficient K_N, K_{Ei} and K_T are given in Table 16.1. As is seen $|K_T - K_N| < |K_T - K_{Ei}|$ for all given values of the speeds of the electron, where v is the speed of electron, and c is the speed of light.

It is interesting to note that the best agreement of calculated masses, in motion for speeds around

$0.95c$, is according to Eqs. (16.3) and (16.4)

$$m = \frac{m_0}{\sqrt{1 - 0.81\frac{v^2}{c^2}}} \tag{16.4}$$

with the note that the Eq. (16.4) is based on the transformation of coordinates, which satisfies the requirement for invariability, the same as Eq. (16.2) is based on the Lorentz transformation of coordinates.

In reality neither of the said relativistic equations for mass in motion is based on the transformation of coordinates, but the form of each of them reminds us in some way of a certain transformation of coordinates. We shall show later that this is also true, for example, for the Eq. (16.2).

Table 16.1

v/c	K_{Ei}	K_T	K_N	$K_T - K_{Ei}$	$K_T - K_N$
0.1	1.005038	1.004026	1.004988	$-1.0\cdot10^{-3}$	$-9.6\cdot10^{-4}$
0.2	1.020621	1.016424	1.019804	$-4.2\cdot10^{-3}$	$-3.4\cdot10^{-3}$
0.3	1.048285	1.038232	1.044031	$-1.0\cdot10^{-2}$	$-5.8\cdot10^{-3}$
0.4	1.091090	1.071478	1.077033	$-2.0\cdot10^{-2}$	$-5.6\cdot10^{-3}$
0.5	1.154701	1.119796	1.118034	$-3.5\cdot10^{-2}$	$+1.8\cdot10^{-3}$
0.6	1.250000	1.189862	1.166190	$-6.0\cdot10^{-2}$	$+2.4\cdot10^{-2}$
0.7	1.400280	1.295068	1.220656	$-1.1\cdot10^{-1}$	$+7.4\cdot10^{-2}$
0.8	1.666667	1.467369	1.280625	$-2.0\cdot10^{-1}$	$+1.9\cdot10^{-1}$
0.9	2.294157	1.815553	1.345362	$-4.8\cdot10^{-1}$	$+4.7\cdot10^{-1}$

Neutral particles in motion do not create an electromagnetic field around themselves, as is the case with electrically charged particles in motion. Therefore, the speed of motion of neutral particles should not be limited.

Finally we can conclude that the assertion that the maximum speed should be limited to magnitude c (the velocity of light in a vacuum) has some sense only when considering the motion of electrified particles relative to an ether in which that motion takes place.

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17. CONTRACTION OF SPACE

At first man studied the space around him to the limit of horizon where the sky is joined with the earth. In the course of time, after many years of evolution he widened that horizon to billions and more light years and narrowed it down to a dimension of elementary particles. On that long journey there were a great jumps ahead, and sideways as well, which slowed down the rhythm of man's penetration to the unknown. The theory of relativity has both possibilities, to be the great penetration to the unknown, and to be the sideways which turns aside the course of research and in that way slows it up.

The question of space and time is of fundamental importance, not only in the theory of relativity but in physics in general. This is why no theory can be accepted if it does not treat these two concepts correctly.

Until the appearance of the theory of relativity, space and time were two separate entities and they were treated as absolute magnitudes. In the theory of relativity these notions became relative and mutually dependent. So, instead of Euclid's three dimensional space, Minkowski's four dimensional space appears, where time is the fourth dimension. The characteristics of space and time relative to the reference space - body, become dependent on motion or more exactly, dependent on the speed of motion relative to the reference space. Because of motion, the contraction of space appears in the direction of motion, that is, the contraction of one space dimension in the direction of motion, contraction of the length. With the contraction of space the contraction of the body in the direction of its motion appears. Lorentz deriving his famous transformation explained or more precisely, he tried to explain the negative result of Michelson's experiment. However, Einstein accepted his transformation and rejected the explanation.

In case of Michelson's experiment according to Lorentz, the contraction of the body is in the moving system in which it is at rest, and is caused by the effect of ether on atoms and molecules which means all together on the whole body which moves within it.

Einstein does not acknowledge the ether or any other privileged coordinate system, which could give a motive to introduce the idea about the ether. According to him, the contraction of the body appears due to motion, so there is no contraction in a system where the body is at rest, but in a system in relation to which the body moves. According to that, Michelson's equipment was at rest in the system where the measurement was made and there could not be any contraction, so the effort that Lorentz made to prove the contraction was useless. In regard to that, the question arises, if the contraction given by equations of transformation really exists or it is an illusion achieved by means of mathematics. We will consider this question, in the way that Einstein did, as it is in science literature and in a new way.

The procedure for determining the contraction of space, body or length, which are all the same, will be accomplished in cases of four transformations: the Lorentz transformation and the transformations No. 2, No. 4 and No. 5.

In the transformations No. 1 and No. 3, the coordinate system K' and the light wave move in the opposite direction and there a dilatation appears instead of contraction. Because of this the equations of these transformations will not be examined in detail, nor will comparison be made with other transformations. In order to come to a conclusion it is enough to analyze four transformations.

17.1 Contraction of space according to the special theory of relativity

Before we look into the method for determining contraction in the scientific literature we will see how Einstein solved this problem by means of a rod [6].

Quotation: "I will place the rod on the x'-axis of K', so that its beginning is at the point x' = 0, and the end falls at the point x' = 1. What is the length of the rod relatively to the system K? In order to find this out, we first have to ask ourselves, where the beginning and the end of the rod lay relatively to K in a certain determined time t in the system K. For both points it is found for time t = 0 from the first equation of the Lorentz transformation

$$x(\text{beginning of rod}) = 0 \cdot \sqrt{1-\frac{v^2}{c^2}} \quad \text{and} \quad x(\text{end of rod}) = 1 \cdot \sqrt{1-\frac{v^2}{c^2}} \tag{17.1}$$

so, two points have the distance $\sqrt{1-v^2/c^2}$.

But relatively to K, the rod moves at speed v. The result is that the length of the rigid rod, which moves at speed v in the direction of one's own longitudinal axis, is $\sqrt{1-v^2/c^2}$ meters. This means that the rod is shorter when it moves than when it is at rest. It becomes shorter the faster it moves." **End of quotation.**

In citated text Einstein uses equation derived by Lorentz transformation. However, he does not respect the condition on which that equation is derived nor what it means.

In equations derived by Lorentz transformation

$$x = \frac{x' + vt'}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{and} \quad t = \frac{t' + \frac{v}{c^2}x'}{\sqrt{1-\frac{v^2}{c^2}}} \tag{17.2}$$

x and x', in these equations, are coordinates of the position of the light wave propagating along x and x'-axis of the systems K and K' respectively. The times t and t' are the times of the coming of the light wave across x and x' coordinate respectively.

The Eqs. (17.2) are derived on condition that when one of x, x', t and t' is equal to zero then all others must be zero too. For example, if t =0 then must be x'=0, t' =0 and x =0.

Accordingly, when t =0 then can not be " $x(\text{end of rod}) = 1 \cdot \sqrt{1-\frac{v^2}{c^2}}$ " but $x(\text{end of rod}) = 0 \cdot \sqrt{1-\frac{v^2}{c^2}} = 0$. Consequently, Einstein's proof of the contraction is incorrect and looks like joke.

17.2 Contraction of space according to the scientific literature

17.2.1 Contraction of space according to the Lorentz transformation

Three examples [10], [11] and [12] have been taken for the analysis from the voluminous scientific literature. All three refer to the Lorentz transformation because there were no others.
Let us see how it is treated in literature [10]:

Quotation: "Let L_0 be the length of the rod in the system for which it is connected and where it is at rest relatively to that system. Let us take two systems K and K'. The latter moves at a speed v relative to the former, in such a way that its motion stays along the mutual x-axes and the axes y and z stay respectively parallel. So, for the coordinate points in those two systems the Lorentz transformation could be applied

$$x' = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}}, \quad y' = y, \quad z' = z \quad \text{and} \quad t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1-\frac{v^2}{c^2}}}$$

Let the rod be connected to the system K' (Fig. 17.1) so that it is in the plane $O'x'y'$ parallel with x', that is, with the x-axis. In the system K' let us mark the beginning of the rod with abscissa x_1', and the end of the rod with x_2'. In the K system let the abscissa of the beginning be x_1 and of the end x_2.

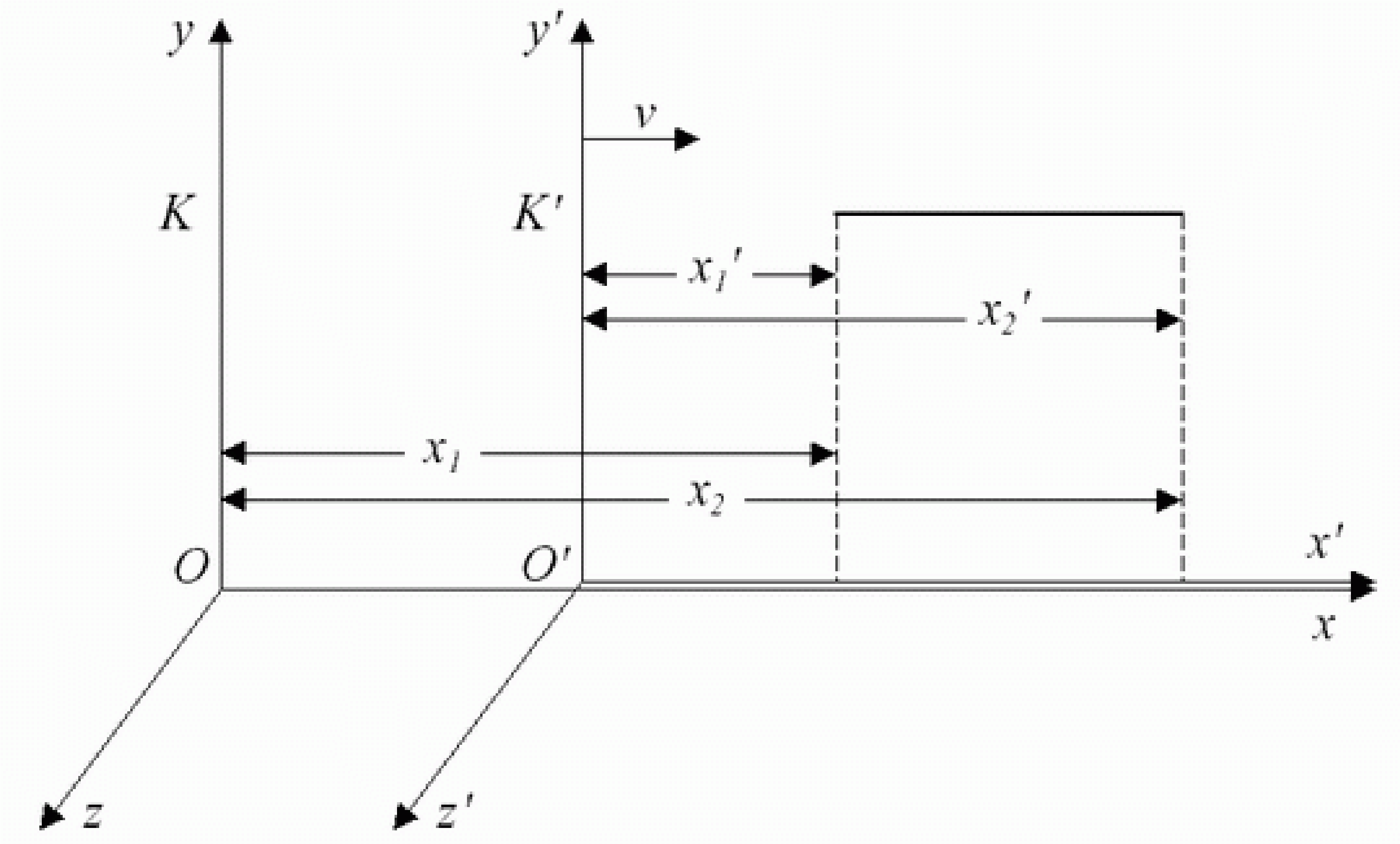

Fig. 17.1

Then

$$x_2' - x_1' = L_0 \qquad (17.3)$$

is the length of the rod in the system which moves relatively to the system K. Of course, in the system K' this L_0 is **proper length** or **the length at rest**.

The length of the same rod in the system K, in relation to which the rod and the system K' are moving at speed v, will be

$$x_2 - x_1 = L \qquad (17.4)$$

According to the Lorentz - Fitzgerald hypothesis L should be shorter than L_0.

We note that the position of the two points in a moving system, that is, two points of a body which moves relatively to an observer, have to be determined **simultaneously**, because of the relativity of time. Simultaneity refers to time in the system from which the observation is made. Simultaneity of determination in the body's own system, that is, the one in which the body does not move is not obligatory, because there one time is connected to the body. But, according to Einstein's theory of relativity, what is simultaneous in one system is not simultaneous in another system which is in motion.

When the position of the beginning and the end of the rod are determined from system K then t is the same, but t' isn't. Therefore we start from the Lorentz transformation of the coordinates

$$x_1' = \frac{x_1 - vt_1}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{and} \quad x_2' = \frac{x_2 - vt_2}{\sqrt{1-\frac{v^2}{c^2}}} \tag{17.5}$$

Both these times, t_1 and t_2, are equal, so that

$$x_2' - x_1' = \frac{x_2 - x_1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{17.6}$$

or

$$L = L_0 \sqrt{1-\frac{v^2}{c^2}} \tag{17.7}$$

Thus

$$x_2 - x_1 < x_2' - x_1' \tag{17.8}$$

End of quotation.

Contraction is treated in a similar way and the same results are obtained in [11].

Thus one arrives at the result that the contraction does not appear in system K' in which the rod is at rest and it can be concluded that nothing happens to the rod, but that the observer, from system K, only sees the contraction due to motion even though it does not exist. This contraction is in accordance with Einstein's understanding, but not with Lorentz, who derived the transformation in order to prove that the contraction happens in a system which moves and in which the body is at rest. This was done in order to explain the negative results of Michelson's experiment where the measurement was made in a system (the earth), which moves relatively to the "absolute inertial system" - the ether.

However in the literature [12] the opposite results have been obtained. There it begins with the same equations, but which have been solved for coordinates of the system K in the function of the coordinates of the system K' which moves, so

$$x_2 = \frac{x_2' + vt_2'}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad x_1 = \frac{x_1' + vt_1'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{17.9}$$

here also it is claimed that $t_1' = t_2'$, so, it is evident that

$$x_2 - x_1 = \frac{x_2' - x_1'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{17.10}$$

or

$$L_0 = L\sqrt{1 - \frac{v^2}{c^2}} \tag{17.11}$$

and

$$x_2 - x_1 > x_2' - x_1' \tag{17.12}$$

As can be seen, contraction of the length of the rod here is in the system K', however in the previous case it was in the system K.

Let's see what will happen in the following three transformations using the same procedure for determining the contraction of space as in the first quoted case of the Lorentz transformation.

17.2.2 Contraction of space according to transformation No. 2

In this case, according to Eqs. (12.22), the coordinates in a system K' are

$$x_2' = x_2\sqrt{1 + \frac{v^2}{c^2}} - vt_2 \quad \text{and} \quad x_1' = x_1\sqrt{1 + \frac{v^2}{c^2}} - vt_1 \tag{17.13}$$

After substitution $t_2 = t_1$, and by subtraction we obtain

$$x_2' - x_1' = (x_2 - x_1)\sqrt{1 + \frac{v^2}{c^2}} \tag{17.14}$$

or

$$L = \frac{L_0}{\sqrt{1 + \frac{v^2}{c^2}}} \tag{17.15}$$

and

$$x_2 - x_1 < x_2' - x_1' \tag{17.16}$$

The contraction is in system K (or the dilatation in the system K'), but its magnitude differs from the magnitude of the contraction in the first case, that is, contraction according to the Lorentz transformation.

17.2.3 Contraction of space according to transformation No. 4

Coordinates in the system K' are given by Eqs. (12.24)

$$x_2' = x_2 - vt_2 \quad \text{and} \quad x_1' = x_1 - vt_1 \tag{17.17}$$

and from that at $t_2 = t_1$

$$L = L_0 \tag{17.18}$$

and

$$x_2' - x_1' = x_2 - x_1 \tag{17.19}$$

In this case there is no contraction in any system.

17.2.4 Contraction of space according to transformation No. 5

According to Eqs. (12.25) the coordinates in a system K' are

$$x_2' = \frac{x_2 - vt_2}{1+\dfrac{v}{c}} \quad \text{and} \quad x_1' = \frac{x_1 - vt_1}{1+\dfrac{v}{c}} \tag{17.20}$$

so it is at $t_2 = t_1$

$$x_2' - x_1' = \frac{x_2 - x_1}{1+\dfrac{v}{c}} \tag{17.21}$$

or

$$L = L_0\left(1+\frac{v}{c}\right) \tag{17.22}$$

and

$$x_2 - x_1 > x_2' - x_1' \tag{17.23}$$

Finally, we also obtain the opposite case. Namely, according to this transformation the contraction of the rod appears in a the system where the rod is at rest, that is, in system K'. Of course, in the system relative to which the rod moves, the dilatation of the rod appears, and that is contradictory to the theory of relativity.

What is to be concluded from this? We come to the conclusion that every transformation gives a different value of contraction. In case of four transformations three contradictory possible solutions are obtained: in system K relatively to which the rod moves, either contraction occurs, or there is no change, or dilatation of the rod occurs. Such results are certainly unacceptable. How can such contradictory results be arrived at? An error has occurred somewhere. And certainly there is an error.

The error is in accepting that light wave comes to the ends of the rod at the same time, that is $t_2 = t_1$. If the following was used

$$vt_2 = v\frac{x_2}{c} \quad \text{and} \quad vt_1 = v\frac{x_1}{c}$$

which is defined by the fundamentals of the theory of relativity, the calculation would be correct, but that result would not have been in accordance with the theory of relativity, that is with Einstein's hypothesis on contraction. Therefore $t_2 = t_1$ was reached by "looking," as was the convenient result that

$$L = L_0\sqrt{1-\frac{v^2}{c^2}}$$

The incorrectness of the previous method of confirming the existence of contraction and determining its magnitude can be proved in another way. Namely, the basic principle of the special theory of relativity is that the speed of light in both inertial systems K and K' is the same and it is equal to the velocity of light in vacuum. If the procedure in determining of the length interval and the time interval in the systems K and K' is correct then by division of the length interval with the corresponding time interval we should obtain the speed equal to the light velocity in vacuum in both systems. This ascertainment will be done later on, that is, after considering the dilatation of time in the theory of relativity.

17.3 A new way of determining the contraction of space

Before we start to consider this method of determining the contraction of space let us remind ourselves of the remarks made and emphasized earlier on. First of all these are as follows: the coordinates x and x' are the coordinates of the light ray apex's (or light wave front) position, which moves along x and x'-axes of the coordinate systems K and K' respectively. The axes x and x' are parallel; the motion of the origin of the system K' is along the x-axis, and the motion of the light ray or the wave is followed only along the x and x'-axes.

Let us remember, Einstein himself gave $x = ct$ in Eqs. (15.1), (15.2) and (15.3) that is $t = x/c$ and $x' = ct'$ and from there also $t' = x'/c$. This is a starting point in deriving the Lorentz transformation [Eqs. (10.1) and (10.2)]. In agreement with this we can also substitute $t_2 = x_2/c$ and $t_1 = x_1/c$. Coordinates x_2 and x_1 are coordinates of the light ray apex on the x-axis of the system K at times t_2 and t_1 respectively, and nothing else. The same is valid for x'_2, x'_1, t'_2 and t'_1 of the system K'.

On the basis of above presented we come to the conclusion that the new way of determining the contraction of space is in the spirit of the basic idea of the theory of relativity.

17.3.1 Contraction of space according to the Lorentz transformation

The coordinates in the observed systems K and K' are given in the form

$$x_2' = \frac{x_2 - vt_2}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{and} \quad x_1' = \frac{x_1 - vt_1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{17.24}$$

After substitution $t_2 = x_2/c$ and $t_1 = x_1/c$ and by subtraction we obtain

$$x_2' - x_1' = (x_2 - x_1)\sqrt{\frac{c-v}{c+v}} \tag{17.25}$$

or

$$L = L'\sqrt{\frac{c+v}{c-v}} \neq L_0\sqrt{1-\frac{v^2}{c^2}} \tag{17.26}$$

and

$$x_2 - x_1 > x_2' - x_1' \tag{17.27}$$

So, this means that the contraction occurs in the moving system K', but in that system Einstein's rod is at rest, which is contrary to the theory of relativity. Besides, the coefficient of the space contraction is not $\sqrt{1-v^2/c^2}$ and from this it results that the Lorentz's hypothesis about contraction is not correct even in a mathematical sense.

This was so when observation was made from the system K. Earlier on we saw that the opposite effect is obtained if we make the observation from the system K'. This has been presented in Eqs. (17.6) and (17.10).

Let us check if this will occur if we use the new way of determination of the contraction. So, like in Eq. (17.9)

$$x_2 = \frac{x'_2 + vt'_2}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{and} \quad x_1 = \frac{x'_1 + vt'_1}{\sqrt{1-\frac{v^2}{c^2}}}$$

After substitution $t'_1 = x'_1/c$ and $t'_2 = x'_2/c$ and by subtraction we have

$$x_2 - x_1 = (x'_2 - x'_1)\sqrt{\frac{c+v}{c-v}}$$

or

$$L = L'\sqrt{\frac{c+v}{c-v}} \neq L_0\sqrt{1-\frac{v^2}{c^2}}$$

and

$$x_2 - x_1 > x'_2 - x'_1$$

As can be seen we obtain the same result as in the previous case. This proves the correctness of new method of determining of the contraction, because if the contraction exists, even just in a mathematical sense, it cannot depend on the place where it is observed from. Especially if one insists that it occurs in the case of real bodies - rods.

17.3.2 Contraction of space according to transformation No. 2

According to Eqs. (12.22) the coordinates in a system K' are

$$x'_2 = x_2\sqrt{1+\frac{v^2}{c^2}} - vt_2 \quad \text{and} \quad x'_1 = x_1\sqrt{1+\frac{v^2}{c^2}} - vt_1 \tag{17.28}$$

After substitution $t_2 = x_2/c$ and $t_1 = x_1/c$ and subtraction we obtain

$$x_2' - x_1' = (x_2 - x_1)\left(\sqrt{1 + \frac{v^2}{c^2}} - \frac{v}{c}\right) \qquad (17.29)$$

or

$$L = \frac{L'}{\sqrt{1 + \frac{v^2}{c^2}} - \frac{v}{c}} \qquad (17.30)$$

and

$$x_2 - x_1 > x_2' - x_1' \qquad (17.31)$$

As in the previous case, the contraction is in the system K' in which the body is at rest, but the magnitude of the contraction is different.

17.3.3 Contraction of space according to transformation No. 4

As mentioned earlier, this transformation and the next No. 5, have been derived from the condition of invariability of the equation for the propagation of the light plane wave or the sound plane wave.
According to Eqs. (12.24) the following may be written

$$x_2' = x_2 - vt_2 \quad \text{and} \quad x_1' = x_1 - vt_1 \qquad (17.32)$$

As before, by substitution $t_2 = x_2 / c$ and $t_1 = x_1 / c$ and by subtraction we obtain

$$x_2' - x_1' = (x_2 - x_1)\left(1 - \frac{v}{c}\right) \qquad (17.33)$$

or

$$L = \frac{L'}{1 - \frac{v}{c}} \tag{17.34}$$

and

$$x_2 - x_1 > x_2' - x_1' \tag{17.35}$$

As in the previous cases contraction appears in system K' in which the body is at rest, but the magnitude of contraction is different from the two previous cases.

17.3.4 Contraction of space according to transformation No. 5

According to Eqs. (12.25) it is

$$x_2' = \frac{x_2 - vt_2}{1 + \frac{v}{c}} \quad \text{and} \quad x_1' = \frac{x_1 - vt_1}{1 + \frac{v}{c}} \tag{17.36}$$

After substitution $t_2 = x_2 / c$ and $t_1 = x_1 / c$ and by subtraction we have

$$x_2 - x_1 = \left(x_2' - x_1'\right)\frac{c + v}{c - v} \tag{17.37}$$

or

$$L = L'\frac{c + v}{c - v} \tag{17.38}$$

and

$$x_2 - x_1 > x_2' - x_1' \tag{17.39}$$

As in the three previous cases the contraction is in system K' in which the body is at rest. Its magnitude also differs from the magnitudes in all three previous cases.

Naturally, instead of contraction in the system K' we can say dilatation in the system K, but it would not be correct, because contraction arises in the coordinate system K', but only in a mathematical sense.

So, according to the new way of determining the contraction of space, body or length, in all four transformations the contraction occurs in the coordinate system K' in which the body is at rest, while this system moves with uniform translation relatively to the system K.

This contraction - shortening does not depend on where the system is being observed from and it has some logic. Because the coordinate system K', which moves after the light or sound wave, reduces the space or length along the x-axis, which the wave takes up in its motion. This reduction, subtraction, increases with the speed v of the system K'. What is it, if it is not a contraction of length or space? If the contraction were a physical reality, then the length x' of the rod (from the origin of the system K' to the front of the wave) would shorten almost to zero, if the speed v of the system K' got close to the velocity of light.

In Fig. 17.2 a contraction process is shown. It is assumed that $v = c/3$, in other words, that the coordinate system K' moves after the light wave at a speed which is equal to one third of the velocity of light.

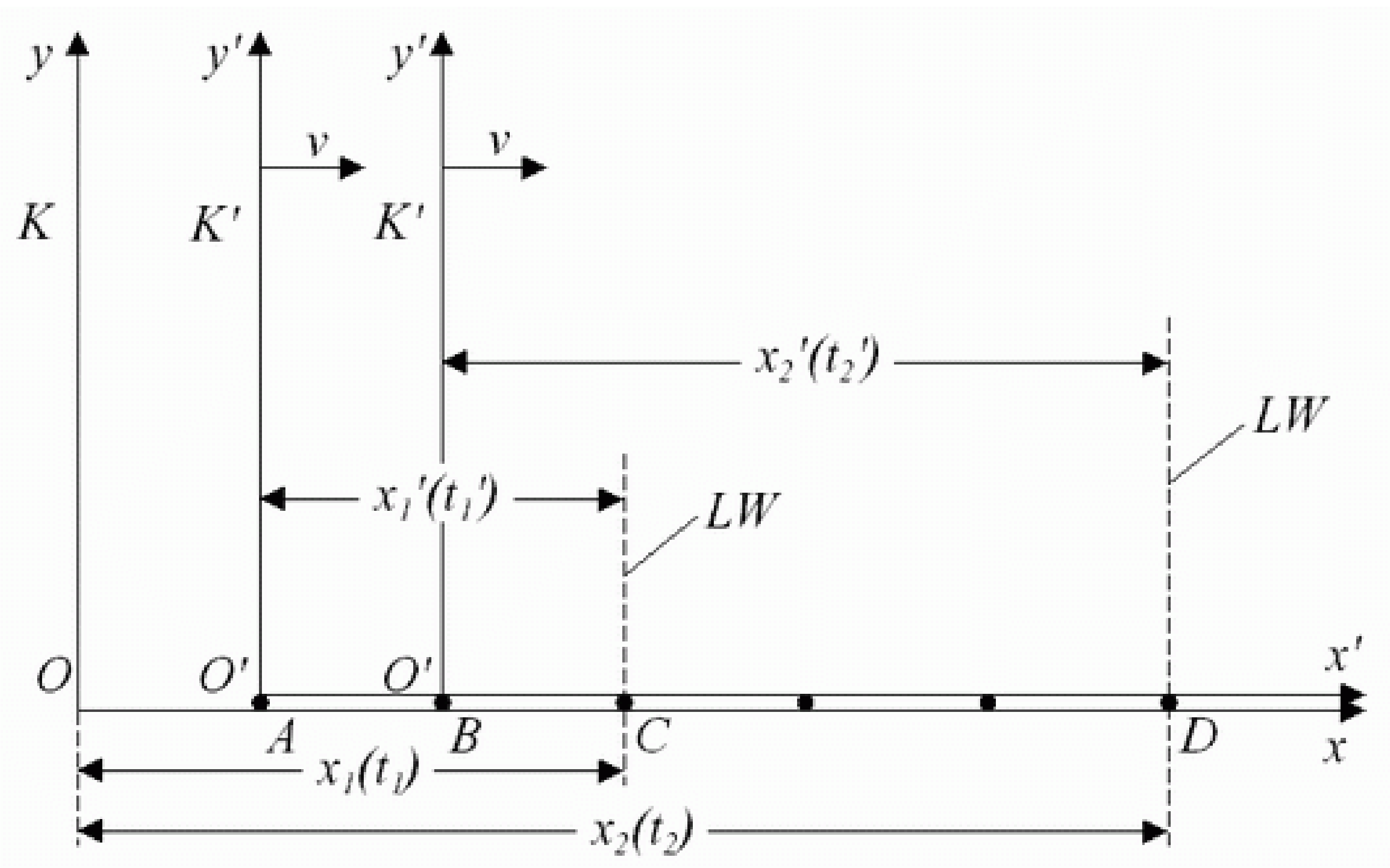

Fig. 17.2

After the first second the light wave passed along the x-axis a distance which is proportional to the length of three divisions in system K and reached the point C. During this time, the origin of the coordinate system K' passed one third of that distance, that is the distance which corresponds to the length of one division, and reached the point A. So, x_1 = 3 divisions, and x_1' = 2 divisions. In the next second the wave will pass the next same length, and then will be x_2 = 6 divisions, and x_2' = 4 divisions, that is, the wave will reach the point D, and origin of the system K' the point B. So, $x_2 - x_1$ = 3 divisions and $x_2' - x_1'$ = 2 divisions and in that way $x_2 - x_1 = k(x_2' - x_1')$ where k = 3 / 2.

For the different speeds v of the system K' the value of the contraction coefficient k are different too. With an increase of the speed v, x_2' and x_1' are reduced, as well as their difference, because the system K' is getting closer to the light wave. If the system K' had the speed equal to the velocity of light, then x_2' and x_1' would be equal to zero, their differences would be equal to zero too, and the contraction coefficient would be infinitely great.

The old method of determining the contraction of space did not pass the test. It was shown that at the same speed v of the system K' according to the old method can be: contraction, dilatation or no change to the rod depending on the transformation which is being used, or depending on where it is being observed from. In other words it seems that the rod can change, that is, be shorter, remain the same, or be longer under the same physical conditions. What happens to the rod does not depend only on its motion, but also on the choice of the coordinate transformation which is used. Simply said it depends only upon applied mathematics, which is unacceptable.

The new way of determining the state of the contraction or dilatation does not have this shortcoming. It confirms the same state for all the coordinate transformations - contraction in the system K' in which the rod is at rest, as Lorentz asserted. When we say the rod we think of the length and not of the body. However, baring in mind that each coordinate transformation gives a different value for contraction, the logical question arises: "Can the contraction be accepted as a realistic physics process?" The answer, of course, is negative. Simply said the contraction in question is not a real physical process but a pure product of mathematics. A mathematician would say: "It depends on the type of the variable substitution".

The realistic physical process of contraction occurs when some bodies move through some environments which resist that motion. This contraction, certainly depends on the speed of the body's motion, but also on the characteristics of that body: neutral particles, electrified particles, solid bodies etc. The resistance to motion and contraction also depend on the connection of the body with that environment which surrounds it and the effects it produces by moving. For example, an electrified body in motion generates an electromagnetic field and establishes new relations with the surrounding environment. It can interact in various ways with the environment, inductive, capacitive, nuclear, gravitational etc. The environment can strongly resist an increase of the body's speed - particle speed, above a certain value, such as the speed at which the "electromagnetic barrier" breaks - the velocity of light. However the contraction of a body without doubt varies according to the characteristics of that body and its connection to the environment, not according to Lorentz and Einstein's calculations. The contraction results from physics and not from mathematics.

Finally we can conclude that Einstein's contraction of space is not a physical reality but a pure illusion based on mathematics.

home

18. DILATATION (CONTRACTION) OF TIME

Classical physics, with Newton at the head of considers time to be the absolute value which flows "continually, evenly and independently of anything else". In 1895 Lorentz introduced the concept of local time into physics, and in 1905 Einstein gave this a completely new interpretation.

While working on his transformation, Lorentz came to the conclusion that the hypothesis of space contraction was not sufficient, and in 1895 he offered another which was as amazing as the previous one: "In systems which move with uniform translation a new measure for time is necessary". The new hypothesis was necessary so that electromagnetic phenomena in the moving systems would be the same as in the ether. Both hypotheses indicate that space and time have to be measured in different ways in the quiescent ether and in systems which move relative to that ether. In this way time was relativised, changing at transition from one system K to another K'. Lorentz called the new time **local time**, and treated it as an auxiliary mathematical magnitude, not as absolute time.

Einstein asserts that there is no means by which make possible to determine the existence of absolute time and its differentiation from the infinite number of local times in systems of reading which move relatively. According to him, time is connected to space, to bodies, and flows differently in different systems, in some places slower and in others faster. How time will flow depends on the relative speed of motion. It flows slower in motion and faster at rest. An important conclusion of the theory of relativity is that time dilation occurs with motion.

As there were some remarks on the old way of determining the contraction of space there are also criticisms of the method of determining the dilatation of time. Before approaching a determination of the contraction of time in a new way, we will carry out an analysis of the determination of the time dilatation according to the special theory of relativity and the scientific literature. As before, we will use the equations of four chosen coordinate transformations for analysis.

18.1 Dilatation of time according to the special theory of relativity

In the special theory of relativity [6] on the subject of time dilatation, Einstein says the following:

Quotation: "Let us observe the clock which shows seconds and which is always at rest at the origin (x' = 0) of the system K'. Let t' = 0 and t' = 1 be two successive strikes of this clock. For both these strikes the first and fourth equation of the Lorentz transformation give

$$t = 0 \quad \text{and} \quad t = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{18.1}$$

If it is measured in the system K, then the clock moves at a speed v, and between its two strikes, measured from the same reference body, passes not one but

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

seconds, thus a somewhat longer time. In consequence of motion, the clock runs more slowly than when it is at rest. In this case also velocity c likewise plays the role of the unattainable speed." **End of quotation.**

This is all there is about the dilatation of time in the special theory of relativity.

The first and the fourth equations of the Lorentz transformation (10.11), solved for t yield

$$t=\frac{t'+\frac{v}{c^2}x'}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (18.2)$$

Einstein first takes in Eq. (18.2) that x' = 0 and t' = 0 which is correct, and then he takes x' = 0 and t' = 1 which must not be used, because he himself demands by Eq. (15.3) that $x'=ct'$. He says the same in deriving the Lorentz transformation in Eq. (10.2). So, when x'=0 must be t'=0.

If Einstein had kept to the conditions under which he derived the Lorentz transformation, and if he had taken into consideration that the time t in system K, expressed by means of coordinates x' and t' of the system K' is given by the Eq. (18.2) and that it is, according to the second principle of the theory of relativity, always $x'=ct'$ he would have had to derive the coefficient of the dilation of time in this way

$$t=\frac{t'+\frac{v}{c^2}x'}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{t'+\frac{v}{c^2}ct'}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{t'\left(1+\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}}=t'\sqrt{\frac{c+v}{c-v}} \qquad (18.3)$$

From this it necessarily follows that, between two strikes of the clock, in system K pass not one but

$$\sqrt{\frac{c+v}{c-v}}$$

seconds, and not as Einstein asserts

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

seconds.

Einstein's derivation of the proof of the relativity of time and the magnitude of the dilation of time contradicts his assertion that the time t in system K depends on the coordinate x' as well, that is on the position of the clock in the system K'. So, if one chooses not to abide by the principles of the theory of relativity and not to respect the conditions under which the Lorentz transformation is derived, then he can, following Einstein's way, derive a "proof" that between two strikes of the clock which is in motion, any number of seconds may pass in system K, while in system K', where the clock is at rest, only one second passes.

For example, let us assume that the clock is not at the origin of system K' but at some point $x' = a = k\frac{c^2}{v}$. Then in system K, according to Einstein's procedure cited above

$$\frac{1+\frac{v}{c^2}k\frac{c^2}{v}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{1+k}{\sqrt{1-\frac{v^2}{c^2}}}$$

seconds would pass between two strikes of the clock instead of

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

seconds, when the clock is at the origin of system K', that is when x' = 0.

In this way, by choosing the position of the clock in system K', in effect by choosing the value of constant a, that is k, it can be proved that, in system K, in which the clock is moving, any number of seconds pass between two strikes of the clock.

From the above it follows that Einstein's derivation of the relativity of time and its extent (the coefficient of dilation) is incorrect. The relationship between the time t, which passes in the system at rest K and the corresponding time t' which passes in the moving system K' is given by the relation

$$\frac{t}{t'} = \sqrt{\frac{c+v}{c-v}} \neq \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{18.4}$$

Before going further, some explanations are necessary.

The condition of time and space (dilatation or contraction) in any coordinate system are independent of the fact whether and from where someone is observing them.

In the system K during the motion of the light wave, there is neither contraction nor dilatation, of both space and time. However, in the system K' which "pursues" the light wave, the contraction of space and time appears, but only in a mathematical sense. If that system K' were to reach that wave, that is, if the speed of the system K' were equal to the velocity of light, then the space would disappear, or more exactly put, the interstice between the origin and the wave front would disappear. Then the time t' disappears as well. This has been explained earlier on. For all that, nothing has happened in system K. Therefore it is more reasonable to observe the condition in the system K' than in the system K.

Einstein analyses phenomena in relation to system K. As a result the dilation of time is, according to him, in system K, instead of contraction of time in system K', where it in fact occurs, at least in a mathematical sense.

18.2 Dilatation of time according to the scientific literature

In case of the Lorentz transformation further presentation of the contraction - dilatation of time is based on the literature [10], where we must keep in mind that the procedure and final result is the same with the other authors.

18.2.1 Dilatation of time according to the Lorentz transformation

Here is how the dilatation of time has been treated in the literature [10]:

Quotation: "Einstein's explanation of the Lorentz transformation for time, shows that time flows differently in different coordinate systems, in some places faster, and in some place slower, because absolute time does not exist. It is easy to show this by taking the corresponding relation for time

$$t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{18.5}$$

In order to determine the time interval in the inertial system K', which moves with uniform translation relatively to the system K, we will take a certain process which is of course realistic. Let the beginning of the process in the system K' be at the moment t_1', and the end of the process at the moment t_2'. Then the process in the system K' has lasted for time $t_2' - t_1'$. This interval in the K' system corresponds to a certain interval in the system K. Since the moment t_1' in the system K' corresponds to the moment t_1 in the system K and moment t_2' corresponds to the moment t_2, that this process observed from the system K will last for time $t_2 - t_1$. But, since according to Einstein time depends on the position and not only on the speed, as is seen in Eq. (18.5), it can be taken that, observed from K, the beginning of the event has happened in the point of the abscissa x_1 of the system K, and the end in the point of the abscissa x_2. In the system K' the process takes place in one place. Then it is clear that between the distance $x_2 - x_1$, and the time interval $t_2 - t_1$, there is a relation

$$x_2 - x_1 = v(t_2 - t_1)$$

because the body (K'), in which the process takes place, has been moved for that distance at speed v observed from K.

According to Eq. (18.5) will be

$$t_1' = \frac{t_1 - \frac{v}{c^2}x_1}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad t_2' = \frac{t_2 - \frac{v}{c^2}x_2}{\sqrt{1 - \frac{v^2}{c^2}}}$$

and from there

$$t_2' - t_1' = \frac{t_2 - t_1 - (x_2 - x_1)\frac{v}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{(t_2 - t_1)\left(1 - \frac{v^2}{c^2}\right)}{\sqrt{1 - \frac{v^2}{c^2}}}$$

So,

$$t_2 - t_1 = \frac{t_2' - t_1'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{18.6}$$

This important relation shows that

$$t_2 - t_1 > t_2' - t_1' \tag{18.7}$$

that is, the time interval in the system which is connected to the process, whose duration is measured, is smaller than the time interval for the same process whose duration is measured from another system with mutual motion. It can be seen that one second in the system K' corresponds $1/\sqrt{1 - v^2/c^2}$ to seconds in system K.

This means that the process is slower in the system K than in the system K'. From this we reach a conclusion about the clock, that is, the time flow register. It turns out that **the clock functions more slowly in the system in relation to which the clock moves, that is, the clock functions slower when it is moving, than when it is at rest.** In other words, time, connected to a body, **flows slower in motion than at rest. Motion causes the dilatation of time.** This is a very important conclusion of Einstein's theory of relativity." **End of quotation.**

In the following three transformations the same procedure will be applied in order to determine the dilatation of time, without comments in detail.

18.2.2 Dilatation of time according to transformation No. 2

In this case of transformation time is given, in the coordinate system K', by Eq. (12.22) as follows

$$t' = t\sqrt{1 + \frac{v^2}{c^2}} - \frac{v}{c^2}x \tag{18.8}$$

so

$$t_1' = t_1\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x_1 \quad \text{and} \quad t_2' = t_2\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x_2$$

and

$$t_2' - t_1' = (t_2 - t_1)\sqrt{1+\frac{v^2}{c^2}} - (x_2 - x_1)\frac{v}{c^2}$$

As in the previous case, that is after substitution $x_2 - x_1 = v(t_2 - t_1)$ we obtain

$$t_2' - t_1' = (t_2 - t_1)\left[\sqrt{1+\frac{v^2}{c^2}} - \frac{v^2}{c^2}\right] \tag{18.9}$$

Since $\sqrt{1+\frac{v^2}{c^2}} - \frac{v^2}{c^2} < 1$ then from Eq. (18.9) we have

$$t_2 - t_1 > t_2' - t_1' \tag{18.10}$$

The dilatation of time is in the system K, as in the case of the Lorentz transformation, but magnitudes of these dilatations are different. So, for example, if $v = 0.95c$ then the dilatation coefficient in case of Lorentz transformation is $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = 3.2$, but in case of this transformation $\frac{1}{\sqrt{1+\frac{v^2}{c^2}} - \frac{v^2}{c^2}} = 2.1$. As can be seen the difference is big.

18.2.3 Dilatation of time according to transformation No. 4

For this transformation, time in the system K' is given by Eq. (12.24), as follows

$$t' = \left(1 - \frac{v}{c}\right)t \tag{18.11}$$

and from there

$$t_1' = \left(1 - \frac{v}{c}\right)t_1 \quad \text{and} \quad t_2' = \left(1 - \frac{v}{c}\right)t_2$$

So, by subtraction we obtain

$$t_2' - t_1' = (t_2 - t_1)\left(1 - \frac{v}{c}\right) \tag{18.12}$$

which results

$$t_2 - t_1 > t_2' - t_1' \tag{18.13}$$

The dilatation of time appears in the system K also, as in the two previous cases, but the dilatation coefficient is considerably larger. For example, if $v = 0.95c$ then the dilatation coefficient is 20.

18.2.4 Dilatation of time according to transformation No. 5

For this transformation, time in the system K' is given by Eq. (12.25) as follows

$$t' = \frac{t - \frac{v}{c^2}x}{1 + \frac{v}{c}} \tag{18.14}$$

so

$$t_1' = \frac{t_1 - \frac{v}{c^2}x_1}{1+\frac{v}{c}} \quad \text{and} \quad t_2' = \frac{t_2 - \frac{v}{c^2}x_2}{1+\frac{v}{c}}$$

After substitution $x_2 - x_1 = v(t_2 - t_1)$ and subtraction yields

$$t_2' - t_1' = \frac{(t_2 - t_1) - (t_2 - t_1)\frac{v^2}{c^2}}{1+\frac{v}{c}} = \frac{(t_2 - t_1)\left(1 - \frac{v^2}{c^2}\right)}{1+\frac{v}{c}}$$

that is

$$t_2' - t_1' = (t_2 - t_1)\left(1 - \frac{v}{c}\right) \tag{18.15}$$

so

$$t_2 - t_1 > t_2' - t_1' \tag{18.16}$$

The dilatation of time is the same as in the previous case.

18.3 Checking the correctness of determining the contraction of space and dilatation of time

Earlier on, it was said that the correctness of the method of determining the contraction of space and dilatation of time, would be checked. This checking is done by dividing the length interval with the corresponding time interval in the corresponding coordinate system. If the method of determining the contraction and dilatation is correct, then the quotient will have to be the velocity of light because the theory of relativity is based upon it.

The checking is done for all four treated transformations.

18.3.1 Checking in case of the Lorentz transformation

The interval of the length is given by Eq. (17.6)

$$x_2 - x_1 = \left(x_2' - x_1'\right)\sqrt{1 - \frac{v^2}{c^2}}$$

and the interval of time by Eq. (18.6)

$$t_2 - t_1 = \frac{t_2' - t_1'}{\sqrt{1 - \frac{v^2}{c^2}}}$$

so, by division we have

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{\left(x_2' - x_1'\right)\sqrt{1 - \frac{v^2}{c^2}}}{\frac{t_2' - t_1'}{\sqrt{1 - \frac{v^2}{c^2}}}} = \frac{x_2' - x_1'}{t_2' - t_1'}\left(1 - \frac{v^2}{c^2}\right) \neq c \tag{18.17}$$

18.3.2 Checking in case of transformation No. 2

The length interval given by Eq. (17.14) is

$$x_2 - x_1 = \frac{x_2' - x_1'}{\sqrt{1 + \frac{v^2}{c^2}}}$$

and time interval by Eq. (18.9)

$$t_2 - t_1 = \frac{t_2' - t_1'}{\sqrt{1 + \frac{v^2}{c^2}} - \frac{v^2}{c^2}}$$

so, by division we have

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{x_2' - x_1'}{t_2' - t_1'} \frac{\sqrt{1 + \frac{v^2}{c^2}} - \frac{v^2}{c^2}}{\sqrt{1 + \frac{v^2}{c^2}}} \neq c \tag{18.18}$$

18.3.3 Checking in case of transformation No. 4

The length interval given by Eq. (17.19) is

$$x_2 - x_1 = x_2' - x_1'$$

and time interval by Eq. (18.12)

$$t_2 - t_1 = \frac{t_2' - t_1'}{1 - \frac{v}{c}}$$

so, by division we obtain

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{x_2' - x_1'}{t_2' - t_1'}\left(1 - \frac{v}{c}\right) \neq c \tag{18.19}$$

18.3.4 Checking in case of transformation No. 5

The length interval given by Eq. (17.21) is

$$x_2 - x_1 = (x_2' - x_1')\left(1 + \frac{v}{c}\right)$$

and time interval by Eq. (18.15)

$$t_2 - t_1 = \frac{t_2' - t_1'}{1 - \frac{v}{c}}$$

so, by division we obtain

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{(x_2' - x_1')\left(1 + \frac{v}{c}\right)\left(1 - \frac{v}{c}\right)}{t_2' - t_1'} = \frac{x_2' - x_1'}{t_2' - t_1'}\left(1 - \frac{v^2}{c^2}\right) \neq c \qquad (18.20)$$

Finally, we can say that in all four cases of transformations is proved that the quotient which is obtained by division of the length interval by the corresponding time interval is not equal to the velocity of light, which is explicitly required by the theory of relativity, because this theory is based on that. The only possible conclusion is that the way of calculating the contraction of space and dilatation of time is not correct.

18.4 A new way of determining the contraction of time

Here we say contraction of time instead of dilatation of time, because, as we said earlier on, the contraction of time in a mathematical sense really arose, but in the moving coordinate system K'.

All four transformations will also be treated here as in the previous case. The new way of determining the contraction of time in the system K' is based on the substitution of $x = ct$, that is $x_1 = ct_1$ and $x_2 = ct_2$. The old way as we saw is based on the substitution of $x = vt$, that is $x_1 = vt_1$ and $x_2 = vt_2$ what is contrary to the second principle of the theory of relativity.

18.4.1 Contraction of time according to the Lorentz transformation

In this transformation time in the system K' is given by the equation

$$t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (18.21)$$

and from there

$$t_2' - t_1' = \frac{t_2 - t_1 - (x_2 - x_1)\dfrac{v}{c^2}}{\sqrt{1 - \dfrac{v^2}{c^2}}}$$

After substitution $x_2 - x_1 = c(t_2 - t_1)$ we obtain

$$t_2' - t_1' = \frac{(t_2 - t_1)\left(1 - \dfrac{v}{c}\right)}{\sqrt{1 - \dfrac{v^2}{c^2}}}$$

that is

$$t_2' - t_1' = (t_2 - t_1)\sqrt{\frac{c - v}{c + v}} \tag{18.22}$$

so

$$t_2 - t_1 > t_2' - t_1' \tag{18.23}$$

18.4.2 Contraction of time according to transformation No. 2

Time in system K' is given by equation

$$t' = t\sqrt{1 + \frac{v^2}{c^2}} - \frac{v}{c^2}x \tag{18.24}$$

that is

$$t_1' = t_1\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x_1 \quad \text{and} \quad t_2' = t_2\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c^2}x_2$$

From there and after substitution $x_2 = ct_2$ and $x_1 = ct_1$ we have

$$t_2' - t_1' = (t_2 - t_1)\left(\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c}\right) \tag{18.25}$$

and

$$t_2 - t_1 > t_2' - t_1' \tag{18.26}$$

18.4.3 Contraction of time according to transformation No. 4

Time in system K' is given by equation

$$t' = \left(1 - \frac{v}{c}\right)t \tag{18.27}$$

and from there

$$t_2' = \left(1 - \frac{v}{c}\right)t_2 \quad \text{and} \quad t_1' = \left(1 - \frac{v}{c}\right)t_1$$

After substitution $x_2 = ct_2$ and $x_1 = ct_1$ and subtraction we obtain

$$t_2' - t_1' = (t_2 - t_1)\left(1 - \frac{v}{c}\right) \tag{18.28}$$

so

$$t_2 - t_1 > t_2' - t_1' \tag{18.29}$$

18.4.4 Contraction of time according to transformation No. 5

In this case time in system K' is given by equation

$$t' = \frac{t - \frac{v}{c^2}x}{1 + \frac{v}{c}} \tag{18.30}$$

and from there

$$t_2' = \frac{t_2 - \frac{v}{c^2}x_2}{1 + \frac{v}{c}} \quad \text{and} \quad t_1' = \frac{t_1 - \frac{v}{c^2}x_1}{1 + \frac{v}{c}}$$

After substitution $x_2 = ct_2$ and $x_1 = ct_1$ and subtraction we have

$$t_2' - t_1' = (t_2 - t_1)\left(\frac{c - v}{c + v}\right) \tag{18.31}$$

so

$$t_2 - t_1 > t_2' - t_1' \tag{18.32}$$

So, the contraction of time for all four used transformations, in a new way of determining the contraction, happen in the system K'. However all these contractions are different.

Let us we see now, what will happen if we express t by means of t' and x' and after that let us find out where the contraction of time is. Therefore we shall take the time from the Lorentz transformation using Eq. (12.20)

$$t = \frac{t' + \frac{v}{c^2} x'}{\sqrt{1 - \frac{v^2}{c^2}}}$$

that is

$$t_2 = \frac{t_2' + \frac{v}{c^2} x_2'}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad t_1 = \frac{t_1' + \frac{v}{c^2} x_1'}{\sqrt{1 - \frac{v^2}{c^2}}}$$

and after substitution $x_2' = ct_2'$ and $x_1' = ct_1'$ and subtraction we obtain

$$t_2 - t_1 = (t_2' - t_1') \sqrt{\frac{c + v}{c - v}}$$

This equation is the same as Eq. (18.22), that is we obtain the same result as when we expressed t' by means of t and x.

Finally we can conclude that the time contraction always appears in system K' independently of the type of coordinate transformation and does not depend on where the system is being observed from, like the contraction of space, which is quite logical, and confirms the correctness of a new way of determining the contraction of time. But, here we must remember that the magnitudes of time contraction also depend on the type of the transformation.

18.5 Checking the correctness of the new way of determining the contraction of space and time

Since the procedure is already known, a shortened procedure of checking has been given for each transformation.

18.5.1 Checking in case of the Lorentz transformation

According to Eq. (17.25) is

$$x_2 - x_1 = \left(x_2' - x_1'\right)\sqrt{\frac{c+v}{c-v}}$$

and according to Eq. (18.22) is

$$t_2 - t_1 = \left(t_2' - t_1'\right)\sqrt{\frac{c+v}{c-v}}$$

so, by division we obtain

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{\left(x_2' - x_1'\right)\sqrt{\frac{c+v}{c-v}}}{\left(t_2' - t_1'\right)\sqrt{\frac{c+v}{c-v}}} = \frac{x_2' - x_1'}{t_2' - t_1'} = \frac{c\left(t_2' - t_1'\right)}{t_2' - t_1'} = c \qquad (18.33)$$

18.5.2 Checking in case of transformation No. 2

According to Eq. (17.29) is

$$x_2 - x_1 = \frac{x_2' - x_1'}{\sqrt{1 + \frac{v^2}{c^2}} - \frac{v}{c}}$$

and according to Eq. (18.25) is

$$t_2 - t_1 = \frac{t_2' - t_1'}{\sqrt{1 + \frac{v^2}{c^2}} - \frac{v}{c}}$$

so, by division we obtain

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{\dfrac{x_2' - x_1'}{\sqrt{1 + \dfrac{v^2}{c^2}} - \dfrac{v}{c}}}{\dfrac{t_2' - t_1'}{\sqrt{1 + \dfrac{v^2}{c^2}} - \dfrac{v}{c}}} = \frac{x_2' - x_1'}{t_2' - t_1'} = \frac{c\left(t_2' - t_1'\right)}{t_2' - t_1'} = c \qquad (18.34)$$

18.5.3 Checking in case of transformation No. 4

According to Eq. (17.33) is

$$x_2 - x_1 = \frac{x_2' - x_1'}{1 - \dfrac{v}{c}}$$

and according to Eq. (18.28) is

$$t_2 - t_1 = \frac{t_2' - t_1'}{1 - \dfrac{v}{c}}$$

so, by division we obtain

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{\dfrac{x_2' - x_1'}{1 - \dfrac{v}{c}}}{\dfrac{t_2' - t_1'}{1 - \dfrac{v}{c}}} = \frac{x_2' - x_1'}{t_2' - t_1'} = c \qquad (18.35)$$

18.5.4 Checking in case of transformation No. 5

According to Eq. (17.37) is

$$x_2 - x_1 = \left(x_2' - x_1'\right)\left(\frac{c+v}{c-v}\right)$$

and according to Eq. (18.31) is

$$t_2 - t_1 = \left(t_2' - t_1'\right)\left(\frac{c+v}{c-v}\right)$$

so, by division we obtain

$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{\left(x_2' - x_1'\right)\left(\frac{c+v}{c-v}\right)}{\left(t_2' - t_1'\right)\left(\frac{c+v}{c-v}\right)} = c \tag{18.36}$$

These checks show that the new way of determining the contraction of space and time is correct, because in all four cases of the transformation treated, by dividing the length interval with the time interval, both in system K and K', the velocity of light was obtained.

At the end, in regard to time contraction it should be said that even in the new correct procedure of determining the contraction of space and time different values for the different coordinate transformations are obtained at the same speed v of the system K' relatively to the system K. From this it can be concluded that time contraction cannot be connected to the duration of some realistic physical process or state. The real duration of some process cannot depend on the mathematical procedure of the coordinate transformation. Neither can time depend on it. So the time we obtain can only be some conditional or local time as Lorentz called it.

The contraction of time is a mathematical concept related to the motion of the light wave or acoustic wave which is followed from two inertial systems, under the condition that the speed of the wave in both systems is equal to the velocity of light, or, to the speed of sound, when sound is in question.

If the coordinate system K is the system of reference, where time passes normally, then the countdown of time ("ticking of a clock") in system K' is slowed relatively to the countdown of time in system K. Because of this we should rather talk about time contraction in system K' than the dilatation of time in the system K. Simply said, we can talk about time and space contraction in the coordinate system K' which moves with uniform translation relatively to the other coordinate system K and under the condition that the system K' moves in the direction of the light wave - ray motion.

Up till now the event of contraction - dilatation of time and space has been considered only in the case of motion of the coordinate system K' in the same direction as the light wave. This was done because Lorentz did the same. In such an approach in the analysis it has been discovered that in system K' contraction of time and space occurs regularly, no matter if it is a plane or spherical wave, and what the transformation coordinate is.

However, with motion of the system K' in the opposite direction of the light ray (or wave) motion, which has the same validity as the previous direction, a contrary state occurs. In system K', instead of the earlier contraction we obtain the dilatation of time and space. This can be easily shown by the procedures already used, but on the basic of the new transformations No. 1 and 3. It must be born in mind that the new coordinate transformations also satisfy the requirement for invariability of equation for propagation of electromagnetic waves, same as Lorentz. As such they are equal to the Lorentz transformation, that is they have the same validity as the Lorentz transformation. Because of that, it is impossible to claim in advance what, and to what degree, will happen in motion, contraction or dilatation, not even in mathematical sense. This is even more evident with the application of the following transformation of coordinates, which also satisfy the requirement for invariability, as does the Lorentz transformation.

$$x' = \frac{x - kvt}{\sqrt{1 - k^2 \frac{v^2}{c^2}}}; \quad y' = y; \quad z' = z; \quad t' = \frac{t - k\frac{v}{c^2}x}{\sqrt{1 - k^2 \frac{v^2}{c^2}}} \tag{18.37}$$

as well as

$$x' = x\sqrt{1 + k^2 \frac{v^2}{c^2}} - kvt; \quad y' = y; \quad z' = z; \quad t' = t\sqrt{1 + k^2 \frac{v^2}{c^2}} - k\frac{v}{c^2}x \tag{18.38}$$

where k, from the standpoint of invariability, can be any number, even an imaginary one.

The transformed coordinates (18.37) have a mathematical form similar to Lorentz, and for k = 1 they are the same as Lorentz.

By changing the parameter k we can get an infinite number of transformations of coordinates, and with their application an infinite number of different values of dilatations and contractions of time and space and that for the same relative speed of motion v of the coordinate system K'.

Likewise, for the case of a plane wave there are countless transformations of coordinates, which are obtained by changing the parameter k, and with the application we also get countless different values of dilatations and contractions of time and space for the same relative speed v of the coordinate system K'.

If we take an imaginary value for the parameter k, whereby any physical interpretation is excluded, the requirement for invariability of the equations for propagation of electromagnetic radiation is also satisfied.

Einstein's assertions about dilatation of the time and contraction of space are without base, because we are not able to establish which system is at rest and which is moving.

At the end, it can be concluded, in connection with the contraction of space and dilatation of time, as follows.

Einstein's derivation of equation for the contraction of space and dilatation of time are not correct nor the coefficient of the contraction and dilatation are accurate even in mathematical sense. This assertion is proved in the chapters 17.1, 18.1 and 18.3.

Correct expressions for the contraction of space and time, in mathematical sense and in case of the Lorentz transformation, are given by Eqs. (17.26) and (18.22). Those equations show that the contraction of space and time originate in the moving system K' in which a body is at rest.

Finally, it should be said that Einstein's contraction of space and dilatation of time is not a physical reality, but an illusion, realized through a particular mathematical procedure accomplished by means of transformation of the coordinates with the aim of achieving invariability of equation of general laws in the area of electromagnetism.

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19. ADDITION OF SPEEDS

19.1 Addition of speeds in a vacuum

The addition of speeds as Einstein presents it, goes against human experience and reason. Accepting this way of addition would mean rejecting all that has been learnt and affirmed about addition throughout the centuries.

In order to understand the problem of addition it is important to see what Einstein said about it [6].

Quotation: "Let a railway wagon be moving along a track at a constant speed v. Let a man walk along the wagon at a speed w in the direction of the wagon's motion. By which speed W relatively to the railway embankment is the man moving during his walk? It seems that is only one possible answer results from this way of thinking:

If the man stopped after one second, he would, relative to the embankment, have moved forward for a certain distance v which is equal to the speed of the wagon. Actually, relative to the wagon, that is, in relation to the embankment, he would also have traveled forward by a pace the distance w, which corresponds to the speed of his walk. Thus, relative to the embankment, in the given second the man travels in all the distance

$$W = v + w \tag{19.1}$$

Later on, we will see that this way of thinking which is in accordance with classical mechanics, expresses the addition theorem, cannot be retained, and that this law, we had just now written, does not represent the truth". **End of quotation.**

As can be seen from the quotation, Einstein has a different attitude to the addition of speeds even with the simplest and most obvious forms of motion.

Further on Einstein says:

Quotation: "Instead of the man walking in the wagon, we will introduce a point which relatively to the coordinate system K' will move according to equation

$$x' = wt' \tag{19.2}$$

From the first and forth equation of the Galilean transformation x' and t' can be expressed by means of x and t, so we obtain

$$x = (v + w)t \tag{19.3}$$

This equation expresses nothing but the law of point motion relative to the system K (a man relative to the railway embankment) which we will mark as W, so we have

(A) $$W = v + w \tag{19.4}$$

This considered case we can likewise thoroughly study also on the base of the theory of relativity. Then in equation

$$x' = wt'$$

we should express x' and t' by means of x and t using the first and fourth equation of the Lorentz transformation. [As we said, according to the second principle of the theory of special relativity have to be $x'/c = t'$ that is $x' = ct'$. Because of that in equation $x' = wt'$ have to be $w = c$ at all events. Beside that, the Lorentz transformation has been derived by using corresponding equations for a case of light propagation, but not for a case of mechanical motion. Therefore, this transformation could not be derived, at all, by using equation of mechanical motion, and have nothing in common with mechanical motion. The exception is only spherical acoustic wave. Therefore that equations of Lorentz transformation can not be applied on mechanical motion, except in case of spherical wave motion, where instead of the speed of light, the speed of sound should be taken. So, it should always be born in mind that Lorentz transformed coordinates refer to the coordinates of the light wave position or a ray in the coordinate systems K and K', and by no means to an arbitrary position of a point in these systems. (Remark M.P.).] Then we obtain, instead of Eq. (A), equation

(B) $$W = \frac{w + v}{1 + \frac{vw}{c^2}} \tag{19.5}$$

which, according to the theory of relativity, corresponds to the theorem on addition of speeds having the same direction. The question now is, which of these two theorems corresponds to experience. In this context we learn something from a very important test performed half a century ago by the genius physicist Fizeau but which was later repeated by some of the best physicists experimentalist, so that result of the test is unquestionable." **End of quotation.**

In the passage quoted a shorter procedure of derivation of Eq. (B) about addition of speeds is given. Considering the great importance of this equation it is necessary for the sake of clarity to present the whole procedure.

The first and fourth equation of the Lorentz transformation, where x' and t' are expressed by means of x and t, as we know are

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{and} \quad t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Using these equations and the Eq. (19.2) given in the previous quotation

$$x' = wt'$$

we obtain

$$\frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{w\left(t - \frac{v}{c^2}x\right)}{\sqrt{1 - \frac{v^2}{c^2}}}$$

and from there finally

$$\frac{x}{t} = \frac{w + v}{1 + \frac{vw}{c^2}} = W \qquad (19.6)$$

where $W = W_A$ is a sum of a speeds.

According to Einstein, the sum of speeds can not be higher than the speed of light in vacuum. For example, if we take that $w = c$, and also that $v = c$, then according to the Eq. (B), that is (19.6), their sum is

$$W = \frac{w + v}{1 + \frac{w \cdot v}{c^2}} = \frac{c + c}{1 + \frac{c \cdot c}{c^2}} = c \qquad (19.7)$$

which is contrary to everyday experience. That it is so, we can check and see in the following example.

Let a light pulse of short duration be sent to a mirror formed by two adjoining sides of a cube. The mirror of that shape divides the light pulse into two parts and two light pulses are created. In this way they are directed in two opposite directions. In one second each of these two pulses will travel 300000 km. Bearing in mind that they move in opposite directions the distance between them will be 600000 km. From this it certainly follows that they went away from each other at the speed of 600000 km/s, i.e. their relative speed was 600000 km/s. In other words, the sum of their speeds was 600000 km/s, and not 300000 km/s as Einstein claims in his equation for addition of speeds.

In a similar way, we can show the falsehood of Einstein's claim that the subtraction of the speed of light and some other speed equals the speed of light.

Einstein's equations for addition and subtraction of speeds can be derived in a different, simpler way from which it becomes evident what they really represent.

Eq. (19.6) is obtained by direct division of the first by the forth equation of the Lorentz or some other transformations as follows

$$W_A = W = \frac{x}{t} = \frac{\dfrac{x' + vt'}{\sqrt{1 - \dfrac{v^2}{c^2}}}}{\dfrac{t' + \dfrac{v}{c^2}x'}{\sqrt{1 - \dfrac{v^2}{c^2}}}} = \frac{\dfrac{x'}{t'} + v}{1 + \dfrac{v}{c^2}\dfrac{x'}{t'}} = \frac{c + v}{1 + \dfrac{v}{c^2}c} = c \tag{19.8}$$

because $\dfrac{x'}{t'} = w = c$, and also $\dfrac{x}{t} = c$.

The difference of the speeds

$$W_S = \frac{W - v}{1 - \dfrac{vW}{c^2}} \tag{19.9}$$

W_S is also obtained by direct division of the first by the fourth equation of the Lorentz or some other transformations, but under the condition that x' and t' are given as a function of x and t.

$$W_s = w = \frac{x'}{t'} = \frac{\dfrac{x - vt}{\sqrt{1 - \dfrac{v^2}{c^2}}}}{\dfrac{t - \dfrac{v}{c^2}x}{\sqrt{1 - \dfrac{v^2}{c^2}}}} = \frac{\dfrac{x}{t} - v}{1 - \dfrac{v}{c^2}\dfrac{x}{t}} = \frac{c - v}{1 - \dfrac{v}{c^2}c} = c \tag{19.10}$$

Let us analyze Eq. (19.6) and try to find out what it really represents. Let's start from the beginning.

Lorentz derived the transformation of coordinates for the case of spherical light wave motion along the x-axis in the two inertial systems K and K', where the system K' moves translatory at a speed v along the x-axis and without acceleration relatively to K. For that, he starts from conditions $x = ct$ and $x' = ct'$. Consequently his first and fourth equation are valid only under such conditions. On the basis of this condition, the principle of the constancy of the speed of light, the special theory of relativity was derived. Because of that, it is always and only

$$W = \frac{x}{t} = c \tag{19.11}$$

and

$$w = \frac{x'}{t'} = c \tag{19.12}$$

so it is also always and only

$$W = \frac{x}{t} = \frac{w + v}{1 + \dfrac{vw}{c^2}} = \frac{c + v}{1 + \dfrac{v}{c}} = c \tag{19.13}$$

and

$$w = \frac{x'}{t'} = \frac{W - v}{1 - \frac{vW}{c^2}} = \frac{c - v}{1 - \frac{vc}{c^2}} = c \qquad (19.14)$$

This is for the case for the Lorentz transformation and transformation No. 5 which gives the same equation for the addition and subtraction of speeds.

In case of transformation No. 2 we derived the following equation for the addition of speeds

$$W_A = \frac{w\left[\sqrt{1+\frac{v^2}{c^2}} + \frac{v}{c}\right]}{\sqrt{1+\frac{v^2}{c^2} + \frac{vw}{c^2}}} \qquad (19.15)$$

and for the speed subtraction

$$W_S = \frac{W\left[\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c}\right]}{\sqrt{1+\frac{v^2}{c^2} - \frac{vW}{c^2}}} \qquad (19.16)$$

If in Eqs. (19.15) and (19.16) we make substitution $W = w = c$ we obtain

$$W_{A/S} = \frac{c\left[\sqrt{1+\frac{v^2}{c^2}} \pm \frac{v}{c}\right]}{\sqrt{1+\frac{v^2}{c^2} \pm \frac{v}{c}}} = c \qquad (19.17)$$

The form of the equation for the addition speeds and for the subtraction speeds in the case of transformation No. 4, considerably differs from the previous. So, in case of the addition of speeds

$$W_A = \left(1 - \frac{v}{c}\right) w + v \qquad (19.18)$$

and in case of the subtraction of speeds

$$W_S = \frac{W - v}{1 - \dfrac{v}{c}} \qquad (19.19)$$

But here, as well, by substituting $w = c$ we obtain the same, that is

$$W_A = \left(1 - \frac{v}{c}\right) c + v = c \qquad (19.20)$$

and

$$W_S = \frac{c - v}{1 - \dfrac{v}{c}} = c \qquad (19.21)$$

Thus, for different transformations there may be different equations for the addition of speeds, and for the subtraction of speeds but the result of the sum and difference must always be the same and equal to the speed of light.

At the end we can conclude as follows. Einstein's equation about the addition of speeds, is really about the velocity of propagation of a light wave along the x-axis in the system K. That velocity of the light wave propagation is expressed by means of coordinates x' and t' and velocity v of the system K'. The sum of the addition of speeds cannot be higher than the velocity of light no matter how high v is, and has to be equal to the velocity of light only, since under that condition it is derived by means of the Lorentz transformation. Many people, without any justification, have used this equation as a proof that the velocity of light is the highest possible velocity in nature. On the basis of this equation they assert that even relative speed cannot be higher than the velocity of light.

Einstein's equation describing the subtraction of speeds is really about the velocity of light wave propagation along the x'-axis in a moving coordinate system K' which is expressed by means of the coordinates x and t and velocity v. The difference of speeds given by the equation about subtraction of speeds always is also equal to the velocity of light no matter how high speed v is, because it is derived under the same condition as the previous. Let us repeat that this condition in fact is the condition that the velocity of light in both coordinate systems K and K' has to be the same and equal to c for the case of vacuum.

Einstein's inconsistency and the weakness of the theory of relativity can also be seen in the case of the theorem of addition of speeds.

As we know, according to that theorem, when adding and subtracting the speed of light with any other speed the result equals the speed of light. If this is true then it is inexplicable why Einstein wrote in his first paper on relativity [2], in which he derived the Theorem on addition of speeds, in the third formula

$$t_B - t_A = \frac{r_{AB}}{c - v} \quad \text{and} \quad t'_A - t_B = \frac{r_{AB}}{c + v}$$

With these two formulas, at the very beginning, Einstein refuted his Theorem on the addition of speeds in the course of its derivation. **For, if what the theorem claims were true, then it would be senseless to use the expressions $c - v$ and $c + v$, when in their place only c should be taken.** However, that cannot be done, because then it would be $t_B - t_A = t'_A - t_B$, which is not true and which would make Einstein's treatment of the relativity of length and time interval absurd.

To this point we have been discussing light propagation in a vacuum, because it was for those conditions the Lorentz and other transformations were derived.

19.2 Addition of speeds in water

How would the Lorentz and other transformations, as well as other equations for the addition and subtraction of speeds look in the case of some other environment? It is clear that if the transformations are to be derived, the other new environment will have to be homogenous and isotropic too.

Let us suppose that the new environment is water. Let both inertial systems be in water, so the light wave and the coordinate system K' move through water. In order to be valid the Lorentz transformation would have to be $x_w = c_w t$ and $x'_w = c_w t'$ where x_w and x'_w are the coordinates of the light wave position along the x and x'-axes in the system K and K' respectively and c_w is the velocity of light in water. In order to exist an invariability of the equation for the light propagation in water it is indispensibly to be

$$x_w^2 + y_w^2 + z_w^2 - c_w^2 t^2 = x_w'^2 + y_w'^2 + z_w'^2 - c_w^2 t'^2 \qquad (19.22)$$

In that case the first and fourth equation of the Lorentz transformation solved for x_w and t would have the form

$$x_w = \frac{x'_w + vt'}{\sqrt{1 - \frac{v^2}{c_w^2}}} \quad \text{and} \quad t = \frac{t' + \frac{v}{c_w^2} x'_w}{\sqrt{1 - \frac{v^2}{c_w^2}}} \tag{19.23}$$

Dividing x_w with t we obtain

$$\frac{x_w}{t} = W_{wA} = \frac{w_w + v}{1 + \frac{v w_w}{c_w^2}} \tag{19.24}$$

If we make substitution in Eqs. (19.23) and (19.24)

$$c_w = \frac{c}{n}, \quad W_w = \frac{x_w}{t} = \frac{\frac{c}{n} t}{t} = \frac{c}{n} \quad \text{and} \quad w_w = \frac{x'_w}{t'} = \frac{\frac{c}{n} t'}{t'} = \frac{c}{n}$$

then we have for the addition of speeds

$$W_{wA} = \frac{w_w + v}{1 + \frac{v}{c_w^2} w_w} = \frac{\frac{c}{n} + v}{1 + \frac{v \frac{c}{n}}{\frac{c^2}{n^2}}} = \frac{c}{n} \tag{19.25}$$

and for subtraction of speeds

$$W_{ws} = \frac{W_w - v}{1 - \frac{v}{c_w^2} W_w} = \frac{\frac{c}{n} - v}{1 - \frac{v \frac{c}{n}}{\frac{c^2}{n^2}}} = \frac{c}{n} \tag{19.26}$$

Thus, if one respects all the conditions for which the transformation of coordinates was derived, then the sum and the difference of the speeds according to Einstein's Eq. (B), should be equal to the speed of light in that environment, for which the coordinate transformation had been derived. Everything else is wrong, or a dexterous thought trick, that is, a dexterous thought joke.

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20. FIZEAU'S TEST AND THE SPECIAL THEORY OF RELATIVITY

As the main proof of the correctness of the special theory of relativity Einstein cites Fizeau's experiment as experimentum crucius, that is, its result. He always refers to Fizeau's experiment as if it explicitly and without any doubt confirms the correctness of the theorem on the addition of speeds. Einstein even dedicated one chapter in his writings to it [6].

In one place he says: "The experiment solves the problem with great accuracy in a favor to Eq. (B) which has been derived in accordance with the theory of relativity. The influence of the speed v, at which water flows, on the propagation of light, according to Zeeman's last measurement, is represented in the formula (B) with the precision better the one percent."

Let's examine whether the quoted assertion stands.

In Eq. (B), that is in Eq. (19.5) for the addition of speeds, which is derived by using equations of the Lorentz transformation, Einstein substitutes $w = c/n$ and then in the case of Fizeau's experiment he obtains

$$W = \frac{w+v}{1+\dfrac{vw}{c^2}} = \frac{\dfrac{c}{n}+v}{1+\dfrac{v}{c^2}\dfrac{c}{n}} = \frac{\dfrac{c}{n}+v-\dfrac{v}{n^2}-\dfrac{v^2}{cn}}{1-\dfrac{v^2}{n^2c^2}} \approx \frac{c}{n}+v\left(1-\frac{1}{n^2}\right) \qquad (20.1)$$

which corresponds to the results of Fizeau's experiment. In this equation v is the speed of water motion in the pipe and $w = c/n$ is the velocity of the light propagation in quiescent water.

As showed before, Fizeau came to the same equation but based upon the experiment. This gave Einstein the right to assert that the result of the experiment convincingly confirms the correctness of his theory, and that there is no other theory which could explain the result of Fizeau's experiment. Many others also state the same. However, if the same substitution is made in Eq. (19.18) for the addition of speeds, derived upon the basis of the coordinate transformation No. 4 which is derived for the case of the plane wave propagation we obtain

$$W = \left(1-\frac{v}{c}\right)w+v = \left(1-\frac{v}{c}\right)\frac{c}{n}+v = \frac{c}{n}+v\left(1-\frac{1}{n}\right) \qquad (20.2)$$

which doesn't agree with the result of Fizeau's experiment. So the problem, arises and the question: "Why it doesn't agree with the result of the experiment, nor with the result obtained by using Eq. (20.1)?" The answer to this question is rather complex, because many things have to be considered, and that is why we will explain it step by step.

The Lorentz transformation was derived for the spherical light wave and it identically satisfied the requirement for invariability of the equation for the spherical light wave propagation. In case of a plane wave this requirement of identity cannot be achieved by the equations of that transformation. Only equality is achieved.

All interferometric measurements are performed by collimated radiation, that is, by plane wave radiation. Fizeau also used them in the experiment. Because of that, keeping in mind the type of light waves, Eq. (20.2), would give a more exact result which is derived for the case of plane waves. But it isn't so. The opposite happens. The result obtained by Eq. (20.1), which is derived for the case of spherical wave better corresponds with the result of experiment.

Transformation No. 5, is also for the case of plane wave, but its equation for the addition of speeds is the same as in the case of the Lorentz transformation. This means, that by using the equation of the transformation for the plane wave we can obtain two values for the coefficient of the "ether drawing", $k = 1 - 1/n$ and $k = 1 - 1/n^2$. But it isn't all. There are more anomalies and surprises, in the sense "now you see it, you don't".

If in transformation No. 4, which is a stumbling - block, in equation for time t' we substitute $x = ct$, that is $t = x/c$, then we obtain the following equations of transformation

$$x' = x - vt \quad \text{and} \quad t' = t - \frac{v}{c^2}x \tag{20.3}$$

and from there

$$x = \frac{x' + vt'}{1 - \frac{v^2}{c^2}} \quad \text{and} \quad t = \frac{t' + \frac{v}{c^2}x'}{1 - \frac{v^2}{c^2}} \tag{20.4}$$

Dividing x with t, in case of the transformation No. 4, we obtain a new equation for the addition of speeds which is the same as in case of the Lorentz transformation or transformation No. 5, which proves that the derivation of the transformation is correct

$$\frac{x}{t} = W = \frac{w + v}{1 + \frac{vw}{c^2}}$$

Now a new difficulty arises. How to explain why, by substitution $w = c/n$, which is connected to Fizeau's experiment, another value is obtained for the sum of speeds whose coefficient of "ether drawing" is $k = 1 - 1/n^2$ instead of $k = 1 - 1/n$ for the previous forms of the same equation, before substitution $t = x/c$. Especially when this happens, by using the same equations from the same coordinates transformation.

The presented anomalies prove that Einstein's equation for the addition of speeds cannot be used in the case of Fizeau's experiment in the form it has been given and in the way it has been used.

Where is the error in using the equations for the addition of speeds in interpretation of Fizeau's results and what caused it? The cause of the error lies in the fact that Einstein's equations for the addition of speeds and the subtraction of speeds were derived for conditions which differ greatly from the conditions under which the experiment was performed.

Lorentz transformation and the new transformations were derived for a vacuum, that is for an isotropic and homogenous environment where the velocity of light propagation is equal to the velocity c in both K and K' system. The theorem on addition of speeds which is given by Eq. (B), that is by Eq. (19.5), is derived by using the equation $x' = wt'$ in which x' and t' are expressed with x and t by using the first and fourth equation of the Lorentz transformation.

Fizeau's experiment was performed in water, in an environment which differs considerably from vacuum and where the speed of light propagation is c/n. For the explanation of the experiment results Einstein used the following equation for addition of speeds

$$W_A = \frac{\dfrac{c}{n} + v}{1 + \dfrac{v}{cn}} \tag{20.5}$$

which is derived from the equation

$$x' = wt' = \frac{c}{n} t' \tag{20.6}$$

where x' and t' are expressed with x and t by using the first and fourth equation of the Lorentz transformation (derived for vacuum), as it is done in Eq. (19.6) or in the following way where x and t are expressed through x' and t'

$$W_A = \frac{x}{t} = \frac{\dfrac{x' + vt'}{\sqrt{1 - \dfrac{v^2}{c^2}}}}{\dfrac{t' + \dfrac{v}{c^2}x'}{\sqrt{1 - \dfrac{v^2}{c^2}}}} = \frac{x' + vt'}{t' + \dfrac{v}{c^2}x'} = \frac{\dfrac{c}{n} + v}{1 + \dfrac{v}{cn}} \qquad (20.7)$$

Thus, in Einstein's explanation of Fizeau's experiment we find two completely different environments, water and air (vacuum) with different speeds of light propagation. He connects the coordinates of the system K' for moving water, while the coordinate system K is out of water, in air (vacuum) and connected to the unmoving source of radiation. Because of that, the speed of light propagation in the system K' is c/n, and at the same time the speed of the propagation of the same light waves in the system K is c.

The same wave or ray, in those two coordinate systems, cannot at the same time have two velocities of propagation c/n and c. But if it does have them, then there can be no transformation of coordinates and Einstein's Eq. (B) for the addition of speeds, because there are no more the second and third fundamental principle of relativity; in a word there is no more the theory of relativity. Einstein, as a famous physicist, had to know that.

Let us see what would happen if both systems were in water, that is, if Fizeau's measurement system was to be sank. The measurement result would remain the same, because by the test records the difference of the interference pictures at two conditions of the water in the pipes: when the water is at rest and when it is in motion. There is no influence on the measurement and result if the surrounding water outside of the pipe is at rest. By doing this a homogenous and isotropic environment would be achieved, and conditions for the deriving transformation and existing of certain equations for the addition of speeds would be realized.

It is clear that in the new environment equation derived for the addition of speeds in a vacuum is not valid. The equation which could be valid for that new environment is Eq. (19.24), given in the previous chapter where $c_w = c/n$ is the velocity of light in water and n is index of water refraction. So, if that relativistic equation is applied correctly in case of Fizeau's test, then a sum and a difference of the velocity of light in water and the speed of water motion in the pipe, will be equal to the velocity of light in water, as it was presented in previous chapter by Eqs. (19.25) and (19.26). These equations, for the sake of clearness, we give again

$$W_{wA} = \frac{w_w + v}{1 + \frac{v}{c_w^2} w_w} = \frac{\frac{c}{n} + v}{1 + \frac{v \frac{c}{n}}{\frac{c^2}{n^2}}} = \frac{c}{n} \tag{20.8}$$

and

$$W_{wS} = \frac{W_w - v}{1 - \frac{v}{c_w^2} W_w} = \frac{\frac{c}{n} - v}{1 - \frac{v \frac{c}{n}}{\frac{c^2}{n^2}}} = \frac{c}{n} \tag{20.9}$$

This result is logical, because it was conditioned by the initial requirement $x'_w / t'_w = c / n$ and $c_w = c / n$ in case of water environment and $x' / t' = c$ in case of vacuum. According to this, **Einstein's equation for the addition of speeds can not be used in connection with Fizeau's experiment, nor can it be used for any kind of speeds addition.** Simple said, that equation presents the velocity of light wave propagation in a unmoving inertial system K in case of vacuum. In case of water that sum of Einstein's speeds addition according to Eq. (19.25) is equal to c / n, and the speed of water motion has no influence on it.

According to the theory of relativity the speed of light, in each uniform and isotropic environment (vacuum, water and so on), must be the same in both systems K and K', since it is conditioned by the postulate on the constancy of the speed of light.

Finally, according to all the above we can conclude as follows. **The result of Fizeau's test is not proof, and can not be any proof of the correctness of the special theory of relativity. On the contrary, it shows that the theorem on addition of speeds is wrong, that it is based on a wrong assumption and it is applied in a wrong way.**

With the explanation of Fizeau's experiment, given in chapter 14, it is obvious that in that case there cannot be a simple relativistic addition and subtraction of speeds, even if they were correct, because it is a case of more complex physical process which imposes a more complex way of calculating the interference shift.

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21. THE INFLUENCE OF MOTION OF THE RADIATION SOURCE AND THE RECEIVER ON LIGHT AND SOUND FREQUENCY (DOPPLER EFFECT)

21.1 The classical way of determining the Doppler effect

The Doppler effect is well known in classical physics. In 1842 Doppler discovered that the motion of a radiation source influences the frequency of acoustic or light radiation. However, the motion of the radiation source and also the motion of the receiver of radiation influence the frequency which is registered by receiver.

When a radiation source moves towards the observer the radiation frequency is increased, when it moves away this frequency is decreased. So, the radiation frequency is increased in the direction the source is moving, and decreased in the opposite direction.

If we mark with f_0 the frequency, in relation to the system to which the source is connected, that is, the frequency of the source, and with f - the frequency which the receiver receives, then

$$f = \frac{f_0}{1 + \frac{v_s}{c}} \qquad (21.1)$$

when the source moves away from the receiver and

$$f = \frac{f_0}{1 - \frac{v_s}{c}} \qquad (21.2)$$

when the source approach to the receiver.

In case of receiver motion we have

$$f = f_0\left(1 - \frac{v_r}{c}\right) \qquad (21.3)$$

when the receiver moves away from the source and

$$f = f_0\left(1 + \frac{v_r}{c}\right) \tag{21.4}$$

when the receiver approaches the source.

In previous equations v_s is the speed of the source, v_r is the speed of the receiver and c is the velocity of light or sound.

The given equations can be applied for motion along the straight line "radiation source - receiver". When the motion is under some φ angle in relation to that straight line, then in expression $c \pm v$ we take $(c \pm v)\cos\varphi$. So, instead of Eqs. (21.1) and (21.2) as well as (21.3) and (21.4) we obtain

$$f = \frac{f_0}{1 \mp \frac{v_s}{c}\cos\varphi} = \frac{f_0\left(1 \pm \frac{v_s}{c}\cos\varphi\right)}{1 - \frac{v_s^2}{c^2}\cos^2\varphi} \tag{21.5}$$

in case of source motion and

$$f = f_0\left(1 \mp \frac{v_r\cos\varphi}{c}\right) \tag{21.6}$$

in case of receiver motion.

In case of receiver and source motion in the same direction in relation to the environment we have

$$f = f_0\frac{1 \pm \frac{v_r}{c}}{1 \pm \frac{v_s}{c}} \tag{21.7}$$

When $v_s = v_r$ then $f = f_0$. However, the change of frequency does not depend on the difference in speed $v_r - v_s$ but in general on v_r and v_s in relation to the environment.

The above is a summary of how classical physics, based on experience and everyday measurements in the sphere of radar and laser technique, treats the Doppler effect, that is, the Doppler frequency shift.

21.2 The relativistic way of determining the Doppler effect

The theory of relativity has another approach and other formulas for the calculation of the Doppler effect. Along with a longitudinal, there is also the transversal Doppler effect, which is not accepted by classical physics.

21.2.1 Determining the Doppler effect by use of equations of the Lorentz transformation

The theory of relativity comes to the formulas for the Doppler effect by means of the Lorentz transformation equations. For that, this theory starts from the fact that the intensity of the plane light wave which propagates in vacuum in a system K is proportional to

$$\sin\omega\left(t-\frac{x\cdot\cos\alpha_1+y\cdot\cos\alpha_2+z\cdot\cos\alpha_3}{c}\right) \tag{21.8}$$

and the intensity of the same light wave in system K' is proportional to

$$\sin\omega'\left(t'-\frac{x'\cdot\cos\alpha_1'+y'\cdot\cos\alpha_2'+z'\cdot\cos\alpha_3'}{c}\right) \tag{21.9}$$

where $\cos\alpha_1$, $\cos\alpha_2$, $\cos\alpha_3$, $\cos\alpha_1'$, $\cos\alpha_2'$ and $\cos\alpha_3'$ are the cosine of orientation of the wave normal relatively to the corresponding coordinate system.

According to the theory of relativity, expression (21.8) is invariant with respect to the transformation, so we then have

$$\begin{aligned}&\omega\left(t-\frac{x\cdot\cos\alpha_1+y\cdot\cos\alpha_2+z\cdot\cos\alpha_3}{c}\right)=\\&=\omega'\left(t'-\frac{x'\cdot\cos\alpha_1'+y'\cdot\cos\alpha_2'+z'\cdot\cos\alpha_3'}{c}\right)\end{aligned} \tag{21.10}$$

Using the first and fourth equation of the Lorentz transformation in the first expression of Eq. (21.10) yields

$$\omega\left(\frac{t'+\frac{v}{c^2}x'}{\sqrt{1-\frac{v^2}{c^2}}}-\frac{x'+vt'}{\sqrt{1-\frac{v^2}{c^2}}}\frac{\cos\alpha_1}{c}-\frac{y'\cdot\cos\alpha_2}{c}-\frac{z'\cdot\cos\alpha_3}{c}\right)=$$
$$=\omega\left(\frac{1-\frac{v}{c}\cos\alpha_1}{\sqrt{1-\frac{v^2}{c^2}}}t'+\frac{\frac{v}{c^2}-\frac{\cos\alpha_1}{c}}{\sqrt{1-\frac{v^2}{c^2}}}x'-\frac{y'\cdot\cos\alpha_2}{c}-\frac{z'\cdot\cos\alpha_3}{c}\right) \quad (21.11)$$

Comparison of the coefficients of t' in Eq. (21.10) and (21.11) we obtain the following relation

$$\omega'=\omega\frac{1-\frac{v}{c}\cos\alpha_1}{\sqrt{1-\frac{v^2}{c^2}}} \quad (21.12)$$

In this way, according to the theory of relativity, we come to the equation (21.12), which is used for the calculation of the Doppler effect. In regard to this equation Einstein says [5]:

Quotation: "Let us explain the formula for ω' for two different possibilities: when the observer is moving but the infinitely distant source is at rest and opposite, when the observer is at rest but the source is moving.

a) if the observer is moving at a speed v relative to an infinitely distant light source with the frequency f, so that the line "light source - observer" forms an angle α with the observer's speed relative to the coordinate system which is at rest relative to the light source, then the frequency of light f' received by the observer will be given by equation

$$f'=f\,\frac{1-\frac{v}{c}\cos\alpha}{\sqrt{1-\frac{v^2}{c^2}}} \quad (21.13)$$

b) If the light source which radiates light of frequency f_0, in the system which is moving with it, moves so that the line "light source - observer" forms an angle α with the speed of the light source relatively to the system that is at rest relatively to the observer, then the frequency f, received by the observer is given by equation

$$f = f_0 \frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \frac{v}{c}\cos\alpha} \qquad (21.14)$$

Both these relations express the Doppler effect in a general form." **End of quotation.**

The Eq. (21.14), which Einstein gave for the case of a radiation source in motion, cannot be correctly derived neither by the relativistic procedure nor by the classical. As such it is neither relativistic nor classical. The relativistic equation for the Doppler effect for the case of a source in motion, which is derived by the relativistic procedure as well as the Eq. (21.13), is useless, since it gives a result contrary to the well known reality. With the aim of proving this claim, let us derive the relativistic equation of the Doppler effect for the case of a radiation source in motion.

In deriving this equation we shall use the same principle and procedure as in the derivation of Eq. (21.12), that is (21.13), for the case of a moving receiver. In that derivation the radiation source was at rest in the unmoving system K, and the receiver was in the moving system K'. Thus, the receiver was moving together with the system K' relatively to the system K and also to the radiation source. Under those condition the Lorentz transformation was applied to the Eq. (21.10), so that the coordinates of the system K were transformed to the system K' (x and t were expressed by means of x' and t'), from which the observation was performed, that is the receiving of radiation.

In case of motion of the radiation source relatively to the receiver, which is at rest, the source should be connected to the moving system K', and the receiver to the unmoving system K. So the source will move together with system K' relatively to the system K and to the receiver which is at rest in that system. Since, in this case the observer is in system K, then the transformation of coordinates is performed relative to that system, and Eq. (21.10) should take the following form

$$\omega\left(t-\frac{x}{c}\cos\alpha_1-\frac{y}{c}\cos\alpha_2-\frac{z}{c}\cos\alpha_3\right)=$$

$$=\omega_0\left(t'-\frac{x'}{c}\cos\alpha_1'-\frac{y'}{c}\cos\alpha_2'-\frac{z'}{c}\cos\alpha_3'\right)=$$

$$=\omega_0\left(\frac{t-\frac{v}{c^2}x}{\sqrt{1-\frac{v^2}{c^2}}}-\frac{x-vt}{\sqrt{1-\frac{v^2}{c^2}}}\frac{\cos\alpha_1'}{c}-\frac{y}{c}\cos\alpha_2'-\frac{z}{c}\cos\alpha_3'\right)=$$

$$=\omega_0\left(\frac{1+\frac{v}{c}\cos\alpha_1'}{\sqrt{1-\frac{v^2}{c^2}}}t-\frac{\cos\alpha_1'+\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}\frac{x}{c}-\frac{y}{c}\cos\alpha_2'-\frac{z}{c}\cos\alpha_3'\right)$$

Taking that $\cos\alpha_1 \approx \cos\alpha_1' = \cos\alpha$ and $\omega = 2\pi f$ we finally get

$$f = f_0\frac{1+\frac{v}{c}\cos\alpha}{\sqrt{1-\frac{v^2}{c^2}}} \tag{21.15}$$

From this derived relativistic Eq. (21.15) and also from before mentioned Eq. (21.14) it turns out that the frequency of radiation, received by the observer, increases when the source of radiation moves away from observer, and decreases when the source of radiation approaches the observer. However, it is well known that in reality the opposite happens.

From this example it can already be seen that the relativistic way of determining the Doppler effect is unsustainable. Nevertheless, it is interesting to show other fallacies and weaknesses of the relativistic way of determining the Doppler effect.

If motion is along a straight line "light source - observer" α = 0 and $\cos\alpha$ = 1, and then

$$f' = f\frac{1-\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}} = f\sqrt{\frac{c-v}{c+v}} \tag{21.16}$$

in case of receiver motion and

$$f = f_0\frac{\sqrt{1-\frac{v^2}{c^2}}}{1-\frac{v}{c}} = f_0\sqrt{\frac{c+v}{c-v}} \tag{21.17}$$

in case of source motion.

Eqs. (21.16) and (21.17) express the longitudinal Doppler effect.

If the motion is normal to the straight line "light source - observer", then α = 90° and $\cos\alpha$ = 0, so

$$f_t' = \frac{f}{\sqrt{1-\frac{v^2}{c^2}}} \tag{21.18}$$

in case of receiver motion and

$$f_t = f_0\sqrt{1-\frac{v^2}{c^2}} \tag{21.19}$$

in case of source motion.

Eqs. (21.18) and (21.19) express, the so called, transversal Doppler effect.

So, by using the Lorentz transformation which is derived for a spherical light wave, equations for the Doppler shift for a plane light wave motion are obtained. As mentioned earlier, with the Lorentz transformation the requirement for identical satisfaction of the invariability of equations for a plane light wave propagation is not achieved. Einstein himself required the invariability as can be seen in the quoted text: "The simple derivation of the Lorentz transformation", given in chapter 10.

Why did Einstein chose the plane wave and not the spherical wave in deriving relativistic equations of The Doppler effect? Probably those equations cannot be derived by using the equation of a spherical wave. The transversal Doppler effect is a relativistic product. The assertion about its existence is unfounded, which can be seen from the following consideration.

Let us take the case in Fig. 21.1 where S is a radiation source of spherical light waves which is at rest and R is a receiver which moves along the straight line ABC. When it moves from point A to point B the receiver gets closer to the source ($BS < AS$) all the way to the point B, so the frequency which the receiver receives is higher than the source frequency. In further motion, from the point B towards the point C, the receiver moves away from the source, so the frequency which it receives is lower than the source frequency. In transition from a higher to a lower frequency than that of the source radiation has to pass through the same frequency of the source radiation. In other words, on the way from plus to minus, zero must be crossed. This transition from the higher to lower frequency appears at point B, which means that there is no the frequency shift at point B. In other words, there is no a transversal Doppler effect, given by Eq. (21.18) and also by Eq. (21.19), because the same is valid for the light source motion, as well.

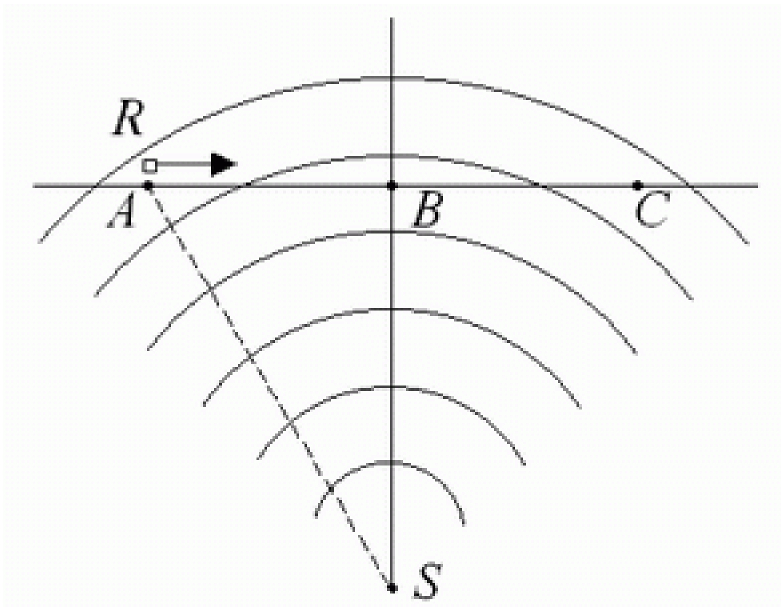

Fig. 21.1

The relativistic equations for the Doppler effect are derived for the case of propagation of plane waves, which, necessarily means that they cannot be used for the propagation of spherical waves. However, the Lorentz transformation of coordinates was applied to plane waves, which does not satisfy the requirement for invariability of the equation for propagation of a plane wave. Judging by this, relativistic equations for the Doppler effect cannot be applied to the propagation of plane waves either.

The relativistic equations for the calculation of the longitudinal Doppler effect, which is the only one that exists, can be used only when the speed of motion is small relative to the speed of light, and then, in essence, they give the same result as classical equations, whose form is simpler and easier to apply. For higher speeds, which approach the speed of light, and for which they are designed, relativistic equations are useless since the mistakes in determining the Doppler effect are unacceptably large. The proof of this is simple and can easily be derived in the following way.

Fig. 21.2 shows one possible arrangement of devices for the performance of this proof: at point A we have a radio transmitter which can emit radio pulses with a pulse repetition rate of 100 MHz; at point B, at a distance of 0.27 km is the first radio receiver; at point C, in the same direction and at a distance of 0.3 km is the second radio receiver and at point D there is a starting device, which is connected with the said radio devices with cables of the same length and electric characteristics, which enable simultaneous switching on and off of all three radio devices.

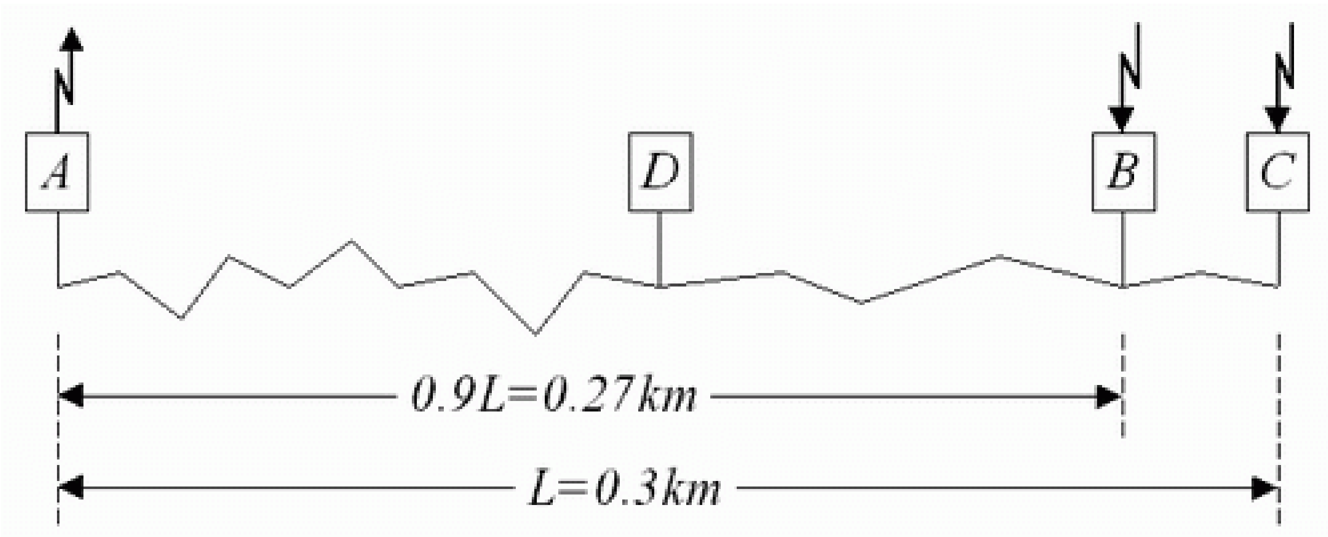

Fig. 21.2

A spatial distribution of radio pulses after t = 10^{-6} s from the time of the emission beginning is as in Fig. 21.3

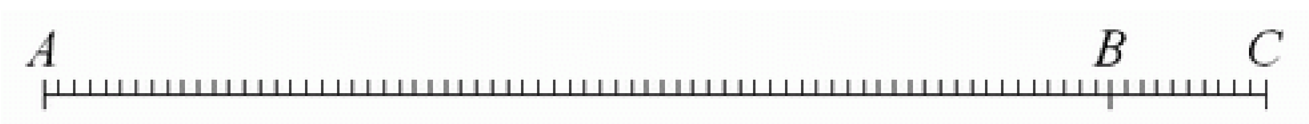

Fig. 21.3

The radio pulse, emitted from point A, will travel the distance L = 0.3 km and reach point C in time t = 10^{-6} s. If, with the help of the starting device, all three radio devices are switched on at the same time for the duration of t = 10^{-6} s, then in that time the radio transmitter, from point A, will emit 100 radio pulses, and the first radio pulse will reach the radio receiver at point C. Ten pulses will pass and be registered by the radio receiver at point B. The other 90 pulses will be on the way from point A to the point B.

Let us assume that the first radio receiver from point B was next to the radio transmitter at point A at the moment when all the radio devices were switched on, and that from that moment it was moved at the speed of $0.9c$ towards point C (like the coordinate system K', whose speed of motion was $v = 0.9c$). After the time of 10^{-6} s from the moment of switching on it will arrive at the point B. On that path from point A to point B ten radio pulses will pass by it, in the direction of point C, at the speed c. The first receiver will register these ten pulses in motion. The other 90 pulses will be in motion from the transmitter towards the first receiver at point B, which is given in Fig. 21.3. Had the first receiver stayed at point A, it would have registered all 100 pulses. Since it moved away from the radiation source at the speed $v = 0.9c$ it registered only 10 pulses, which is in accordance with the classical equation for the Doppler effect

$$f_k = f_0\left(1 - \frac{v}{c}\right) = f_0\left(1 - 0.9\right) = 0.1 \cdot f_0$$

According to the relativistic Eq. (21.13), that frequency, because of the Doppler effect, should be

$$f_r = f_0 \frac{1 - \frac{v}{c}}{\sqrt{1 - \frac{v^2}{c^2}}} = 0.2294 \cdot f_0$$

from which follows that the first radio receiver, on the path from the point A to the point B, should have registered 23 instead of 10 impulses. It means that between point A and point B, after 10^{-6} s from the start, 23 impulses instead of 10 impulses would be arranged, which it certainly did not, and cannot be.

From the given example we see that when a receiver moves away from the source of radiation at the speed of $0.9c$, the mistake in determining frequency according to the relativistic formula is as much as 130%. With the increase of speed, the mistake increases as well. Such major mistakes are certainly unacceptable, as is the relativistic way of determining the frequency of the Doppler shift.

The relativistic formulas for the energy of electromagnetic waves are also unacceptable, since their form is based on the relativistic formulas for frequency. Einstein used these equations in, for example, deriving the Eq. (23.48) for kinetic energy.

Earlier on it was stated that all coordinate transformations have the same value, if they satisfy the requirement for the invariability of the equation of the light wave propagation. Therefore let us see what will happen if we use equations of the transformation No. 2, No. 4 and No. 5 instead of the equations of the Lorentz transformation. The application of equations of transformations No. 4 and No. 5 is especially interesting, because they have been derived for the case of the plane wave, which is used in the theory of relativity to derive relativistic equations of the Doppler effect. By equations of these two transformations, as we know, the identical satisfaction of the invariability of the equation for plane wave propagation is achieved. Judging by this it should be that, at applying equations of these transformations, obtained results in the most real way would show the true value and steadiness of the relativistic way of determining that effect.

21.2.2 Determining the Doppler effect by use of equations of transformation No. 2

Substitution of expressions for t and x from Eq. (12.22) into (21.10) and comparing the coefficient of t' from the expression so obtained and the corresponding expression in Eq. (21.10) in the same way as in previous case, we obtain

$$f' = f\left(\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c}\cos\alpha\right) \qquad (21.20)$$

in case of receiver motion and

$$f = \frac{f_0}{\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c}\cos\alpha} \qquad (21.21)$$

in case of light source motion.

Eqs. (21.20) and (21.21), which are derived by use of the equations of transformation No. 2, express the Doppler effect in general form. As can be seen it greatly differs from Eqs. (21.13) and (21.14) from the previous case, that is from the adequate equations derived by using of equations of the Lorentz transformation.

For motion along the line "radiation source - receiver" it is α = 0 and $\cos\alpha$ = 1 so that

$$f' = f\left(\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c}\right) \qquad (21.22)$$

for receiver motion and

$$f = \frac{f_0}{\sqrt{1+\frac{v^2}{c^2}} - \frac{v}{c}} \qquad (21.23)$$

for source motion.

Eqs. (21.22) and (21.23) express the longitudinal Doppler effect.

When α = 90°, that is, when motion is normal to direction of "radiation source - receiver", the so-called transversal Doppler effect appears. Then $\cos\alpha$ = 0 and for receiver motion Eq. (21.20) obtains the following form

$$f_t' = f\left(\sqrt{1+\frac{v^2}{c^2}}\right) \tag{21.24}$$

and for source motion Eq. (21.21) obtains the form

$$f_t = \frac{f_0}{\sqrt{1+\frac{v^2}{c^2}}} \tag{21.25}$$

The transversal Doppler effect is expressed by Eqs. (21.24) and (21.25).

Thus, using the equations of transformation No. 2 for derivation equations of The Doppler effect according to theory of relativity, both the longitudinal and transversal Doppler effect appear. However, they differ both in the form of the equations and in their value from the previous case, that is, when the equations of the Lorentz transformation are used.

21.2.3 Determining the Doppler effect by use of equations of transformation No. 4

Substitution of equations for x and t from Eq. (12.24) into Eq. (21.10) yields

$$\omega\left(\frac{t'}{1-\frac{v}{c}} - \frac{x' + \frac{vt'}{1-\frac{v}{c}}}{c}\cos\alpha_1 - \frac{y'\cdot\cos\alpha_2}{c} - \frac{z'\cdot\cos\alpha_3}{c}\right) = \omega\left(\frac{1-\frac{v}{c}\cos\alpha_1}{1-\frac{v}{c}}t' - \frac{x'\cdot\cos\alpha_1}{c} - \frac{y'\cdot\cos\alpha_2}{c} - \frac{z'\cdot\cos\alpha_3}{c}\right) \tag{21.26}$$

Comparing the coefficient of t' from Eqs. (21.26) and (21.10) we obtain, for receiver motion

$$f' = f\,\frac{1-\dfrac{v}{c}\cos\alpha_1}{1-\dfrac{v}{c}}$$

that is

$$f' = f\,\frac{1-\dfrac{v}{c}\cos\alpha}{1-\dfrac{v}{c}} \tag{21.27}$$

and for source motion

$$f = f_0\,\frac{1-\dfrac{v}{c}}{1-\dfrac{v}{c}\cos\alpha} \tag{21.28}$$

If the receiver or source motion is along the straight line "radiation source - receiver" then α = 0 and $\cos\alpha$ = 1, so from Eq. (21.27) we obtain that $f' = f$ and from Eq. (21.28) $f = f_0$, which means that there is no longitudinal Doppler effect in both cases, for the motion of the receiver and that of the source, which runs counter to the well known reality.

However, when the motion is normal to the direction of "radiation source - receiver", that is at α = 90° and $\cos\alpha$ = 0, then in the case of receiver motion

$$f_t' = \frac{f}{1-\dfrac{v}{c}} \tag{21.29}$$

and in case of source motion

$$f_t = f_0\left(1-\frac{v}{c}\right) \tag{21.30}$$

Eqs. (21.29) and (21.30) express the transversal Doppler effect.

This means that when we apply transformation No. 4, in the relativistic procedure for determining the Doppler effect, we find that there is no longitudinal Doppler effect but only a transversal one and this, as we know runs contra to what was established long ago by experiment and is confirmed in everyday practice.

21.2.4 Determining the Doppler effect by use of the equations of the transformation No. 5

By substitution of equations for x and t from Eq. (12.25) into Eq. (21.10) and by comparing the coefficient of t' from the equation thus obtained and the corresponding expression in Eq. (21.10) we find that, in the case of receiver motion

$$f' = f\frac{1-\frac{v}{c}\cos\alpha}{1-\frac{v}{c}} \tag{21.31}$$

and in the case of source motion

$$f = f_0\frac{1-\frac{v}{c}}{1-\frac{v}{c}\cos\alpha} \tag{21.32}$$

As can be seen, Eq. (21.31) is identical to Eq. (21.27) and Eq. (21.32) to Eq. (21.28). So, the application of transformation No. 4 and transformation No. 5 in the relativistic method of determining the Doppler effect give the same result. In both cases the longitudinal Doppler effect does not exist. Only transferal effects exist and they are equal in both cases of transformation. This kind of agreement does not appear when we use the transformations for spherical waves (the Lorentz transformation and transformation No. 2). Bearing in mind that the relativistic method of determining the Doppler effect is based on the equation for propagation of the plane light wave, it might be concluded that the results obtained using equations of transformation for plane waves are more reliable. However, when equations of transformations for the plane wave are used in the procedure of determining the Doppler effect the results, as is shown, are quite opposite to reality.

As a conclusion we may say that the relativistic method of determining the Doppler effect is very interesting mathematical game, which cannot be related to the reality of physics in a logical sense.

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22. ABERRATION

In 1725 James Bradley discovered the aberration of stars, that is the stellar aberration. He found that the displacement, measured as an angle between the real and seeming direction of light rays from a star, is small and in the direction of the observer's motion. In addition he discovered that the aberration is the consequence of the finite speed of light and the transverse motion of the observer. If we disregard the aberration caused by the movement of the solar system, then we are left with the annual aberration due to the orbital motion of the earth around the sun and the diurnal aberration due to the rotation of the earth.

Annual aberration is, for practical purposes, constant at β_a = 20.496", which corresponds to the orbital speed of the earth around the sun V_0 = 29.79 km/s. The diurnal aberration depends on latitude. Its maximum is β_{dm} = 0.32" at equator and at a latitude of 45° (Belgrade) its magnitude is β_d = 0.226".

At the present there are two quite different explanations of the phenomena of aberration, the classical and the relativistic. The first is based on the corpuscular nature of light alone, and the second is based on the wave nature of light alone. This places both explanations in doubt. Besides, according to the classical explanation of aberration the light rays reach the observer from the real position of the observed star, whereas, according to the relativistic explanation the light rays reach the observer from the direction of the seeming position of the star.

Because of these differences it is essential to scrutinize both explanations and also a third possible explanation which is based on the existence of the earth's and sun's ether and their relative motion.

22.1 The classical way of determining the angle of aberration

According to the classical explanation aberration happens as a consequence of the finality of the speed of light and an observer's motion. Other possible causes, according to this explanation, do no exist. The classical way of determining the angle of aberration is based on the given explanation and it is derived in the following manner.

Let us assume that the observer moves in a straight line at a constant speed v from point A towards point E, and a ray of light from star S_R, towards point B at a speed c, as shown in Fig. 22.1. Let the distance $\overline{DB}$ be proportional to the speed of light in the same manner as the distance $\overline{AB}$ is proportional to the observer's speed v so that $t = \frac{\overline{DB}}{c} = \frac{\overline{AB}}{v}$. In this condition light will come from point D to point B in the same time as it will take the observer to move from point A to point B. If we place a telescope so that its objective lens is at point D, and the eye piece at point B, then the observation of the star would be impossible for the following reason. Until the light from point D on the objective lens reaches point B, the eye piece moves to point C, because of the motion at speed v, and from there the observation is impossible. To make the observation possible the eye piece should be placed in point A. Then, in the time needed for the light to pass from the lens from point D to point B, the eye piece from point A will reach point B, which will enable the normal observation of the star. Hence, to be able to observe a star, a telescope should be turned at a certain small angle from the real angle towards the star, and in the direction of the motion of the observer, that is the telescope. That small angle of turning is called the angle of aberration.

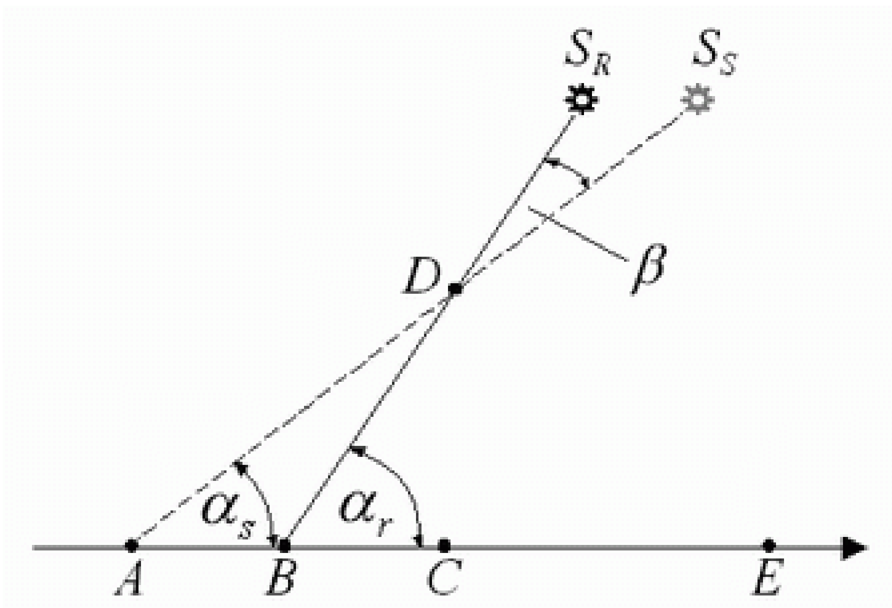

Fig. 22.1

Classical equation for determining the angle of aberration, derived according to the Fig. 22.1, is

$$\sin\beta = \frac{v}{c}\sin\alpha_s \tag{22.1}$$

where S_R is the real position of the star, S_S is the seeming position of the star, β is the angle of aberration which is derived using classical equations, v is the speed of an observer and α_r is the angle between the real direction towards the celestial body and the direction of the speed at which the observer moves. In this calculation $\alpha_s = \alpha_r - \beta$, that is it is always true that $\alpha_s < \alpha_r$ when the observer moves to the right.

Thus, the classical explanation of aberration is based on the corpuscular nature of light. It is assumed that the telescope should be turned at an appropriate angle from the real direction to the celestial body so that the light corpuscle, entering the objective lens, can fall in the center of the eye piece, which, during the passage of the light corpuscle through the telescope, moves in the direction of the telescope's motion.

However, this explanation clashes with the result of the famous Michelson - Morley's measurements.

Until now there has been no explanation why the angle of aberration does not change when a telescope is filled with water or some other matter whose index of refraction is bigger than the index of refraction of air or vacuum. As we know, according to the classical explanation the angle of aberration depends on light speed and the speed at which the telescope moves. When the telescope is filled up with water then the speed of light in it is less by around 1.33 times, and the speed of the telescope's motion remains the same, and because of that, and according to the given explanation and the Fig. 22.1, the angle of aberration should be bigger. However, it remains the same. The explanation for this is found maybe in the new explanation of Fizeau's test result given in chapter 14. Namely, the direction of photon motion inside of a such telescope stays the same when the telescope is filled up with water because water carries the photons in the direction of telescope motion in the time segment while it is absorbed in water during its passage through the telescope.

22.2 The relativistic way of determining the angle of aberration

Aberration is considered as a proof of the correctness of the special theory of relativity. However, closer analysis brings this proof into serious doubt.

The relativistic explanation of aberration is based on the wave form of light and the motion relative to those waves. Thereby it is assumed that the light coming from stars is in the form of plane wave.

The relativistic method of determining the angle of aberration is as follows.

Let there in the unmoving coordinate system K propagated plane waves of light with the phase given by expression

$$\omega\left(t-\frac{x}{c}\cos\alpha_1-\frac{y}{c}\cos\alpha_2-\frac{z}{c}\cos\alpha_3\right) \tag{22.2}$$

The phase of these same waves in moving coordinate system K', which moves uniformly relative to the system K along the x-axis at speed v, is given by expression

$$\omega'\left(t'-\frac{x'}{c}\cos\alpha_1'-\frac{y'}{c}\cos\alpha_2'-\frac{z'}{c}\cos\alpha_3'\right) \tag{22.3}$$

where α_1, α_2, α_3, α_1', α_2', α_3' are the angles of the normal to the front of plane waves with the corresponding axes of the systems K and K' respectively, or the angles of direction of light ray with the corresponding axes of the corresponding system.

The expressions (22.2) and (22.3) are invariant and the Lorenz transformation can be applied to them. By application of this transformation in relation to the system K' we get

$$\omega'\left(t'-\frac{x'}{c}\cos\alpha_1'-\frac{y'}{c}\cos\alpha_2'-\frac{z'}{c}\cos\alpha_3'\right)=$$
$$=\omega\left(t-\frac{x}{c}\cos\alpha_1-\frac{y}{c}\cos\alpha_2-\frac{z}{c}\cos\alpha_3\right)=$$
$$=\omega\left(\frac{t'+\frac{v}{c^2}x'}{\sqrt{1-\frac{v^2}{c^2}}}-\frac{x'+vt'}{c\sqrt{1-\frac{v^2}{c^2}}}\cos\alpha_1-\frac{y'}{c}\cos\alpha_2-\frac{z'}{c}\cos\alpha_3\right)=$$
$$=\omega\left(\frac{1-\frac{v}{c}\cos\alpha_1}{\sqrt{1-\frac{v^2}{c^2}}}t'-\frac{\cos\alpha_1-\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}\frac{x'}{c}-\frac{y'}{c}\cos\alpha_2-\frac{z'}{c}\cos\alpha_3\right)$$

and from there

$$\omega' t'=\omega\frac{1-\frac{v}{c}\cos\alpha_1}{\sqrt{1-\frac{v^2}{c^2}}}t' \quad \text{and} \quad \omega'\frac{x'}{c}\cos\alpha_1'=\omega\frac{x'}{c}\frac{\cos\alpha_1-\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}$$

hence

$$\cos\alpha_1'=\frac{\cos\alpha_1-\frac{v}{c}}{1-\frac{v}{c}\cos\alpha_1} \tag{22.4}$$

where α_1 is the angle formed by the light ray or the normal of the plane of the plane wave with the x-axis, α_1' is the angle formed by the same normal with the x'-axis and v is the speed of motion of the system K' relatively to the system K, that is the speed of the observer in the direction of x and x'-

axes. Since the x and x'-axes are parallel, then α_r is the angle formed by the direction to the real position of the star with the direction of motion of the observer, and α_s is the angle formed between the direction to the seeming position of the star and the direction of the observer's motion. Consequently, the equation for the aberration angle, derived by the relativistic method, is

$$\beta_r = \alpha_1 - \alpha_1' = \alpha_r - \alpha_s \tag{22.5}$$

22.3 Objections to the relativistic approach to determining the angle of aberration

The angle of aberration derived by the relativistic method is in accordance with the results of measurement and is equal to the angle obtained by classical procedure. That circumstance is taken as proof of the correctness of the theory of relativity. Nevertheless, in spite of this agreement there are certain objections which refer primarily to the low speeds of the observer's motion at which that agreement is good, to the relativistic explanation of the cause of aberration and to the way the equation of aberration angle is derived.

However, the agreement of the angle of aberration calculated by relativistic procedure with its angle calculated according to classical methods is good only at extremely low velocities of the observer relative to the speed of light, such as the orbital velocity of the earth which is about 30 km/s. The agreement begins to break down at greater velocities. For example, the angle of aberration calculated using relativistic Eqs. (22.4) and (22.5), for an observer moving at $v = 0.8c$ when the angle of the real position of the star is α_r = 90° is β_r = 53.13°. The angle calculated using the classical Eq. (22.1) under the same conditions as before is β = 38.66°. As can be seen, the difference $\beta_r - \beta$ = 14.47° is considerable.

Consequently, we cannot claim that the agreement between the two methods of calculating aberration is good when it only occurs using extremely low velocities for the observer relative to the speed of light. Similarly we cannot assert that the relativistic way of calculating the angle of aberration is correct for higher relativistic velocities.

The relativistic way of deriving the equation for aberration angle uses the Lorenz transformation of coordinates with the equation for propagation of plane light waves. Using the other transformation of coordinates, given in this book, and with the exception of transformation No. 5, different angles of aberration are obtained.

When we use the transformation of coordinates No. 5, given by the Eqs. (12.25), which is derived for the plane wave, we obtain the same equation for aberration angle as when the Lorenz transformation is applied and that being so independently of whether x' and t' are expressed via x and t or vice versa.

It is interesting to note that the application of two quoted transformations in deriving the equation for the Doppler effect give completely different equations, which was shown in the previous chapter. It is even more interesting that these completely different equations are used (via ω and ω') for deriving the equations for angle of aberration and that they give the same final result, that is the same equation of aberration angle.

With the relativistic method of determining angle of aberration the unmoving system K is connected to the plane waves which come from the observed star. So, at first sight it seems that the system K is at rest, and that the speed of the system K' relatively to it is around 30 km/s. However, in reality it is not so.

Let us imagine that the observed star, is a pulsar from which every second a directed beam of light of short duration comes to earth. Let at some moment t = 0 the axis of that beam corresponds to the y -axis of the system K and the pulsar travel in the direction of the x -axis at the speed of, for example, 200 km/s. Under these conditions the axis of the next beam pulse of the pulsar's emission will be at a point on the x -axis, at the distance of 200 km from the y -axis, that is from the origin of the system K. If at the moment t = 0 the origin of the system K' was at the origin of the system K, then after a second the origin of the system K' will be at a point on the x -axis at 30 km distance (under the condition that v = 30 km/s) from the origin of the system K.

From this it follows that the relative speed between the system K' and the axis of the beam is 170 km/s and that the system K' moves in the negative direction and oppositely to the course of aberration. Therefore, if the principles of relativity are respected, the system K should be connected to the star, and the system K' to the observer. However, if this was done then the result of such a calculation would be way off the reality.

The derivation of the relativistic equation is performed with the help of two inertial systems, which move relatively, and under the condition that the speed of light, from the same source, is the same in both systems. This condition has meaning only in the case when each of the two systems has its own ether, which carries the light. Such is the case with relativistic determining of the angle of aberration.

22.4 A new explanation of aberration

The existing classical explanation of aberration is unsatisfactory because it is based on the corpuscular nature of light alone and its explanation by wave theory is impossible.

In the case of a light source on earth all three aberrations would occur; solar, annual and diurnal. However, it is well known that, in this case there is no aberration at all [11]. Until now no satisfactory explanation for this phenomenon has been suggested.

There is no satisfactory explanation of the fact that a telescope filled with water exhibits the same aberration as one filled with air. Some scientists have tried to explain this phenomenon using Einstein's theorem on speed addition, but this cannot be correct since the theorem was derived for conditions of vacuum, not water.

The question of light propagation through the cosmos has remained unexplained since Michelson's famous experiment and the rejection of the very idea that an ether may exist.

According to the classical explanation aberration happens as a consequence of the observer's motion, that is as a consequence of the telescope's motion in relation to the direction of the light rays from the observed star, which are passing through the telescope. However, the result of the Michelson - Morley's experiments disputes that classical explanation of aberration. It has been established, by those experiments, that there were no motion of the interferometer and its parts in relation to the used rays - beams of light, as it is described in the chapter 5. Consequently, the telescope does not move too in relation to the light rays from the star, which are passing through the telescope. From this also results that the used light rays come to the telescope from the direction of the seeming position of the observed star, but not from the direction of the real position of the star, as it is stated in the classical explanation of aberration. Accordingly, the result of the Michelson - Morley's experiments and aberration are irrefutable proof of the earth's ether existence.

In the long run the correct and logical explanation of aberration and other previously mentioned, unexplained phenomena may come to be based on the existence of the earth's and sun's ether and their relative motion.

The sun has its ether which fills the space bigger than the space of the solar system. The earth also has its ether which fills a considerably smaller space. It is similar to the magnetic fields of these two cosmic bodies.

The light from the sun or some other cosmic body passes through the sun's ether before it comes into the earth's ether. The earth with its ether travels around the sun, and thus through the sun's ether. The relative motion of these two ethers is the cause of aberration of light when passing from one ether into the other.

The sun rotates around its own axis. The velocity of the angular rotation of the sun's surface is $2.865 \cdot 10^{-6}$ rad/s [21]. The velocity of the angular rotation of the inner part of the sun, which generates the sun's ether, and of the ether itself is $3.99 \cdot 10^{-7}$ rad/s.

Thus the velocity of motion of the sun's ether in the earth's orbit is two times higher than the velocity of the earth in its motion round the sun. Aberration, therefore, originates when the light rays move from one ether to the other which move relative to one another. This happens in the same way as it would were the sun's ether quiescent and the earth's ether moved at orbital velocity, but in the opposite direction to its real course. This explanation is in accordance with the course of aberration too. Aberration would have the opposite course in case of a pull of the hypothetical quiescent cosmic ether by the earth's motion.

22.5 Did Bradley make a mistake in determining the course of diurnal aberration?

Diurnal aberration is small and negligible in comparison with annual aberration. Its measurement is complex and difficult to achieve. Therefore, in Bradley's time, and for a long time after, the magnitude and the course of diurnal aberration could not be measured owing to the lack of good telescopes and the complexity of measurement. As a result diurnal aberration was calculated using Eq. (22.1) and its course was taken to be the same as annual aberration.

Bradley observed that the maximum displacements in the seeming position of stars occurred when the earth was in positions 1 and 3 as shown in Fig. 22.2

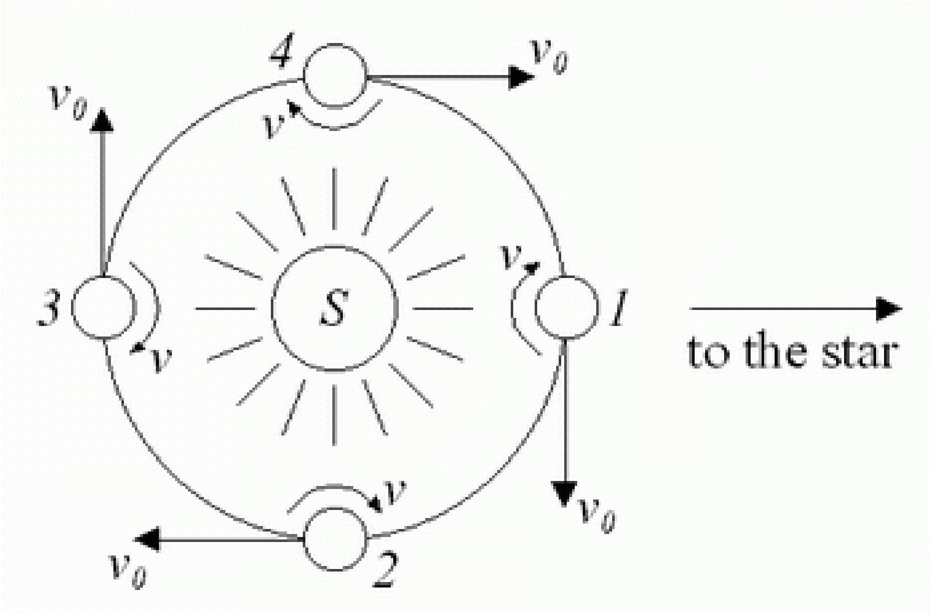

Fig. 22.2

When orbital and rotational velocity are in the same course (position 1 in Fig. 22.2) then, as is generally accepted, the total aberration β_t would be the sum of the annual aberration β_a and the diurnal aberration β_d as shown in Fig. 22.3 and the measured seeming angle would be given by equation

$$\alpha_{s1} = \alpha_r - (\beta_a + \beta_d) \tag{22.6}$$

in which α_{s1} is the angle of seeming position and α_r is the angle of the true position.

At position 3 in Fig. 22.2 the course of rotational velocity is opposite to that of the orbital velocity, so that the total aberration is the difference between the annual and diurnal aberration, as shown in Fig. 22.4. The seeming angle is then given by

$$\alpha_{s3} = \alpha_r + (\beta_a - \beta_d) \tag{22.7}$$

Use of Eqs. (22.6) and (22.7) gives

$$\beta_a = \frac{\alpha_{s3} - \alpha_{s1}}{2} \tag{22.8}$$

$$\alpha_r = \frac{\alpha_{s1} + \alpha_{s3}}{2} + \beta_d \tag{22.9}$$

In order to find the real position of the star we must know the diurnal aberration. As was said before, this was obtained using the classical Eq. (22.1) for the calculation of aberration and the direction was taken according to the course of annual aberration. After that it was possible to test the validity of the Eqs. (22.6) (22.7) (22.8) and (22.9). Someone doing this could be convinced that all was correct when in fact it could be incorrect.

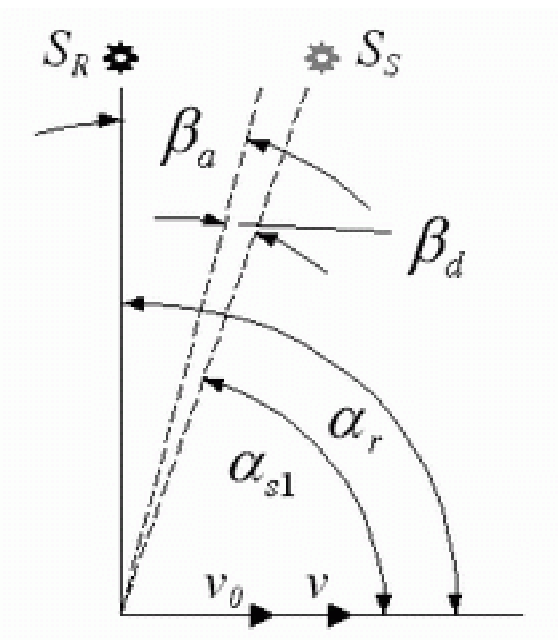

Fig. 22.3

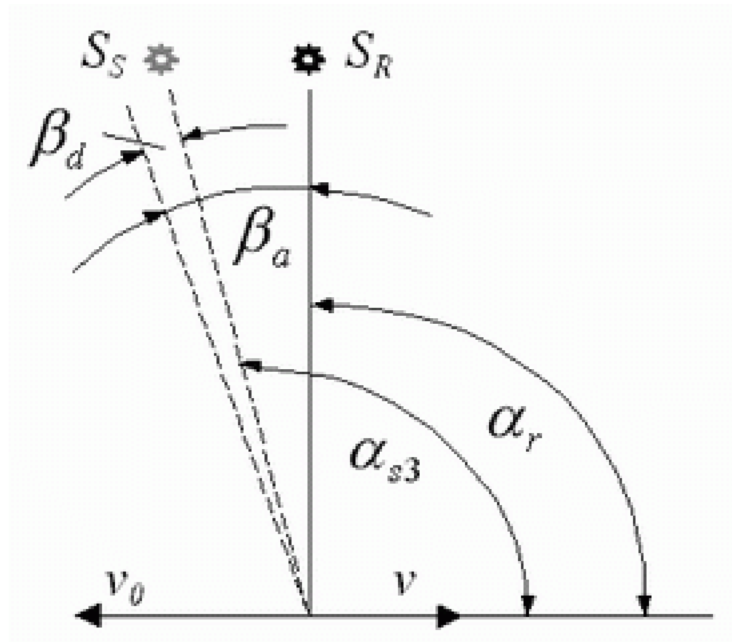

Fig. 22.4

Now let us imagine that the diurnal aberration has the same magnitude as before, but in the opposite course. This situation corresponds to the existence of the sun's and earth's ether and their relative motion. Then the situation in Figs. 22.3 and 22.4 would be as in Figs. 22.5 and 22.6 respectively.

According to Fig. 22.5 the measured seeming angle α_{s1} would be

$$\alpha_{s1} = \alpha'_r - (\beta_a - \beta_d) \tag{22.10}$$

and according to Fig. 22.6

$$\alpha_{s3} = \alpha'_r + (\beta_a + \beta_d) \tag{22.11}$$

Using Eqs. (22.10) and (22.11) we obtain

$$\beta_a = \frac{\alpha_{s3} - \alpha_{s1}}{2} \tag{22.12}$$

and

$$\alpha_r' = \frac{\alpha_{s1} + \alpha_{s3}}{2} - \beta_d \tag{22.13}$$

Consequently, the annual aberration would not be changed, but the angle of the real position would be smaller by $2\beta_d$ making the angle of the real position

$$\alpha_r' = \alpha_r - 2 \cdot \beta_d \tag{22.14}$$

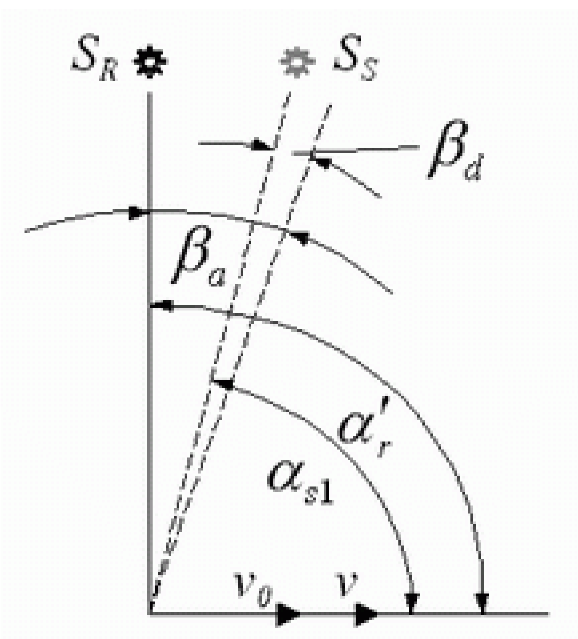

Fig. 22.5

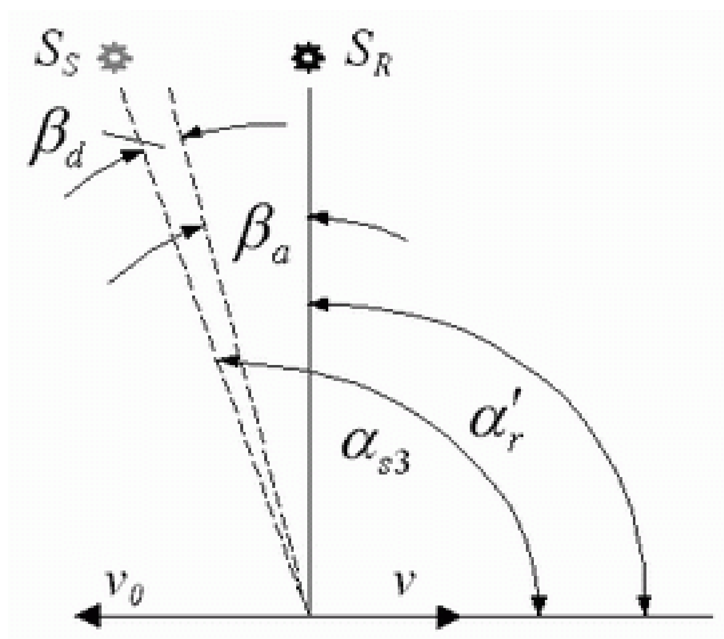

Fig. 22.6

It is not at all simple to ascertain the course of diurnal aberration. For example, we can measure the seeming angles α_{s1} and α_{s3} and using Eqs. (22.1) and (22.9) we can calculate the magnitude of the diurnal aberration β_d and the angle of the real position α_r respectively. After that we can attempt to ascertain the course of the diurnal aberration by the measurement of the seeming angles α_{s2} and α_{s4} when the earth is at position 2 and 4, as shown in Fig. 22.2. Following the accepted opinion that the course of aberration is always the same as a course of the observer's motion we shall wrongly believe that α_r is the angle of the real position of an extremely distant star and we shall see that it is really

$$\alpha_{s2} = \alpha_{s4} = \alpha_r - \beta_d \tag{22.15}$$

So we shall believe that all is correct, even though the diurnal aberration has the opposite course and α_r is not the angle of the real position.

As a matter of fact, when the star under consideration is extremely distant we should use

$$\alpha_{s2} = \alpha_{s4} = \alpha_r' + \beta_d = (\alpha_r - 2 \cdot \beta_d) + \beta_d = \alpha_r - \beta_d \tag{22.16}$$

However, this equation gives the same result as Eq. (22.15). Therefore we can not determine the course of the diurnal aberration by using the measured angles of aberration α_{s1}, α_{s3}, α_{s2} and α_{s4}.

The measurement of small angles in astronomy, such as diurnal aberration, close to the horizontal plane is difficult and insecure because of atmospheric and other influences. Therefore, the measurement of the diurnal aberration and determination of its course have probably never been made.

22.6 Ascertaining the course of the diurnal aberration by means of astronomical observation

The correctness of the two above stated hypotheses is possible to test by means of a simple astronomical observation of a star's seeming motion when its seeming position, at the beginning of the observation, is in the direction of the earth's axis of rotation. By choosing such a starting point the observation is considerably simplified. The direction of the incoming light rays in this case is at a right angle in relation to the direction of the observer's velocity of motion. As a result the influence of the thickness of the earth's ether, which is unknown, is excluded.

For the sake of easier explanation of this method we shall assume that the astronomical telescope does not invert the image. We shall also ignore the annual aberration and the change of its course during the observation since these will not influence the result of the analysis. In this way we analyse change in the seeming position of the star that is the result of diurnal aberration alone.

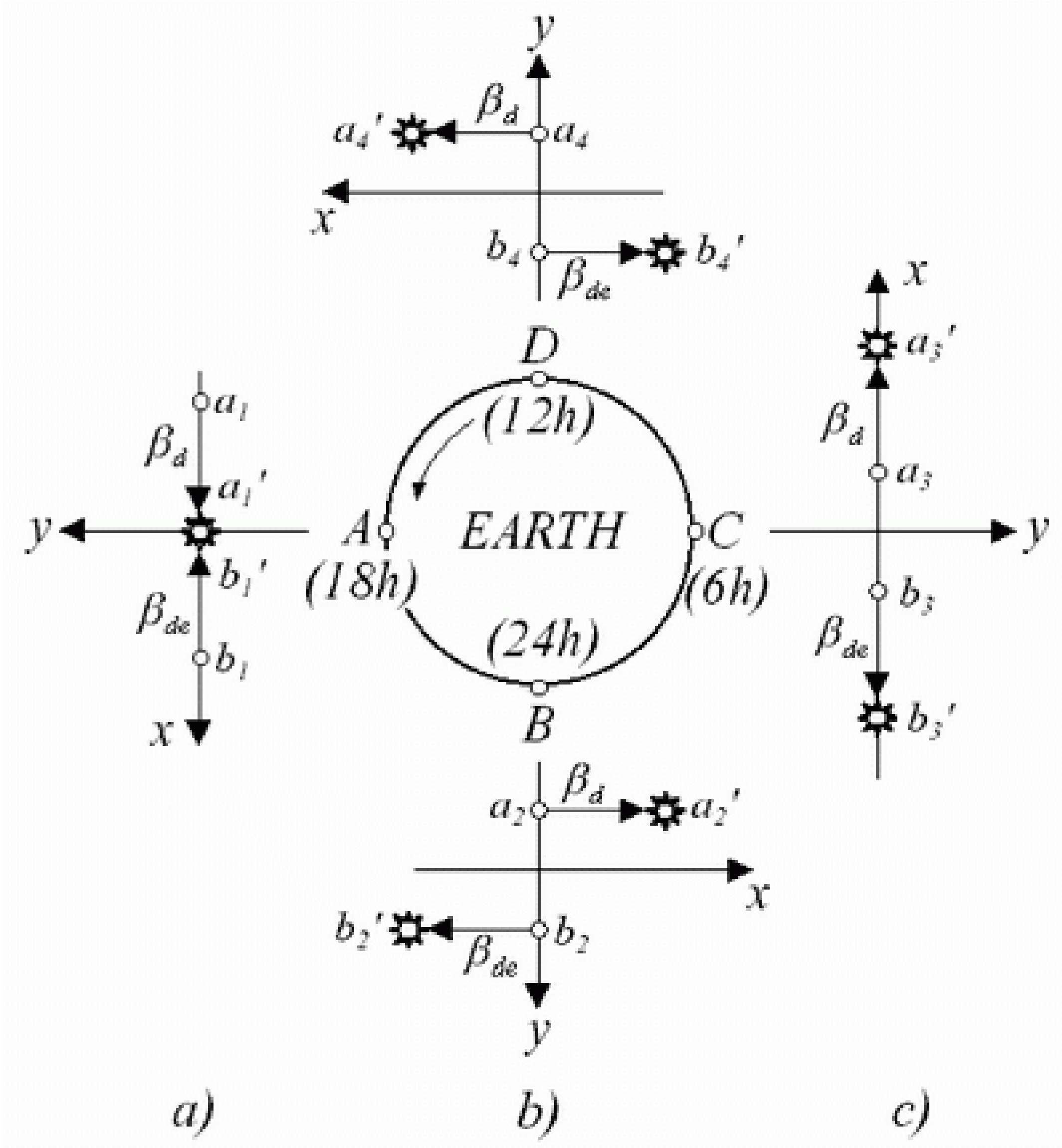

Fig. 22.7

The procedure of the observation and analysis is as follows: At 18:00h, or some other time in the evening the observer aims the telescope at a star the seeming position of which, at that moment, is in the direction of the earth's axis of rotation. The telescope is positioned so that the image of the star is in the centre of the cross-sights. If we connect the coordinate system to the cross-sights so that the horizontal bar corresponds to the x-axis and the vertical to the y-axis, then the image of the observed star is also at the centre of the coordinate system.

If earth's ether does not exist the image of the star will shift from point a_1 to the centre of the cross-sight, that is the centre of the coordinate system, as shown in Fig. 22.7a. But if the earth's ether exists the image of the star will shift from point b_1 to the centre of the cross-sights due to the diurnal aberration which is, in this case, in the opposite course relative to the course of the observer's motion. So the image of the star may be at point a_1 or at point b_1, depending on whether the earth's ether exists or not. We do not know at what point the star is because we do not know if the earth's ether exists. This needs to be established through further analysis.

During the next 05h59'01" (to 23h59'01") the telescope shifts from position A to position B, because of the earth's rotation. At the same time the coordinate system (the cross-sights) changes orientation by 90° relative to its orientation in position A. The new position is shown in Fig. 22.7b. The image of the star at point a_1, in Fig. 22.7a moves to point a_2 and, due to diurnal aberration, moves further to position a_2'. If the earth's ether exists then the image of the star at point b_1 would shift to point b_2, and from there, due to diurnal aberration in the opposite course, to point b_2'. The distance between these two possible positions of the star's image along the x-axis and the y-axis are $2\beta_d$.

During the next 05h59'01" (to 05h58'02") the telescope moves from position B to position C. The situation then will be as shown in Fig. 22.7c. The image of the star at point a_2, as shown in Fig. 22.7b, will move to point a_3', shown in Fig. 22.7c and the image at point b_2 will move to point b_3'. The coordinate system will have rotated by 90° relative to its orientation in position B. In this position of the telescope the distance between two possible positions of the star's image in the coordinate system (the cross-sights of the telescope) is $4\beta_d$. Such small angles are detectable by modern astronomical telescopes.

In Fig. 22.8 the curves of the movement of the star's image are shown, in the cross-sights of a telescope at latitude 45° trained constantly in the direction of the earth's axis of rotation. The observation starts at 18:00h. The curve indicated by a full line indicates the pattern of movement when there is no earth's ether and the dotted line is the pattern to be expected if the earth's and sun's ether exist and move relative to one another. In drawing these curves it has been taken into account that astronomical telescopes invert the image and that the course of the annual aberration changes during the observation.

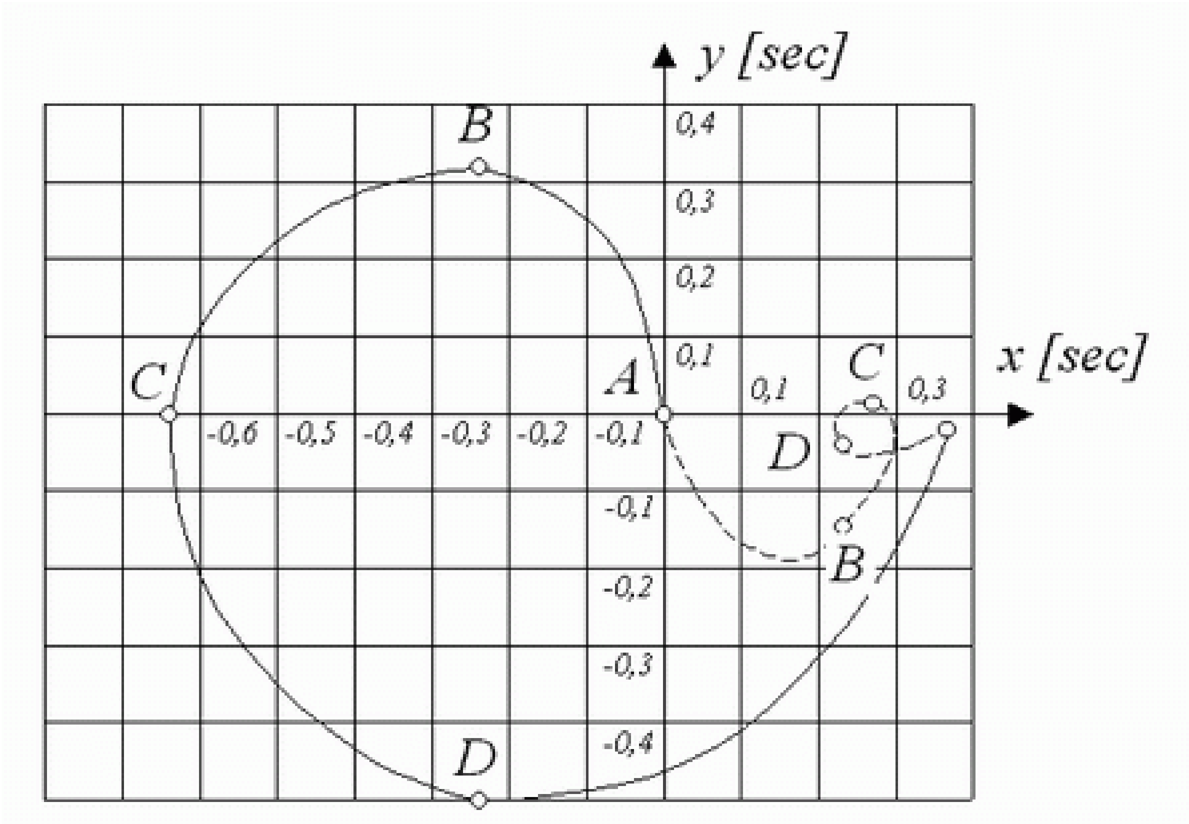

Fig. 22.8

22.7 Possible errors in determining the earth's axis of rotation if the earth's and sun's ether exist

The appearance of the image of the observed star at points b_2' and b_3' in the cross-sights, presented in Figs. 22.7b and 22.7c, according to the method of observation described, would be the proof that earth's and sun's ethers existed. At the same time it would be the proof that aberration is the result of the relative motion of those two ethers. Nevertheless, if this does not take place, and the image of the observed star appears at points a_2' and a_3', this still does not mean that the course of diurnal aberration is the same as the course of the observer's motion, that is, it does not prove that earth's and sun's ethers do not exist.

The direction of the earth's axis of rotation could be determined by the astronomical observation of the position of a star distant, at a greater or lesser angle, from the direction of the earth's axis of rotation. Then it is taken that the course of the diurnal aberration is the same as the course of the rotational motion of the telescope. If earth's and sun's ethers exist, however, then the direction of the earth's axis of rotation will have been incorrectly determined by such a procedure. The real direction of the earth's axis of rotation in relation to a direction determined in such a way differs by an angle equal to double the value of diurnal aberration for the observatory from which the observation was performed.

To make this problem easier to understand, let us examine the possibility of making a mistake in determining the direction of the earth's axis of rotation.

When we aim a telescope at a star, then the image of that star appears at the centre of the cross-sights, which corresponds to point A in Fig. 22.9. That position of the image of the star corresponds to the seeming position of the star. If only diurnal aberration existed then point B in Fig. 22.9 would correspond to the real position of the star.

If there were no aberration then we would see the stars in their real positions. If, under those conditions, we aimed a telescope at a star so that its image fell in the centre of the cross-sights and left it for 24 hours, then the image of the star would describe the circle 1 shown in Fig. 22.9.

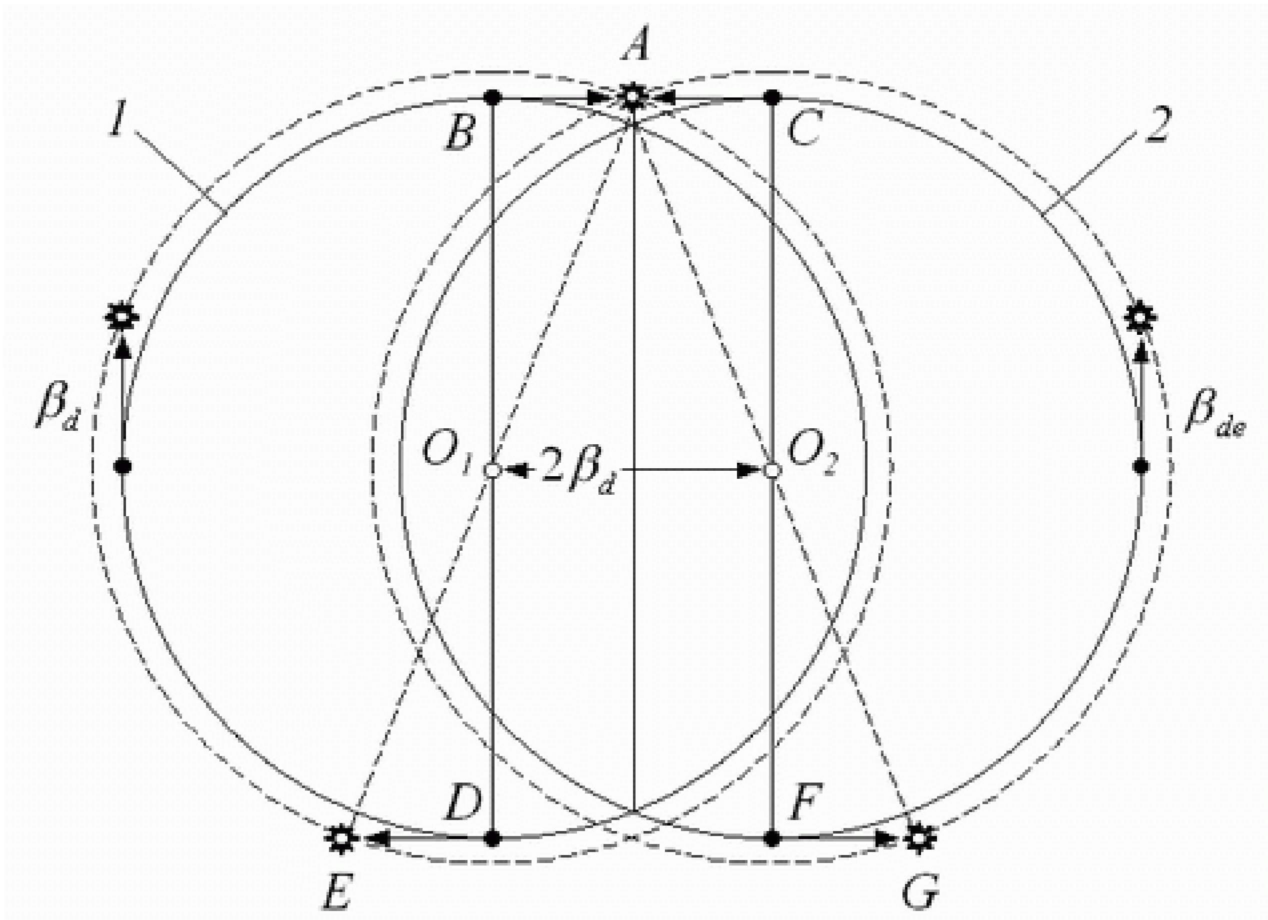

Fig. 22.9

If only diurnal aberration existed, then the image of the observed star, under the same conditions, would describe a circle the centre of which would be the same as the centre of circle 1. The direction of the earth's axis of rotation would pass through the centre O_1 of circle 1. That centre is on the section of the line BD and line AE. The line BD is normal to the direction of the rotational motion of the observatory at the beginning of the observation and after the rotation of the earth at an angle of 180°.

However, if earth's and sun's ethers exist then the image of the observed star is in the real position at point C of the cross-sight, as shown in Fig. 22.9. If we now apply the same procedure, as in the previous case, then we find that the earth's axis of rotation passes through point O_2, which is the centre of circle 2, that is, through the section of line CF and AG. The angular distance separation O_1 and O_2 is equal to $2\beta_d$. As a result it is clear that every observatory could make an error in determining the direction of the earth's axis of rotation, equal to double the diurnal aberration at that observatory.

From the above it results that, if the sun's and earth's ethers exist, every observatory would make a different error in determining the direction of the earth's axis of rotation, that error being equal to $2\beta_d$ at every observatory. This situation presents us with the possibility of establishing whether these ethers really exist.

So, for example, the diurnal aberration at the site of the St Petersburg observatory (latitude 59.90°) is β_{dsp} = 0.1598". The possible error in determining the direction of the earth's axis of rotation at this observatory may be $2\beta_{dsp}$ = 0.3195". The diurnal aberration at the site of the Paris observatory (latitude 48.86°) is β_{dp} = 0.2096" so the possible error in the determination of the direction of the earth's axis of rotation may be $2\beta_{dp}$ = 0.4192". From this it results that the difference in the determined directions of the earth's axis of rotation between these two observatories might be 0.0997" which means that we can establish the existence of the sun's and earth's ethers by comparing the direction of the earth's axis of rotation as determined at these two observatories. Naturally this is only valid when the two observatories determine the direction of the earth's axis of rotation independently and with sufficient accuracy.

If the direction of the earth's axis of rotation has been correctly determined in a different way then the procedure detailed above can be used to show that the sun's and earth's ethers exist.

22.8 One possibility for a demonstration of the existance of the sun's ether

The construction and the description of the new interferometer for the demonstration of the existance of the earth's ether are given in the chapter 6 of this book. Two methods for that demonstration, by use of the above mentioned interferometer, are given in the chapter 8.

The existance of the sun's ether can also be proved, but on the base of a shift of the spectral lines in the spectrum of radiation of some star. For this purpose one should take the spectrum of radiation of some convenient star, from the three points on the earth's orbit (see Fig. 22.10), as follows:

a) from the point A when the earth approaches to the chosen star,

b) from the point B in which the rays from that star form the right angle with the direction of the earth's orbital motion and

c) from the point C when the earth removes from the chosen star

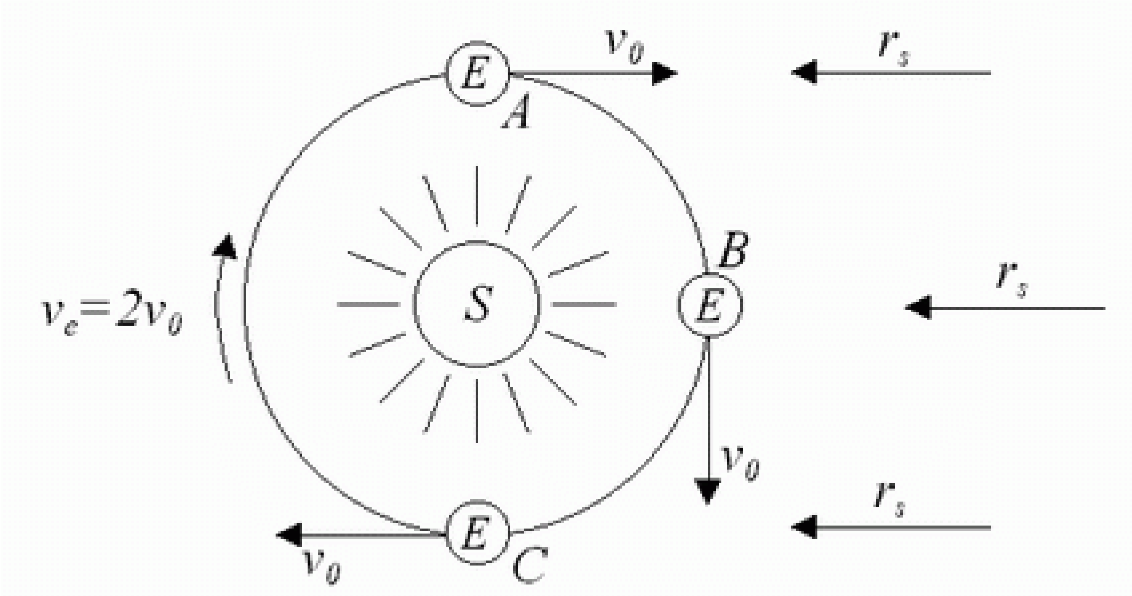

Fig. 22.10

The marks in Fig. 22.10 are: S is the sun, E is the earth, v_0 is the earth's orbital velocity, r_s are the light rays from the chosen star and v_e is the velocity of the sun's ether in the region of the earth's orbit. The wavelenghts of radiation from the chosen star, in the point B, do not depend on the existance of the above mentioned ethers, because the motions of those ethers are normal to the direction of the light rays propagation. Therefore, the wavelenght of some chosen line in the spectrum of the received light, in the point A, in case of the nonentity of the ethers, should be

$$\lambda_A = \frac{\lambda_B}{1+\dfrac{v_0}{c}} \approx \lambda_B\left(1-\frac{v_0}{c}\right) \tag{22.17}$$

where c is the speed of light, and λ_B is the wavelenght in the point B. However, if the sun's ether exists as a carrier of an electromagnetic radiation, and if its hypothetical velocity of motion, in the region of the earth's orbit, is two times higher than the earth's orbital velocity, then the wavelenght of the chosen line in the spectrum of the received radiation from the chosen star, in the point A, is

$$\lambda'_A = \frac{\lambda_B}{1-\dfrac{v_0}{c}} \approx \lambda_B\left(1+\frac{v_0}{c}\right) \tag{22.18}$$

The difference of the wavelenghts λ'_A and λ_A is

$$\Delta\lambda_A = \lambda'_A - \lambda_A \approx \lambda_B \, 2\frac{v_0}{c} = 2 \cdot 10^{-4} \, \lambda_B \tag{22.19}$$

The wavelenght of the chosen line in the spectrum of the received light in the point C, in case of the existance of the sun's ether, should be

$$\lambda'_C \approx \lambda_B \left(1 - \frac{v_0}{c}\right) \tag{22.20}$$

so that

$$\Delta\lambda'_{AC} = \lambda'_A - \lambda'_C \approx \lambda_B \, 2\frac{v_0}{c} = 2 \cdot 10^{-4} \, \lambda_B \tag{22.21}$$

However, in the case of the nonentity of the ether should be

$$\lambda_C \approx \lambda_B \left(1 + \frac{v_0}{c}\right) \tag{22.22}$$

and

$$\Delta\lambda_{AC} = \lambda_A - \lambda_C = -2 \cdot 10^{-4} \, \lambda_B \tag{22.23}$$

that is

$$\Delta\lambda'_{AC} - \Delta\lambda_{AC} = 4 \cdot 10^{-4} \, \lambda_B \tag{22.24}$$

Above presented method does not give supposed result. Therefore, it was impossible to discover the existance of the sun's ether and its motion up to now.

The wavelenghts of electromagnetic radiations from the star, measured on the earth, practically do not depend on that whether or not the earth's and sun's ether exist. Reason for that is the change of the wavelenghts of electromagnetic radiations on their entrance into the sun's and earth's ether. However, there are no changes of the wavelenghts only when the direction of radiation is normal to the direction of the ether motion, as it is shown in figure 22.10 for the case of radiation motion to the point B.

In the direction of the point A, in the same figure, the sun's ether, as a carrier and a receiver of electromagnetic radiation, moves to the observed star by velocity $2v_0$ = 60 km/s. Therefore, the wavelenght of the observed line in the spectrum of the coming radiation, measured in the sun's ether, should be

$$\lambda_{SEA} = \lambda_B \frac{1}{1+2\frac{v_0}{c}} = \lambda_B\left(1-2\frac{v_0}{c}+4\frac{v_0^2}{c^2}-\ldots\right) \approx \lambda_B\left(1-2\frac{v_0}{c}\right) \tag{22.25}$$

In the direction to the point C sun's ether, as a carrier and a receiver of electromagnetic radiation, removes from the observed star by velocity $2v_0$. In that case the wavelenght of the observed line in the spectrum of the coming radiation, measured in the sun's ether, should be

$$\lambda_{SEC} = \lambda_B \frac{1}{1-2\frac{v_0}{c}} = \lambda_B\left(1+2\frac{v_0}{c}+4\frac{v_0^2}{c^2}+\ldots\right) \approx \lambda_B\left(1+2\frac{v_0}{c}\right) \tag{22.26}$$

However, the sun's ether, as a carrier and a source of radiation, removes from the earth and from the point A towards the observed star by velocity v_0. Therefore, the wavelenght of the observed line in the spectrum, measured in the earth's ether and at the point A on the earth, should be

$$\lambda_{ZEA} = \lambda_{SEA}\left(1+\frac{v_0}{c}\right) \approx \lambda_B\left(1-\frac{v_0}{c}\right) \tag{22.27}$$

If the sun's and earth's ether do not exist then, because of the earth's motion toward the observed star by velocity v_0, the wavelenght of the observed line, measured at the point A on the earth, should be

$$\lambda_{ZA} = \lambda_B \frac{1}{1+\frac{v_0}{c}} \approx \lambda_B\left(1-\frac{v_0}{c}\right) \tag{22.27a}$$

The sun's ether, as a source of radiation, approaches to the point C on the earth by velocity v_0, so that the wavelenght of the observed line in the spectrum, measured in the earth's ether and at the point

C on the earth, should be

$$\lambda_{ZBC} = \lambda_{SBC}\left(1-\frac{v_0}{c}\right) \approx \lambda_B\left(1+\frac{v_0}{c}\right) \tag{22.28}$$

If ethers do not exist then the wavelenght of the observed line in the spectrum, measured at the point C on the earth which removes from the observed star by velocity v_0, should be

$$\lambda_{ZC} = \lambda_B \frac{1}{1-\dfrac{v_0}{c}} \approx \lambda_B\left(1+\frac{v_0}{c}\right) \tag{22.28a}$$

So, as it can be seen from Eqs. (22.27) and (22.27a), and also from Eqs. (22.28) and (22.28a) the results pratically are the same, and do not depend on that whether or not ethers exist. However, some small differences exist, but they are so small ($\lambda_{ZBA} - \lambda_{ZA} \approx \lambda_{ZBC} - \lambda_{ZC} \approx \lambda_B \frac{v_0^2}{c^2}$) so that they can not be detected by current equipment.

However, the existance of the sun's ether and its motion can be detected by means of new interferometer placed in the cosmic flying vehicle. Interferometer, for that purpose, have to be small dimensions and weight. The sheme of that interferometer is given in picture 22.11

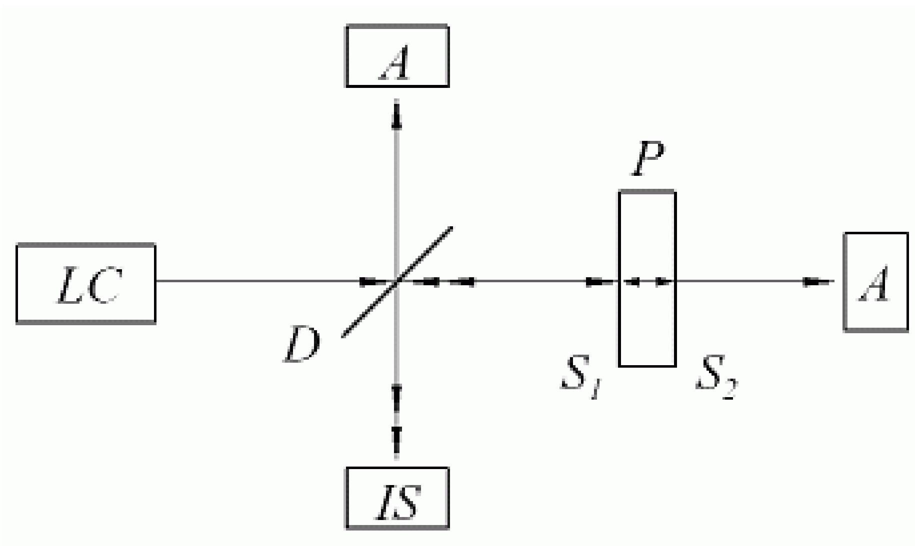

Fig. 22.11

where LC is a laser with the collimator, D is the beamsplitter, P is the plate - glass for the splitting and the shift of the laser beams which interfere, IS is an indicator of the interference and the shifts of the interfered stripes and A are absorbers of radiations.

The surfaces of the front side S_1 and back side S_2 of the plate - glass have to be polished and planparallel. The reflection of the front and back side of the plate - glass should be so chosen in order to get convenient relation between the intesity of useful beam and the intesity of parasitic beams, which originate by many reflections between the front and back side of the plate - glass. For example, if we want the relation to be 17 then the reflection of the front side should be about 20% and back side about 30%.

The velocity of motion of the sun's ether near to the earth and outside of the earth's ether is approximatelly 60 km/s. If the thickness of the plate - glass would be 2 mm and the refraction index of glass 1.5 then the shift between interferented beams would be

$$\Delta S = 4\,Ln\frac{v_0}{c} = 4\cdot 2\cdot 10^{-3}\cdot 1.5\frac{6\cdot 10}{3\cdot 10^5} = 2.4\cdot 10^{-6}\ \mathrm{m}$$

at the turn of the interferometer for 180 degrees from the direction of the sun's ether motion. At the turn over 10 degrees the shift would be

$$\Delta S = 0.13333\cdot 10^{-6}\ \mathrm{m}$$

The velocity and the direction of the cosmic flying vechile relative to the sun have to be taken into cosideration at such experiment.

In above given calculation of the interference shift it is taken that the rocket with the interferometer moves in the direction to the sun or opposite. In this way the velocity of the rocket does not influence on the result of the measurement.

If the sun's ether exists then the ethers of the other stars exist too. Therefore, the light rays from the far away stars would pass throught the numerous ethers in the way to the earth. The aberration originates at every transition of the light rays from the one ether into the other ether. Because of that the determination of the real position of the far away stars would be impossible.

Proof that the sun's and earth's ethers, and the ether in general exist has far greater significance for astronomy and for science in general than just an explanation of the phenomenon of aberration. As a result, every opportunity should be taken to demonstrate that the ether exists, even when the chances of success are small. Some of those possibilities are given by the methods described above.

home

23. MASS AND ENERGY

The best known and the most used part of the theory of relativity, which in essence does not belong to this theory, refers to the field of physics which deals with the questions of mass and energy of bodies, as well as the questions of mutual relation of mass and energy. Many physicists strongly believe that the correctness of the theory of relativity is proved in the best and most convincing way just in this sphere.

The theory of relativity and its author became as popular as they are thanks to the realization of some possibilities predicted by this "theory". These unusual predictions referred to the possibility of obtaining huge amounts of energy through transforming mass into energy, which was later realized in nuclear explosions and nuclear reactors. With the explosion of the first nuclear bomb the popularity of Albert Einstein and his theory increased enormously. Many, those poorly informed, unjustifiably believe Einstein to be a creator of atom bomb.

In classical physics mass and energy are two completely different notions, which cannot be related. According to the theory of relativity mass and energy are one and the same, but in different forms of existence. Mass can be changed into energy, and likewise energy into mass. If a body gains energy, then its mass is increased, and if it looses energy its mass decreases. Hence, mass is greater when a body is moving than when the body is at rest, it is greater when a body is heated than when it is cold, etc.

23.1 The classical way of determining the masses of an electron in motion

The study of electrons in motion established, first in theory, and later by experiment, that its mass changes depending on its speed. Long before the theory of relativity, in his theory on electromagnetism, published in 1892, Lorentz laid the greatest significance on the question of the interdependence of an electron's mass and its speed. While moving, the electron as an electrically charged particle creates an electromagnetic field which surrounds its. The faster the electron moves, the greater the resistance of that electromagnetic field to further increase of electron's speed. The effect is the same as if with the increase of speed the electron's mass increases. That is why that mass was named "electromagnetic mass".

In 1901 Kaufmann [W. Kaufmann, Gesell. Wiss. Gött. Nachr. 143, 291, 1901.; W. Kaufmann, Physik Zeitschr. 4, 55, 1902.] experimentally confirmed that an electron's mass increases with the increase of its speed. Using an electrical field to accelerate the motion of an electron and an electric field as also a magnetic field to divert the electron from its direction of motion, Kaufmann found that the mass of the electron increases in relation to its speed and that the electron has two masses, the so called transversal mass and the longitudinal mass. These findings caused a great surprise among physicists since, to that point, only one mass was known. The longitudinal mass of the electron resists increases in velocity in the direction of its motion as mass does in classical physics. The transversal mass of the electron, however, resists the deviation of the electron from its direction of motion.

In classical physics there is only one mass. For example, in rotary motion a body will tend to move at a tangent to the circle, because that is, at every moment, its direction of movement. However, centripetal force compels it to move in a circle. Centrifugal force and also centripetal force are the result of the resistance of the transversal mass to move in a circle. At first sight it seems that every body has two masses, longitudinal and transversal. In the case of an ordinary body, however, these two masses are of the same magnitude, so that the body will react equally to increases in the velocity of motion and the velocity of deviation. As a result only one concept of mass existed until Kaufmann made his measurements. Afterwards the concepts of longitudinal and transversal mass appeared.

Abraham [M. Abraham, Ann. d. Physik, 10, 105, 1903.] was the first to derive equations for longitudinal and transversal mass. According to him the longitudinal mass of an electron was given by the equation

$$m_{long} = \frac{3}{4}\frac{c^2}{v^2}\left(\frac{2c^2}{c^2 - v^2} - \frac{c}{v}\ln\frac{c+v}{c-v}\right)\cdot m_0 \tag{23.1}$$

and the transversal mass by equation

$$m_{trans} = \frac{3}{4}\frac{c^2}{v^2}\left(\frac{c^2 + v^2}{2cv}\ln\frac{c+v}{c-v} - 1\right)\cdot m_0 \tag{23.2}$$

where m_0 is the mass of the electron at rest and v the speed at which an electron moves. For very small speeds v, in relation to light speed, according to the Eqs. (23.1) and (23.2), the masses m_{long} and m_{trans} become equal to m_0, and with the increase of speed v up to the light speed that masses become infinitely large.

Abraham's theory, that is the values for the electron's mass calculated according to the Eqs. (23.1) and (23.2) matched well with Kaufmann's experimental results.

23.2 The relativistic way of determining the masses of an electron in motion

Relativistic equations for the mass of a moving electron have been derived, up to now, in different ways, and have been published in many journals and books. All of those derivations, however, have some shortcomings and, as a result, cannot be accepted without great reserve.

23.2.1 Lorentz equations for the masses of an electron in motion

As well as the transformation of coordinates and the hypotheses on the contraction of a body and the dilation of time, Lorentz also proposed a hypothesis on the deformation of the spherical shape of an electron in motion. According to this hypothesis the dimensions of the sphere will shorten in the direction of its motion. On this basis he derived equations for longitudinal and transversal mass which were published [H. A. Lorentz, Electromagnetic phenomena in a system moving with any velocity smaller than that of light, Proc. Royal Acad. Amsterdam, 6, 809, 1904.; H. A. Lorentz, Ergebnisse und probleme der elektronentheorie, Vortrag gehalten am 20 Dezember 1904. im Elektrotechnicshen Vein zu Berlin] in 1904. His equation for longitudinal mass is

$$m_{long} = \frac{m_0}{\left(\sqrt{1-\frac{v^2}{c^2}}\right)^3} \tag{23.3}$$

and for transversal mass

$$m_{trans} = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{23.4}$$

Lorentz Eq. (23.4), wrongly attributed by many to Einstein, is accepted as the general relativistic equation for the calculation of the mass of a moving body, without any indication that it was derived for the transversal mass of a moving electron.

Both of Lorentz equations have been confirmed by numerous experiments, but their derivation is still controversial. Their derivation is based on the existence of the ether, but the ether has been rejected. As a result, many papers have been published on the derivation of the relativistic Eq. (23.4) for the transversal mass of an electron in motion. Some scientists have used Einstein's theorem on addition in the derivation of this equation. But such a derivation cannot be accepted since the theorem on addition is not correct, as was proved in chapter 19 of this book.

23.2.2 Sommerfield's derivation of the equations for the masses of an electron in motion

Sommerfield's derivation of the relativistic equations for the masses of the electron in motion is interesting and will be quoted in it's entirety.

Quotation: "Here we shall only investigate the changes that we have to make in the concept of the fundamental quantity $\vec{p} = m\vec{v}$, the momentum, as a result of our new relativity principle.

We have called $\mathbf{P}$ a vector. This means that the three components of $\mathbf{P}$ transform just like the coordinates themselves [i.e., the components of the radius vector $\mathbf{r} = (x, y, t)$] in a change of the system of coordinates. We therefore say that $\mathbf{P}$ is covariant to $\mathbf{r}$.

This is valid only from the viewpoint of the Galilean transformation, where the time is regarded as absolute. From the viewpoint of the Lorentz transformation the radius vector is a four-component quantity, a **four-vector**

(15) $$\mathbf{x} = (x_1, x_2, x_3, x_4)$$ (23.5)

Our relativistic momentum will similarly have to be a four-vector, i.e., must be covariant to $\mathbf{x}$, if it is to have a meaning in relativity theory. We arrive at this four-vector in the following manner:

a) (15) being a four-vector, the coordinate distance between two neighboring points

(16) $$\mathbf{dx} = (dx_1, dx_2, dx_3, dx_4) = (dx_1, dx_2, dx_3, ic\,dt)$$ (23.6)

is also a four-vector.

b) The magnitude of this distance is certainly invariant under a Lorentz transformation. Apart from a factor ic it is given by

(17) $$d\tau = \left[dt^2 - \frac{1}{c^2}\left(dx_1^2 + dx_2^2 + dx_3^2\right)\right]^{1/2}$$ (23.7)

We follow Minkowski in calling $d\tau$ the element of **proper time**; in contrast to dt it is relativistically invariant. We shall factor out dt in (17) and introduce the ordinary velocity v of three dimensions, to obtain

(17a) $$d\tau = dt\left(1 - \frac{v^2}{c^2}\right)^{1/2} = dt\left(1 - \beta^2\right)^{1/2}$$ (23.8)

c) Division of the four-vector (16) by the invariant (17a) yields another four-vector; we call it the four-vector velocity

(18) $$\frac{1}{\left(1 - \beta^2\right)^{1/2}}\left(\frac{dx_1}{dt}, \frac{dx_2}{dt}, \frac{dx_3}{dt}, ic\right)$$ (23.9)

d) Earlier we derived the momentum vector $\mathbf{p}$ by multiplying the velocity three-vector by a mass m independent of the reference frame. We shall similarly deduce the momentum four-vector $\mathbf{P}$ from the four-vector (18) by multiplication by a mass factor independent of the frame of reference. We shall call this mass factor the **rest mass** m_0 and obtain

(19) $$p = \frac{m_0}{\left(1-\beta^2\right)^{1/2}}\left(\frac{dx_1}{dt}, \frac{dx_2}{dt}, \frac{dx_3}{dt}, ic\right) \qquad (23.10)$$

It is proper to call the quantity in front of the parenthesis the moving mass (since it reduces to the rest mass for $\beta = 0$), or simply the mass. We therefore assert that

(20) $$m = \frac{m_0}{\left(1-\beta^2\right)^{1/2}} \qquad (23.11)$$

This expression was first derived by Lorentz in 1904 under very special assumptions (deformable electron). The derivation from the principle of relativity makes such special assumptions unnecessary. Eq. (20) has been confirmed by many precision experiments with fast electrons. Together with optical experiments, notably that of Michelson and Morley, it forms the basis of the theory of relativity." [A. Sommerfeld, MECHANICS, Lecture on Theoretical Physics, vol. I, p. 14 - 15 and 30 - 31] **End of quotation.**

From the above we should note the following. The derivation gives only one Eq. (20) (following the numbering of equations on the left side in the quoted text) for the mass, which must mean that the electron in motion has only one mass, like an ordinary body in classical physics, and not a longitudinal and transversal mass as Kaufmann's experiments indicated. The equation is derived in principle and not in detail, so that it cannot be checked its correctness.

The following quotation from the same book will clarify somewhat more on the subject of the mass of an electron in motion.

Quotation: "Here the variation of mass as a purely internal affair of the electron; there is no question of any momentum gained from or lost to the surroundings. The equation of motion is therefore $\dot{p} = F$, i.e., in view of (20)

(6) $$\frac{d}{dt}\left(\frac{m_0 \cdot \mathbf{v}}{\left(1-\beta^2\right)^{1/2}}\right) = \mathbf{F} \qquad (23.12)$$

Let us first consider the rectilinear motion of an electron $\mathbf{F}$ acts longitudinally, that is, in the direction of $\mathbf{v}$, so that $\mathbf{F} = F_{long}$ and $\mathbf{v} = v$.

We shall change Eq. (6) to the form "mass · acceleration = force", a customary procedure in the early part of the century, though unnecessarily complicated. To this end we carry out the differentiation on the left

(6a) $$\frac{m_0\,\dot{v}}{\left(1-\beta^2\right)^{1/2}}+m_0\,v\frac{d}{dt}\left(1-\beta^2\right)^{-1/2}=\frac{m_0}{\left(1-\beta^2\right)^{1/2}}\left(\dot{v}+\frac{v\,\beta\,\dot{\beta}}{1-\beta^2}\right)$$ (23.13)

Now $\beta=\frac{v}{c}$ so that $\dot{\beta}=\frac{\dot{v}}{c}$ and hence $v\beta\dot{\beta}=\beta^2\dot{v}$. Consequently Eq. (6a) becomes

(6b) $$\frac{m_0\,\dot{v}}{\left(1-\beta^2\right)^{1/2}}\left(1-\frac{\beta^2}{1-\beta^2}\right)=\frac{m_0}{\left(1-\beta^2\right)^{3/2}}\dot{v}=F_{long}$$ (23.14)

The **longitudinal mass** multiplying the acceleration $\dot{v}$ is therefore

(7) $$m_{long}=\frac{m_0}{\left(1-\beta^2\right)^{3/2}}$$ (23.15)

If, on the other hand, $\mathbf{F}$ acts transversely, i.e., normal to the trajectory, only the direction, not the magnitude of the velocity is altered. In that case $\dot{\beta}$ is zero; (6) simply yields

$$\frac{m_0}{\left(1-\beta^2\right)^{1/2}}\dot{v}=F_{trans}$$

For this reason one introduced at the time a **transverse mass** different from the longitudinal mass and given by

(8) $$m_{trans}=\frac{m_0}{\left(1-\beta^2\right)^{1/2}}$$ (23.16)

In view of these complications we emphasize that the above distinction between two kinds of masses becomes unnecessary if we use only the rational form (6) of the equation of motion." **End of quotation.**

In connection with this quotation we can conclude the following:

a) As distinct from the first text quoted the existence of the longitudinal and transversal mass of an electron is confirmed.

b) bearing in mind that $\beta=v/c$ and if $\dot{\beta}$ = 0 then $\dot{v}$ must also be equal to 0. Therefore the derivation of Eq. (8) for transversal mass is not correct.

c) the transversal force is equal to the product of the transversal mass and the transversal acceleration, but not the product of the transversal mass and the longitudinal acceleration, as stated in equation

$$\frac{m_0}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}\dot{v} = F_{trans}$$

since in this equation $v = v_{long}$. Therefore this equation would read

$$\frac{m_0}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}\dot{v}_{trans} = F_{trans} \qquad (23.17)$$

and is valid only on condition that $v_{long} > v_{trans}$. When this condition is not satisfied we cannot determine the longitudinal or transversal mass. For example, in case of $v_{long} = v_{trans}$ we do not know which is the transversal velocity and which is the longitudinal velocity. In that case Eqs. (23.3) and (23.4) for the longitudinal and transversal mass, which are different, do not make sense.

23.2.3 Einstein's derivation of the equations for the masses of an electron in motion

In his first paper on the theory of relativity [2] from 1905, under the title "The dynamics of a (weakly) accelerated electron" Einstein derived relativistic equations for determining the mass of an electron depending on its speed. He repeated this derivation in the paper [5] in 1907 under the title "The derivation of equations of motion for a (weakly accelerated) material point or electron". In both cases the derivations of these equations are incorrect, both from the standpoint of physics and mathematics. A reader can not be expected to accept these claims. Therefore it is necessary to quote both mentioned derivations with commentary, so that the reader can see for himself that the relativistic way of derivation of equations for electron's mass is unacceptable, as are the relativistic equations according to which that mass is calculated.

Quotation (from the paper [2] published in 1905): "§10 THE DYNAMICS OF A (WEAKLY ACCELERATED) ELECTRON

Let there be a point particle with the electric charge e (in further text called "electron") moving in an electromagnetic field; on the law of its motion we can assume the following.

If the electron is at rest in the course of a certain time interval, then in the next time element, the motion of the electron, as long as it is slow, will be described by the equations

$$m\frac{d^2x}{dt^2} = eE_x$$
$$m\frac{d^2y}{dt^2} = eE_y \qquad (23.18)$$
$$m\frac{d^2z}{dt^2} = eE_z$$

where x, y and z are the coordinates of the electron's position, m the mass of electron and E_x, E_y and E_z the vectors of the electric field.

Further, let the electron in the course of a certain time interval have the speed v. Let us find the law by which the electron moves in the time element immediately after that time interval.

Without limiting the whole of thinking we can allow and indeed we shall allow that in that time, when we start our observation, our electron is found at the coordinate origin of the system K and that it moves along the x-axis, at speed v. It is clear that in such a case, in the stated time interval (t = 0) the electron is at rest in relation to the coordinate system K', which moves parallel to the x-axis at a constant speed of v.

With earlier made assumptions in accordance with the principle of relativity it follows that the equations of electron motion, observed from the system K', in the course of time, immediately after t = 0 (small values of t) have the form

$$m\frac{d^2x'}{dt'^2} = eE'_x$$
$$m\frac{d^2y'}{dt'^2} = eE'_y \qquad (23.19)$$
$$m\frac{d^2z'}{dt'^2} = eE'_z$$

where the marked magnitudes x', y', z', E'_x, E'_y, E'_z refer to the system K'. If we take that with $t = x = y = z = 0$ must be $t' = x' = y' = z' = 0$ these will be the correct formulas of transformation from §3 and §6 (the transformation of coordinates and on that basis the transformation of Maxwell's equations for vacuum. Note by M.P.) and therefore the following equations will be valid

$$t' = \beta\left(t - \frac{v}{c^2}x\right) \qquad E'_x = E_x$$
$$x' = \beta(x - vt) \qquad E'_y = \beta\left(E_y - \frac{v}{c}N\right) \tag{23.20}$$
$$y' = y \qquad E'_z = \beta\left(E_z + \frac{v}{c}M\right)$$
$$z' = z$$

where L, M, N form vector of the magnetic field and $\beta = 1/\sqrt{1 - v^2/c^2}$.

With the help of these equations we shall perform the transformation of the given equations of motion from the system K' to the system K and we shall obtain

(A)

$$\frac{d^2x}{dt^2} = \frac{e}{m}\frac{1}{\beta^3}E_x$$
$$\frac{d^2y}{dt^2} = \frac{e}{m}\frac{1}{\beta}\left(E_y - \frac{v}{c}N\right) \tag{23.21}$$
$$\frac{d^2z}{dt^2} = \frac{e}{m}\frac{1}{\beta}\left(E_z + \frac{v}{c}M\right)$$

Relying on the usual way of reasoning let us determine the "longitudinal" and "transversal" mass of an electron in motion. Let us write the Eqs. (A) in the following form

$$m\beta^3\frac{d^2x}{dt^2} = eE_x = eE'_x$$
$$m\beta^2\frac{d^2y}{dt^2} = e\beta\left(E_y - \frac{v}{c}N\right) = eE'_y \tag{23.22}$$
$$m\beta^2\frac{d^2z}{dt^2} = e\beta\left(E_z + \frac{v}{c}M\right) = eE'_z$$

and remark firstly that eE'_x, eE'_y, eE'_z are the components of the ponderomotor force, which affects the electron, wherefore these components are analyzed in the coordinate system, which, at a given moment, moves together with the electron and at the same speed as the electron. (That force could be measured by spring weight, which is at rest in that system). If we name that force simply "the force which affects the electron" and keep the equation (for quantitative values)

$$\textbf{mass} \cdot \textbf{acceleration} = \textbf{force}$$

and if we further establish that we must measure the acceleration in the system K, which is at rest, then from the earlier shown equations we get

$$\textbf{longitudinal mass} = \frac{m}{\left(\sqrt{1-\frac{v^2}{c^2}}\right)^3} \tag{23.23}$$

$$\textbf{transversal mass} = \frac{m}{1-\frac{v^2}{c^2}} \tag{23.24}$$

Of course we shall get different values for mass in different determination of force and acceleration, because when comparing different theories of electron motion one should be very careful. We stress that these results in relation to mass are also correct for neutral material points as well, since such a material point can be, by joining with any small charge, changed into an electron (in our sense of the word).

Let us determine the kinetic energy of the electron. If the electron, from the coordinate system K with an initial speed 0, moves all the time along the x-axis under the influence of electrostatic force E_x, it is clear, that the energy taken form electrostatic field will be equal $\int eE_x dx$. Since the electron is slowly accelerated and as a consequence of that it need not emit energy in the form of radiation, then the energy taken from the electrostatic field must be equal to the energy of the electron's motion. Taking into account that in the course of the whole studied process of motion the first of the Eqs. (A) is valid, then we get that

$$W = \int e\,E_x\,dx = \int m\,\beta^3\,\frac{d^2x}{dt^2}\,dx = \int_0^v \frac{m\,v\,dv}{\left(\sqrt{1-\frac{v^2}{c^2}}\right)^3} = = m\,c^2\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}-1\right) \qquad (23.25)$$

With $v = c$ the value of W becomes, in that manner, infinitely large. As with the previous results, the same is here, the speeds cannot be larger than the speed of light. This expression for kinetic energy must also be valid for any mass for the earlier given proof." **End of quotation.**

In the paper [5] from 1907 Einstein again derives equations of electron motion, as in the above quoted paper, but with some further, more detailed explanations, which did not appear in the 1905 paper, which are also incorrect, and therefore we shall quote that paper as well.

Quotation (from the paper [5] published in 1907): "§8 THE DERIVATION OF EQUATIONS OF THE MOTION OF A (WEAKLY ACCELERATED) MATERIAL POINT OR ELECTRON

If we take an electromagnetic field in which a particle with electric charge e (in further text called "electron") moves then we can assume the following on the law of its motion.

If the electron in a given moment of time is at rest in (un-accelerated) system K, its future motion in the system K will then be in accordance with the equations

$$\begin{aligned} m\,\frac{d^2x}{dt^2} &= e\,E_x \\ m\,\frac{d^2y}{dt^2} &= e\,E_y \\ m\,\frac{d^2z}{dt^2} &= e\,E_z \end{aligned} \qquad (23.26)$$

where x, y, z are the coordinates of the electron in the system K, and m is a constant which we shall call the electron's mass.

Let us introduce system K' which moves relatively to K the same as in our previous analysis and let us transform our equations of motion with the help of transformation formulas (1) and (7a) [Eq. (23.20) in this book.] (The transformation of coordinates and on that basis the transformation of Maxwell's equations. Note by M.P.). The first of these formulas in our case has this form

$$
\begin{aligned}
t' &= \beta\left(t - \frac{v}{c^2}x\right) \\
x' &= \beta(x - vt) \\
y' &= y \\
z' &= z \\
\beta &= \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}
\end{aligned}
$$

By introducing $\frac{dx}{dt} = \dot{x}$, etc. from these equations we get

$$\frac{dx'}{dt'} = \frac{\beta\left(\dot{x} - v\right)}{\beta\left(1 - \frac{v}{c^2}\dot{x}\right)}, \quad \text{etc.} \tag{23.27}$$

$$\frac{d^2x'}{dt'^2} = \frac{\frac{d}{dt'}\left(\frac{dx'}{dt'}\right)}{\beta\left(1 - \frac{v}{c^2}\dot{x}\right)} = \frac{1}{\beta}\frac{\left(1 - \frac{v}{c^2}\dot{x}\right)\ddot{x} + \left(\dot{x} - v\right)\frac{v}{c^2}\ddot{x}}{\left(1 - \frac{v}{c^2}\dot{x}\right)}, \quad \text{etc.} \tag{23.28}$$

By introducing these expressions in the earlier given equations, by putting $\dot{x} = v$, $\dot{y}$ = 0, $\dot{z}$ = 0 and at the same time substituting E'_x, E'_y, E'_z by the formulas (7a) we get

$$\begin{aligned} m\beta^3\ddot{x} &= eE_x \\ m\beta\ddot{y} &= e\left(E_y - \frac{v}{c}N\right) \\ m\beta\ddot{z} &= e\left(E_z + \frac{v^2}{c}M\right) \end{aligned} \tag{23.29}$$

These equations are the equations of electron motion when at the studied moment of time $\dot{x} = v$, $\dot{y}$ = 0, $\dot{z}$ = 0." **End of quotation.**

So, the derivation of equations of electron motion is the same as in the pervious paper with an attempt to explain how are obtained Eq. (23.22) that is Eq. (23.29) via transformation of coordinates. However, that explanation is also incomplete and wrong.

23.3 Objections to the Einstein's way of deriving equations for masses of a moving electron

With a careful analysis of the quoted papers, which refer to the mass and kinetic energy of a moving electron, every mathematician and physicist can see that there are inconsistencies and mistakes in the derivation of the equations. Some of these mistakes are so big that they make the derivation of equations unacceptable. The derived equation for the transversal mass of a moving electron is also unacceptable. In short, it is unacceptable that a physicist, as far as physics is concerned, or a mathematician, as far as mathematics is concerned, can make such mistakes. The impression is that those mistakes, in the equation's derivation, are made deliberately so that the final result of the derivation could be a desired equation.

Objections to Einstein's derivation and derived equations in the earlier quoted papers are the following:

a) Eqs. (23.18) do not describe the motion of an electron, as it is claimed. They are not correct, because in the equation derivation it was wrongly asserted that the electron mass m was a constant value, while it is well known that electron mass is a variable value dependent of the speed of its motion.

Besides, in all equation derivation, it was assumed that electron motion is slow in relation to the speed of light, as if it was a case of deriving classical equations, and in fact relativistic equations were derived, which should describe the motion of electrons at high - relativistic speeds, close to the speed of light.

b) The Eqs. (23.19) are also not correct. These are not equations of electron motion relatively to the system K', as it is claimed, because there it is also taken that the mass of a moving electron is a constant value.

c) As has been said before, in the initial Eqs. (23.18), (23.19), (23.21) and later in all the equations for deriving relativistic equations for mass, it is taken that the mass of an electron in motion is constant and of the same magnitude in both coordinate systems, which move relatively at speed v. However, according to the theory of relativity the mass of an electron in the system K', in which the electron is at rest is m_0, whereas its mass in the system K in which it is moved at speed v is

$m = m_0 / \sqrt{1 - v^2 / c^2}$. From this it can be seen that the procedure for the derivation of the equations for relativistic mass is in fact the same as the procedure for the derivation of equations for some kind of would-be relativistic accelerations by means of the Lorentz transformation. Later we shall demonstrate that this is the case.

Using Eqs. (23.19) and (23.20) for longitudinal acceleration we have

$$a_{r\,long} = \frac{d^2x'}{dt'^2} = \frac{1}{dt'} d\,\frac{dx'}{dt'} = \frac{1}{dt'} d\,\frac{\beta\left(dx - v\,dt\right)}{\beta\left(dt - \frac{v}{c^2}dx\right)} = \frac{1}{\beta\left(dt - \frac{v}{c^2}dx\right)} \cdot d\,\frac{\dot{x} - v}{1 - \frac{v}{c^2}\dot{x}} = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{3/2}}\ddot{x} = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{3/2}}\frac{d^2x}{dt^2} = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{3/2}} a_{long} \tag{23.30}$$

From this it results that the relativistic longitudinal acceleration is given by equation

$$a_{r\,long} = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{3/2}} a_{long} \tag{23.31}$$

In this derivation it was taken that $\frac{dx}{dt} = \dot{x} = v$ is constant, and that $\frac{d^2x}{dt^2} = \ddot{x} \neq 0$ as it is $\dot{x} - v \neq 0$. However in the derivation of the equation for transversal acceleration, and hence for transversal mass, it is also taken that $\frac{dx}{dt} = \dot{x} = v$ is constant, but in distinction from the case above, in this case it is taken that $\frac{d^2x}{dt^2} = \frac{d\dot{x}}{dt} = \ddot{x} = 0$.

Thus in the case of transversal acceleration we have

$$a_{r\,trans} = \frac{d^2y'}{dt'^2} = \frac{d}{dt'}\left[\frac{\dot{y}}{\beta\left(1-\frac{v}{c^2}\dot{x}\right)}\right] =$$

$$= \frac{1}{\beta\left(1-\frac{v}{c^2}\right)dt}\frac{1}{\beta}\frac{d\dot{y} - d\dot{y}\frac{v}{c^2}\dot{x} + \dot{y}\frac{v}{c^2}d\dot{x}}{\left(1-\frac{v}{c^2}\dot{x}\right)^2} = \tag{23.32}$$

$$= \frac{1}{\beta^2}\frac{\ddot{y}\left(1-\frac{v^2}{c^2}\right)^2}{\left(1-\frac{v^2}{c^2}\right)^3} = \frac{1}{1-\frac{v^2}{c^2}}\frac{d^2y}{dt^2} = \frac{1}{1-\frac{v^2}{c^2}}a_{trans}$$

which means that the relativistic transversal acceleration is given by

$$a_{r\,trans} = \frac{1}{1-\frac{v^2}{c^2}}a_{trans} \tag{23.33}$$

Equations derived in this way, which are related to relativistic acceleration, are taken as equations for relativistic mass. Such a procedure is unacceptable since, in physics mass is not simply the same as acceleration. The inconsistencies in the derivation of the equations are no less unacceptable. In particular the incorrect Eq. (23.24) for transversal mass is unacceptable. This equation proves that such a method of deriving equations for the masses of an electron in motion is not correct and cannot be accepted.

d) In the derivation of Eqs. (23.19) it is taken that the electron is momentarily at the origin of the system K and that it moves along the x-axis at a speed v. Only in that moment (t = 0) is the electron found at rest relatively to the system K', which also moves parallel to the x-axis, but at a constant speed of v. Under these assumptions, and in the course of time immediately after t = 0, the Eqs. (23.19) are allegedly the equations of electron motion in the system K'. The question can be put, what are the equations of electron motion when the time t is not close to the time t = 0. Then the speed of the electron must be higher than the speed at which the system K' moves, for the force $F = eE'_x$ constantly works on the electron. Nevertheless, in the final equations it is taken that the speed of the electron is equal to the constant speed v, that is the speed of the system K'. Sometimes it is even taken that $v = x/t$ which is contrary to the main postulates of the theory of relativity, since according to the Lorentz transformations x is the position of a spherical light wave which propagates along the x-axis at light speed, then $x/t = c$.

The electron moves under the effect of force $F = eE'_x = eE_x$. The speed of the electron depends on the magnitude of that force and its duration. If the duration of that force equals zero, the speed of the electron must also be zero. Hence if t = 0, that is if $t = x = y = z = t' = x' = y' = z' = 0$ the speed of the electron can not be equal to the speed v, therefore the initial conditions for derivation of the Eq. (23.19) do not make sense.

e) Eqs. (23.18) and (23.22) should describe the motion of the same electron in the same coordinate system K. Because of that their form would have to be the same, but, for incomprehensible reasons, it is not so. With the "passage" of Eqs. (23.18) through the system K', in a strange, magical way the following equation is realized

$$\begin{aligned} E_x &= \frac{1}{\beta^3} E_x \quad \left(\text{or} \quad \frac{d^2 x}{dt^2} = \beta^3 \frac{d^2 x}{dt^2} \right) \\ E_y &= \frac{1}{\beta} \left(E_y - \frac{v}{c} N \right) \\ E_z &= \frac{1}{\beta} \left(E_z + \frac{v}{c} M \right) \end{aligned} \tag{23.34}$$

which can be only in case when $1/\sqrt{1 - v^2/c^2} = 1$, that is when v = 0. However, in that case the connection with the theory of relativity is lost, since when v = 0 then there is no other coordinate system and there is no relative motion. If, regardless of all that it is still claimed that everything is correct, then that is where science stops and magic starts. In fact, such a derivation of equations does look like a magician's act, who shows an empty hat to his audience then puts a rabbit in the hat (system K') and says a few magic words, and then to the audience's astonishment, pulls a fox out of the hat.

f) In the second quoted paper of 1907 Einstein tried indirectly to correct his Eq. (23.24) for the transversal mass of a moving electron by means of the system of Eqs. (23.29) which read

$$
\begin{aligned}
m\beta^3\ddot{x} &= eE_x \\
m\beta\ddot{y} &= e\left(E_y - \frac{v}{c}N\right) \\
m\beta\ddot{z} &= e\left(E_z + \frac{v}{c}M\right)
\end{aligned}
\tag{23.35}
$$

These equations are obtained by division of both left and right side of the second and third equation from the system (23.22) by β. In this way he makes it seem that, on the left side of the of the second and third equations "mass · acceleration", and on the right side "a force." From this it results that $m\beta$ is the transversal mass. However, after such divisions, the right side of the second and third equations do not represent "the force". Since the components of the transformed electric field from the system K' to the system K by means of the Lorentz transformation have the following form

$$
\begin{aligned}
E'_x &= E_x \\
E'_y &= \beta\left(E_y - \frac{v}{c}N\right) \\
E'_z &= \beta\left(E_z + \frac{v}{c}M\right)
\end{aligned}
\tag{23.36}
$$

as Einstein himself wrote in the same paper of 1907 [5] by Eqs. (7a) and by Eqs. (23.20) and (23.22) given in the paper of 1905, quoted above [2]. Besides this, the derivation of the equations given in Eq. (23.28) is also incorrect. For example, it cannot be $\frac{d^2x'}{dt'^2} = \frac{\frac{d}{dt'}\left(\frac{dx'}{dt'}\right)}{\beta\left(1 - \frac{v}{c^2}\dot{x}\right)}$, but rather should be $\frac{d^2x'}{dt'^2} = \frac{d}{dt'}\left(\frac{dx'}{dt'}\right)$, etc.

g) At the present time it is well known that the change of mass of an electrically charged particle in motion is a consequence of the creation of an electromagnetic field around the electrically charged particle in motion. From there some logical questions arise: "What happens with a neutral particle in motion? Does its mass also change with its speed?" A logical answer would be that the mass of a neutral particle does not change with motion. Such particles in motion do not create electromagnetic fields which would resist further increase of the particle's speed, which would manifest as an increase of mass. Some other physical process which would affect the particle's inertia, or the body as a whole, in motion, is not known.

Therefore, nothing else remains but to conclude that the mass of a neutral particle, and a body in general, does not change with the change in speed of motion. Therefore, Einstein's generalization that all bodies change their mass with the speed in the same way as an electron is unacceptable.

h) At the end we can conclude that Einstein's derivation of relativistic equations for the masses of a moving electron are unacceptable. The derivations are not soundly based in physics and lack mathematical correctness. Even in this incorrect way Einstein did not manage to derive the most important equation in the theory of relativity $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$ but the incorrect equation $m = \frac{m_0}{1 - \frac{v^2}{c^2}}$. As regards this main equation in the theory of relativity, we can say that it is not relativistic, nor can it be derived by correct relativistic procedure.

23.4 Concept of mass

As has been said above, the moving electron has two masses - the longitudinal and the transversal.

In the theory of relativity, and in many other publications it is accepted that the mass of an electron in motion, and the mass of the moving body in general is given by Lorentz's Eq. (23.4) for the transversal mass of an electron in motion. The longitudinal mass and the transversal mass are almost never mentioned, only the relativistic mass m_r, or simply mass m. As a result, those insufficiently versed in the subject believe that the electron will resist an change in velocity with the transversal mass, which is defined by Eq. (23.4).

As was said before, the longitudinal mass resists changes of velocity in the direction of motion of the electron, or body, whereas the transversal mass resists the deviation of the electron from a straight path. Accordingly the longitudinal mass is more important than the transversal because it is the measure of the inertia of the electron or body. Also the longitudinal mass is considerably greater than the transversal at relativistic velocities. Their relation for the electron is given by

$$\frac{m_{long}}{m_{trans}} = \frac{1}{1 - \frac{v^2}{c^2}} \tag{23.37}$$

The relation of the longitudinal and the transversal mass of an electron in motion and the mass at rest, calculated according to Abraham's and Lorentz's equations for different velocities v is given in Table 23.1.

Table 23.1

$\frac{v}{c}$	$\frac{m_{long.A.}}{m_0}$	$\frac{m_{long.L.}}{m_0}$	$\frac{m_{trans.A.}}{m_0}$	$\frac{m_{trans.L.}}{m_0}$
0.1	1.012	1.015	1.004	1.005
0.2	1.050	1.063	1.016	1.021
0.3	1.192	1.152	1.038	1.048
0.4	1.231	1.299	1.072	1.091
0.5	1.408	1.540	1.120	1.155
0.6	1.697	1.953	1.190	1.250
0.7	2.221	2.746	1.295	1.400
0.8	3.292	4.630	1.467	1.667
0.9	6.717	12.075	1.816	2.294
0.95	13.15	32.846	2.218	3.203
0.98	35.063	126.899	2.808	5.025
0.99	72.816	356.22	3.286	7.089

From Table 23.1 we can see the following:

- The longitudinal mass becomes much greater than the transversal mass as the velocity of the electron increases.

- The values of the longitudinal and transversal masses, calculated according to Abraham's and Lorentz's equations are in good agreement with low, non-relativistic velocities. The differences increase, however, with an increase in velocity. These differences become so big at relativistic velocities, close to the speed of light that they are unacceptable. The question, therefore arises, which equations are correct? At the same time the conclusion offers itself, that these were only approximate equations made on the basis of Kaufmann's test results. Bearing in mind the remarks made above on the derivation of relativistic equations, this is quite logical.

While discussing mass, we should note that there are disagreements about the very concept. Many well known scientists have asserted that electrons have no mass in the classic sense, but rather, **electromagnetic mass** only.

The idea that inert mass is in fact an induction, appeared in a study on the electrodynamics of electricity in motion. In the paper, "On electrical and magnetic effects produced by motion of the electrostatic electrified body" [Philosophical Magazine, 11, 229-249, 1881.], J Thomson considered the possibility of reducing inertia to electromagnetism.

In accordance with Maxwell's theory, an electrical displacement (that is a current of displacement) causes the same effects as an ordinary current. Therefore the magnetic field originates with the displacement current. The energy of that field, in accordance with the law of energy conservation, must be produced to account for the motion of the electrified carrier. But the motion of the electrified carrier appears as a source of energy, and this is why it must tolerate resistance on moving. As a result, Thomson concluded that, "resistance must be equivalent to the increase of the mass of the electrified moving carrier" [Philosophical Magazine, 11, 230, 1881.].

Oliver Heaviside made considerable advances on Thomson's results in his paper "On the electromagnetic effects which appear on the motion of electrical charges through a dielectric" [Philosophical Magazine, 27, 324-339, 1889.].

Kaufmann came to the conclusion, after the measurement of the longitudinal and transversal mass of an electron in motion, that "the real mass of an electron is equal to zero, and that the mass of the electron is an electromagnetic phenomenon" [W. Kaufman, Über die elektromagnetische Masse des Elektrons, Göttinger Nachrichten, S. 291-296, 1902.].

On the basis of Kaufmann's experiments, Abraham concluded that, "The inertia of an electron originates from electromagnetic field". Appearing at a conference in Karlsbad, he triumphantly announced, "The mass of the electron is purely electromagnetic in nature" [M. Abraham, Die Dinamik des Elektrons, 22, 24, 28; M. Abraham, Physikalische Zeitschrift, 4, 57, 1902. "Verhanlungen der 74. Naturforscherversammlung in Karlsbad: Die Masse des Elektrons is rein elektromagnetischer Art"].

Lorentz greeted this conclusion as "undoubtedly one of the most significant results of contemporary physics" [G. A. Lorenc, Teorija elektronov, str.76].

Poincare declared in his book, "Science and Method", "what we name mass is apparition only. Each inertia is electromagnetic in origin" [A. Paunkare, NAUKA I METOD, SPb, str. 170, 1910.].

The proponents of relativity do not accept the concept of such mass of an electron. They do not accept the fact that an electron in motion generates an electromagnetic field, which resists increases in the electron's velocity, thus increasing the inertia of the electron, and hence its mass.

According to the theory of relativity, the increase in the mass of the electron in motion originates exclusively as a result of relative motion. Physical reality and an understanding of that reality are not important in the relativistic procedure for solving certain problems. Equations derived for particular environments (vacuum), in some cases are used for others (water), as in the relativistic explanation of Fizeau's test results. It also happens that equations derived for certain particular magnitudes (acceleration) are used for other magnitudes (mass).

Introducing the second coordinate system is an artificial procedure, that works like the magicians wand or top hat. For example, in deriving equations for longitudinal and transversal mass, Einstein introduces a second coordinate system, which moves translatory to the first, by velocity v. In that second system he determines the longitudinal and transversal mass of a moving electron by means of the coordinates of the first system. Equations derived in that way would accord with Kaufmann's results. However it is well known that Kaufmann and his equipment were at rest in the first system, which was also at rest and that Kaufmann made his observations in this system and not in some other moving system.

23.5 The kinetic energy of an electron in motion

In order to derive an equation for the kinetic energy of an electron we can use the equation for the longitudinal mass or the equation for the transversal mass. If we use the equation for the longitudinal mass it is used known equation "energy = mass · acceleration · distance" in this way

$$E_k = \int F\,dx = \int m\frac{d^2x}{dt^2}dx = \int m\,d\left(\frac{dx}{dt}\right)\frac{dx}{dt} = \int m\,v\,dv =$$
$$= m_0\int_0^v \frac{1}{\left(1-\frac{v^2}{c^2}\right)^{3/2}}v\,dv = m_0\,c^2\left[\frac{1}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}-1\right] = \tag{23.38}$$
$$= c^2\left(m_{trans}-m_0\right) = c^2\,\Delta m_{trans}$$

When we use the transversal mass in the derivation of the equation for kinetic energy the procedure is almost the same, only the force being defined in another way

$$E_k = \int F\,dx = \int\frac{d(m\,v)}{dt}dx = \int d(m\,v)v = \int d\left[\frac{m_0\,v}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}\right]v =$$
$$= m_0\int_0^v\frac{v\,dv}{\left(1-\frac{v^2}{c^2}\right)^{3/2}} = m_0\,c^2\left[\frac{1}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}-1\right] = \tag{23.39}$$
$$= c^2\left(m_{trans}-m_0\right) = c^2\,\Delta m_{trans}$$

So, we obtain, in both derivations, the same correct equation for the kinetic energy of a moving electron.

Thus the change of kinetic energy is equal to the product of the change in the transversal mass and the second power of the speed of light. So when the electron receives energy then it's transversal mass increases proportionally. But, when the electron loses energy then its transversal mass decreases proportionally to the lost energy. When the transversal mass is changed then the longitudinal mass changes as well. The changes in longitudinal mass are greater because the longitudinal mass is greater than the transversal mass, especially at relativistic velocities, close to the speed of light. These changes, however, have not been taken into consideration.

The equations for kinetic energy (23.38) or (23.39) are very similar and describe very clearly the transformation of energy into mass, mass into energy, or, more precisely, transformation of energy into electromagnetic mass, that is kinetic energy of an electrified particle into electromagnetic energy, or an electromagnetic field.

Such a transformation of mass into energy is called the defect of mass, and it is connected with nuclear reactions, such as fission and fusion. In the course of such reactions the mass of the material concerned decreases and this partial decrease is accompanied by the release of an enormous amount of energy in the form of radiation and the kinetic energy of the particles.

The equation which describes the kinetic energy of an electron in motion is not relativistic, nor should it be treated as such since the equation for the mass of an electron in motion is not a relativistic equation at all.

23.6 The energy of a body

The equation for the amount of energy contained in a body, $E = mc^2$, where m is the mass of the body, is the most famous equation in physics. Its simplicity is dumbfounding, particularly when we bear in mind that it defines one of the most complex processes known to physical science, the total transformation of matter into energy and energy into matter. This equation has contributed most to Einstein's fame and to the fame of the theory of relativity, although it is not a relativistic equation nor was it derived by Einstein. There is also doubt that it is accurate. Besides that Poincare first derived that equation in implicit form in 1900.

23.6.1 The accuracy of the equation $E = mc^2$

Determining the energy of the electromagnetic field generated by an electron in motion, Heaviside found that the energy of an electron at rest is $E = \frac{4}{3} m_0 c^2$ where m_0 is the mass of the electron at rest. In order to calculate the energy of the field caused by the motion of an electron, and compare it to the energy of an electron at rest, Heaviside used Maxwell's theory by which the energy of the electromagnetic field generated by a moving electron is [Philosophical Magazine, 27, 324-339, 1889.]

$$\Delta E = \frac{1}{8\pi} \int H \, d\tau = \frac{q^2}{8\pi} \frac{v^2}{c^2} \int_a^{\infty} \int_0^{2\pi} \int_0^{\pi} \frac{\sin\theta}{r^4} r^2 \sin\theta \, d\theta \, d\varphi \, dr = \frac{q^2 v^2}{3 a c^2} \qquad (23.40)$$

where H is the vector of the magnetic field, $d\tau = r^2 \sin\theta \, d\theta \, d\varphi \, dr$ is an element of the volume, r is the distance from the electron, a is the radius of the sphere of the electron, v is the speed of motion of the electron, c is the speed of light and q = $4.803204197 \cdot 10^{-10}$ stat C is the electric charge of the electron.

Magnitudes q, v, c, a and E in Eqs. (23.40), (23.41) and (23.42) are in the units of the CGS system.

Bearing in mind that the energy of the field is equal to the kinetic energy of the electron, and that at low speed of the electron $\Delta E = E_k = \frac{1}{2} m_0 v^2 = \frac{q^2 v^2}{3ac^2}$ he found that the mass of the electron at rest could be determined using the equation

$$m_0 = \frac{2q^2}{3ac^2} \qquad (23.41)$$

Using this finding, and taking that the total electromagnetic energy E_0 out of the stationary sphere with a radius a and with the electric charge q on its surface, is equal to $q^2/2a$, which can be shown by simple integrating. He found that

$$m_0 = \frac{2q^2}{3ac^2} = \frac{4}{3c^2} \cdot \frac{q^2}{2a} = \frac{4}{3}\frac{E_0}{c^2} \qquad (23.42)$$

and from there

$$E_0 = \frac{3}{4} m_0 c^2 \qquad (23.43)$$

or generalising

$$E = \frac{3}{4} mc^2 \qquad (23.44)$$

The discussion on whether the energy of an electron at rest or a body in general is best expressed by $E = mc^2$ or $E = \frac{3}{4} mc^2$ is not yet finished.

Here is what Einstein [A. Einstein, $E = mc^2$ The most urgent Problem, Sci. Illustr., I, 16-17, 1946.] himself said about the accuracy of the equation $E = mc^2$: "It is taken that the equivalence of mass and energy is expressed (although it is not completely accurate) by formula $E = mc^2$."

However, generalizations given by equation (23.44) and by equation $E = mc^2$ are not sure, and the discussions about accuracy of those two equations do not make sense.

In the first case it is allegedly the energy of the electrical field of an electron at rest only. The energy of motion inside of the electron does not take into consideration. Besides, the energy E_0 in equations (23.42) and (23.43) are related to the energy of the electrical field of the electrified sphere, whose charge is q and radius a. At that we should take into consideration that the charge of the sphere is formed by a great numbers of electrons. However, in case of electrical field of an electron, that charge is unit charge, that is, the charge of one electron only.

The energy E, in the second case, is the result of motion of the electron as an electrically charged particle, that is, the energy of electromagnetic field generated by motion of the electron.

In the both cases, those energies are not energies originated by transformation of some real mass.

23.6.2 Poincare's derivation of the equation $E = mc^2$

In his paper of 1900, entitled "Lorentz's theory and the principle of counteraction" [H. Poincaré, La théorie de Lorentz et le principe de réaction, Archives Néerlandaises des sciences exactes et naturelles, 2, 232, 1900.] Poincare characterises electromagnetic energy as "a flux that possesses energy." He was the first to indicate that electromagnetic radiation has a total momentum equal to Poynting's vector divided by the speed of light squared

$$g = \frac{S}{c^2} \tag{23.45}$$

Taking that $S = E \cdot c$, where E is the electromagnetic energy absorbed by the body whose mass is m, he applied the law on the conservation of momentum in order to calculate the speed of the retreat of the absorbing body using the following equation

$$mv = \frac{S}{c^2} = \left(\frac{E}{c^2}\right)c \tag{23.46}$$

On analysis of this equation it becomes apparent that the mass, or inertia of electromagnetic radiation is equal to E/c^2.

In his paper "Determining the relation between mass and energy" [Journal of the Optical Society of America, 42, 540-543, 1952.] of 1952 Ives reconstructed Poincare's article in detail and in the light of "Poincare's principle of relativity" and demonstrated that Poincare's arguments, if we hold to the final conclusion only, necessarily lead to the following relation of electromagnetic energy and mass

$$m = \frac{E}{c^2} \tag{23.47}$$

where m is the change of inert mass and E is treated energy (absorbed or emitted).

Consequently, Heaviside in 1889 derived the equation $E = \frac{3}{4}mc^2$. Poincare in 1900 derived an implicit form of $E = mc^2$. Later it will be shown that Einstein did not create the equation $E = mc^2$. His derivation of 1905 and later was incorrect and thus unacceptable. But in spite of this the equation is still considered to be Einstein's.

23.6.3 Einstein's derivation of the equation $E = mc^2$

Einstein gave the first derivation of the equation $E = mc^2$ in his paper [3] in 1905 under the title "Does a body's inertia depend on the energy contained in it?", and he gave the second derivation in the paper [4] from 1946 under the title "Elementary derivation of equivalency between mass and energy". In both cases the derivation of equations was not correctly done so the final result $E = mc^2$ can not be accepted, nor can it be accepted that it is a relativistic equation. To show that it is best to quote the mentioned papers on whole and then to point out the incorrectness in the equation derivation, which will be done below.

Quotation (from the paper [3] from 1905): "DOES A BODY'S INERTIA DEPEND ON THE ENERGY CONTAINED IN IT?

The research results, published [Ann. Phys., 17, 891, 1905.] earlier, lead us to a very interesting result from which I drew a conclusion that I will give in this paper.

In previous research I started not only from the Maxwell - Hertz equations for vacuum and Maxwell's formula for electromagnetic energy of space but also from the following principle.

The laws, according to which the states of physical systems change, do not depend from that on which of the two coordinate systems, moving with uniform translation relatively to each other, these changes of state refer to (the principle of relativity). Starting from that I have personally come to the following result.

Let a system of plane waves of light, relatively to the coordinate system (x, y, z), have the energy E and let the direction of the ray (normal to the front of the wave) form an angle α with the x-axis. If we introduce a new coordinate system (x', y', z') moving uniformly and rectilinearly relatively to the system (x, y, z) and if the origin of the first system moves at the speed v along the x-axis then the mentioned light energy, measured in the system (x', y', z') will be

$$E' = E\frac{1 - \frac{v}{c}\cos\alpha}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (23.48)$$

where c is the speed of light. In the further text we shall use this result. [This Eq. (23.48) originates form Einstein's relativistic Eq. (21.13) for the Doppler shift in which a wave frequency is substituted by wave energy, for the energy is proportional to the frequency according to Planck's equation $E = hf$ where h is Planck's constant, and f is a frequency of a photon or a wave. Plank's equation $E = h\nu$ does not valid in the case of electromagnetic waves generated by motion of free carriers of electricity as they are radio waves. Their amplitudes and energies are not quantified because they can be changed continuously at the same frequency by the change of applied voltage on an antenna. Note by M.P.]

Let there be an unmoving body in the system (x, y, z), and the body's energy relative to the system (x, y, z) equals E_0. Let the energy of that same body relative to the system (x', y', z') which is moving, as we said, at the speed v, be equal to H_0.

Let that body send a plane light wave with the energy $L/2$ [measured in relation to the system (x, y, z)] in the direction which forms an angle α with the x-axis, and at the same time let it send the same amount of light in the opposite direction. Thereby the body will remain at rest relatively to the system (x, y, z). For that process the law on the conservation of energy must be satisfied and that being (according to the principle of relativity) relatively to both the coordinate systems. If we mark with E_1 the energy of the body measured in the system (x, y, z) after the emission of light and the adequate energy with H_1 relatively to the system (x', y', z'), and using the above given relation we get

$$E_0 = E_1 + \left(\frac{L}{2} + \frac{L}{2}\right) \tag{23.49}$$

$$H_0 = H_1 + \left[\frac{L}{2}\frac{1-\frac{v}{c}\cos\alpha}{\sqrt{1-\frac{v^2}{c^2}}} + \frac{L}{2}\frac{1+\frac{v}{c}\cos\alpha}{\sqrt{1-\frac{v^2}{c^2}}}\right] = H_1 + \frac{L}{\sqrt{1-\frac{v^2}{c^2}}} \tag{23.50}$$

By subtracting the first equation from the second we get

$$\left(H_0 - E_0\right) - \left(H_1 - E_1\right) = L\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right) \tag{23.51}$$

In this relation both differences of the form $H - E$ have a simple physical meaning. The magnitudes H and E represent the values of energies of one and the same body in two coordinate systems which move relatively to each other while the body is at rest in one system [in the system (x, y, z)].

In that way it is clear that the difference $H - E$ can deviate form the kinetic energy E_k of the body, taken in the relation to the other system [system (x', y', z')], only for an additive constant C, which depends on the choice of arbitrary additive constants in the expressions for the energy H and E. Therefore we can put that

$$\begin{aligned} H_0 - E_0 &= E_{k0} + C \\ H_1 - E_1 &= E_{k1} + C \end{aligned} \tag{23.52}$$

since the constant C does not change with the emission of light.

In that way we get that

$$E_{k0} - E_{k1} = L\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right) \tag{23.53}$$

The kinetic energy of the body relatively to the system (x', y', z') decreases with the emission of light by the quantity which does not depend on the nature of the body. Moreover, the difference $E_{k0} - E_{k1}$ depends on speed in the same way as the kinetic energy of an electron [see chapter 10 of the earlier quoted paper, that is the quotation in chapter 23.2.3 of this book and the Eq. (23.25) in the above given quotation. Note by M.P.].

Neglecting the small magnitudes of the fourth and higher orders we can get

$$E_{k0} - E_{k1} = \frac{L}{c^2}\frac{v^2}{2} \tag{23.54}$$

From that equation it immediately follows that if a body emits energy L in the form of radiation then its mass decreases by the value L/c^2. Thereby, it is, obviously, not important that the energy, taken from the body, directly passes into the energy of emitted radiation, consequently we can reach a more general conclusion.

The mass of a body is the measure of the energy contained in it; if the energy changes by the value L, then the mass changes by the value $L/(9 \cdot 10^{20})$. The energy is here measured in ergs, and mass in grams." **End of quotation.**

Let us now study Einstein's second derivation of the equivalence of mass and energy [4] published in 1946. In this case we shall also quote the paper so that the reader can have the full picture.

Quotation: "ELEMENTARY DERIVATION OF THE EQUIVALENCE OF MASS AND ENERGY

The law of equivalence, here given, which has not been published before, has two advantages. Regardless of the fact that special principle of relativity had to be used, this derivation does not demand the application of a formal apparatus of theory, but it relies on the three laws known from before.

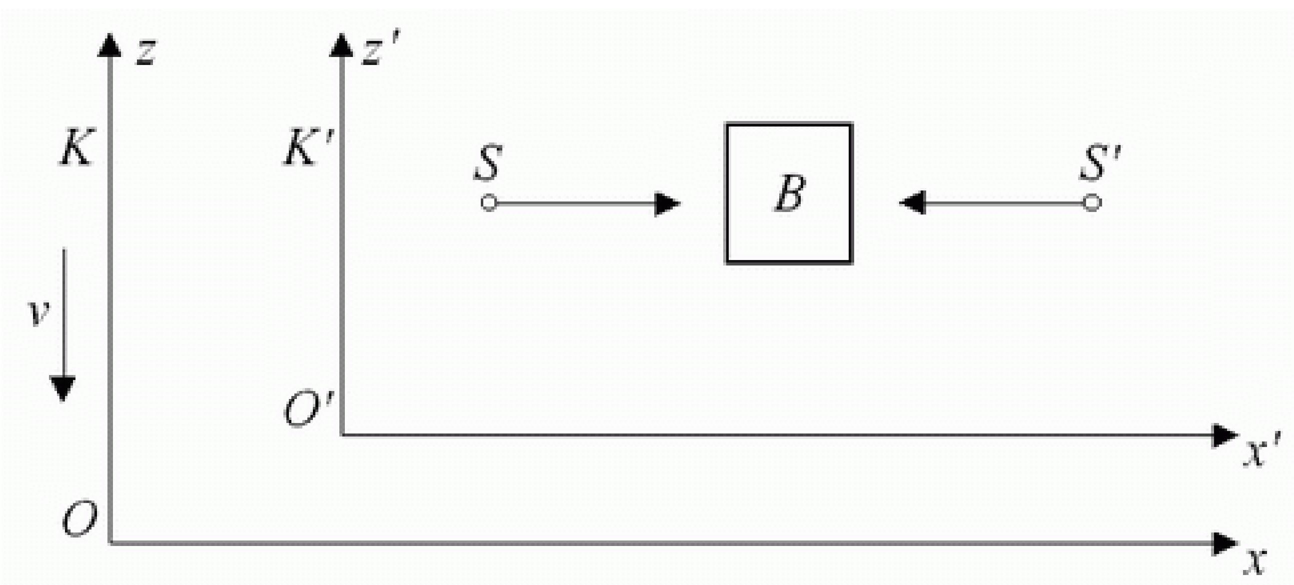

Fig. 23.2

(1) The law on the conservation of momentum.

(2) The expression for the pressure of radiation, that is for the momentum of a wave packet which moves in a set direction.

(3) The known expression for the aberration of light (the affect of the motion of earth on the position in which unmoving stars are seen - Bradley's law).

We shall now study the following system. Let a body B be free and let it be at rest relatively to the system K'. Two wave packets S and S', each with the energy $E/2$ move in the positive and negative direction of the x'-axis respectively and they are absorbed by the body B. As a result of that absorption the energy of the body B increases by E. Under those circumstances the body B remains at rest relatively to the system K' because of the symmetry.

Now we shall study that process relatively to the reading system K, which moves at a constant speed v relatively to the system K' and in a negative direction of the z'-axis. Relatively to the system K that process is described in the following way. The body B moves in the positive direction of the z-axis at the speed v. The direction of the two wave packets form the angle α with the x-axis of the system K.

In accordance with the aberration law, in the first approximation $\alpha = \frac{v}{c}$ where c is the speed of light. From the study of the process in the system K' we know that the speed of the body B remains the same after the absorption of the wave packets S and S'.

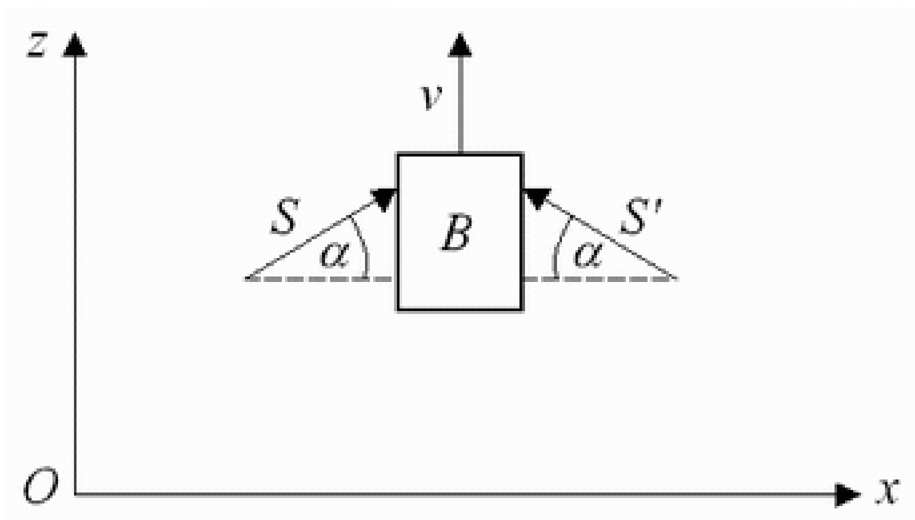

Fig. 23.3

Let us now apply the law on the conservation of a momentum of our system relatively to the z-axis in the reading system K.

I Let M be the mass of the body B until absorption; then Mv represents the expression for the momentum of the body B (in accordance with classical mechanics). Each wave packet has the energy $E/2$ and because of that, in accordance with Maxwell's well known theory, has the momentum of $\frac{E}{2c}$. Strictly speaking, that momentum of the wave packet S is relatively to the reading system K'. However, when the speed v is small relatively to c, then the momentum remains the same relatively to the system K with the accuracy up to small value of the second order ($\frac{v^2}{c^2}$ in comparison with 1). A component of that momentum along the z -axis equals $\frac{E}{2c}\sin\alpha$, or with the sufficient accuracy (if we neglect small magnitudes of higher orders) $\frac{E}{2c}\alpha$ or $\frac{E}{2}\frac{v}{c^2}$. Therefore the components of the momentums of the wave packets S and S' along the z -axis, taken together, equal $E\frac{v}{c^2}$. In that way the total momentum of the system until absorption equals

$$M v+\frac{E}{c^2}v \tag{23.55}$$

II Let M' be the mass of the body after the absorption. Earlier we have taken into account the possibility of mass increase with absorption of the energy E (that is essential so that the final result of our study should not be contradictory). Then the momentum of the system after the absorption will equal

$$M'\cdot v$$

Finally let us apply the law on the conservation of momentum in the direction of the z -axis. That gives the mutual relation

$$M v+\frac{E}{c^2}v=M'v \tag{23.56}$$

or

$$M'-M=\frac{E}{c^2} \tag{23.57}$$

That mutual relation expresses the law of equivalence of mass and energy, The increase of the energy E is connected with the mass increase by E/c^2. In so far that energy is usually determined with the accuracy up to additive constant, we can choose the last so that

$$E=M c^2 \tag{23.58}$$

End of quotation.

23.7 Objections to Einstein's derivation of the equation $E = mc^2$

In reference to the last two quoted papers a number of objections can be made in relation to the derivation and the derived equations on the basis of which Einstein gave the general conclusion that a body's mass is the measure of energy, that is that $E = mc^2$. However we shall concentrate on two important objections which will suffice to show that the relativistic way of derivation given in those papers was incorrect. The objections are as follows.

a) It is generally accepted among scientists that Einstein first gave a complete theory on the inertia of energy [Maks Born, Atomnaja fizika, str. 72, 1965.]. Reference is often made to his article "Does the inertia of the body depend on the energy contained in it?" which was published in 1905. As we saw above Einstein asserts that "if the body emits an energy L in the form of radiation then its mass decreases by L/c^2". Generalising from this Einstein concludes: "The mass of a body is the measure of the energy contained within it". However, he failed to prove the assertion in the article mentioned.

It is historically interesting that Einstein's conclusion that $E = mc^2$ as it was published in "Annalen Physik" was logically wrong. The conclusion is based on an argument that just would prove [20]. In this article, where Einstein attempts to prove that the mass of a body decreases when the body emits radiation, this loss of mass is not taken into account in the procedure by which the equation is derived.

Ives proved that Einstein derived the equation incorrectly [Journal of the Optical Society of America, 42, 540-543, 1952.]. We shall now summarise that proof. Ives's numbers of the equations are given on the left.

Ives found that Einstein derived Eq. (23.50) correctly, that is the next to come (23.59)

(1) $$(H_0 - E_0) - (H_1 - E_1) = L\left(\frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} - 1\right) \qquad (23.59)$$

and after that he says the following

Quotation: "However, if we mark with m_0 and m_1 the mass of the body before and after radiation respectively, then the kinetic energies of the body E_{k0} and E_{k1} relative to the system K' will be

(2) $$E_{k0} = m_0 c^2 \left(\frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} - 1 \right)$$ (23.60)

and

(3) $$E_{k1} = m_1 c^2 \left(\frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} - 1 \right)$$ (23.61)

At this point Einstein mistakenly states that $(H_0 - E_0) = E_{k0} + C$ and $(H_1 - E_1) = E_{k1} + C$ and in this way, by means of subtraction, and on the basis of Eq. (1) gets

(4) $$E_{k0} - E_{k1} = L \left(\frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} - 1 \right)$$ (23.62)

and as an approximation

(5) $$E_{k0} - E_{k1} = \frac{1}{2} \frac{L}{c^2} v^2$$ (23.63)

Taking into account Eqs. (2) and (3) he must get

(6) $$E_{k0} - E_{k1} = (m_0 - m_1)c^2 \left(\frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} - 1 \right) \tag{23.64}$$

which combined with Eq. (1) must give

(7) $$(H_0 - E_0) - (H_1 - E_1) = \frac{L}{(m_0 - m_1)c^2}(E_{k0} - E_{k1}) \tag{23.65}$$

or the two next relations would be treated as different

$$(H_0 - E_0) = \frac{L}{(m_0 - m_1)c^2}(E_{k0} + C) \tag{23.66}$$

and

$$(H_1 - E_1) = \frac{L}{(m_0 - m_1)c^2}(E_{k1} + C) \tag{23.67}$$

Comparing these equations with Einstein's equations $(H_0 - E_0) = E_{k0} + C$ and $(H_1 - E_1) = E_{k1} + C$ we see that Einstein inadvertently asserts that

(8) $$\frac{L}{(m_0 - m_1)c^2} = 1 \tag{23.68}$$

which, strictly speaking, should be proved [20]". **End of quotation.**

At the end of the above mentioned article Ives gives the following conclusion: "It emerges from Einstein's manipulation of observations by two observers because it has been slipped in by the assumption which Planck questioned. The relation $E = mc^2$ was not derived by Einstein."

From the above it becomes quite clear that Einstein did not present the theorem on the inertia of matter, or prove that $E = mc^2$ in his paper of 1905, although some known physicists continue to refer

to that paper. Relativists refuse to accept that Einstein made a mistake even when the mistake is evident.
The quoted Ives's article is sufficient for an estimate of the correctness of the Einstein's relativistic derivation of equations. However, Einstein's article and the relativistic way of the derivation of equation have also the others shortcomings.
b) In the chapter 21 of this book it was shown that the relativistic formulas for the Doppler effect are unacceptable and that they are more like a mathematical game than physics. This is particularly true for the case of relativistic speeds. In his paper [5] Einstein gave relativistic formula (21.13) for the Doppler effect for the frequency of reception when the receiver of radiation is in motion, and the source of radiation is at rest, as well as the formula (21.14) for the case when the source of radiation moves, and the receiver of radiation is at rest.

In Einstein's first paper, here quoted, he stated that the radiating body is at rest in the system (x, y, z) which is at rest. In that case the energy of light waves in the system (x', y', z') which moves with uniform translation relatively to the system (x, y, z) is given by Eq. (23.48). On the basis of that equation the final Eq. (23.53) was derived.
In case of two or more systems, which move relatively to each other, there is no possibility of determining which system is at rest and which of them moves. It can only be established that the systems move relative to one another, that is that one moves relatively to the other and that for each of them can be equally claimed to be at rest and to be moving.
According to the theory of relativity which rejected the ether as an absolute system, all inertial systems are equal. Therefore, in case of two inertial systems we can analyze some physical phenomena in two ways, that is by observing that phenomenon from one or the other system. Obviously, the event should be in one system, and the observer in the other. According to the theory of relativity the result of the analysis must not depend on which system the event is observed from, because all inertial systems are equal. By the way, in connection with this Einstein, in the first quoted paper, himself wrote: "The laws, according to which the states of physical systems change, do not depend from that on which of the two coordinate systems, moving with uniform translation relatively to each other, this changes of state refer to." In the spirit of this let us put a source of radiation of plane waves, from the first quoted paper, in the system (x', y', z') so that it is at rest in that system, which moves. In that case, according to the Eq. (21.14), the energy of light waves measured in the system (x, y, z) is

$$L = L_0 \frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \frac{v}{c}\cos\alpha} \tag{23.69}$$

By using the Eq. (23.69) in the same way as it was used in the first quoted paper Eq. (23.48) and in the same procedure of deriving equations we get the next equation for kinetic energy

$$E_{k0} - E_{k1} = L\left(\frac{\sqrt{1-\frac{v^2}{c^2}}}{1-\frac{v^2}{c^2}\cos^2\alpha} - 1\right) \qquad (23.70)$$

which is significantly different from the responding Eq. (23.53) in the quoted paper, which also proves that the procedure of relativistic derivation of the equation for kinetic energy is not correct. The final result depends on whether the radiation is in the system at rest or in the system which moves. Since we cannot say which system is at rest, and which one moves, then we cannot claim which of the two different equations is correct. If the theory was good the equations would have the same form in both cases.

c) On the basis of the equation for kinetic energy (23.53) Einstein draws a general conclusion, which cannot be accepted without some reserve. So, by using the equation

$$\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = 1 + \frac{1}{2}\frac{v^2}{c^2} + \frac{3}{8}\frac{v^4}{c^4} + \frac{5}{16}\frac{v^6}{c^6} + \ldots$$

he takes the first two elements of the order and he neglects the others, which must not be done in the case of higher speeds. For example, with $v = 0.8c$ the value of neglected elements of the order is greater than the taken element $\frac{1}{2}\frac{v^2}{c^2}$. With that kind of selection he reaches a corrected equation for kinetic energy and compares it with the classical equation

$$E_{k0} - E_{k1} = \frac{1}{2}\frac{L}{c^2}v^2 = \frac{1}{2}mv^2 \qquad (23.71)$$

From this comparison he concludes that $m = \frac{L}{c^2}$, that is $m = \frac{L}{c^2} = \frac{E}{c^2}$, and from there that $E = mc^2$. So, he took a small speed, used in classical equations and very small energies, which refer to small mass defects, that is the mass, which an electrically charged particle gains or loses with the change of the speed of motion. On that basis, which is definitely uncertain, he draws a general conclusion.

This applies particularly when we take the following into consideration. According to Heaviside the energy contained in the mass of an electron at rest is given by Eq. (23.43) which runs $E = \frac{3}{4} m_0 c^2$. However, for the proton as the first composite stable and positively charged particle, that formula does not apply because, according to Eq. (23.41) from which Heaviside's Eq. (23.43) is derived, the proton would have to have a radius 1836.16 times smaller than the radius of the electron. It is believed, however, that these particles have roughly the same radius. In addition, the equation $E = mc^2$ does not refer to the mass of an electron at rest or a body in general, but rather electromagnetic mass which is attributed to the energy of the electromagnetic field created by the movement of a charged particle.

d) The other quoted paper does not belong to the theory of relativity because "it does not demand the application of a formal apparatus of theory, but relies only the three laws known from before," as Einstein says himself.

Nevertheless, let us consider the way Einstein derives the equations and conclusions.

This derivation is not in accordance with classical physics nor with the theory of relativity.

It is necessary to be reminded of some facts, connected to the classical and relativistic explanation of aberration, before an analysis of the Einstein's way of consideration of the process and derivation of equations.

According to the classical explanation of aberration, light rays from a star are approaching to the moving observer from the direction of the real position of the observed star. Because of that, there is no aberration of the light rays at their approach to the some body or telescope. Aberration seemingly originates while the light rays are passing through the telescope. However, the light rays do not change the direction of motion while passing through the moving telescope, too (See chapter 22.1).

The determination of the angle of aberration and explanation of the phenomenon of aberration in relativistic procedure is based on two coordinate systems which relative move. At that, it is taken that the first system is at rest and the second is moving, so that the source of the light is at rest in the first system, and the observer is at rest in the moving system. Aberration is originating in the moving system and the light rays approach to the observer, body or telescope from the direction of the seeming position of the observed star.

Einstein starts to consider the process using two coordinate systems K and K' which relative move. In consideration of such start the procedure should be relativistic.

However, Einstein puts the body B and the sources of the wave packets S and S' in the same system K' which is at rest (See Fig. 23.2). Because of that, the consideration of the process is neither classical nor relativistic.

At such arrangement, the body B absorbs the wave packets and stays in the balance because of symmetry of the effect of the wave packets. After that, he takes that the body B moves by velocity v relative to the system K. The system K' does not exist in the farther consideration (See Fig. 23.3). Then, he takes that the aberration allegedly originates relative to the system K, because the body B moves in this system. So, the wave packets allegedly reach the body B at an angle $\beta = 90 - \alpha$, where α is allegedly the angle of aberration. However, as it is said before, according to the classical explanation of aberration, this angle β does not change at motion of the body B and must be 90 degrees. Apart from that he is taking that absorbing body B and the sources of the wave packets are in the same coordinate system, and aberration originates in the system at rest. It is two big mistakes at the same time. Because of that, farther consideration of this process and derivation of equations do not make sense.

But, the problem is not only in the misconception of aberration and application of aberration. There are also the other incorrectnesses in this article. For example, he did some neglecting in the derivation of equations and in this way he got incorrect, but wished result.

In deriving the Eq. (23.72) he uses components of energies of wave packets in the direction of the body B motion, which are the result of allegedly aberration. At that, he does not take into consideration the decrease of absorbed energies because of a retreat of the body B from the sources of the wave packets. In this way he finds total impulse of energy in system K in the direction of the z -axis.

$$P_{vz} = \frac{E_{vz}}{c} = 2 \cdot \frac{E}{2c} \sin\alpha \approx E\frac{v}{c^2} \qquad (23.72)$$

where α is an angle of allegedly aberration in the system K given by classical equation.

After that he applies the law of conservation of the impulse in the direction of the z -axis and yields

$$M\,v + \frac{E}{c^2}v = M'v \qquad (23.73)$$

and from there

$$\Delta m_{K'} = M' - M = \frac{E}{c^2} \qquad (23.74)$$

where M is the mass of the body B before absorption of energy of the wave packets and M' is the mass of the body B after absorption of that energy. On the base of it Einstein gave general conclusion

$$E = M\,c^2 \quad \text{that is} \quad M = \frac{E}{c^2} \qquad (23.75)$$

In deriving the Eq. (23.72) Einstein did not take into consideration the decrease of absorbed energy of the wave packets caused by the retreat of the body B from the sources of the wave packets in conformity with Eq. (21.3). If he had done this he would have got that Eq. (23.75) reads

$$\Delta m_K = M' - M = \frac{E}{c^2}\left(1-\frac{v^2}{c^2}\right) \tag{23.76}$$

Eq. (23.76) shows that even thought incorrect mixture of classical and relativistic procedure do not yield wished results. Besides, from Eq. (23.76) results that the mass of the body decreases when its velocity increases. Such finding is wrong and unacceptable.

Finally, let us suppose that everything is correct in connection with the comprehension of aberration and its application in this article, and let us apply relativistic procedure with the use of classical equation of aberration. Then, the absorbed energy of the wave packets in the direction of the body B motion, in conformity with Eq. (21.13), will be

$$E_{zK} = E\,\frac{1-\dfrac{v^2}{c^2}}{\left(1-\dfrac{v^2}{c^2}\right)^{1/2}} \tag{23.77}$$

and the momentum of that energy

$$P_{zK} = \frac{E}{c^2}v\,\frac{1-\dfrac{v^2}{c^2}}{\left(1-\dfrac{v^2}{c^2}\right)^{1/2}} \tag{23.78}$$

In transforming the mass from system K' to system K he have to decide which mass to take into consideration, the longitudinal mass or the transversal. Naturally this is valid only on condition that any body has the two mentioned masses in the same way as an electron in motion.

We have noted before that the electron has a longitudinal mass which resists changes in speed in the direction of motion and a transversal mass that resists deviations from the direction of motion. Relativists assert that the equation valid for the electron, as a charged particle, is also valid for neutral particles and for bodies in general. Sticking to this, and bearing in mind that the action on the momentum of the energies is in the direction of motion of the body B, we are was obliged to take the longitudinal mass into account. In that case we will conclude that the mass of the body B in system K, given by Lorentz's Eq. (23.3) is

$$m_K = \frac{m_{K'}}{\left(1-\frac{v^2}{c^2}\right)^{3/2}} \tag{23.79}$$

Using Eqs. (23.78) and (23.79) and the law on the conservation of momentum in the direction of the z -axis in the system K we obtain

$$\frac{m_K v}{\left(1-\frac{v^2}{c^2}\right)^{3/2}} + \frac{E}{c^2} v \frac{1-\frac{v^2}{c^2}}{\left(1-\frac{v^2}{c^2}\right)^{1/2}} = \frac{m_K + \Delta m_K}{\left(1-\frac{v^2}{c^2}\right)^{3/2}} v \tag{23.80}$$

and from there

$$E = \frac{\Delta m_K c^2}{\left(1-\frac{v^2}{c^2}\right)^2} \quad \text{or} \quad \Delta m_K = \frac{E}{c^2}\left(1-\frac{v^2}{c^2}\right)^2 \neq \frac{E}{c^2} \tag{23.81}$$

The conclusion given by Eq. (23.81) is completely unacceptable, since in this case the increase in mass $\Delta m_{K'}$ of the body B in system K', caused by the absorption of energy by the body B in system K', depends on speed v of any system K relative to the system K'. Besides, from Eq. (23.81) results that the mass of the body decreases when its velocity increases.

The transversal mass can be taken into consideration in the quoted derivation of the desired equation, since the relativists use it in the case of the longitudinal motion as well. Then the mass of the body B in system K would be attained using Lorentz's equation

$$m_K = m_{K'}\left(1-\frac{v^2}{c^2}\right)^{-1/2} \tag{23.82}$$

Using Eq. (23.82) to accomplish the same procedure for the derivation of the desired equation we get

$$\frac{m_K v}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}+\frac{E}{c^2}v\frac{1-\frac{v^2}{c^2}}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}=\frac{m_K+\Delta m_K}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}v \tag{23.83}$$

and from there

$$E=\frac{\Delta m_K c^2}{1-\frac{v^2}{c^2}} \quad \text{or} \quad \Delta m_K=\frac{E}{c^2}\left(1-\frac{v^2}{c^2}\right)\neq\frac{E}{c^2} \tag{23.84}$$

The equation derived, (23.84) cannot be accepted either for the reasons given above in connection with Eq. (23.81).

At the end the following can be said. Einstein did not derive the equation for a body's total energy $E=mc^2$ on the basis of the theory of relativity, hence that equation cannot be considered as a product of that theory. It was developed by generalization on the basis of the equation for an electron's kinetic energy $E=\Delta mc^2$, which is also not a product of the theory of relativity. Besides it was concluded that the energy of a particle is not only proportional to the change in the moving particle's mass but that it is also proportional to the particle's total mass, and also that the energy of a body is proportional to the body's mass on the whole. In that way a daring conclusion was made that the energy of a body is the measure of its mass and vice versa. That this is really so was allegedly confirmed by the annihilation of matter and antimatter.

It is believed that the best example for the total transformation of matter into energy and energy into matter is the annihilation of electrons and positrons at the moment of their collision and the appearance of electron - positron pairs at irradiation a matter with gamma rays, whose energy is greater than 1.022 MeV. However, in chapter 26 of this book it will be shown that the annihilation of electrons and positrons does not exist, the same as the transformation of their total mass into energy of the gamma radiation does not exist. Therefore one should be very careful and accept with reserve the proposition that the total energy of a body equals the product of its total mass and the speed of light squared. It seems that it is still unknown how much energy is concentrated in the mass of a particle at rest, nor in the mass of a body as a whole.

23.8 The derivation of the equation $E=mc^2$ by the classical procedure

Equation $E=mc^2$ which defines the relationship between mass and energy, is not a relativistic equation but purely classical. I have derived that equation according to the correct classical procedure, using well-known physical laws that have been confirmed many times in practice.

Maxwell put forward the theory that the energy flux of electromagnetic radiation behaves as if it contains a momentum that exerts pressure on obstacles to the propagation of that radiation which can be defined by the equation

$$p = \frac{E}{c}(1 + R) \tag{23.85}$$

where E is the energy of the radiation which falls on a unit of the surface of a body, in a unit of time, c is the speed of light and R is the coefficient of reflection of the body's surface.

Maxwell also theoretically explained the phenomena of the pressure exerted by electromagnetic radiation and determined its magnitude. Later, the pressure exerted by radiation was confirmed experimentally. We can see the pressure exerted by radiation in nature when a comet develops a tail. The head of a comet, which consists of one or more large solid parts, always points towards the sun. The tail, which consists of gasses and ice particles streams away from the sun. This is the result of the pressure exerted by solar radiation on the gasses and particles of the tail.

The equation $E = mc^2$ can be derived by correct classical procedures, using the phenomena of the pressure exerted by electromagnetic radiation.

The equation has indeed been derived on the basis of the pressure exerted at the total absorption of light. The derivation of the equation $E = mc^2$ on the base of the total absorption is less convenient. The reason for this is the impossibility of determining the quantity of the absorbed energy spent in the mechanical work under the force of the pressure of radiation. We know that the energy absorbed from the radiation is expended in heating the body and on mechanical work, but we do not know in what proportion.

I derived the equation $E = mc^2$ using the phenomena of the pressure of light at total reflection [The concept of the total reflection of radiation is understood as the reflection of light at which the energy of the incoming light is equal to the sum of the reflected energy and the energy spent in mechanical work.], the Doppler effect and Plank's law, as follows.

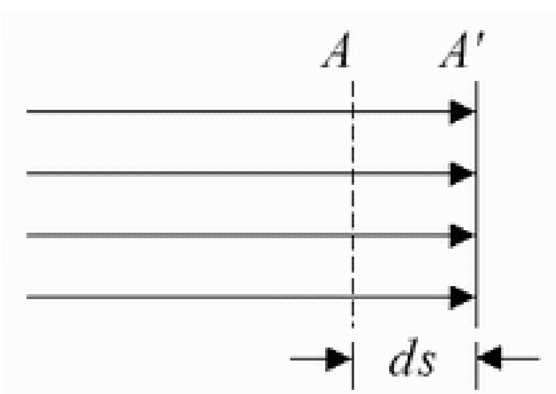

Fig. 23.4

Let us assume that light with energy dE and frequency f, falls at an angle of 90° onto a thin, moveable, totally reflective plate of area S. The plate moves from point A to point A' over a distance ds, under the pressure of the light radiation, as shown schematically in Fig. 23.4. The greater part of the incoming energy which we denote dE_{1R} is reflected back. A very small part dE_{2R} is spent on the mechanical work needed to move the plate from A to A'.

If p is the pressure exerted by the light, then pS is the force of the pressure on the area S, and the mechanical work realised

$$dE_{2R} = p\,S\,ds \tag{23.86}$$

If the flow of light is constant over the time dt, then the force of the pressure is constant too. In these circumstances, the plate will accelerate with the mean velocity v_s. In this case we have

$$dE_{2R} = p\,S\,v_s\,dt \tag{23.87}$$

from which we get (23.88)

$$dE_{2R} = v_s\,dP_i \tag{23.88}$$

where dP_i is the momentum transferred to the reflective plate through the pressure exerted upon it by the light rays over time dt.

The reflective plate will retreat under the pressure of the radiation. Therefore, the frequency of the light radiation that falls on the plate, which as receiver of radiation retreacts, is

$$f_P = f\left(1 - \frac{v_s}{c}\right) \tag{23.89}$$

According to Huygens' law the irradiated plate becomes the source of radiation. In compliance with this and bearing in mind that the reflective plate, as the source of radiation is retreating, we can write that the frequency of the reflected radiation is

$$f_R = f_P \frac{1}{1+\frac{v_s}{c}} = f \frac{1-\frac{v_s}{c}}{1+\frac{v_s}{c}} \tag{23.90}$$

According to Planck's law, the energy of a light wave is proportional to its frequency. As a result of this and in the light of Eq. (23.90) the energy of the reflected radiation is

$$dE_{1R} = dE \frac{1-\frac{v_s}{c}}{1+\frac{v_s}{c}} \tag{23.91}$$

Using Eq. (23.91) and taking into account that $v << c$ we get

$$dE_{2R} = dE - dE_{1R} = dE - dE \frac{1-\frac{v_s}{c}}{1+\frac{v_s}{c}} \approx 2\frac{v_s}{c} dE \tag{23.92}$$

From Eqs. (23.88) and (23.92) we have

$$\int_0^{P_i} dP_i = \frac{2}{c} \int_0^{E} dE \tag{23.93}$$

and from there

$$P_i = 2\frac{E}{c} \tag{23.94}$$

If we ascribe a certain mass m , to the energy of light, and bearing in mind that on the reflection of light elastic collision occurs, then we can conclude that the momentum transferred to the small reflected plate, is equal to double the momentum of the mass ascribed to the light energy. So we can write

$$P_i = 2mc \tag{23.95}$$

From Eqs. (23.94) and (23.95) we have

$$2\frac{E}{c} = 2mc \tag{23.96}$$

and from there, finally

$$E = mc^2 \tag{23.97}$$

By the way, according to Maxwell's well known theory, as we said before, the energy flux E of electromagnetic radiation possesses an momentum E/c. On the base of that Poincare concluded that $E/c = mc$ and from that $E = mc^2$, where m is the mass ascribed to the energy E.

And thus it is clear that the equation which describes the relationship between mass and energy, $E = mc^2$, is a classical equation. It is not a relativistic equation because it has not been, nor can it be derived according to correct relativistic procedure.

23.9 The derivation of the equation $m = m_0 / \sqrt{1 - v^2/c^2}$ by the classical procedure

The equation $E = mc^2$, which was derived in the previous chapter, is used to derive the equation $m = m_0 / \sqrt{1 - v^2/c^2}$. This is done because it is well known that electromagnetic radiation acts on electrons by exerting pressure. In this way the electron receives energy which is transformed into mechanical work, i.e. the motion of the electron, which changes the mass of the electron in relation to its velocity of motion. Such interaction between an electromagnetic field and an electron are well known as the photoelectric effect, or Compton's effect.

According to Newton's second law

$$F = ma = m\frac{dv}{dt} \tag{23.98}$$

from which follows

$$F\,dt = m\,dv \tag{23.99}$$

or

$$F\,dt = d(m\,v) \tag{23.100}$$

If the mass changes with the velocity, as it does with an electron or some other electrified particle, then

$$F\,dt = v\,dm + m\,dv \tag{23.101}$$

The work of the force F on the path ds is equal to the spent energy dE so that

$$dE = F\,ds = F\,\frac{ds}{dt}dt = F\,v\,dt \tag{23.102}$$

By multiplying Eq. (23.101) with v we get

$$F\,v\,dt = v^2\,dm + m\,v\,dv \tag{23.103}$$

From Eqs. (23.102) and (23.103) we have

$$dE = v^2\,dm + m\,v\,dv \tag{23.104}$$

[Eq. (23.104) can also be derived in this way:
$dE = Fds = \dfrac{d(mv)}{dt}ds = d(mv)\dfrac{ds}{dt} = (vdm + mdv)v = v^2dm + mvdv$.]

If E is the energy of the electromagnetic radiation, then, according to Eq. (23.97)

$$dE = c^2\,dm \tag{23.105}$$

because the speed of light is constant.

From Eqs. (23.104) and (23.105) we get

$$c^2\,dm = v^2\,dm + m\,v\,dv \tag{23.106}$$

After separation of the variables we have

$$\frac{dm}{m} = \frac{v\,dv}{c^2 - v^2} \tag{23.107}$$

Since, at the speed $v = 0$, the mass of an electron is equal to its mass at rest m_0, and at speed v its mass is equal to the mass m, we can write

$$\int_{m_0}^{m} \frac{dm}{m} = \int_{0}^{v} \frac{v\,dv}{c^2 - v^2} \tag{23.108}$$

and from there

$$\ln m \Big|_{m_0}^{m} = \frac{1}{2} \ln\left(c^2 - v^2\right) \Big|_0^v$$

Substituting the limits we get

$$\ln m - \ln m_0 = -\frac{1}{2}\left[\ln\left(c^2 - v^2\right) - \ln c^2\right]$$

that is

$$\ln \frac{m}{m_0} = \ln\left(\frac{c^2 - v^2}{c^2}\right)^{-\frac{1}{2}} = \ln \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

and finally

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

or

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (23.109)$$

So another very important, allegedly relativistic equation, which cannot be derived by correct relativistic procedure using two inertial coordinate systems moving relative to one another, can be derived according to purely classical procedure. Like $E = mc^2$, this is not a relativistic but a purely classical equation.

In connection with these two equations it is necessary to discuss some seeming contradictions.

According to Eq. (23.109) every mass which moves at the speed of light is infinitely large. Therefore the Eq. (23.109) conflicts with Eq. (23.97) even though this Eq. (23.109) was derived from Eq. (23.97). From this it necessarily results that the photons and also the energy of electromagnetic radiation have no mass at all. It also means that electromagnetic radiation is not corpuscular in nature but only wave like. Because of this we said above that the mass m was ascribed to the energy of light E, but not that the energy of light E possessed mass m.

The pressure exerted by light, or by electromagnetic radiation in general, is not the result of some real mass, contained in the radiation which moves at the speed of light. The pressure exerted by light is the result of the electromagnetic wave action on the reflecting conductible layer in the following way.

The electric field of the electromagnetic wave acts by force on the free electrified particles in the conductible layer and causes them to move. Well known Lorentz force acts on electrified particles because of their motion in the magnetic field of the electromagnetic wave. This force is transmitted to the conductible layer and manifests itself as the pressure exerted by electromagnetic radiation. The electric and magnetic field of the electromagnetic wave also acts on the ions and electrified particles bound to the atom. Under the influence of the electric field of an electromagnetic wave displacement of bound electrified particles occurs in insulators, creating a displacement current.

In fact, the mass that we ascribe to the energy of radiation is electromagnetic mass and is, in fact, the energy of the electromagnetic field generated by electrified particles in motion. Only such a "mass", electromagnetic mass or the energy of an electromagnetic field, can move at the speed of light only and not increase to infinity at this speed.

Consequently, if by mass it is understood electromagnetic mass or the energy of an electromagnetic field, then Eqs. (23.109) and (23.97) do not conflict. Therefore, the derivation of Eq. (23.97) using the phenomenon of the Doppler effect, and the total reflection of light radiation, and also the derivation of Eq. (23.109) on the basis of Eq. (23.97), are logical and correct. The two equations are closely connected and express the connection between electromagnetic mass and electromagnetic fields, so that the energy of the electromagnetic field is equal to the electromagnetic mass and the second power of the speed of light. Therefore Eq. (23.97) should read

$$E = \Delta mc^2 = (m - m_0)c^2 = m_{em}c^2 \tag{23.110}$$

where m_{em} is the electromagnetic mass.

According to Eq. (23.110) we should take the mass of the electron (or some other electrified particle) at velocity $v = 0$ to be equal to the mass m_0, and at velocity v its mass is equal to the mass $m = m_0 + m_{em}$. In which case Eq. (23.108) would read

$$\int_{m_0}^{m_0 + m_{em}} \frac{dm}{m} = \int_0^v \frac{vdv}{c^2 - v^2} \tag{23.111}$$

Solving Eq. (23.111) we get

$$m_{em} = m_0 \left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right) \tag{23.112}$$

Electromagnetic mass is the apparent increase in the mass of an electron with velocity. As a result we can say that the total mass of an electron contains the electromagnetic mass m_{em} and mass at rest m_0, and that the electromagnetic mass leaves the electron in the form of electromagnetic radiation as its speed of motion falls (by braking, on transition from orbit to orbit, or in some other way).

The velocity v, in Eqs. (23.98) to (23.112), is the velocity of motion of an electron relative to an ether in which the electron moves.

As it is well known that the charge of an electron is negative and the charge of a proton is positive. However, absolute values of the magnitudes of these two charges are equal. From this results that an electron and a proton will generate the magnetic fields equal magnitude at the same velocity of motion. Consequently, the increase of an inertia of the proton in motion must be equal to the increase of the inertia of the electron in motion. Therefore, the equation (23.112), which relates to the electromagnetic mass of an electron in motion, for the proton in motion would read

$$m_{emp} = \frac{m_{0p}}{1836.15}\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}-1\right) \tag{23.113}$$

For the same reason, equation (23.109), which relates to the total mass of an electron in motion, for the proton in motion would read

$$m_p = m_{0p}\left(1+\frac{1}{1836.15}\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}-1\right)\right) \tag{23.114}$$

The correctness of equations (23.113) and (23.114) can be experimentally proved by measurement of the wavelenght of the braking radiation which originates at the brake of motion of a proton got by ionization of hydrogen. The proof of the correctness of these two equations would be great contribution to physics in comprehension of the conception of allegedly change of mass of the body in motion, and also great contribution in comprehension of mutual relation of mass and the energy.

23.10 The pressure of electromagnetic radiation, the red shift and the cosmic rays

The stars emit a continuous spectrum and also line spectrums. From the position of the lines in the spectrum of the radiation from a star we can determine the chemical composition of the star, since every element has a distinctive pattern of lines in its spectrum. The line nature of these spectra make possible to calculate the velocity of the approach or retreat of the star using equation for the Doppler effect

$$v_{rad} = \pm c\frac{\lambda - \lambda_0}{\lambda_0} = \pm c\frac{\Delta\lambda}{\lambda_0} \tag{23.115}$$

where λ_0 is the wavelength of radiation when the source of radiation is at rest, relative to the observer, λ is the wavelength of radiation when the source of radiation is moving relative to the observer and c is the speed of light.

If the body emitting the radiation is retreating from the receiver - observer , then the observer will notice that the lines shift towards the red end of the spectrum by $\Delta\lambda$. This shift of the lines in the spectrum of starlight is termed red shift. The red shift increases with the radial speed of the star as a source of radiation, that is with the velocity of its retreat. If the star is moving towards the observer a blue shift will occur.

When Hubbell studied the spectra of the radiation from distant galaxies in 1929, he discovered that the characteristic lines in the spectrum of this radiation shifted, en-mass, to the infrared without changing their relationship. Hubbell also observed that the greater the distance of the observed galaxy, the greater the red shift. On the basis of this observation it was concluded that the farther away the galaxy, the faster it is retreating, which means that the universe is expanding. The next conclusion drawn was that this expansion must have had its beginning. Thus came about the big bang theory in which the cosmos was "born". Some astronomers assert that, at that moment, space, matter and time came into existence. It is also asserted that, before the big bang, all the matter in today's cosmos was concentrated in "primordial atom", whose density was about 10^{96} kg/m^3 [16] and which was considerably smaller that the size of an electron.

In this way we have come to the conclusion that today's universe is spatially limited, that is, it contains a limited amount of matter and has a limited age. Einstein asserted the same. Accepting Friedman's [A. Friedmann, Zeitschr. f. Phys., 10, 377, 1922.] method, he calculated that the hypothetical density of the matter in the universe was $\rho \approx 3.5\cdot10^{-23}$ g/cm^3 and that the universe is $1.5\cdot10^9$ years old. He claimed that the cosmos is spatially limited in the form of a hypersphere, the volume of which is $V = 2\pi^2 a^3$ and the radius

$$a = \sqrt{1.08\cdot10^{27}\,\frac{1}{\rho}} \tag{23.116}$$

Today, Einstein's calculations, as given above, are not considered acceptable. The universe is now considered to be much older and larger. This succeeded thanks to the discoveries that have made possible the use of much better observation instruments and methods which have enabled the discoveries of more distant galaxies and thus changed outwards limits of the universe in time, space and quantity of matter.

So, it turns out that the cosmos is so big as far as we are able to see it. Many allegedly great scientists accept this strange assertion that the cosmos is limited and that its dimensions enlarge.

All the above mentioned conclusions are based on the accepted explanation of the red shift. According to this explanation the red shift is the result of the expansion of the universe, or better put the dispersion of the universe. No other explanation of red shift has been discovered.

However, astronomers discovered, on the base of red shift, that the velocities of removing of the most distant quasars are about 5.8 times higher that the speed of light. This finding disputes Hubble's hypothesis about the cause of the red shift, since the speed of light is a maximum possible speed.

In order to accept the assertion that the cosmos was born in the big bang we must address the question of what existed before. Regretfully, no such explanation has been forthcoming, and there is no logic in the assertion that the whole substance of the universe was concentrated in the "first atom" for an infinitely long time.

At the same time, in order to accept the idea that the universe is expanding and is spatially limited, we must consider the question of what is beyond its present limits. Some may say that there is nothing, but that in turn begs the question, of whether anything can or does exist in that nothing. For example, does the electromagnetic radiation from the most distant, or other galaxies in some way penetrate this void?

If electromagnetic radiation spreads beyond these bounds, which it is quite logical to accept, since the speed of light is higher than the radial velocities of the galaxies and starlight propagates in all directions, then electromagnetic radiation at least, has to exist outside the so called limits of the universe.

If the galaxies originated in a big bang, then it would be logical to expect their velocities to decrease with distance from the place of origin as a result of the constant effect of gravitational forces originating from the remained mass of the radially dispersing matter. However, allegedly opposite occurs.

Physicists and astronomers have not an acceptable explanation for this paradox. In connection with the spreading of the cosmos and dispersion of galaxies Einstein gave very strange hypothesis. According to that hypothesis the antigravitation exists as well as gravitation.

The proponents of the big bang say that in the cosmos there are about 10 billions galaxies and in each of them about 10 billions stars, whose average mass is aproximately equal to the mass of the sun. If the total mass of the cosmic gases and dust and the other cosmic bodies is greater even four times than the mass of all stars in the cosmos is, then the total mass in the cosmos would be about 10^{51} kg. If the density of the mass in the primordial atom was 10^{96} kg/m^3, as the proponents of the big bang say as well, then the volume of the primordial atom was 27 times smaller that the volume of an electron, or $6 \cdot 10^{14}$ times smaller than the volume of the smallest atom.

It is more logical to postulate that after the big bang comes a big collapse, and after the big collapse again a big bang and so on ad infinitum. This would constitute some form of natural process of birth and death for galaxies, or groups of galaxies, but not for the whole universe.

The history of science is full of incorrect assertions and hypothesise. The science of astronomy is no exception. For example, astronomers started with a geocentric system and moved on, via the heliocentric system to the big bang.

At the same time, many experiments have been performed that failed to produce the desired results. The Michelson - Morely experiment is a case in point, it has been repeated many times without a positive result. Sometimes experiments produce quite unexpected results, as was the case with the Fizeau's test. Indeed, far more experiments produce negative results than positive.

Assertions about the limits of the universe and its age, or its origin in a big bang are difficult to accept without serious reserve. In connection with this I do not believe that the galaxies are dispersing radially, but that their courses of motion are governed by the gravitational forces originating from other galaxies. As a result, the red shift in the spectrum of their radiation cannot be the result of the Doppler effect, caused by radial dispersion, and must be due to some other cause. Accordingly, I have dared to put forward a new hypothesis on the cause of the red shift and a test that might confirm the hypothesis. True, the chances of success for such an experiment are small, but nonetheless I think it would be worth performing.

The interaction of photons and cosmic rays could be the cause of the red shift. It is known that the photoelectric effect or Compton's effect and the phenomena of the pressure exerted by light are based on the interaction of photons and electrified particles, where the photons deliver part or all of their energy to the electrified particles.

Primary cosmic rays consist of protons, alpha particles, electrons and other electrified particles. Appearance of those electrified particles in the cosmos is the result of the ionization of cosmic gases (hydrogen, helium and the others) upon the influence of electromagnetic rays (γ -rays, X-rays, UV-rays), which originate at the nuclear and other processes in the stars. Besides, high energy cosmic rays, produced in this way, perform the ionization of the cosmic gases too, and thus produce new cosmic rays.

When photons interact with these rays, part of their energy is transferred to the electrified particles. At this point the photon loses energy, and thus, its wavelength is increased. The greater the distance, that the photon travels through the universe, the greater the chances that it will interact with electrified particles. The more interactions of this type the greater the energy loss for the photons and consequently, the greater the red shift. Thus, the fact that photons from the most remote galaxies have the greatest red shifts is not a result of the Doppler effect caused by the dispersion of those galaxies. The universe is not expanding, and if that is the case, we have to accept that there was no beginning of that expansion; in other words, the big bang did not occur. All the theories about the birth of the universe with the big bang and the temporal and spatial limitations of the universe may in fact be groundless.

The blue shift observed in the spectra of some galaxies may only occur in the case of relatively close galaxies that are moving towards the earth. In these circumstances the blue shift may indeed be caused by the Doppler effect which would cancel out the red shift caused by the interaction of electromagnetic radiation from these galaxies with cosmic rays.

The energies of the cosmic rays can be up to 10^{20} eV. Up to now there was no acceptable explanation of the origin so enormous energies of the cosmic rays. However, in order to explain this phenomenon, we must know that at every collision of a photon and electrified particle (cosmic ray) in the cosmos, the photon gives over a part of its energy to electrified particle, and shifts to red. Therefore, if we have this in mind then we can assert that the origin of the enormous energies of the cosmic rays can be also explained by the numerous interaction of the cosmic rays and photons (γ-rays, X-rays, UV-rays, and so on).

Electromagnetic radiation also exerts pressure on particles of matter, molecules and the atoms of gasses. As we mentioned before, this phenomena is well known and can be seen in the tails that comets develop at perihelion. In this case a portion of the energy of the solar radiation is spent on mechanical work in the pressure exerted by the radiation on the tail of the comet. Due to the energy loss at this point the wavelength of the radiation is increased, resulting in a red shift in the spectra of reflected radiation.

When radiation and particles of matter or gasses interact the scattering of the radiation only occurs when the particles of matter or the molecules of the gas are large enough in relation to the wavelength of the radiation, otherwise, the interaction takes place without the occurrence of scattering. For example, a particle 20 nanometers in diameter will scatter as much light as 10^{12} separate atoms. Raleigh found that the scattering of light radiation by the molecules of atmospheric gases is proportionate to the fourth power of the wavelength of the radiation. This factor $1/\lambda^4$ shows that the scattering blue radiation ($\lambda \approx$ 400 nm) is six times greater than the scattering of red colour ($\lambda \approx$ 640 nm). As a result, the molecules of the upper atmosphere for the most part, scatter radiation blue in colour, which gives the sky its blue shade.

The scattering of electromagnetic radiation in the earth's atmosphere is a consequence of the interaction between the electrical and magnetic field of electromagnetic radiation and charged particles, free, or bonded to atoms, molecules and particles of matter.

In the process of scattering of radiation in the molecules of a gas or the particles of dust or smoke the molecules and particles are forced to retreat by the pressure of the radiation. As a result the Doppler effect is observed in the scattered radiation, that is, a red shift is observed in the spectrum of the scattered radiation. The magnitude of the red shift is proportional to the speed of the retreat and the velocity of the retreat is proportional to the energy of the radiation spent in the mechanical work performed under the influence of the pressure force of the radiation. However, when discussing the scattering of light by the molecules of gasses we should bear in mind that the scattering occurs in the direction of the movement of the radiation as well. It is clear that during the interaction of electromagnetic radiation with the charged particles in the molecules of a gas, the energy of the radiation is expended in mechanical work. This work is performed during the exertion of pressure by the radiation upon the molecules of the gas. In conformity with Planck's law an increase in the wavelength of the radiation occurs.

Consequently we arrive at the conclusion that the red shift may also be the result of interaction between electromagnetic radiation and the charged particles in the atoms and molecules of gases in the universe. Similarly we can conclude that the red shift may also appear in the spectrum of solar radiation after the passage of that radiation through the earth's atmosphere.

The radiation from the sun is more and more red as the sun nears the horizon. This is the result of the greater attenuation of radiation at shorter wavelengths due to dispersion and absorption by particles of dust and smoke and gas molecules in the atmosphere. Also the rays of the sun are passing through the lower layers of the atmosphere close to the ground where the dust and smoke particles and gasses are most concentrated. It is possible that a red shift occurs at this stage, due to the interaction of solar radiation with the electrified particles and gas molecules in the atmosphere. It should also be remembered that the gasses of the atmosphere are partially ionised, and that the atmosphere contains free charged particles.

It is obvious that the distance travelled by the rays of the sun through the ground layer of the earth's atmosphere is negligible in comparison with the distance travelled by light from some star. The density of the atmospheric gasses near the earth's surface is, however much greater than in intergalactic space. As a result we still cannot exclude the possibility of a slight red shift in the spectrum of solar radiation at sunrise and sunset. In order to detect such a red shift it would be necessary to have readings for the spectrum of solar radiation from above the earth's atmosphere, and to obtain a mean value for the position of the lines in the sun's spectrum at sunrise and sunset. The spectrum of solar radiation would be taken on the same plane, at sunrise and sunset to ensure that the distance travelled by the solar radiation through the earth's atmosphere is the same. It would be necessary to ensure that the spectrum was taken at the maximum possible lenght of the way of the sun's rays through the atmosphere and this would demand that the experiment were made under conditions of excellent visibility, certainly outside urban areas where the density of aerosols is lower.

The Doppler effect caused by the motion of the spectroscope, in relation to the sun is annulled by the use of mean values for sunrise and sunset. We should also note that if the earth's ether exists it will complicate the measurement because we do not know its thickness above the earth and therefore cannot determine the Doppler shift. For all these reasons the use of mean values for the lines in the spectrum of solar radiation is recommended.

Instead of the solar spectrum taken above the atmosphere, one could also use the solar spectrum made at great elevation, when the sun is at its zenith and atmospheric conditions are exceptionally good. In such circumstances the influence of the atmosphere on the spectrum of the solar radiation would be at its minimum.

The line spectrums of hydrogen and helium, taken in the laboratory on the earth, can also be used for the comparison with the line spectrums of hydrogen and helium in the spectrum of the sun's light coming through the ground layer of the atmosphere.

Finally, the appearance of the redshift in the spectrum of the light passed through earth's atmosphere, can be proved by means of a laser. For that experiment are need a suitable high power stabilized laser whose radiation is well collimated, and spectrometer for the measurement of the wavelenght of the laser's radiation. The lenght of the way of the laser beam, from the laser to the spectrometer, should be as long as possible in order to be realized enough large and measurable redshift. The length of the way of the laser beam limit the earth's curve and atmospheric attenuation of the laser's radiation. That length of the way, from the laser to the spectrometer, can be more than hundred kilometers at exceptionally atmospheric transparency. However, if one use a special prismatic retroreflector then the lenght of the way of the laser beam from the laser to the retroreflector and back to the spectrometer can be more than two hundred kilometers. The power of the laser beam can be very high. Besides that the laser's radiation is coherent and its emission line is very narrow. Consequently this method is simple, easily practicable and the most reliable for the proving or disproving the hypothesis about the appearance of the redshift in the spectrum of the light passed through the earth's atmosphere.

If a red shift were discovered in the spectrum of light radiation passing through the atmosphere, in the manner described above, it would be of great significance to astrophysics and astronomy in the whole.

home

24. ON SIMULTANEITY AND RELATIVITY OF LENGTH AND TIME INTERVAL

The main subject of the special theory of relativity are three concepts and they are: simultaneity, relativity of lengths and relativity of time intervals. Einstein began his work on the theory of relativity by defining and explaining these concepts in the first and second paragraph of his first paper in that field [2].

The relativistic way of treating time, simultaneity and space is the subject of many discussions in different scientific spheres, from physics to philosophy.

24.1 Einstein's determination of simultaneity and relativity of length and time interval

With regard to the importance of the mentioned concepts and the originality in their treatment, it is best if the reader gets first hand information on Einstein's exposition. For that purpose we shall quote here both paragraphs from his first paper on relativity, and then give our commentary on the quoted material.

Quotation: "§1 Determining simultaneity

Let us take a coordinate system in which are valid the equations of Newton's mechanics. For the purpose of distinguishing it from later introduced coordinate systems and for the purpose of defining terminology let us name this coordinate system an "unmoving system".

If a material point is at rest relatively to this coordinate system, then its position relatively to that system can be determined by the methods of Euclid's geometry with the help of solid ruler and expressed in Descartes coordinates.

If we want to describe a motion of some material point, we set the values of its coordinates in the function of time. Thereby we should bear in mind that such a mathematical description has physical meaning only then when it is previously clarified what is meant by the concept of "time". We should focus our attention to the fact that in all our judgements, in which time plays some role, the judgment about simultaneity always appears. If I, for example, say: "That train arrives here at 7 o'clock." That, for example, means the following: "The small hand on my watch showing seven o'clock and the arrival of the train are simultaneous events." [Here will not be considered an inaccuracy in the conception of the simultaneity of two events, which originate (approximately) in the same place, which would also be overcome by the help of some abstraction.]

It can be shown that all difficulties in connection with the determining "time" can be overcome if, instead of the word "time", I write "the position of the small hand on my clocks". Such a decision really is sufficient only in case when we determine the time for the particular place in which the clocks are just situated. However, that decision is already insufficient when we should connect, from the point of view of time, two series of events, one another, which flowing in different places. In one word, it would determine the time of events which occur in places distant from clocks.

If we want to determine the time of events, we could, of course, satisfy ourselves by compelling an observer, who is standing with a watch at the origin, to compare corresponding positions of the watch hands with every light signal coming to him through vacuum and informing him of the registered event. However, that comparison is connected with the difficulties that we know from experiments. Namely, it will not be independent of the place where the observer is standing with the clock. We shall come up with a far more practical determination by means of the following reasoning.

If a clock is placed at point A in space, then the observer, standing at point A, can determine the time of events in the immediate vicinity of point A through the simultaneous observation of these events and the position of the clock hands. If at another point B of space there is also a clock (we add: "The same clock as at the point A") then it is also possible for an observer at point B to assess the time of events in the immediate vicinity of B. However, it is impossible to compare, from the point of view of time, some event at A with an event at B without making further assumptions. For now we shall only determine "A - time" and "B - time", but not the general "time" for A and B. The latter can be determined by introducing the definition that the "time" needed for the passage of light from A to B equals the "time" needed for the passage of light from B to A. At a moment t_A by "A - time" let a ray of light come out of A towards

B, let it reflect at the moment t_B by " B - time" from B to A and return to A at the moment t'_A by " A - time". The clocks in A and B will, according to the definition, run in a synchronized manner if

$$t_B - t_A = t'_A - t_B \tag{24.1}$$

We believe that the determining of simultaneity can be given in an un-contradictory manner and for an arbitrary number of points and that the following claims are true:

1) If the clock at B runs synchronized with the clock at A then the clock in A runs synchronized with the clock at B.

2) If the clock in A runs synchronized with the clock at B, as well as with the clock at C, then the clocks at B and C run synchronized relatively to each other.

In this manner, by using some physical thought experiments, we have determined what should be understood by synchronized clocks, which are at rest in different places and owing to that we have, obviously, obtained the definition of the concepts: "simultaneity" and "time". The "time" of events - that is simultaneously with events indication of clocks at rest, which are placed at the place of the events and which run synchronized with a certain number of clocks at rest.

In accordance with the experiment we shall also assume that the magnitude

$$\frac{2\overline{AB}}{t'_A - t_A} = c \tag{24.2}$$

is an universal constant (the speed of light in vacuum).

Having in mind that we determined time with the help of clocks at rest in the system at rest, then we shall name the time belonging to the system at rest the "time in the system at rest".

§2 On relativity of length and time interval

Further thinking relies on the principle of relativity and the principle of the constancy of the speed of light. We formulate both principles in the following way:

1) The laws by which the states of physical systems change, do not depend from that on which of the two systems, moving with uniform translation relatively to each other, these changes of state refer to.

2) Every ray of light moves in the "unmoving" system of coordinates at a definite speed c, independently of whether that ray of light is emitted by an unmoving body or a moving body.

Thereby we have

$$\text{speed} = \frac{\text{the path of light ray}}{\text{time interval}}$$

whereat "time interval" should be understood in the sense of the definition in §1.

Let us take a solid piston at rest and let its length l be measured with a ruler, which is also at rest. Now let us imagine that the piston, whose axis is directed by the x-axis of the unmoving coordinate system, is pushed into gradual motion (at a speed v) uniformly and translatory in the direction of the growth of value x. Let us now question the length of the piston in motion, which we are intending to determine with the help of two following operations.

a) The observer is moving together with the said ruler and with the measured piston and measures the length of the piston directly by resting the ruler against the piston, the same as if the measured piston, observer and measuring device were at rest.

b) With the help of separate unmoving clocks in the unmoving system, which are synchronized, in the sense of §1, the observer determines in which points of the unmoving system the beginning and the end of the measured piston are at a certain time t. The distance between these two points, measured by the said procedure, with the ruler at rest, is the length which can be marked as the "length of the piston".

In accordance with the principle of relativity, the length determined by the operation "a", which we shall call the "length of the piston in the moving system" should be equal to the length l of the piston at rest.

The length determined by the operation "b", which we shall call "the length (in motion) of the piston in an unmoving system" will be determined on the basis of our two principles and we shall find that it is different from l.

In the kinematics, which is usually applied, it is taken without objection that the lengths determined with the help of the two said operations are equal, or, in other words, that a solid body, which is moving, at a moment t in geometrical relation can be completely substituted with the same body when it is at rest in a certain position.

Let us imagine that clocks are fastened at both ends of the piston (A and B) which are synchronous with clocks in the unmoving system, that is, their indication respond to the "time in the unmoving system" in exactly those places in which these clock are situated; consequently these clocks are "synchronous in the unmoving system".

Let us further imagine that by each clock there is an observer, moving with it, and that these observers apply on both clocks, as established in §1, the criteria of simultaneity in the working of the two clocks. At a time t_A [The "time" here signifies the "time in the unmoving system" and together with the "positions of the hands of the moving clocks, which are situated in that place under discussion".] let a ray of light come out of A, let it reflect at B at a time t_B and return to A at a time moment t'_A. Taking into account the principle of constancy of the speed of light we find

$$t_B - t_A = \frac{r_{AB}}{c - v} \quad \text{and} \quad t'_A - t_B = \frac{r_{AB}}{c + v} \tag{24.3}$$

where r_{AB} is the length of a moving piston, measured in an unmoving system. So, the observer who is moving together with the piston, will find that the clocks at points A and B do no run synchronized, whereas the observers, who are in the unmoving system would claim that the clocks were synchronized.

So, we see that we should not give an absolute meaning to the concept of simultaneity. Two events which are simultaneous, when observed from one coordinate system, are not understood as such when observed from the system which is moving relatively to the given system." **End of quotation.**

24.2 Objections to Einstein's determination of simultaneity and relativity of length and time interval

From the above quoted text the reader may have noticed Einstein's following claims.

Every point of space has its time. There is no general time. Thus, for example, point A has time t_A, and point B has time t_B. The time in a coordinate system at rest differs from the time in the moving system, so there is "time in the system at rest" and "time in the moving system". His time is the position of the small hand on a clock.

Simultaneity can exist only in one coordinate system, in the system which is at rest or in a moving system. Furthermore, the absolute meaning of time does not exist, since the events which are simultaneous at the observation from one system are not simultaneous at the observation from another system which is moving relatively to the given system.

For measuring time and establishing of simultaneity of events clocks are used which work synchronized in the system at rest or in the system which is moving relatively to the system at rest. According to Einstein, they cannot work in synchronization in both systems at the same time. The synchronization of the clocks at A and B he conditions by the equality of time needed for a light ray to pass from A to B with the time needed for the same ray to pass from B to A, that is $t_B - t_A = t'_A - t_B$.

He bases the negation of the existence of absolute time and simultaneity on the alleged impossibility of determining the existence of such time and simultaneity. In fact, this leads in essence to the assertion that something does not exist because I cannot determine its existence, thereby I do no take into account my ignorance or lack of equipment for the determination.

With the following examples we can see the problem of determining time and simultaneity.

Let us have a line of boats as in the Fig. 24.1.

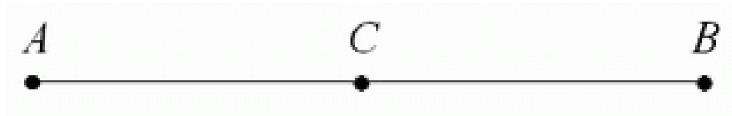

Fig. 24.1

When the boats are at rest, clocks on them can be synchronized in the following way. Let us place boat C right in the middle and let us fire a shot from boat C. The sound of that shot will be heard at the same time on boats A and B and it will be possible to synchronize all clocks to a set, agreed time, that is their telling of time will be synchronized. When that line of boats is moving, it is obvious that we can apply the same method again. Sailors who do not know that the boats are moving relatively to the air, will be convinced that they have synchronized the clocks in A and B. However, when the boats are moving then a signal from point C will take longer time to reach boat A than boat B, because boat A is going away from the source of sound, and the boat B is coming towards the sound. That difference depends on the speed at which the line of boats is traveling. Therefore, it is impossible to synchronize the clocks by that procedure when a line of boats is moving. However, it would be completely wrong to claim that there are no other technical possibilities for synchronizing clocks in a given line of boats which is moving. For example, first the speed of the line of boats can be determined, then the time needed for the sound to travel form boat C to the boats A and B. On the basis of this data a sound signal should be sent from the boat C in the direction of each of them, which they will receive at the same time and synchronize their clocks by it. It is clear that thereby a signal sent in the direction B should be delayed relatively to the signal sent in the direction A. The delay will be the time difference between the time needed for the signal to reach boat B, which is travelling towards the sound, and boat A, which is going away from the sound.

The precision in determining simultaneity, and thus the precision in synchronizing clocks, in first case, when the line of boats is at rest, will depend on the precision of determining the distances AC and CB. In the second case, when the line is moving, it will depend on the precision of determining these distances and also on the precision of determining the speed of motion.

Whether two events are simultaneous or not does not depend on how we seen then and whether we see them at all. Our judgment whether something is or is not simultaneous does not depend only on our observation of the moment when a ray of light comes from the scene of an event, but also on our knowledge related to the event and the scene of the event. Thus, for example, two men are observing the explosion of a star through telescopes. One of them knows nothing about the distance to the star, and the other one is an astronomer. The fist one will think that the star explosion is happening at the same time as he is observing the star, while the other will know that it happened in a remote past, maybe even a million years ago, if the star is a million light years away from us. From this example we see that a subjective judgment of simultaneity is unreliable.

With the development of social community, grew the need for common general time. Prehistoric man had no such need. For him the time of his zone of motion around a cave was sufficient. However, developed societies can not even be imagined with such segmented time.

In principle, we measure time with the course of events. For example, for the ancient Egyptians the flooding of the Nile was such an event. It happened every year and so they could count years by it. With time man defined and measured time better and better.

All determinations, both of position and time are relatively to something. Today, the whole world time is measured relatively to the moment of the sun passing above zero longitude. Moreover, relatively to that moment the earth is divided into 24 time zones. In each time zone all clocks, at the same moment relatively to the passage of the sun above zero longitude show in advance defined time. Thus our civilization has a general earth time in a wide and narrow sense. If there was a need for general galactic or cosmic time then we would have to find a possibility of connecting the zero time to some galactic that is cosmic event.

The existence of general time on earth is imposed by the need to coordinate the activities of people all over the world. By using time, defined in this manner, we can, for example, bring about the simultaneity of two events in any two points in the world, at rest or moving, with a precision which equals the precision of registering the simultaneity of two events in the immediate vicinity. Such possibilities exist thanks to the agreed way of determining - measuring time, human knowledge and achieved technical capacities. If the determination of simultaneity and the measurement of time were as disputable and inaccessible as Einstein maintains, then modern systems of remote guidance, from various military systems to the systems for cosmic research would not exist.

The way in which Einstein treats time and simultaneity, concerning knowledge of events and physical processes on which the judgment of time and simultaneity are based, is of poor quality. It is subjective and adjusted so that the reader reaches wrong conclusions determined beforehand, which will serve for the further derivation of new wrong conclusions. That this is really the case can be seen in the next chapter, number 2, in which relativity of lengths and time intervals is studied.

When talking about the relativity of lengths and time intervals Einstein uses a piston length l, which is at rest or it is moving at a constant speed along the x-axis, so that the piston axis matches with the x-axis. He also uses a ruler with which he measures the piston at rest and in motion. When the piston is at rest an observer measures the length of the piston by holding the ruler against the piston and in that way he determines that the piston's length equals l. Then the observer moves with a ruler and the piston together (for example in a train). Then, again the observer in motion holds the ruler against the piston and determines again that the piston's length is l. In that way the observer finds that the length of a piston at rest equals the length of a moving piston, when the measurement is performed by the observer who moves together with the piston. In short it means that the length of the piston at rest is equal to the length of the piston in motion, when that length is measured in a moving system in which the piston is at rest.

The third measurement method is more complex, since the observer, who is at rest, should measure the length of a moving piston. That is the same as if the observer from the railway embankment measured the length of a wagon of a fast train, going past him. It is clear that in this case he cannot measure the length of the wagon by holding a ruler against the outer wall of the wagon. Therefore Einstein uses a different kind of measurement. In that measurement he uses light rays and clocks. **And that is where the great deception in the construction of the theory of relativity begins - the deception on which this theory is based.**

In this experiment he uses two clocks, one of which fixed to the beginning of the piston at point A, and the other to the end of the piston at point B. He also puts the source of light at point A, and a mirror at point B which reflects light back to point A. With the piston, which is at rest, thus equipped, he checks whether the clocks are synchronized, in the way that is described in the quoted text and the Eq. (24.1) on the equality of time intervals

$$t_B - t_A = t'_A - t_B$$

where t_A and t'_A are the times shown by the clock at point A (beginning of the piston), and t_B is the time shown by the clock at point B (the end of the piston). The time interval $t_B - t_A$ is the time needed for a ray of light sent from point A to reach point B, and the time interval $t'_A - t_B$ is the time needed for the same light ray, after being reflected from the mirror at point B, to return to point A. Since $\overline{AB} = \overline{BA}$ then the clocks will be synchronized if the equality of time interval given by the Eq. (24.1) is satisfied.

In that manner he determines that the clocks are synchronized. On the basis of the measured time intervals and the light speed he finds that the piston's length is

$$l = c\left(t_B - t_A\right) = c\left(t'_A - t_B\right) \tag{24.4}$$

After making adjustments in this way, checking that the clocks are synchronized and determining the length of the piston, he puts the equipped piston into a state of motion at a constant speed v and repeats the experiment to check whether the clocks are working in synchronization.

A schematic representation of the experiment is given in the Figs. 24.2.1, 24.2.2 and 24.2.3. Fig. 24.2.1 gives the starting position of the piston, that is the state at the moment when a light ray starts from point A (the beginning of the piston) towards point B. In Fig. 24.2.2 the position of the piston at the moment when the ray arrives at the mirror at point B (the end of the piston) is shown, and Fig. 24.2.3 gives the position of the piston at the moment when the ray reflected from the mirror at point B arrives back at point A. The starting position of the piston is given in full lines; the second position of the piston (when the ray arrives at point B) is given in interrupted lines and the third position (when the ray arrives back in the point A) in dotted lines.

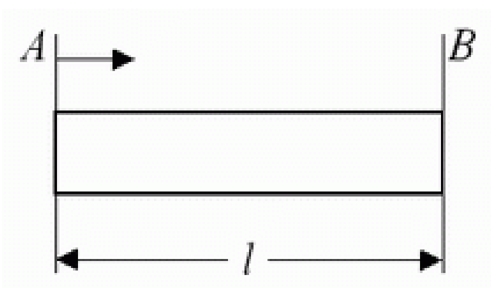

Fig. 24.2.1

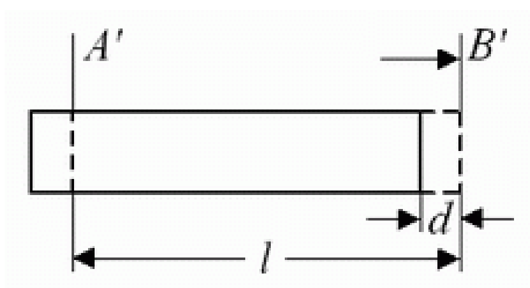

Fig. 24.2.2

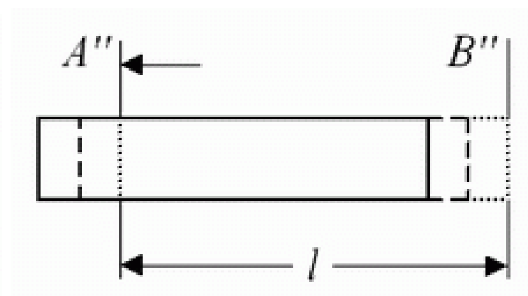

Fig. 24.2.3

As the pictures show, the ray passes from point A towards point B. The time (moment) of the start of the ray from point A towards point B is noted by an observer on the basis of the time shown by the clock at point A. From that moment the ray moves towards point B. During that time while the ray is moving at speed c towards the mirror, the piston with the mirror is moving in the same direction so that the mirror is moving ahead by the length d and arrives from point B at point B'. Therefore, to reach the mirror, the ray had to cover the distance $l + d$. As we know, if the piston had not moved, the ray would have covered only the distance which is equal to the length l. This means that because of the piston's motion the ray had to cover a longer distance, and more time is needed for this, so

$$t_{B'} - t_A = \frac{l+d}{c} = \frac{l}{c-v} \tag{24.5}$$

Because of that, the time needed for the ray to arrive at point B when the piston is at rest will differ from the time needed for the ray to arrive at point B' when the piston is moving. The observer will see that a time difference in the arrivals of the ray occurred, and Einstein would conclude, of course wrongly and probably intentionally, that the time shown by the clocks changed because, as a result of motion, the rhythm of the clock "ticking" changed, and not because the length of the path covered by the light ray changed.

While the ray returns, after being reflected from the mirror, at point A'' covers a distance shorter than the length of the piston because the beginning of the piston (point A) is coming towards the light ray at the speed v, so

$$t_{B'} - t_{A''} = \frac{l}{c+v} \tag{24.6}$$

The observer will notice that the time of the ray's return, according to the clock at A when the piston is moving, differs from the time of the return of the ray when the piston is at rest. Einstein concludes that this clock also changed its "rhythm of ticking" because of its motion. However, it is clear that time intervals changed because of the change in the length of the ray's path, so that

$$t_B - t_A \neq t_{B'} - t_A \quad \text{and} \quad t_{A'} - t_B \neq t_{A''} - t_{B'} \tag{24.7}$$

And also

$$l \neq l + d \quad \text{and} \quad l \neq l - d_1 \tag{24.8}$$

As has already been said, Einstein deduces a conclusion, which is obviously wrong, that the clocks stop being synchronized as soon as they start moving and because of that the concept of simultaneity should not be given absolute meaning.

Einstein's previous experiment with a piston can be made with sound instead of light. However, in that case, at the same length and the speed of piston motion, the disagreement between the clocks would go up by around 10^{12} times, because the speed of sound is about 10^6 times smaller than the speed of light. Naturally, with experiments where sound is used, the speed of piston motion must be less than the speed of sound.

The clocks at rest can be synchronized even when they are far apart, by using the procedure and the requirement given by Eq. (24.1). Accordingly, a moving piston can be of any length, and still the clocks at its end would go on working in a synchronized manner.

In the theory of relativity it is claimed that the de-synchronized function of the clocks which were synchronized while at rest occurs because of the motion of those clocks. However, it is not mentioned anywhere that the de-synchronization is also a function of the piston length, that is the distance between the clocks. De-synchronization is reduced with the reduction of the piston length, so the clocks, which are placed next to each other "tick" in rhythm, that is they are synchronized, independently of that how fast they move. The reason for this is clear from the explanation given in Figs. 24.2.1, 24.2.2 and 24.2.3, and which can be summarized thus: the greater the distance between the clocks, the greater the de-synchronization, because the light needs to travel not only the distance l but also the additional distance d, for which the piston moves while the light travels the distance l. That move d is proportional to the length and the speed at which the piston moves.

The explanation given above of the different time taken by light rays to pass along the piston when it is at rest and when it is in motion is based on the real situation and is not in accordance with the theory of relativity; neither is Einstein's discussion of the synchronisation of the clock at rest and in motion. The fundamental principle of the theory of relativity is the constant velocity of light which will be the same in both systems, K and K'. Also, according to this theory, the length of the piston is the same in all systems in which the piston is at rest.

As a result, if the light source, the mirror and the clocks are fastened to the ends of the piston as Einstein describes in §2 quoted above, then, according to the theory of relativity, the time taken for the light rays to pass from the beginning to the end of the piston and vice versa must be the same, whether the piston is at rest in system K or moves with system K'. In both cases, according to the theory, the speed of light relative to the piston is the same, and the length of the piston is the same too, since the piston is at rest in the system in which the measurement is made. Therefore, the observer who moves with the piston would not be able to perceive the change in the time taken for the rays to pass along the piston and would not be able to conclude that the clocks which are in motion do not work in the same rhythm as the clocks that are at rest. In reality the clocks will work in the same rhythm but they will show different times taken by the light rays to pass along the piston, for the reason explained before in Figs. 24.2.1 24.2.2 and 24.2.3.

As a result Einstein's claim, that synchronized clocks while at rest lose synchronization when moving, is unfounded and that physical process in the given thought experiment with a piston and a clock in motion is incorrectly analyzed and interpreted in order to lead the reader astray and make him accept the claim that time and length change only because of motion.

In the text quoted in §2, when assessing the synchronization of the clocks, Einstein says: "Taking into account the principle of the constancy of the speed of light, we find

$$t_B - t_A = \frac{r_{AB}}{c - v} \quad \text{and} \quad t'_A - t_B = \frac{r_{AB}}{c + v} \tag{24.3}$$

where r_{AB} is the length of a moving piston measured in an unmoving system."

With the two given Eqs. (24.3) at the very beginning of his work on the theory of relativity Einstein negated his postulate that the speed of light in vacuum is the maximum speed in nature and his theorem on the addition of speeds, according to which the sum and the difference of the speed of light and any other speed equals the speed of light. Since, if the speed of light is the maximum possible speed then using the expression $c + v$ becomes senseless since, according to him the speed $c + v$ does not exist. Also, if his theorem on the addition of speeds is correct, why does he then use the expressions $c - v$ and $c + v$ in the Eq. (24.3), and later in other equations, where it is simpler instead to use only c. However, if he did that, he could not derive his equations and draw his conclusions, or the conclusion in connection with Eqs. (24.3).

Einstein claims that the theory of relativity is a theory of principles. However, we can conclude that the theory of relativity have some declared principles, but it does not keep to these principles, and thus it is not a theory of principles. Many of its key claims are in conflict. Many of its findings are incorrect, and nearly all are derived in an unacceptable fashion. Consequently, the theory of relativity is not a consistent scientific theory, if it can be called a scientific theory at all.

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25. THE PROBLEM OF MOTION IN THE THEORY OF RELATIVITY

All the equations in the theory of special relativity were derived by use of two inertial coordinate systems. In the deriving of equations it is taken that the first coordinate system K is unmoving and that the second coordinate system K' moves at a speed v relative to the first. Such an approach to the problem of motion makes sense only from the view point of mathematics. However it is unacceptable from the view point of physics, because in nature everything is in motion. Besides, the theory of relativity does not accept the possibility of the existence of an ether.

When we say that one body moves then we keep always in mind the change of the positions of that body with time relative to a second body. However, this second body can be in motion or at rest relative to a third body. At the same time this third body can be in motion or at rest relative to a fourth body, etc.

Let us consider two examples of motion in order to clarify this point.

We shall consider, as a first example, the case of two travelers in a passenger train moving at a speed v relative to the railway and to the railroad embankment.

The first traveler is sitting quietly in the coach. In that way he moves at the speed v, together with the train, relative to the railway.

The second traveler moves through the coach at a speed v relative to the coach, but in the opposite direction to the motion of the train. In that way he moves at the speed v relative to the first traveler sitting quietly. However, he does not change his position and stays at rest relative to the railway and to the railroad embankment.

Now we put the question: "Which of these two travelers is moving and which is unmoving, to which traveler should we connect the unmoving coordinate system K and which the moving system K'?"

In this case it is obvious that for both of these travelers it can equally well be asserted that they are unmoving or in motion. So, there is no sure solution. This case comes to be more indefinite if we take into consideration that all are in motion: the earth around the sun, the sun together with the earth in our galaxy, our galaxy with the galactic group, etc. In brief, all are in motion, from having the smallest elementary particles even to the group of galaxies.

Lorentz connected the unmoving coordinate system K to the quiescent cosmic ether. Such a solution would make sense if the quiescent cosmic ether existed.

The second example of motion, which we shall consider, is more complex. It will be used to demonstrate the incorrectness of the theory of relativity and to support of the hypothesis of the existence of the earth's ether.

For that purpose let us connect the unmoving system K to the sun and the moving system K' to the earth. Let us suppose that on the earth there is a large rocket launcher with a rocket. The rocket launcher with the rocket are moving in the system K, together with the earth, at a speed v=30 km/s. However, the rocket launcher does not move in the system K' connected to the earth.

Let we suppose that the rocket has been started from the launcher in the opposite direction to the direction of motion of the earth. Let the speed of the flight of the rocket, in the system K' connected to the earth, be v=-30 km/s. In this case the rocket will be at rest relative to the system K, which is connected to the sun. Therefore, the system K can be connected to the moving rocket too. In this way we connect the unmoving system K to the moving rocket. Consequently, we can put the question again: "Which system is really unmoving and which is moving?" However, there is no sure solution as in the previously mentioned case of two travelers in the coach of the moving train.

The state of motion of the launcher does not change after the start of the rocket. It will continue to move together with the earth and its speed in the system K will remain v=30 km/s.

If we apply the theory of relativity to this case, in order to calculate the increase of mass due to motion in the system K, then we shall find the results which are quite opposite to the theory of relativity. The mass of the rocket will allegedly decrease after its start, because the rocket ceases to move in the system K. However, the mass of the rocket launcher will allegedly stay increased in the system K, because the launcher moves in that system.

The above assertions cannot be proved because the rocket and rocket launcher are neutral bodies. I said before that the equation (23.l09) was valid for the mass of an electron in motion only. Therefore, let us take two electrons instead of the rocket and rocket launcher. In this way we will be able to prove the above given assertions.

Let us assume that the first electron of the pair of electrons is moving, like the started rocket, and let the second electron be at rest on the earth like the rocket launcher.

In physics it is well known that an electron in motion on the earth generates a magnetic field. Its mass is increased according to the equation (23.109). Also it is well known that an electron at rest on the earth does not generate a magnetic field and therefore its mass is equal to the so-called mass at rest. Accordingly, the increase of mass will originate with the first electron which moves on the earth like the started rocket.

Let us consider what happens relative to the system K connected to the sun.

The first electron moving on the earth at the speed v=-30 km/s is at rest in the system K and relative to the sun. On the contrary, the second electron, which is unmoving on the earth and in the system K', is moving relative to the system K and to the sun at the speed v=30 km/s. Now we put the question: "Which of these two electrons has a greater mass in the system K; the first which is unmoving in that system, or the second which is moving in that system?"

In the theory of relativity it is decidedly asserted that there is no increase in mass of the body, in the system in which the body is at rest. Therefore, according to the theory of relativity the first electron, which is moving on the earth and at rest in the system K, cannot have increased in mass in the system K. However, if we stop the motion of the first electron relative to the earth then that electron will release the magnetic field generated by its motion. The energy of that field will be emitted in the form of an electromagnetic braking radiation, which can be detected in the system K. In this way, the mass of the first electron will be decreased by emission of the braking radiation. After that the first electron starts to move together with the earth like the second electron.

The observer from the sun, and from the system K connected to the sun, will see that the first electron stops being at rest and has started to move together with the earth at the speed v=30 km/s. That observer will also see that the first electron emits an electromagnetic wave at the start of its motion together with the earth. However, this phenomenon is contrary to the known laws of physics. In fact, in physics a starting radiation has never been observed, but only the braking radiation. The generated magnetic field leaves the electron in the form of electromagnetic radiation only at the decrease of speed of motion of the electron. Considering that the mass of the electron is decreased by emission of the braking radiation, one can conclude that the mass of the electron in motion in a coordinate system can be less than the mass of the electron at rest in that system. This phenomenon, which happens in reality, is contrary to the theory of relativity.

From the above it can be seen that we should not take into consideration the motion only as the cause of some phenomenon, as it is done in the theory of relativity. We have to take into consideration not only the motion, but also the physical processes, which happen in the process of motion, as the circumstances in which that motion is performed.

In connection with the above we must put a key question: "Why does an electron generate a magnetic field in motion on the earth, and why that electron does not generate a magnetic field in motion together with the earth relative to the sun?" Up to now, nobody has asked this question so that there is no ready answer. However, for the moment, there is only one logical answer and one logical explanation. The answer and the explanation are to be found in the existence of the earth's ether and in the recognition that an electron generates a magnetic field in motion relative to the ether only.

Electromagnetic braking radiation originates at the decrease of the speed of motion of an electron relative to the earth's ether, when it moves in that ether.

An unmoving electron on the earth and relative to the earth's ether does not generate a magnetic field independently of its speed of motion relative to the sun or to any other body in the cosmos.

When we talk about the ether let us return to the Lorentz hypothesis on the contraction of a body in motion through the ether. Lorentz gave a coefficient of the contraction, but it cannot be accepted, because it is derived under an incorrect supposition. Namely, he considered that there was an absolute quiescent ubiquitous cosmic ether, through which the earth moved. Therefore, Lorentz considered that the Michelson's interferometer, during the Michelson-Morley's experiment, moved through the cosmic ether together with the earth. That motion through the ether was allegedly the cause of the shortening of the interferometer's branch in the direction of motion of the interferometer, and that this shortening was the cause of the failure of the experiment. However, that supposition was incorrect. In fact, the interferometer was at rest in the earth's ether so that there was not motion relative to the ether and this was the real cause of the unsuccessfulness of the Michelson-Morley experiment. In fact, the unsuccessfulness of the Michelson-Morley experiment is proof of the existence of the earth's ether.

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26. ANTIMATTER AND THE ANNIHILATION OF MATTER AND ANTIMATTER DO NOT EXIST

The discovery of the positron in 1933 was followed by the opening of a peculiar and extremely interesting field in physics, the field of antimatter. It was a big surprise, both for physicists and astronomers, philosophers and all those who deal with the question of the origin and composition of the material world.

When the positron was discovered it was established that it had the same mass as an electron and that its charge was of the same magnitude as an electron, but of the opposite sign, which is why it got the name of positron.

Proof that the positron is antimatter and that it, as such, annihilates in contact with matter was experimentally obtained immediately following its discovery. Even at that early stage it was established that positrons disappeared very shortly after their appearance, and that from the place of the disappearance two gamma rays of the same energy of 0.511 MeV were emitted. Since that energy equal the product of an electron mass (or positron) and the speed of light squared, it was concluded that the positron was antimatter and therefore its contact with an electron brings about their destruction - annihilation. In that process their masses disappear by being transformed into the energy of radiation, as predicted by famous equation

$$E = mc^2 \tag{26.1}$$

Thus the existence of not only antimatter and annihilation of matter and antimatter were confirmed, but also the correctness of the claim that matter changes into energy according to the Eq. (26.1).

Later other particles of antimatter were discovered, and the natural symmetry, that for every particle of matter there is a particle of antimatter, was confirmed.

Nevertheless, despite everything said above, a detailed analysis of the interaction of positron and electron, puts the claim about the existence of their annihilation as well as the claim that the positron is antimatter into doubt. We will now attempt to put this assertion to the proof.

To develop that proof it is necessary to establish the energy of the magnetic field which electrons and positrons, as electrically charged particles, generate with their motion. At the same time, we need to establish an electron's radius dependent on its speed of motion and particularly at the moment of their collision. Afterwards, using Coulomb's law, we need to determine the kinetic energy of an electron and positron at the moment of their collision. By comparing the amount of magnetic and kinetic energy with the energy of gamma rays emitted from their collision, we come to the demanded proof that the radiation energy originates from the kinetic energy, that there is no annihilation and that the positron is not antimatter.

26.1 The energy of a magnetic field and the radius of an electron in motion

This calculation is true for the positron too, because the energy of a moving electron's magnetic field equals the energy of the magnetic field of a positron moving at the same speed.

If we consider that an electron has a spherical shape then its radius is easiest to calculate by using the equation for the electrostatic energy of an electron. Such a calculation is most often found in expert publications. However, it does not give an electron's radius depending on the speed of its motion. To calculate the radius of an electron dependent on the speed of its motion we should use the equation for the energy of magnetic field, which the electron, as an electrically charged particle, generates with its motion. That calculation was given by Lorentz in his Electromagnetic theory, and after him Robert A. Millikan [17], and we use it here, with minor alteration.

The energy E of magnetic field per unit volume is given by

$$E = 10^{-7} \cdot 2\pi H^2 \tag{26.2}$$

The strength of the magnetic field H at the distance r from the electrical charge in motion in the charge plane is $\frac{1}{4\pi}\frac{ev}{r^2}$, where e is the electrical charge, and v is its speed. Besides, the strength of the magnetic field at a point at the distance $r\theta$ from the electrical charge, where θ is the angle between r and the motion direction, is given by

$$H = \frac{1}{4\pi}\frac{ev}{r^2}\sin\theta \tag{26.3}$$

From there it follows that the total energy of the magnetic field, created by the effect of the electrical charge in motion is

$$E_u = \int E\,d\tau = 10^{-7} \cdot 2\pi \int H^2\,d\tau \tag{26.4}$$

where τ is an element of volume, and the integration is extended all over space. However, by expressing it with v, θ, and ϕ, we have

$$d\tau = r\,d\theta \cdot dr \cdot r\sin\theta\,d\phi \tag{26.5}$$

Therefore, the total energy is

$$E_u = 10^{-7}\frac{e^2 v^2}{8\pi}\int \frac{\sin^2\theta}{r^4}d\tau = \\ = 10^{-7}\frac{e^2 v^2}{8\pi}\int_{\infty}^{a}\frac{dr}{r^2}\int_0^{2\pi}d\phi\int_0^{\pi}\sin^3\theta\, d\theta = 10^{-7}\frac{e^2 v^2}{3a} \tag{26.6}$$

Since the kinetic energy is $E_k = \frac{1}{2}mv^2$, then the radius of the sphere of an electrical charge in motion is found by putting

$$\frac{1}{2}mv^2 = 10^{-7}\frac{e^2 v^2}{3a} \tag{26.7}$$

and from there

$$a = 10^{-7}\frac{2}{3}\frac{e^2}{m} \tag{26.8}$$

This is true while v is small in comparison to the speed of light.

Lorentz, and then Millikan found that an electron's radius, at speeds considerably lower than the speed of light equals $1.9 \cdot 10^{-15}$ m. By using more precise, later determined, values for the mass and electrical charge of an electron we get that at speeds considerably lower than the speed of light, an electron's radius is

$$a = \frac{2}{3}\frac{e^2}{m_0}10^{-7} = \frac{2}{3}\frac{\left(1.602176462\cdot 10^{-19}\right)^2}{9.10938188\cdot 10^{-31}}10^{-7} = 1.87862686\cdot 10^{-15}\ \mathrm{m}$$

When an electron is moving faster, the classical expression for kinetic energy $E_k = \frac{1}{2}mv^2$ in the Eq. (26.7) cannot be used, since with the increase of speed the magnetic field created by its motion is increased, and that is manifested as an increase in the electron's mass. Because of that we should use a formula for kinetic energy which takes into account an increase of an electron's mass with its speed in the Eq. (26.7)

$$E_k = m_0 c^2 \left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right) \tag{26.9}$$

Combining Eq. (26.9) with (26.7) and by solving for a gives

$$a = 10^{-7} \frac{e^2}{3 m_0} \left(\frac{v}{c} \right)^2 \frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \sqrt{1 - \frac{v^2}{c^2}}} \tag{26.10}$$

By using the Eq. (26.10) the values for an electron's radius depending on its speed are calculated and given in the Table 26.1.

As can be seen from the table an electron's radius is reduced with the increase of speed. However, it should be stressed that the reduction is not according to the equation $a_L = a_0 \sqrt{1 - v^2 / c^2}$, given by Lorentz. With the increase of speed the disagreement grows. For the sake of comparison, the table also gives the values of radius calculated according to Lorentz's given equation.

Table 26.1

$\frac{v}{c}$	$a \cdot 10^{15}$ m	$a_L = a_0 \sqrt{1 - \frac{v^2}{c^2}} \cdot 10^{15}$ m
0.001	1.8786	1.8786
0.1	1.864	1.869
0.2	1.822	1.841
0.3	1.751	1.791
0.4	1.650	1.722
0.5	1.518	1.628
0.6	1.353	1.503
0.7	1.150	1.342
0.8	0.902	1.127

0.866025403	0.70448507	0.939
0.9	0.588	0.819
0.95	0.385	0.587
0.98	0.224	0.374
0.99	0.151	0.265

The radius of an electron is most precisely calculated and given for the case of the moment of the collision with the positron when its speed is $v = 0.866025403 \cdot c$. At that speed an electron's radius is $0.70448507 \cdot 10^{-15}$ m, and the energy of its magnetic field, according to Eq. (26.9), equals the energy of its allegedly annihilation. At the same speed and radius, a positron also creates a magnetic field of the same energy. From this it can be seen that the energy of two gamma rays 0.511 MeV each, emitted at the moment of a positron and electron collision, originates from the energy of the magnetic, or to be more precise, the electromagnetic fields of the electron and the positron, and not from their annihilation. This is one proof that there is no annihilation when electron and positron collide. In further text we will give another proof, based on the well known Coulomb's law.

26.2 The kinetic energy of electron and positron at the moment of their collision

Considering that an electron and positron have, quantitatively, the same electrical charge, but of the opposite sign, that means that a force of attraction operates between them according to Coulomb's law

$$F = \frac{1}{4\pi\,\varepsilon_0}\frac{e^2}{r^2} \tag{26.11}$$

where r is the distance of the centers of the spheres of electron and positron.

The work done by the force of attraction on the road to the collision is transformed into the energy of motion, that is the kinetic energy of each of them. In the course of that process, before the collision the electron and positron cover half of the mutual distance r, therefore the kinetic energy of the electron, and also of the positron, is given by

$$E_k = \frac{1}{2}\int F\,dr = \frac{1}{8\pi\,\varepsilon_0}\int_{\infty}^{d}\frac{e^2}{r^2}dr = \frac{e^2}{8\pi\,\varepsilon_0\,d} = \frac{e^2}{16\pi\,\varepsilon_0\,a} \tag{26.12}$$

where d is the distance of the centers of spheres of electron and positron at the moment of the collision, that is $d = 2a$.

To prove that the kinetic energy of electron and positron, at the moment of their collision, changes into radiant energy, in the form of two gamma rays, we need to prove that the collision occurs when the energy reaches the value of $m_0 c^2$ = 0.511 MeV = 8.18710414·10^{-14} J and that then the distance r of the centers of the spheres of electron and positron equals the sum of the radiuses of these spheres. Therefore, taking that

$$E_k = \frac{e^2}{8\pi \varepsilon_0 d} = m_0 c^2 \tag{26.13}$$

we find that

$$d = \frac{1}{8\pi \varepsilon_0} \frac{e^2}{m_0 c^2} = \frac{1}{8\pi \cdot 8.854187804 \cdot 10^{-12}} \frac{\left(1.602176462 \cdot 10^{-19}\right)^2}{8.18710414 \cdot 10^{-14}} =$$
$$= 1.408970142 \cdot 10^{-15} = 2 \cdot 0.70448507 \cdot 10^{-15} \text{ m} = 2a$$

So, as is shown, the required distance r, at which the kinetic energies equal $m_0 c^2$, is the distance at which the collision occurs, that is it equals the sum of the radiuses of electron and positron. The size of that radius a was calculated earlier by using the equation for the energy of the magnetic field and the condition that the energy equals $m_0 c^2$.

So the second way of calculation, based on the well known Coulomb's law, confirms that electron and positron, at the moment of collision, posses kinetic energies which equal $m_0 c^2$, and which transform into the energy of the two gamma rays which modern physics claims that it is the product of the annihilation of electron and positron.

If annihilation really occurred then the energy of radiation would have to be two times larger than the well known energy $E = 2 \cdot m_0 c^2$ = 2·0.511 MeV, which has been proved by experiment many times.

If, despite of the above given proofs, there were those who still claimed that annihilation of electron and positron really occurred, then they would be under the obligation to explain what happened to the kinetic energies of the two particles at the moment of their collision and alleged disappearance through annihilation.

In connection to this it is worth reminding ourselves that an electron's kinetic energy is also transformed into radiation in case of braking radiation (bremsstrahlung), or with the very well known X-ray radiation (Röntgen radiation). For example, for the realization of X-ray radiation an electron is accelerated up to a certain speed with the help of high electrical voltage. Hence, electrical energy is put in so that electrons can achieve a certain speed, and together with it a certain kinetic energy. When the electron hits the anode, its kinetic energy changes into X-ray radiation. The energy of X-rays thus produced is proportional to the kinetic energy of electrons before they hit the anode.

Bearing in mind the well known fact that energy can neither be destroyed or disappear without trace, then we are compelled to conclude that the kinetic energies of electrons and positrons changed only their form of existence, that is they changed into the energy of gamma radiation. And since the energies of these gamma rays originates from the kinetic energies **then we are also compelled to conclude that annihilation does not exist at all**, at least as far as allegedly the best known and studied case of annihilation in physics - the annihilation of electron and positron, which is commonly accepted as a main proof that matter allegedly changes into energy, and also that antimatter allegedly exists.

26.3 The positron is not antimatter

The coincidence that the kinetic energy of an electron and a positron at the moment of their collision equals $m_0 c^2$ exactly, has deluded physicists into accepting the annihilation of electron and positron, resulting in the belief that the positron, as well as other later discovered particle, belong to that new and fictional category in physics, antimatter. Thus, with the discovery of the positron the existence of antimatter seemed to be confirmed.

Physicists believe that the positron, as antimatter, cannot survive in the presence of matter, and so, the argument goes, that is why it does not exist in nature. That claim is based on the fact that the positron after its appearance quickly disappears with the earlier described phenomenon of radiation from the place of disappearance.

However, it has been known for a long time that the atomic nucleus of some elements emit positrons. So, for example, in 1934 Irene Curie and her husband Pierre discovered that boron, magnesium and aluminum emit positrons after the bombardment of the same elements with alpha particles. Then in the case of boron it was established that the time of the radioactive half-decay in such radiation is 14 minutes. In this case positrons come from the atomic nucleus which is a confusing fact. If the positron is antimatter then its annihilation would have to occur in the atom's nucleus, which is an extremely dense concentration of matter. Because of that it should be impossible for a particle of antimatter to issue from an atomic nucleus. Nevertheless, it does occur.

When we take into account everything said above, it turns out that the positron, the earliest discovered and best known representative of antimatter, is not antimatter at all and that as such, it does not annihilates with matter. In other words, antimatter does not exist.

26.4 A new neutral particle - the ELPOTRIN

Under the influence of the special theory of relativity in modern physics it is claimed that energy can change into matter, which is the reverse process from the process of annihilation where the total matter of a particle changes into energy. The main proof used for this is the appearance of positron-electron pairs when matter is exposed to gamma rays whose energies are equal to or grater than 1.022 MeV. This alleged transformation of energy into matter is well known and confirmed many times by experiment. It is interesting to note that the appearance of the pairs is possible only in the presence of matter, and that it is not known what role matter plays in that insufficiently studied physical process. It is also well known that cosmic rays, whose energies can be up to 10^{20} eV, in collision with atoms produce showers of positron-electron pairs. This phenomenon is also claimed to be the result of the transformation of cosmic radiation energy into matter or, to put it more precisely, into matter and antimatter.

The above claim is wrong, the appearance of positron-electron pairs does not represent a transformation of energy into matter, there is no creation of new particles, because these particles - pears originate from the atomic nucleus. It is clear that in the process connected to this pair-appearance a part of the energy of cosmic or gamma rays (whose energies are greater than the binding energy of the elpotrin) causes an increase in the speed of motion, and thus also an increase in the mass of electrons and positrons. As was said earlier the increase in the electromagnetic mass of electrically charged particles in motion is the result of the magnetic field being generated, which resists further increase in the speed of particles. Hence, in the process of the appearance of electron-positron pairs new particles are not created on account of energy expenditure.

Electrons and positrons do not disappear in collision in the form of radiation, but form a new, still unidentified, neutral particle whose mass is double the mass of an electron. That new particle could be called an ELPOTRIN, which is an abbreviation from electron and positron and resembles the hypothetical particle neutrino. The elpotrin's binding energy is 1.022 MeV. Proof for this, and generally for the existence of the positron in matter is the appearance of positron-electron pairs at the moment when the matter is exposed to gamma rays whose energies are equal to or greater than the elpotrin's binding energy.

In 1927 Pauli suggested that during a β-transformation another particle is emitted at the same time as the β-particle. He called this hypothetical particle a neutrino. It has no charge and its mass is insignificant making it invisible to existing methods of detection.

Allegedly certain confirmation of the existence of free neutrinos was provided as late as 1953 in experiments conducted by F. Reines and C. Cowan. It is claimed that, on that occasion, a huge flux of antineutrinos was created in a powerful fission reactor which acted upon the protons in the following way

$$\bar{\nu} + {}_1p^1 \rightarrow {}_0n^1 + {}_{+1}e^0 \rightarrow {}_1p^1 + {}_{-1}e^0 + {}_{+1}e^0 + \bar{\nu} \qquad (26.14)$$

The protons ${}_1p^1$ were bombarded by antineutrinos $\bar{\nu}$ and then they allegedly got neutrons ${}_0n^1$ and positrons ${}_{+1}e^0$, that is, protons, positrons, electrons and antineutrinos.

The interaction (26.14) must be taken with reserve, even though the two scientists involved received the Nobel Prize for their proof of the existence of the neutrino.

The first doubt about this proof of the existence of the neutrino arises from the fact that there is, in fact, no concrete proof that antineutrinos actually took part in the interaction, this is just a supposition.

The second doubt centres on the authenticity of the interaction bearing in mind the laws on the conservation of the number of particles and electricity. Two particles enter into given interaction; the antineutrino and the proton. And four particles emerge from it: positron and neutron, which disintegrates into a proton, electron and antineutrino whose presence has not been proved either.

A far more realistic explanation of the experiment is based on the bombardment of protons with elpotrins rather than antineutrinos. In this case the interaction would be as follows

$$ {}_{\pm}e^{0} + {}_{1}p^{1} \rightarrow {}_{0}n^{1} + {}_{+1}e^{0} \rightarrow {}_{1}p^{1} + {}_{-1}e^{0} + {}_{+1}e^{0} \rightarrow {}_{1}p^{1} + {}_{\pm}e^{0} \tag{26.15} $$

where ${}_{\pm}e^{0}$ is an elpotrin that consists of an electron ${}_{-1}e^{0}$ and a positron ${}_{+1}e^{0}$. From interaction (26.15) we find that the experiment mentioned proves the existence of the elpotrin but not the existence of the neutrino.

26.5 The composition and nature of matter

The greater the energy of the gamma radiation to which matter is exposed, the more complete is the fragmentation of the atomic nucleus and its parts, and consequently the more numerous are the electron-positron pairs which appear at that moment. This fact as well as the fact that only neutral particles and those with a single charge (negative or positive) have been discovered, lead us to the conclusion that all matter is composed of only two basic particles. These are the particle with a negative electrical charge, named the electron, and the particle with a positive electrical charge, named the positron. All other stable and unstable particles are a combination of those two. That again leads us to the conclusion that in nature the number of electrons equals the number of positrons and in that way symmetry and the equilibrium of electrical charge have been established. Relatively to electrical charge one more thing should be noted. The total kinetic energy of an electron, and a positron, calculated by using Coulomb's law according to the Eq. (26.13), equals the energy of the magnetic field generated by its motion.

If an electron had a mass, in the classical sense, then its total energy of motion, calculated on the basis of Coulomb's law, would consist of the kinetic energy of that mass in motion and the energy of the magnetic field which it, as an electrically charged particle, generates with its motion. However, it is surprising that an electron in motion does not posses, in the classical sense, the kinetic energy of a mass in motion. Its total kinetic energy consists only of the energy of its magnetic field. This is also proved here by comparing the amount of energy of the magnetic field and the kinetic energy of an electron when it collides with a positron. In both cases they equal $m_0 c^2$. On the basis of these facts for now only one reasonable conclusion can be drawn, and that is the following. The total mass of an electron and a positron, and matter in general, is of electromagnetic nature.

However, if the electron has any mass at all, in the classical sense, then its size is far less than its mass m_0, which is said to be the mass of an electron at rest, whereby it is forgotten that an electron is never at rest, because it has its spin, which is known for certain. Also, when talking about an electron, other kind of motion, such as, for example, oscillatory motions, should not be excluded. In connection with that we need to know that the masses of elementary particles inside an atom are less than the masses of these particles when they are at rest outside of the atom. We have seen before that the mass, or more exact said the inertia, of an electrically charged particle depends on a velocity of motion of that particle. Having in mind these facts we can conclude that the realized energy by nuclear fision and fussion originate from kinetic energy of the particles of an atomic nucleus Accordingly, we can also conclude that the defect of the mass of some atomic nucleus is, in fact, the defect of kinetic energy of the particles of atomic nucleus.

In connection with the above said, we can summarize it in brief:

- There is no antimatter nor annihilation of positron and electron;
- The energy of gamma radiation, which appears at the moment of positron-electron collision, originates from the kinetic energy of positron and electron;
- The positron does not disappear when it collides with an electron, but instead, it forms with it a new, still unknown, neutral particle which we have named the ELPOTRIN;
- The mass of the elpotrin is $1.8219 \cdot 10^{-30}$ kg, and the binding energy is 1.022 MeV;
- All matter is composed of only two basic particles, those being the electron and the positron, and
- Mass and matter are totally of electromagnetic nature.

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27. DE BROGLIE'S PERPETUAL MOTION

With the explanation of the photo-electrical effect the idea that light is dualistic in nature, particle (photons) and waves (electromagnetic wave) has become generally accepted. Also, from the relation and equivalence of mass and energy it results that every mass m is accompanied by energy $E = mc^2$ and energy E is accompanied by mass $m = E / c^2$. Consequently, every photon of energy $E = hf$ has the mass

$$m_f = \frac{E}{c^2} = \frac{hf}{c^2} = \frac{h}{\lambda c} \tag{27.1}$$

and also the momentum

$$p_f = m_f c = \frac{hf}{c} = \frac{h}{\lambda} \tag{27.2}$$

from which it results that the wavelength of the photon is

$$\lambda_f = \frac{h}{p_f} = \frac{h}{m_f c} \tag{27.3}$$

where h is the Planck constant.

Therefore a beam of light possesses the momentum $p = E / c$, which also results from electrodynamics. The existence of this momentum is considered to be proof that light has a particle nature as well as a wave nature. In contrast to this it is, ordinary particles and bodies in general are considered to posses an exclusively particle nature.

Encouraged by the dual nature of light, de Broglie, in his doctoral thesis [L. de Broglie, Dissertation, Paris, 1924.; L. de Broglie, Phil. Mag., 47, 446, 1924.] of 1923, put forward the bold hypothesis that all particles have a wave nature as well. According to him, matter itself is dualistic in nature, not just light.

De Broglie asserts that every particle of mass m, moving at speed v, is accompanied by a wave of wavelength

$$\lambda = \frac{h}{p} = \frac{h}{mv} \tag{27.4}$$

Davisson and Germer allegedly confirmed the existence of de Broglie's wavelength experimentally in 1927, and discovered the diffraction of electrons. [C.J. Davisson and L.H. Germer, Nature 119, 558, 1927.]

According to de Broglie's hypothesis, particles do not possess a wave nature when at rest. In order for the wave to accompany the particle, the particle must be set in motion. However, in order to set a particle in motion some energy must be expended. In order to set an electron in motion an acceleration voltage is used. In the electron microscope and X-ray devices, for example, the acceleration voltage is the anode voltage.

The concept of the wave nature of the electron is employed in the electron microscope [23], [24]. The electron microscope is considered to be irrefutable proof that the electron has a wave nature. At this point X-ray devices, that existed before the electron microscope, are forgotten.

In order to obtain de Broglie's wavelength of an electron we should find the momentum of the electron, which is dependent on the velocity, that is, on the kinetic energy of the electron.

The equation for the kinetic energy of the electron, according to Eq. (23.38), in this case is given by

$$E_k = eU = mc^2 - m_0 c^2 \tag{27.5}$$

From Eq. (27.5) we get that the mass of the electron accelerated by voltage U is given by

$$m = m_0 + \frac{eU}{c^2} \tag{27.6}$$

where e is the electrical charge of the electron.

The relationship between mass m and m_0 is given by Lorentz's Eq. (23.4) for transversal mass

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{27.7}$$

Using Eqs. (27.6) and (27.7) we find that the momentum of the electron $p = mv$ is given by

$$p = \sqrt{2 m_0 eU + \left(\frac{eU}{c}\right)^2} \tag{27.8}$$

So, de Broglie's wavelength is given by

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2 m_0 eU + \left(\frac{eU}{c}\right)^2}} \tag{27.9}$$

In case of non-relativistic speeds of electrons, when $v << c$, de Broglie's wavelength is

$$\lambda = \frac{h}{\sqrt{2 m_0 eU}} = \frac{12.264}{\sqrt{U}} \cdot 10^{-10} \text{ m} \tag{27.10}$$

The wavelengths calculated according to Eq. (27.9) are a little different from the wavelengths calculated according to Eq. (27.10). For example, if the accelerating voltage is 60000 V, then the wavelength calculated by use of Eq. (27.9) is $\lambda = 0.04866 \cdot 10^{-10}$ m and calculated by use of Eq. (27.10) is $\lambda = 0.05101 \cdot 10^{-10}$ m.

When we know de Broglie's wavelength we are able, using Planck's equation for the energy of the wave $E = hf = hc/\lambda$, to calculate the energy contained in the wave of that wavelength, and then to compare it with the energy expended to generate that wave. Such information can be used to estimate the correctness of de Broglie's hypothesis. Of course, this is correct only if de Broglie's wave has electromagnetic nature.

For example, the energy of de Broglie's wave of wavelength $\lambda = 0.04866 \cdot 10^{-10}$ m is

$$e_\lambda = \frac{hc}{\lambda} = \frac{6.626 \cdot 10^{-34} \cdot 2.99792 \cdot 10^{8}}{0.04866 \cdot 10^{-10}} = 4.0823 \cdot 10^{-14} \text{ J}$$

and the energy spent, in order to generate that wave is

$$E_k = eU = 1.602 \cdot 10^{-19} \cdot 6 \cdot 10^{4} = 0.9613 \cdot 10^{-14} \text{ J}$$

Comparing these two results we find that the energy of the wave is 4.247 times greater that the energy expended to generate it The alleged gain in energy, that is the gain coefficient, decreases with increases in the anode voltage. For example, at an anode voltage of 100 V the gain coefficient is 101.1. Such a result is surprising, and runs counter to the law on the conservation of energy. If de Broglie were right, and if an electromagnetic wave were involved, this would mean that the long awaited secret of perpetual motion had been uncovered. Unfortunately, this is impossible. De Broglie's hypothesis is, in fact, the result of a tendency to find symmetry in nature even where it does not exist.

We have seen above how the electron in motion generates an electromagnetic field, with which it joins and from which it breaks away on the decrease of the velocity of motion. The relation between the mass of an electron and the field generated appears between the mass of the electron and the energy of the generated field as well. The faster the electron moves, the greater the energy of the field generated and the greater the mass of the electron. As a result, the increase in mass of the electron in motion, as we saw before, must be called electromagnetic mass.

The phenomenon of the generation of an electromagnetic field by the motion of an electron is as well known as X-ray radiation. However, the wavelength of X-ray radiation is considerably larger than de Broglie's wavelength at the same acceleration voltage and corresponds to the energy spent in its generation. Therefore, some kind of dualism of electrified particles in motion really does exist, even without de Broglie's wave. That kind of dualism, in distinction from de Broglie's, has sound basis in proved fact. De Broglie starts from the symmetry in which it is understood that light has a particle nature, and as a result it brings that assertion into doubt as well.

Neutral particles in motion do not generate an electromagnetic field. As a result they do not behave as if they were waves, that is they are not accompanied by a wave as is an electron, or some other electrified particle, in motion.

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28. CONCLUSION

Few theories and authors have won such fame as the theory of relativity and its author Albert Einstein. It is also difficult to find a theory so popular, and yet so unclear, incomplete, paradoxical and contradictory, as is the theory of relativity.

It is simply incredible that a theory with so many deceptions has held the attention of so many of physicists and other scientists from the field of natural and technical sciences for so long, and has managed to retain acceptability and even enter the textbooks for secondary schools and universities.

The acceptance of that theory at the time when it was developed can be somehow understood, since that was a crucial time, when many questions in physics were asked, for which there were no answers.

The results of Fizeau's test, and later Michelson's experiment, destroyed the old conception of the existence of a cosmic quiescent ether, which also meant the destruction of the foundations on which some great theories of the time had been built. Lorentz also found himself in an unenviable situation, since his Electron theory was based on the existence of an ether.

To overcome the arisen difficulties, Lorentz gave a hypothesis on the shortening of a body moving through the ether, which is proportional to the coefficient $\sqrt{1-v^2/c^2}$. In accordance with that hypothesis, Lorentz derived the transformation of coordinates, which was later named after him. With this transformation, time and space were made relative and that laid the foundation for the theory of relativity.

On that foundation Einstein built his special theory of relativity. However, unlike Lorentz, he introduced a new understanding of time and space. According to him, the change in length and time are real physical processes, which occur exclusively as a consequence of motion itself, and not as a consequence of the effect of some ether, which does not exist at all.

Thus Einstein denied the existence of the ether and allegedly gave answers to some questions, which arose after Fizeau's and Michelson's experiment. Unfortunately, his theory did not give the right answers. It can even be said they were deceptions, as the special theory of relativity can be said to be, in essence, a sum of deceptions, which this book has uncovered. It is a failed attempt to build a universal theory on the basis of the known experimental results, which would be, first of all, in accordance with these results.

The so-called results of the special theory of relativity, that are in fact correct but are reached by incorrect relativistic derivation of equations, where known before the appearance of the special theory of relativity. They are to be found in the work of Lorentz (the longitudinal mass and the transversal mass), Poincare ($E = mc^2$), Maxwell ($p = E/c$), Heaviside and others.

Einstein's exposition in that theory is ingeniously thought out to deceive and it largely resembles magician's tricks. Thus, for example, when he explains things which are known and clear even to a secondary school student, he is methodical, very clear to the last detail and exhaustive. However, when we look at the text containing a deception, he is complex, confused, incomplete and brief or, alternatively, long-widened. Despite that long-wideness he does not clarify what is unclear, but complicates it further, so that the text becomes even less clear. On the credit of what is clear in Einstein's exposition, the reader accepts the unclear as well, believing it to be true, and thinking it is his fault that he does not understand Einstein, or that it would take a lot more effort to understand him.

Einstein started his deception right from §1 of his paper on relativity [2], on determining simultaneity, on the basis of the judgement on the synchronized "ticking" of clock in motion. That is the first and the key deception in the special theory of relativity, on the basis of which further deceptions were constructed. Unfortunately, that deception was not spotted, and it even became the subject of serious philosophic discussions.

The first inconsistency appears in §2 of the same paper, where he uses speed $c+v$, although he claims with his fundamental postulate that in nature there is no higher speed than the speed of light in vacuum. Inconsistency is an important characteristic of the theory of relativity, although Einstein claims that the theory of relativity is a theory of principles, that is a theory of consistency.

In §3 he derives transformation of coordinates in a very complex, confused and unclear way, where he also uses expressions $c+v$ and $c-v$. A complicated way of deriving equations offers great opportunities for deceiving the reader. Thus, with the help of clocks and simultaneity control of their "ticking" in two coordinate systems, which move relatively, a light ray and mathematical operations Einstein derived transformation of coordinates and "proved" not only that the existence of time dilatation and space contraction in mathematical sense, but also that they are real physical processes.

However, I derived in a simple way a number of transformations of coordinates on the basis of satisfying the requirement for invariability of equations for the propagation of spherical and plane light wave. By using the Lorentz and these transformations, I proved that Einstein's time dilatation and space contractions are just a mathematical game, which has no connection with some real physical process. In connection with that I have demonstrated that the so-called coefficient of the contraction is not $\sqrt{1-\frac{v^2}{c^2}}$ but $\sqrt{\frac{c-v}{c+v}}$.

In §5 of the said first paper, the theorem on addition of speeds is derived in an equally complex and unclear way. If it had been derived in a simple and comprehensible way, as has been done in this book, it would have been clear that it was not a case of addition or subtraction of any speeds, but that the formulas of the theorem represent the speed of light wave in a coordinate system at rest, in case of addition of speeds, or in a moving coordinate system, in case of subtraction of speeds. Since the transformation of coordinates was derived with the condition that the speed of propagation of spherical light wave in both systems equals the speed of light, then the alleged sum and difference of speeds must be equal to the speed of light.

In deriving equations Einstein uses expressions $c-v$ and $c+v$ and he never changes them with c, although in his theorem on addition of speeds he says that the sum or the difference of light velocity and some other speed are equal to the velocity of light. Thus, Einstein refutes his own theorem.

With the help of this theorem he explains the result of Fizeau's experiment, claiming insistently that the result of the experiment confirms the validity of the theory of relativity and that there is no other theory which can explain it. By such a resolute claim, he hides the fact that the formulas of his theorem are derived for the case of vacuum, and that Fizeau's experiment is performed in water. As an outstanding physicist he must have known that, but nevertheless, he uses the formulas, valid for vacuum, for the case of water, in order to prove the correctness of his theory, which says a lot about Einstein's correctness, and the correctness of his theory.

I derived the equations of the theorem on addition of speeds in moving water in the same way as it was derived for the case of vacuum. By use of those equations I showed that the result of Fizeau's test does not prove the correctness of the theory of relativity, but, on the contrary, refutes it. At the same time the result of the Fizeau's test is explained by use of the new derived equations for the speed of light in moving water.

In deriving the formulas for the angle of aberration and the Doppler effect, he applies the transformation of coordinates for a spherical light wave on a plane light wave, which is incorrect. The formula for the Doppler effect for the case of moving radiation source, which Einstein gives, is not, and can not be, derived in the relativistic procedure, which also shows the failure of the theory of relativity. Also, according to this equation, the frequency of the radiation increases as the radiation source retreats, which runs counter to observed reality.

According to the theory of relativity, apart from the longitudinal Doppler effect, there is also the transversal one, which has no bearing on reality. By using new transformations I showed that the relativistic way of determining the Doppler effect represents an interesting mathematical game which can not be logically connected with reality.

The classical and relativistic explanation of the cause of aberration is disputed and a new explanation is given, which is based upon relative motion of the earth's ether and sun's ether.

An especially important part of the special theory of relativity is the one which refers to a body's mass and energy and their mutual relation. It is generally believed that the theory of relativity proved itself most convincingly in this sphere. However, nobody has spotted that the failure and weakness of this theory was proved most obviously in this sphere, which is shown in this book.

Einstein tried to derive the formula for the mass of a moving electron, as well as the formula which determines the relation of mass and energy in his first paper. So, in §10 of that paper, under the title "Dynamics of a (weakly accelerated) electron", Einstein derives in a wrong way, both from mathematical and physical standpoint, wrong formula for transversal mass of an electron and correct formula for longitudinal mass.

Deriving the equations for the longitudinal and transversal mass of an electron in motion, which are dependent on velocity, Einstein assumes that an electron in motion has only one mass m and treats it as a constant magnitude.

Applying the Lorentz transformation of coordinates to the expressions of the accelerations $\frac{d^2x}{dt^2}$, $\frac{d^2y}{dt^2}$ and $\frac{d^2z}{dt^2}$ he arrives at equations for the longitudinal and transversal acceleration which he thereafter refers to as equations for longitudinal and transversal mass. In this incorrect mathematical game the concept of acceleration is substituted for the concept of mass which have nothing in common from the viewpoint of physical science.

The wrong equation for the transversal mass, an incorrect derivation of the equations, the use of very low, non-relativistic velocities in comparison with the speed of light, and the assumption that mass and acceleration are the same thing, all go to show that the equations for the longitudinal and transversal mass of an electron in motion cannot be derived according to correct relativistic procedure.

The theory of relativity treats the change of the mass of an electron in motion exclusively as a result of relative motion, but not as the result of the physical process caused by motion of an electrically charged particle. In this way the theory ignores the very idea of electromagnetic mass, which is not accepted at all.

The equation for the kinetic energy of an electron and the equation for the transformation of energy into electromagnetic mass and electromagnetic mass into energy cannot be derived by correct relativistic procedure because the equations for the longitudinal and transversal mass cannot be derived by that procedure either. As a result these equations cannot be considered relativistic, nor they should be connected with the theory of relativity.

By the way, the equations for the longitudinal and transversal mass of an electron in motion, which are ascribed to Einstein, were in fact derived by Lorentz before the appearance of Einstein's theory of relativity, but on the supposition that the spherical shape of an electron deformed on motion through the ether.

The formula for the total transformation of mass into energy, $E = mc^2$, was not nor can it be derived by correct relativistic procedure and should not, therefore, be treated as a relativistic equation or connected with the theory of relativity.

For a long time it was thought that Einstein derived a complete theorem on the inertia of energy in the article, "Does the inertia of a body depend on the energy contained in it?" However, in 1953, Ives proved that the theorem was incorrectly derived.

In another article, entitled "The elementary derivation of the equivalence of mass and energy", published in 1946, Einstein derived $E = \Delta mc^2$ using incorrect derivation and thus concluded that $E = mc^2$. It is therefore without foundation to assert that Einstein derived the equation $E = mc^2$ by correct relativistic procedure. In fact it cannot be derived correctly by that procedure. Poincare was the first who derived in implicit form the formula $E = mc^2$.

In chapter 23.8 of this book I have derived this equation $E = mc^2$ completely, according to classical procedure. Using that result I also derived completely the equation $m = m_0 / \sqrt{1 - v^2 / c^2}$ according to correct and purely classical procedure as shown in chapter 23.9 of this book. In this way I have proved that these two most important equations in the theory of relativity do not belong there and are classical equations.

The annihilation of the electron and positron is considered to be the most convincing example of the total transformation of mass into energy. In that process the entire mass of the electron, as matter and the entire mass of the positron as antimatter are allegedly transformed into energy in the form of two gamma rays. At the same time, the appearance of electron-positron pairs when matter is irradiated with gamma rays of energy greater than 1.022 MeV is considered to be a convincing example of the transformation of energy into mass.

In chapter 26, however, it is demonstrated that when electrons and positrons collide they are not annihilated and their mass is not transformed into gamma radiation. A moving electron, as a moving positron, possess kinetic energy. When these particles collide this energy is converted into energy in the form of two gamma rays. From this we must conclude that the positron is not antimatter and that antimatter does not exist. The electron and positron do not disappear on collision, but form a neutral particle. On the irradiation of matter with high energy gamma rays, the bond between the electron and positron is broken and the electron positron pairs appear. Electrons and positrons form the basis of matter, accordingly we should not generalise and assert that $E = m_0 c^2$.

Incidentally, Heaviside derived the equation for the mutual relation of energy and mass of an electron at rest correctly, as $E = \frac{3}{4} m_0 c^2$. The equation $E = mc^2$ is related to the mutual relation of the energy of electromagnetic radiation and the electromagnetic mass ascribed to that energy.

It is considered that Einstein's findings about the dimensions of the universe, its age and the quantity of matter contained within it are incorrect. In connection to this a new hypothesis is presented to explain the red shift in the spectra of radiation from distant galaxies. This hypothesis counteracts the theory that the universe was born in a big bang and that it is expanding. On the basis of this hypothesis the phenomenon of cosmic rays of enormous energies is explained, as well as the origin of primary cosmic rays.

De Broglie's hypothesis about the wave nature of particles only makes sense for electrically charged particles. The wavelength of the wave accompanying the moving charged particle is in reverse proportion to the energy expended in causing the particle to move, and is subject to Plank's law $\lambda = hc / E$. De Broglie's wavelength, which accompanies the electron in motion, is not however in accordance with this law. The energy of de Broglie's wave is greater than the energy expended to generate that wave. This fact, in some way, denies the existence of de Broglie's wave.

Finally we must pose the question of the acceptability of the general theory of relativity. The short answer is as follows: The general theory of relativity can be judged on the basis of this book and on Einstein's own statement, "the general theory of relativity is based on the special theory of relativity" [A. Einstein, Ideas and Opinions, 228-229, 1954. (Article "What is the theory of relativity?", published in "Times" from 12.11.1919.)].

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