Young's Experiment and Solitons. New Arguments in Favor of Ether

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Abstract

The interference of laser photons (λ=532 *nm*) when they pass through two slits of the same width has been studied. The interference is observed up to the value S≈11 *mm* between the slits. Based on this, the assumption has been made that all elementary particles are soliton formations of the electromagnetic field. Solitons of classical physics exhibit the properties of a wave and a corpuscle, thus, we have an explanation of the corpuscular-wave nature of elementary particles as a phenomenon of classical physics. For the formation of solitons, the presence of a medium with the properties of dispersion and nonlinearity is necessary, and this contradicts the foundations of SRT. In this regard, a number of problems related to the foundations of SRT have been analyzed. It has been established that SRT does not pass the verification by the correspondence principle, since at low speeds the Lorentz transformation of time does not pass into the Galilean transformation. This means that SRT cannot be a physical theory. The reader's attention is drawn to the fact that the relationship between the mass of a body and its internal energy, as well as the dependence of the mass of a body on the speed of its motion, do not belong to the problems of the theory of relativity, and therefore, their experimental confirmation cannot be an argument in favor of SRT. It is shown that the idea of the independence of the speed of quanta on the speed of the frame has a direct experimental refutation – the results of measuring the rotation periods of Io (a satellite of Jupiter) taking into account the addition and subtraction of velocities make it possible to obtain results for the speed of light with an accuracy of 1% of the reference value. This is a direct experimental refutation of the SRT.

Keywords: Young's experiment, 2-slit, photon, interference, soliton, ether, special relativity theory

1. Introduction

Experiments on observing the interference of photons on two slits of equal width, at different values of the gap *S* between them, are fundamental, since the results influence the construction of the physical picture of the material world. Thomas Young first conducted the experiment on interference on two slits in 1801 [1]. At that time, it was believed that the experiment unequivocally confirmed the wave nature of light, and thus denied Newton's corpuscular idea.

The successes of geometric optics, both lens and mirror, plus experiments on the external photoelectric effect, the Compton effect, experiments on measuring light pressure, indicate the presence of corpuscular properties in light waves as well. At the beginning of the 20th century, it was believed that the "transverse dimensions" of a photon could range from the sizes of telescope objectives (at that time 5 *meters*) to the order of its wavelength. Regarding the longitudinal geometric dimensions, there was also no clear point of view, although it was allowed that it could reach 3 *meters* or more – the so-called "needle-like photon" according to Einstein's definition [2]. For such a photon model, the concept of a "train of waves" was introduced, that is, a "train of waves" where the role of wagons is played by the wavelength of light. According to the concept, such photons are divided on a silvered plate into two parts, then these parts move in different arms of the interferometer, pass through optical paths of different lengths, and interact with each other at the output, that is, they interfere.

The presence of corpuscular properties in photons prompted de Broglie to assume that "true corpuscles" may have wave properties, and this was confirmed by experiments with electrons, in the corpuscular nature of which no one doubted. The concept of corpuscular-wave dualism appeared for the entire microworld, both for photons and for corpuscles, but without an explanation of the cause. It was not clear why a photon, having the property of a corpuscle, passes simultaneously through two or more slits, and this is indicated by the subsequent interference of its parts, and also why a corpuscle, which is attributed sizes close to zero (electron), diffracts on atomic gratings, and even on large clusters of atoms.

The purpose of our research on the interference of photons on two slits was to establish the maximum value of the distance *S* between the slits, at which interference is still observed. We hoped that the results would help to make progress in understanding the nature of quanta of electromagnetic energy.

2. Experiment

The experimental setup for studying the interference of photons on two slits is shown in Fig. 2.1. A semiconductor laser, λ=532 *nm*, is mounted on an optical bench. To increase the diameter of the beam, the laser beam is formed by lenses 4 and directed to the double slit *S*. The interference pattern is observed on screen 1, or on screen 2 through a metal mirror 3, which is attached to screen 1 when needed – for the case when the diffraction angles are insignificant.

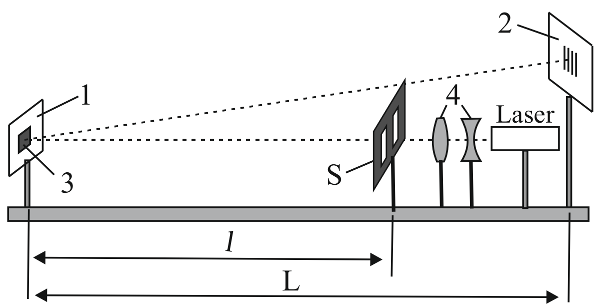

Fig. 2.1. Experimental setup.

S – double slit; 1 – white screen, if necessary, a metal mirror 3 is attached to screen 1, which directs the laser beam to screen 2; 4 – optical lenses for forming a wide beam of photons. L = 370 *cm*, l= 232 *cm*.

Double slits were manufactured in our laboratory. For this, a slit base 1 with a slot was first made, Fig. 2.2. Strips of foil 0.2 *mm* thick of appropriate width were attached to base 1 by spot electric welding. First, the central strip (part 2) was attached, and then the two side ones. The width of the slits S_0 in most cases was 0.1 *mm*. To achieve parallelism of the jaws and to set the required slit width, a metal strip of calibrated thickness, 0.1 *mm*, was inserted between them at the moment of welding.

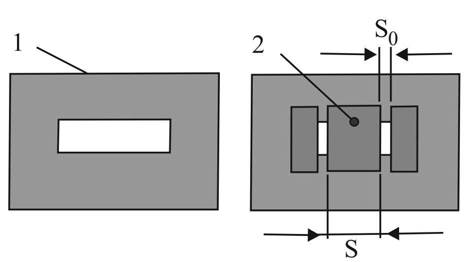

Fig. 2.2. Construction of a flat double slit with a large *S* value.

First, slit base 1 with a slot is made. A plate of width *S* (position 2) is welded to the base, and side plates through a standard of thickness S_0.

With slits smaller than 0.1 *mm*, the zero maxima on the screen are quite wide, and with larger slits, diffraction maxima of higher orders begin to appear between the positions of the zero maxima on the screen, which distorts the interference pattern. To control the presence of interference, one of the slits was covered with an opaque shield through a micrometer screw.

Double slits were attached to a steel screen using magnets – for convenience of mounting, adjustment, and replacement of slits. The steel screen (also with a slot), on which the double slits were mounted, was placed on the optical bench through a rider, Fig. 2.1, position *S*. The interference pattern was observed visually on a white screen. In this paper, we provide images from the screen obtained with an electronic digital camera.

3. Results

3.1. Interference of photons on two slits.

In our research, we did not aim to measure the angles of diffraction or interference, as well as to measure the intensity of the bands, as is done when studying the diffraction of photons on a single slit. This is the work for the future. First of all, we were interested in the moment at which values of the distance *S* between the slits the interference pattern would cease to appear, that is, to try to measure the transverse dimensions of a photon with a wavelength λ 532 *nm*. It is easiest to observe the interference of photons at small values of *S*, in our case it was $S=S_0=0.1$ *mm*. In this case, the zero maxima from both slits on the screen merge into one intense band, and the interference pattern is superimposed on this common zero maximum. As the experiment shows, photons do not enter some places of the zero maximum almost completely. This is manifested in the appearance of dark bands against the background of the zero maximum, Fig. 3.1, *a*). This result in itself is far from simple.

As *S* increases, the zero maxima begin to separate more clearly, the distance between them increases, and the additional interference bands become narrower and narrower, and less intense. At the same time, the number of additional bands increases. We assume that with an increase in *S*, the percentage of photons that take part in interference decreases (most photons pass into the zero maxima). Plus, the energy of the photons is distributed over a larger number of interference bands, and this also leads to a decrease in the intensity of these bands, Fig. 3.1, *b*). Covering one of the slits with a shield demonstrates that most photons indeed pass through a specific slit without deviations, without diffraction (the intensity of zero maxima does not change visually), and only a small part of photons diffracts on a wide obstacle with subsequent interaction of parts of photons that penetrated through two slits simultaneously, that is, with subsequent interference.

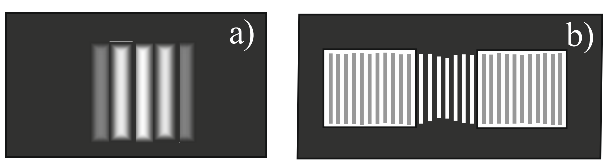

Fig. 3.1. Interference pattern on a double slit. (figure edited in CorelDraw).
a) – at a small value of *S*, $S=S_0=0.1$ *mm*. Interference bands are observed against the background of the zero maximum. *b*) – at $S = 4$ *mm*. $S_0=0.1$ *mm*, the zero maxima are separated. Against the background of the zero maxima, and between them, interference bands are observed, which indicate the passage of photons through two slits simultaneously.

In the pre-laser period, such studies were quite difficult – it is difficult to obtain a parallel beam of light from a non-point source (from a filament or from a heating strip in a lamp), and on the other hand, there were problems with the formation of monochromatic beams due to the absence of necessary light filters. The use of laser beams solves both problems.

As studies have shown, the interference pattern of photons λ=532 *nm* on two slits is observed up to a distance of *S*=11 *mm* between the slits. For us, such a result was absolutely unexpected, since in our previous work we concluded that the transverse geometric dimensions of a photon should be on the order of its wavelength [3,4]. Our expectations were at the level of fractions of a *mm*. Now it turns out that 11 *mm* is probably only the radius of the photon, and its diameter for this wavelength may be equal to 22 *mm*, Fig. 3.2.

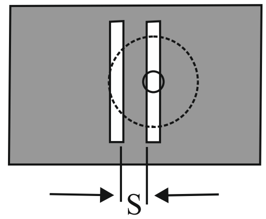

Fig. 3.2. Passage of photons through two slits.
The central part of the photon passes through one of the slits, and its peripheral part through the second, after which their interference occurs.

To explain such a result, it is logical to assume that the main part of the photons passes through one separate slit, and on the screen this is manifested in the appearance of a zero maximum, that is, they pass through the slit without deviation, or with a slight deviation, which is manifested in the broadening of the zero maxima. In some other photons, the central part of the photon also passes through a separate slit, and its peripheral part passes through the second slit. After the photon overcomes the two slits, there is an interaction of those parts of the photon that penetrated through different slits, that is, interference of these parts occurs. Obviously, this manifests some properties of the quantum related to its parameters, with transverse and longitudinal geometric dimensions, with the distribution of electromagnetic energy within the quantum, with oscillatory processes inside the quantum, etc.

Let us estimate the order of the ratio n of the transverse dimensions of the photon to its wavelength, assuming that the diameter of the photon is equal to 22 *mm*.

$$n = 22 \cdot 10^{-3} / 532 \cdot 10^{-9} = 4.2 \cdot 10^{4}$$

What is the longitudinal geometric size of such a photon – whether it is equal to the length of its wave, or larger – is a separate question. At this stage, it can only be noted that in some pulsed lasers, the pulse length is on the order of the wavelength of the photons. It can be considered obvious that the longitudinal geometric size of a photon cannot be greater than the length of the laser pulse. If we proceed from the fact that in the mentioned laser pulse, the length of the photon is on the order of the length of its wave, then in any other situation it cannot be larger in principle. On the other hand, it cannot be that in some cases the photon had one length, and in other cases already another, with the same wavelength. The indicated result, concerning the length of the laser pulse, unambiguously refutes the model of a needle-like photon, but raises anew the question of coherence length. The model of a needle-like photon, that is, a train of waves, was once proposed to explain the process of dividing beams into parts with subsequent interference of these parts.

Looking at Fig. 3.2, we can conclude that a quantum is not just an electromagnetic wave, but some special wave object in which the propagation of oscillations is limited by two coordinates, and there are no limitations along the third coordinate, that is, a photon is a wave localized in space, a solitary wave. This localized wave has the ability to pass both through one slit and through two or more slits simultaneously, for example through a diffraction grating. At the same time, the vast majority of photons overcome the slit without significant deviation from the direction of propagation (zero maxima are intense, but broadened). For those photons that passed through two slits, the central part of the wave probably passes through one slit, and the peripheral part of the wave through the other. After passing through the slits, the indicated parts of the wave interact with each other, unite, and in such a way that the energy of the quantum at the output of the double slit does not change – at least the color of the interference bands is visually the same as that of the zero maximum.

When two slits are open, narrow dark bands appear against the background of the zero maxima. This means that photons do not enter those places after interference. At the same time, bright interference bands appear on the dark background between the zero maxima (at large values of *S*), which were not there before. Between the zero maxima, there are also places where photons do not fall. Thus, narrow interference bands appear between the zero maxima. It is these interference bands that indicate the passage of some photons through two slits simultaneously. When one of the slits is covered with a shield, one of the zero maxima disappears, but the interference bands also disappear. Note that the width of the interference bands for a concrete value of *S* is visually the same, both against the background of the zero maxima and between the maxima, Fig. 3.1, *b*).

From this relatively simple experimental fact, it is difficult to predict whether this result has a "local significance" for physics, or if it is something more serious, and perhaps even fundamental. At this stage, we suggest that the reason for such properties of photons lies in the fact that a photon (and a quantum in general) probably represents a soliton formation, more concretely, a 2*d*-soliton formation of the electromagnetic field. It should be noted that in university physics courses, insufficient attention is paid to the study of such a phenomenon as solitons. It seems that solitons are perceived by physicists to some extent as objects of local importance, as if it is, on the one hand, simply exotic, which does not have a fundamental meaning for understanding the basic laws of nature, and on the other hand, as if it is more of a mathematical problem.

Historically, Russell Scott first observed a soliton on the surface of water in 1834 [5]. Scott's task was to investigate the peculiarities of the passage of a barge along water canals. Once, in the process of towing a barge, a formation on the water surface in the form of a hemisphere with a height of about 30 *cm* and a diameter of 3 *m* broke away from the barge. This formation moved along the canal at a relatively high speed, was reflected from the banks as an object with the property of a solid elastic body, and for several kilometers it did not change either its shape or speed of movement. This means that the wave formation did not give the water either the energy that was concentrated in it, or the kinetic energy.

For a start, for clarity, one can imagine that inside such a soliton there is some kind of oscillatory process with the properties of a standing wave, with the properties of a wave packet. The harmonics of this packet catch up and overtake each other, create conditions for themselves for reflection both from the center of the object and in the direction to the center after spreading to a certain distance. In such a wave formation, oscillations propagate to a certain distance from the center, but these oscillations do not go beyond certain boundaries of space. The wave limits itself in space, isolates itself. Russell Scott called the object he discovered a "solitary wave." The scientific community of that time did not pay due attention to this phenomenon. After nearly 100 years, a number of researchers began to study localized waves, and the self-captured wave was called a "soliton." Nowadays, we can already say that if a wave localizes itself in two directions, in two coordinates, then it is a 2*d*-soliton, if in three, then it is a 3*d*-soliton. An example of a 1*d*-soliton is a tsunami. A tsunami propagates over long distances without losing the energy concentrated in it; it is a kind of "1*d*-corpuscle."

After Russell's work, the study of soliton formations is being conducted relatively intensively. A large number of different types of solitons have been discovered and mathematically described, including the 3*d*-soliton [6]. As already mentioned, by a 3*d*-soliton we will understand a wave that is self-captured along three spatial coordinates. In our opinion, the writing of an equation, the solution of which is a 3*d*-soliton, should be considered a serious achievement of our time, but it passed in the literature without its proper evaluation.

Given the enormous speed of propagation of electromagnetic waves, we must assume that the light-carrying medium is extremely hard, most likely with the properties of a crystalline body. Roughly speaking, by how many times the speed of light is greater than the speed of sound in diamond, by so many times our light-carrying medium is "harder" than diamond. Note that in technology, in mechanical engineering, the concept of "hardness" is defined as the ability of a material to resist the penetration of a special tool (diamond cone, diamond pyramid, steel ball) under the action of a calibrated force. The hardness of the material is judged by the diameter of the trace from the tool, by the diameter of the crater. It immediately becomes obvious that no corpuscles can move in such an environment (no atoms in a diamond crystal can move) – only waves of various types, including solitons.

The attempt to present a photon as a solitary electromagnetic wave, that is, a soliton, was put forward in the work of J. Vigier, [15], (1991). Further development of this idea is presented in [16], (1996). The sizes of photon-solitons at energy 1-2 *eV* in this work are estimated to be equal to $\approx 10^{-10}$ *m*. The problem of how nonlinearities can form in a vacuum is explained in the indicated works as follows: the emitted photon-soliton contains a high density of energy, respectively, and mass, which can deform space, cause nonlinear properties in physical space. Being confident that, according to the theory of relativity, the light-carrying medium is absent, the authors endowed space itself with the properties of nonlinearity.

We have been trying to spread the idea that our material world has a soliton nature, that these solitons are formed in a medium with the properties of a solid body, for a long time, since 1996, [7]. This work is based on the atomic model proposed there. At that distant time, we did not yet know about the existence of solitons, did not know the term "soliton," and used the term "self-captured wave," "self-closed wave." The idea of the existence of self-captured waves appeared under the influence of de Broglie's atomic model, in which the electron has the form of an electromagnetic wave self-closed around the atomic nucleus, [8]. In our subsequent works (in [4] and others), we already used the term "soliton." The very image of the electron as a self-captured wave with the properties of a standing wave, as a 3*d*-soliton, was proposed to explain the cause of the discreteness of the electron's energy levels in the atom and the physical essence of quantum jumps – the number of nodes of a standing wave changes discretely. Hence, we have quantization of the electron's energy in the atom, in the bound state, in the potential well, but already as a phenomenon within the framework of classical physics [4].

For a long time, we did not have an acceptable idea of how transverse oscillations can form in a solid when trying to create longitudinal deformation, that is, how longitudinal oscillations can turn into transverse ones and vice versa. All our attempts began with considering the cubic packing of elements of the light-carrying medium. We mistakenly believed that this is the simplest option.

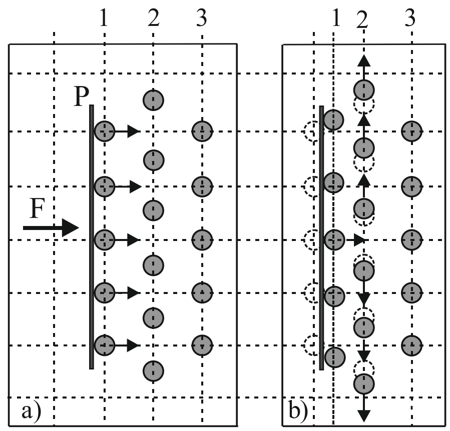

Fig. 3.3. Possible mechanism of transition of longitudinal deformations into transverse ones with dense packing of ether elements.

The dotted line shows the positions of elements in layers 1 and 2 before the action of force *F*. *a*) – force *F* through an imaginary flat platform *P* begins to press the elements of layer 1 between the elements of layer 2. *b*) – elements of layer 1 push apart elements of layer 2 in the transverse direction, plus they themselves are displaced in the transverse direction.

To form a more plausible idea, the key was the assumption that the light-carrying medium with the properties of a solid body can have a dense packing of its elements. In this case, an attempt to deform the ether by a force *F* through an imaginary, hypothetical, flat platform *P*, Fig. 3.3, *b*), leads to the fact that the elements of the first layer of the ether are pressed between the elements of the next layer, resulting in the automatic appearance of transverse deformations. We draw attention to the fact that purely transverse oscillations are a standing wave, when the nodes of the wave are immobile in space. Purely longitudinal oscillations are sound oscillations in gases. It can be considered plausible that quanta are longitudinal-transverse oscillations of the medium, since they propagate in a straight line, but also have the ability to polarize.

We should not forget about the possibility of forming shear deformations, in this case torsional deformations, for which the rotor is not zero. We assume that the process shown in Fig. 3.3 *b*) can also turn into torsional oscillations. It is quite possible that the idea of the existence of torsion oscillations has at least a share of truth. We also assume that torsional deformations represent magnetic fields, magnetic field lines.

The mechanism presented in Fig. 3.3 is only the first attempt to point to the process that underlies the functioning of 2*d*-solitons; this is a demonstration of the fundamental possibility of modeling longitudinal-transverse oscillations within the framework of classical physics. It is quite possible that over time there will be refinements of the proposed model, improvements, more sophisticated hypotheses will appear, but at this stage we can already assert that we have serious arguments in favor of the existence of a light-carrying medium with the properties of a solid body, as well as arguments in favor of the soliton nature of quanta.

3.2. The material world as a set of 3*d* and 2*d*-solitons formed in a light-carrying medium.

Before our inner gaze appears a psychologically quite uncomfortable picture: an infinite, extremely solid medium, which in turn consists of some elements, the sizes of which are probably much (by tens of orders?) smaller than the sizes of elementary particles known to us, such as electrons. In the future, it may turn out that only these elements of the medium can be considered more or less true corpuscles, corpuscles on the scale of our microworld, and at a deeper level, they in turn may also turn out to be solitons. In the literature, these hypothetical particles are sometimes called "amers." Amers are interconnected by elastic forces, which actually determine both the hardness of this old/new ether and the propagation of waves at high speed and without significant energy losses over gigantic distances.

On the other hand, it is the fact of the existence of waves in such a medium that indicates the presence of the property of inertia in those amers, that is, what we associate with the concept of inertial mass. After the deformation of the ether created in some way, amers under the action of the elastic forces of the medium return to their previous state, but they do not stop there, they continue to move by inertia, and then everything repeats. Obviously, we need to postulate that for amers, the phenomenon of gravity is not observed – only inertia. Otherwise, the ether would have collapsed long ago.

So, our material world is exclusively electromagnetic, nothing else, except for different types of electromagnetic waves and the light-carrying medium itself, exists in nature. According to this idea, the main "inertial mass" of the Universe is actually concentrated in the ether, perhaps it is 99.999% of what we today can call a material substance, or simply matter, and maybe more. And what we consider to be gigantic masses (planets, stars, quasars, galaxies) is actually only an insignificant part of matter in electromagnetic form, like waves on the surface of the ocean.

As our experiments have shown, the transverse size of quantum-solitons is 4 orders of magnitude larger than its wavelength. One order would not surprise us very much, but four orders, that is already more than just serious. In the further analysis, we will proceed from the fact that quanta, as 2*d*-solitons, appear in nature mainly during transitions of quantum systems (nucleus, atom, molecule, ion, cluster) from excited states to states with lower energy. It is known that the size of quantum systems at the atomic level is of the order of 1 *nm*, and the transverse size of the energy quantum according to our measurements is of the order of 22 *mm*. How many times is the photon λ532 *nm* larger than the system that emitted it?

$$m=22\cdot 10^{-3}/1\cdot 10^{-9} = 22\cdot 10^{6}$$

So, what picture can one imagine when talking about the emission of a photon by a quantum system? What can one imagine when saying that an excited atom (a combination of 3*d*-solitons) returns to a lower energy level, and emits a portion of energy in the process? Let's try to base it on Fig. 3.4. In this figure, an excited atom tries to create a longitudinal deformation of the ether, the atom tries to create a longitudinal deformation of the medium next to itself, which quickly turns into a transverse one. The transverse deformation cannot propagate to infinity, since there comes a moment when the action of the force creating the longitudinal deformation ends. After some time, the process begins in the reverse direction, the transverse deformation tries to turn into a longitudinal one, and so on. Let's not forget about the possibility of torsional deformations, shear deformations arising at the same time.

An image is taking shape before us, schematically presented in Fig. 3.4. This model does not claim to be the "ultimate truth," but it does present some aspect of the true picture. One of the first atomic models, Rutherford's atomic model, is far from a perfect model, but it reflects a significant part of reality.

In the process of photon emission, atom 1 first tries to create a longitudinal deformation (horizontal lines), but it quickly turns into a transverse one. The transverse deformation spreads to a certain extent, and then begins to transform into a longitudinal one. This is how a wave originates and propagates. It is possible that the quantum has approximately the same appearance as shown in Fig. 3.4. From this figure, one can also make an assumption that the quantum propagates in "jolts." Quite often, the new is a well-forgotten old. Is it possible that we have obtained an explanation of the essence of the process, about which Newton wrote that light moves with "fits of easy reflexion" and "fits of easy transmission"? When a photon falls on a transparent plate at an angle, the question of what to do (reflect from the plate or penetrate inside), the photon decides depending on the phase in which, moving in fits, it approached the surface of the plate. In one case, it will reflect, and in the second, it will penetrate the plate.

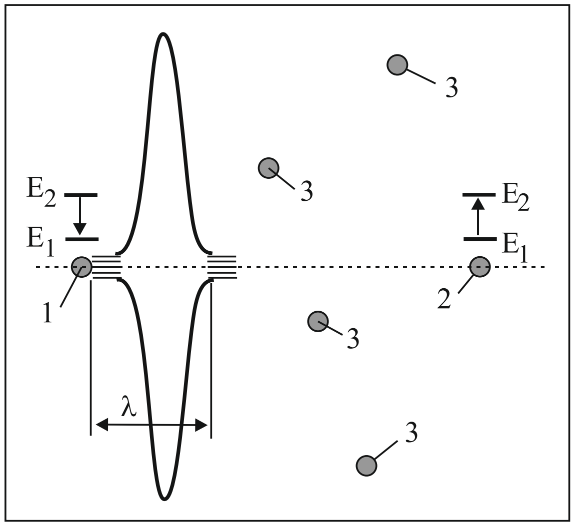

Fig. 3.4. The process of quantum emission by an excited atom. Scale not preserved.
An excited atom 1, being at energy level 2, begins a transition to a lower level. At the same time, it tries to create a longitudinal deformation in the surrounding space (horizontal lines). The longitudinal deformation quickly turns into a transverse one, and the transverse one again into a longitudinal one, and so on.

In an ideal medium, a photon will propagate without changing its parameters indefinitely, at infinite distances. On the other hand, we know that "all hermetic connections leak," that is, nothing is completely ideal in nature. What if, in those Newtonian fits, a small part of the quantum's energy is spent on "heating the ether" during each period of oscillation? If such losses exist, then they are also quantized. The loss of energy by a photon will manifest itself in an increase in its wavelength. The further the photon propagates, the longer its wavelength will be. This is not a new idea, and not our idea, but can such an idea be neglected within the framework of classical physics? Especially if the counter-idea looks fantastic and leads to the conclusion about the accelerated dispersal of galaxies. We assume that the loss of energy by a quantum in each act of transformation can be associated with relic radiation, or there is still some "sub-relic radiation" about which we know nothing yet. Can the fact that relic radiation has a high degree of isotropy in intensity in all 4π *steradians* be considered a coincidence?

It is known that quanta of different wavelengths from pulsars arrive to us with a clear time difference, with short-wave quanta arriving earlier. Within the framework of the proposed hypothesis, this means that even an undisturbed "ideal" ether (the same vacuum, the same physical space) still has dispersion. In ethereal solitons, one of the harmonics of the wave packet is forced to propagate in space, already perturbed by another harmonic, and the perturbed (deformed) ether can exhibit greater dispersion than the undisturbed one, and can also manifest nonlinearity – thus creating conditions for the formation of a quantum-soliton in a medium even with insignificant dispersion and nonlinearity.

A quantum emitted by atom 1 can be absorbed only by a similar atom 2, or by another atom, which has the same difference in energy levels as atom 1, and atom 2 itself is at a lower level. Moreover, atom 2 must be exactly on the line of propagation of the photon (the aiming distance must be zero).

It is quite probable that the process of photon absorption also depends on the phase in which the photon will arrive at the atom, that is, on the phase of that same Newton's "fit." The propagation of a photon in a straight line sets the rules of geometric optics, and this manifests its corpuscular properties. Similarly, the corpuscular properties of a quantum are also manifested when it is absorbed by an atom. We "see" how a photon, with enormous transverse dimensions (on the scales of the microworld), suddenly appears before an atom with an "open mouth" (an open mouth is the presence of corresponding energy levels in the atom). Similarly, to how the photon was once emitted by an atom, now it will be absorbed by another atom, and an object of the microworld with a transverse size of 22 *mm* will simply disappear, and the atom will go into an excited state. The internal energy of the excited atom will increase by exactly the magnitude of the photon's energy, and its inertial mass will also increase.

As for the wave properties of quanta, they are manifested when overcoming obstacles in the form of slits, opaque obstacles, as well as during interference. If at the moment of photon arrival, atom 2 is in an excited state, two identical photons will propagate further (stimulated emission). Most likely, they will propagate "one after another without a spatial gap between them," because two photons cannot occupy the same amount of space – it would already be a new photon with doubled energy, but with the same wavelength and frequency. Planck's formula does not allow such a variant of photon combination, or we know nothing about such processes yet. A photon cannot be absorbed by atoms that are not on the axis of photon propagation (atoms 3 in Fig. 3.4), even if these atoms are identical to atom 1, are at the lower energy level, and fall into the "zone of action" of the quantum.

How can one try to experimentally force two identical photons to propagate along one line, occupying the same part of space? This can be done in interferometers when one photon comes out of the plate, and the second photon at the same point, at the same moment of time, is reflected from the plate in the same direction as the first one. Since two photons cannot occupy the same place in the ether, they will simply push each other out of the common path at some discrete angles. Perhaps this is exactly how interference bands appear on the screen of interferometers, or on thin films, perhaps this process is what we call photon interference? As paradoxical as it may sound, we cannot exclude that during the interference of solitons, their corpuscular properties are also manifested.

We cannot fail to mention the possibility that in our experiments on two slits, what is actually observed is not interference, but diffraction of photons on the gap between the slits, on the obstacle. It may turn out that there is a significant difference between the diffraction of photons on an obstacle and the diffraction at the edge of a slit. We conducted trial studies of the passage of photons through a package of slits up to 30 *mm* thick (with $S = 0.2$ *mm*), as well as the passage of photons through a volumetric 2*d*-structure (through a package of steel tubes with an internal diameter of 0.3 *mm*, medical needles). In all cases, there is some dependence of the interference pattern on both the number of slits and the distance between them, as well as on the type of tube packing method.

On the Internet, one can also find data on experiments on the study of diffraction of photons on wide obstacles [12]. There, too, the cessation of diffraction of red laser photons is observed at a size of about 14 *mm*. The indicated author does not practice publishing his results anywhere except on YouTube. According to his assumption, a photon is a corpuscle, has dimensions close to point-like, but its movement is accompanied by plane waves.

And how to make quanta move one after another without a gap between them? In a tungsten strip of an incandescent lamp, a photon emitted in the depths of the metal can encounter an excited atom on its way, stimulate the transition of the excited atom to a lower level, and then two photons will propagate one after another without a gap between them. The second photon will appear as a result of stimulated emission. Obviously, the coherence length of such a combination of photons will be insignificant, only a few photons, and launching an interferometer with such a source of photons will be a challenging task.

This same mechanism of forming a long chain of photons works in the inverse medium of a laser. As a result, not a "train of waves of one photon" is formed, as was believed at the beginning of the last century, but a "train of photons" with a large coherence length. At the same time, the concept of coherence length will receive a slightly different, but quite visual, interpretation. When dividing a beam of light on a silvered surface of a plate, it is not the photons themselves that are divided, but trains of photons. Everything happens within the framework of classical physics.

4. Discussion

4.1. Solitons and wave-particle dualism.

Since solitons by their nature exhibit both wave and corpuscular properties, we immediately get a simple answer to two very burning questions of modern physics: what is the physical essence of wave-particle dualism, and why a photon, having the property of a corpuscle (and hence a certain mass) can move at the speed of light, while "true corpuscles" cannot? We already know the answer to the first question – even Scott's solitons on the surface of water with a transverse size of 3 *meters* exhibit the properties of corpuscles, but at the same time remain waves. For solitons, as objects of macrophysics, wave-particle dualism is not a side effect, but a main feature, their deep essence. So why can't this be characteristic of objects of the microworld, for quanta and other elementary particles?

As for the second part of the question, regarding mass, we first need to define the concept of mass in the electromagnetic world. It is known that when two quanta with energies of 0.511 *MeV* each collide head-on, two objects can form, but already with the properties of corpuscles – an electron and a positron. Just an infinitesimally small fraction of a second before the collision of these quanta, there were no electric charges, no rest masses, and suddenly they appear from somewhere. This fact clearly indicates the soliton nature of the newly formed corpuscles, the electromagnetic nature of their mass.

At the same time, in the process of quantum collision, electric charges appear from somewhere. This means that electric charges must also have a soliton origin. Once Feynman raised the question that we not only do not know what an electric charge is, but we also do not know whether we are asking the question correctly – is an electric charge a type of matter (a bit of this matter was glued to a particle, for example to an electron, and it became charged), or is it a property of an elementary particle as a physical object?

In the case when we talk about a light-carrying medium, it is logical to raise the question that the energy concentrated in a particle is directly related to deformations of the medium, that energy is a measure of deformation of the medium, the degree and volume of deformation of the medium. In other terminology, these deformations can be called physical fields.

In solid bodies, two types of deformation are observed – compression-tension deformation and shear deformation. Accordingly, there are Young's moduli for compression and for shear. It will be logical if we try to match one of these types of deformation with an electric field, and the other with a magnetic one. Just a fraction of a *second* ago, there was no electron and no positron at this point in space, but after the interaction of two 2*d*-solitons with energies of 0.511 *MeV* each, two 3*d*-solitons were formed, that is, solitons that can be stationary relative to the medium. As a result of the collision of quanta, the propagation of oscillations became limited along the third coordinate as well. Obviously, according to the law of conservation of energy, each of the newly formed objects has an energy of 0.511 *MeV* concentrated in it. In other words, rest mass appeared.

What, and for what reason, could have changed in the light-carrying medium within the space occupied by the newly formed solitons, and what could have changed beyond the space occupied by the solitons? Let's assume that the oscillatory processes in one of these solitons (let it be an electron) work to compress the ether, to increase the density of ether elements inside the 3*d*-soliton, to reduce the distance between ether elements, and in the second soliton (positron) oscillatory processes work to rarefy the ether inside this 3*d* soliton. We can match this asymmetry in deformations with the electric charges of different polarity known to us, and we can match the dimensions of the volume of the ether cell with the concept of electric potential. Electric potential becomes an absolute concept. The answer to the question about the mechanism of attraction and repulsion of such solitons, what is the reason for the appearance of interaction between them in the form of the Coulomb force – that is a topic for a separate conversation [3,4], but for now we have a plausible answer to Feynman's question above: an electric charge is not a type of matter, but a property of an elementary particle to deform the ether. If inside the soliton-electron the ether is deformed by compression, then outside this soliton the ether is deformed by stretching, and vice versa. Thus, an electric field is formed in the space around the soliton, in which the concept of potential is logically tied to the 3*d*-dimensions of ether cells.

On the other hand, we also have an answer to the question of what mass is in the electromagnetic world. Mass is the amount of electromagnetic energy that is concentrated in a particle, in this case in an electromagnetic soliton. Trying to answer the question of what energy is, we will always ultimately come to the magnitude of ether deformation. The connection between the inertia of a soliton and the energy concentrated in it is well known to us; these are different representations of the same essence. There is the same difference between mass and energy as between heat and mechanical work, and the coefficient that equates the units of measurement is the square of the speed of light.

So why can a photon, which has a certain internal energy and exhibits the property of a corpuscle, move at the speed of light, while 3*d*-corpuscles cannot? Because a photon, as a 2*d*-soliton, is not described by the formula that was obtained for 3*d*-solitons.

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{4.1}$$

The concept of mass, as a measure of inertia, was introduced for 3*d*-solitons. The photon does not have a rest mass not because it doesn't have that mass, but because it has no rest; it is merely a 2*d*-soliton, in which the propagation of the wave is not blocked along one of the three coordinates. A wave called a "tsunami" has the property of a soliton, has energy, and this energy can also be matched with mass, no one doubts this, but a tsunami has no rest. If a photon is indeed a soliton, in which the oscillatory process along one of the coordinates is not blocked, then it propagates in this direction at the speed... of light. It must be recognized that up to this point, we have been making claims against photons based on a formula that was not derived for them. We must apologize to the photons. Such an unexpected and simple intermediate result we obtained based on the simple assumption that a quantum is a 2*d*-soliton of the electromagnetic field, and a medium is needed for the formation of solitons.

We have briefly outlined the essence of the concept of the light-carrying ether, we see that from the position of the soliton nature of elementary particles, the concept easily explains difficult points of physics, even such as electric charge, electric field, electric potential, energy, electromagnetic mass, not to mention wave-particle dualism.

Note that from the proposed point of view, it is very simple to explain the essence of electric power in general. All electric power is formed in the ether and transmitted through the ether. In one place of the ether, we have learned to use the Lorentz force in a magnetic field to separate electric charges created by nature in their time at a certain distance. Thus, we obtain an electric field as a type of ether deformation in this place. Usually, to create this electric field, we use the free energy of wind, sun, gravity, or chemical and nuclear reactions. We know how to transmit an electric field, as an object created in one place of the ether, over a great distance through electrical wires, to connect appropriate mechanisms there that can perform useful work for us. The law of conservation of energy can be formulated in somewhat different terms: ether deformations do not arise by themselves, and do not disappear without a trace, and their sum in an isolated system remains constant. Such a physical picture leaves no chance for speculation about obtaining free energy from the ether itself, unless the question is raised about the release of energy concentrated in the elements of the ether themselves. Once a similar question was raised with the idea of releasing energy concentrated in atomic nuclei.

At this stage, we see how productive the idea of the soliton nature of elementary particles has turned out to be, which requires the presence of a light-carrying medium. At the same time, as of today, a theory that once displaced the light-carrying medium from physics has received general recognition.

Thus, whether we want it or not, understanding that we are running into a very serious opposition from opponents, the situation itself forces us to return to an old problem that has long been officially considered solved, and solved forever – we must consider in detail the theory that displaced the concept of a light-carrying medium from physics.

Let us recall that in the well-known interference experiments of Michelson, attempts were made to record the fact of movement relative to the ether, that is, the fact of absolute movement. At that time, no one even doubted the existence of the ether itself. It was believed that since light is electromagnetic waves, there must be a medium in which these waves can propagate. The results of Michelson's experiments turned out to be negative. When analyzing the results of these experiments, the idea appeared about the contraction of moving bodies in the direction of movement, which provided an explanation for these results (the Fitzgerald-Lorentz contraction), but immediately two new problems arose: *a*) what force shortens all bodies in the direction of their movement, *b*) why doesn't this force slow down the movement of celestial bodies, that is, why is the law of inertia fulfilled very strictly? The idea of the contraction of moving bodies became one of the cornerstones of the new theory of relativity. Instead of admitting that for some incomprehensible reason it was not possible to record movement relative to the ether, the creators of the new theory came to the conclusion that there is actually no ether. If there is no ether, then there is no absolute movement.

Our article is beginning to seriously increase in volume, but it is better to read a voluminous work once than to study dozens of books with "justification" of an incorrect hypothesis for years. Our experience of discussions on the topic of the theory of relativity gives grounds to conclude that in order to harmonize the starting positions of the parties, it is necessary to refresh in memory some basic provisions of physics.

People would get rid of half of their problems if they could agree on the meaning of words. **(Rene Descartes)**

4.2. Three basic concepts of physics.

According to Newton, there are three basic concepts in physics: space, time, and matter, and the science of physics studies the transformation and movement of matter in space and time. Physics does not deal with anything else. Definitions of the concepts of space and time according to Newton.

Absolute, true, and mathematical ***space*** *remains similar and immovable without relation to anything external.*

Absolute, true, and mathematical ***time****, from its own nature, passes equably without relation to anything external, and thus without reference to any change or way of measuring of time.*

These are not ideal definitions. For several hundred years, there have been many attempts to give a physical interpretation of these basic concepts, but no one has proposed a better definition. In our time, we successfully use these concepts, formed to a significant extent at an intuitive level. Nevertheless, as a clarification of the essence of basic concepts, we propose to pay special attention to the basic properties of space and time. Regarding space, we draw attention to the fact that in infinite space, all points are individual, all points represent some physical reality. This means that in space there are not even two points that could be characterized by the same set of spatial coordinates. As of today, no one has yet thought of violating this property of space – such a violation would be too obvious.

A similar basic property is also present for the concept of time, only for time this property is opposite – in the entire infinite space, time has the same value – if "at a given moment of time on planet Earth some physical event occurred, then at the same moment of time on the planet near the star tau Ceti something also happened." In other words, in infinite space, there are not even two points where time would be different. As we can see from these definitions, space and time exhibit in a certain sense opposite properties – if in space there are no two identical points, then time at all points of space has the same value. The two basic concepts of physics in their own way seem to complement each other.

Only on the basis of these concepts can we consider the behavior and interrelationships of the third basic concept – matter. For example, let from point $x_1=10^{100}$ at the moment of time t=0 in the direction to the origin of coordinates, a quantum of electromagnetic field was emitted. Its equation of motion is

$$x_1 = -\,10^{100} + ct \tag{4.2}$$

Let further from point $x_2 = 10^{100}$ in the direction to the same origin of the coordinate system, at the same moment of time t=0, a second quantum was emitted. Its equation of motion:

$$x_2 = 10^{100} - ct \tag{4.3}$$

We can calculate with great accuracy the position of these quanta at any point in time, because mathematics is the same tool of measurement as a tape measure, a stopwatch, or a voltmeter, only absolutely accurate and free. When we introduce a coordinate system for consideration, then by basic agreement, by default, we assume that it models Newton's absolute space, and the time axis models absolute time. We cannot propose anything else at this stage.

A very important point: with such a definition of basic concepts, we can also consider other coordinate systems, that is, we can mentally attach a coordinate system to moving material objects, but there, by agreement, there will be no space of its own and no time of its own. We introduced (Newton introduced) the concepts of space and time for the entire Universe, for all possible coordinate systems, that is, there can be no other space and no other time – only coordinate systems and only the rates of physical processes in these systems.

In moving coordinate systems, among other tasks, measurements of the dimensions of material bodies can be carried out. We have the right to assume that the dimensions of moving bodies can remain unchanged, shorten, or even elongate with increasing speed, but there is no space of their own. If moving material bodies do change their dimensions with speed, then only by virtue of their internal nature, and in no case by virtue of the fact that in moving systems their own space appears from somewhere, which for some reason can contract-elongate, and bodies only follow the changes of this moving space.

An analogous situation exists with time. The rates of physical processes in moving systems can remain unchanged, or they can change with a change in speed, but there is no time of their own there, which could also change the "rate of physical processes." If in the future we encounter works in which there is its own space in moving systems, and it can also shorten, or there is its own time, which can slow down, we will understand that we are dealing, at best, with a mistake, and at worst, with a misunderstanding of the essence of basic agreements, that is, with a pre-error level. Anyone who wants to seriously talk about the slowing down of time in a moving system and about the reduction of space must begin his work with a revision of the concepts of time and space given by Newton, while clearly and lucidly presenting to the reader's judgment what he proposes instead of a single space and a single time, what is his own space in a moving system, and what is a separate time in each moving system. The creators of the "new physics" must clearly explain why the change in the size of material bodies and the change in the rate of physical processes are insufficient for them.

For example: if a live fly is placed in a container with liquid nitrogen, it will freeze there, life processes will stop, but it can be revived even after a million years. It is quite permissible to say that "in liquid nitrogen, time for the fly seemed to stop for a million years," but it must be clearly understood that this is jargon, a pedagogical technique, that only biochemical processes stopped in the fly, while not a single atom changed its position in any molecule. Some carbon nuclei will decay, of course, but this only emphasizes that time has not stopped there.

4.2.1. Mathematics and the problem of measuring physical quantities.

When we analyze equations (4.2) and (4.3), we must clearly understand that mathematics does not deal with the problems of real measurements. The theory is not interested in who, with what instruments, for what money, for how long, places marks on the spatial axes. We are also not interested in who and how places numbers next to marks on a tape measure (on a spatial axis), by what method and with what instruments chronometers are synchronized, how densely those chronometers are placed.

From this follows a very simple conclusion: if someone tries to analyze the methods of real synchronization of clocks, and at the same time argumentatively proves to us that it is impossible to perform them correctly (within the framework of the achievements of physics at that moment of time, of course), shows us what clocks will actually show in a real attempt to synchronize them, and he proposes to enter information about this desynchronization into the laws of nature, that is, into mathematical equations, then we will already understand that we are dealing with a pre-error level of education, with a misunderstanding of the basics of physics. To illustrate the above, Fig. 4.1 shows a moving ruler with chronometers, which are synchronized "by physically achievable methods at the time of manufacturing this ruler with chronometers." The ruler moves at high speed in the direction of increasing coordinate *x*.

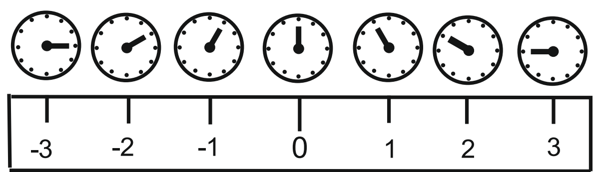

Fig. 4.1. An example of violation of the basic property of time, as a basic concept of physics.
A moving ruler with "really synchronized clocks" is an absolutely inadmissible tool in physics.

On the presented ruler, with positive values of the spatial coordinate, after conducting the synchronization procedure, the clocks show less and less time, because an increasing correction is subtracted from the readings of the zero clock. To the left of the zero division, the clocks show more and more time. This is a principled drawing; below we will refer to it more than once.

4.3. The physical essence of the theory of relativity.

Let us recall that the image of quanta as electromagnetic solitons cannot exist alongside a theory that has expelled the idea of a light-carrying medium from physics. A detailed exposition of the essence of the theory of relativity will take several dozen pages, and this is unacceptable for this work. A brief exposition, however, will not allow us to focus on nuances, the misunderstanding of which invariably results in a long series of prolonged and unproductive discussions.

If within the framework of the provisions of any theory it is possible to obtain a paradoxical conclusion, then this means that the theory is incorrect. But, if in a discussion some subtleties are ignored, for example, such as "the observer's point of view," then the discussion can be successfully led to a dead end. This is exactly what happened with the twin paradox, the paradox of three twins, the paradox of the rod and the barn. Taking these facts into account, in this work we will present a brief exposition of the essence of the theory, but with all the necessary subtleties. We will not consider some moments, as secondary, and to save time.

By definition, the theory of relativity should deal with the comparison of certain quantities measured by means of different coordinate systems, one of which is considered stationary, and the other moves by inertia with a certain speed. It is precisely because of the presence of relative motion of two coordinate systems in the problem that the

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theory of relativity received its name. So, the theory of relativity considers at least two coordinate systems, of which at least one moves by inertia. This is one of the nuances to which we draw the reader's attention. The problem is that there is another "theory of relativity," in which everything is considered in one coordinate system, and it is precisely for this case that we emphasize that in the theory of relativity there must be two coordinate systems, and there must be a comparison of the results of measuring the same physical quantity obtained in different systems.

In the theory of relativity, the problem of comparing quantities is actually reduced to recalculating the results of calculations (obtained using the mathematical base of the theory), but not for any physical quantities, but for the spatial and temporal coordinates of an arbitrary point. At the same time, the coordinates of space and time, which need to be recalculated from system to system, are, by the condition of the problem, considered to be measured in a stationary system, by means of this system. Otherwise, these two coordinates x, t are also called a point of view.

Historically, Galileo was the first to formulate the theory of relativity. It is based on two postulates: 1. The dimensions of material bodies do not depend on the state of their motion relative to space. 2. The rates of physical processes do not depend on the state of motion of material bodies.

Based on these assumptions, equations were written for recalculating spatial coordinates and time. For the case of uniform motion of system K' along the x-axis of the stationary system K with velocity v, the equations have the form (4.4), and their illustration is presented in Fig. 4.2.

$$\begin{cases} x' = x - vt \\ t' = t \end{cases} \tag{4.4}$$

The spatial coordinates that enter into the equations of the theory of relativity are denoted by curly brackets. The symbol K' in the theory of relativity denotes the moving system.

In these equations, the quantity x is the spatial coordinate of an arbitrary and stationary point A in space, that is, x=*const* by condition. In physical sense, the spatial coordinate is the distance, the number of divisions, from the origin of the coordinate system to a given point. The quantity t is an arbitrary moment of time, at the same time, it is also the interval of time from the zero moment (t=0) to the given moment t. Between the quantities x and t in (4.4) there is no causal relationship. This means that having chosen a point A with a spatial coordinate x for consideration, we are absolutely free in choosing the value of the time coordinate t.

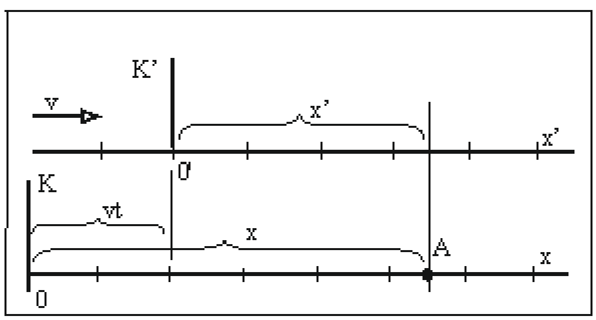

Fig. 4.2. Illustration of Galileo's theory of relativity.
The dimensions of moving bodies (the scale division on the x' axis of the moving system) and the rates of physical processes do not depend on the speed of motion of system K'.

System K is considered stationary, representing absolute space. The values x, t, and v in the theory of relativity are considered known. They are also called the "point of view" of the observer of system K.

The quantity x' is the spatial coordinate of the same arbitrary point A, but measured by means of system K'. Since system K' is moving, the coordinate x', unlike x, is no longer a constant; it depends on the moment t of its measurement,

The quantity t' is the **result of measuring absolute time** by means of the moving system. We emphasize that this is not its own time in the moving system; this is the **measured value of time**. Its magnitude reflects the speed of physical processes in the moving system, including the pace of chronometers. If the rates of physical processes depend on the speed of the system, this should be reflected in the transformation of the time coordinate. In Galileo's time, it was quite obvious that the rates of physical processes do not depend on the state of motion of the system, that is, on the speed of the horse on which the observer rides with a clock in hand. Hence the transformation of the time coordinate in the form of the equation $t'=t$. In Galileo's time, the Pisa Tower played the role of the Large Hadron Collider, but the results of the experiments were very important and reliable.

The quantities x' and t' are often called the point of view of moving observers on the values of coordinates x and t. This means that in equations (4.4), and in the equations of any theory of relativity, **two points of view on the values of spatial and temporal coordinates are actually presented**. Thus, the essence of the theory of relativity consists in the mathematical comparison of the points of view of a stationary and a moving observer on the same physical fact.

In the literature, in various kinds of discussions on the theory of relativity, we often encounter a situation where one of the participants writes down the Lorentz spatial transformation, stating at the same time that according to these transformations "the one who moves shortens his dimensions, as a result of which the coordinate systems are unequal (hence the 'paradox of the rod and the barn')." In response, he receives the argumentation: "And from the point of view of the moving observer, bodies in the stationary system are shortened, so the systems are equal..." after which he manipulates the so-called inverse coordinate transformations.

In fact, the inverse transformations also represent two points of view, only the primed quantities (measured in the moving system) are considered known there, and the unprimed ones need to be calculated. We come across another subtlety here: to avoid speculation, **both direct and inverse transformations must be illustrated by the same figure**, because it is the same physical situation. This example demonstrates to us the importance of a detailed presentation of the theory with all the subtleties, in this case with points of view. Only in Galileo's theory can direct and inverse transformations be illustrated by the same figure, that is, by Figure 4.2.

In accordance with the style proposed by Galileo, in any theory of relativity that may yet appear in the future, primed quantities should represent the results of measurements made by means of moving systems. Moreover, primed and unprimed quantities cannot be mixed, either through addition or through multiplication. By agreement, in direct coordinate transformations, primed quantities should be on the left side of the equals sign. This means that the direct coordinate transformations of any theory of relativity represent primarily the "point of view" of moving observers, and the point of view of a stationary observer is considered known; it is contained in the right part of the same equations in the form of quantities x, t, v, c.

It is quite possible that the analysis of the system of equations (4.4) prompted Galileo to conclude that in nature there is no way to experimentally establish the fact of movement of an isolated coordinate system relative to a stationary system. In Galileo's time, this was a closed cabin of a ship passively floating with a uniform current relative to the banks of a river, and the experiments were mechanical experiments such as the propagation of sound in the cabin, the flight of a fly, the fall of a drop of water, etc. Now we call this "Galileo's principle of relativity."

Lorentz tried to extend this principle to all physical experiments. At that time, Maxwell's equations were already known, and views were widespread that the entire material world probably has an electromagnetic nature. If it is impossible to record the fact of one's movement in an isolated system by any experiments, then this means that all the laws of physics should have the same mathematical form in all moving inertial systems, only in primed units. Such an idea frees physicists from the need to conduct specific experiments to detect absolute motion, and allows solving the problem mathematically. This is similar to how the law of conservation of energy allows not considering and not analyzing specific models of perpetual motion machines.

As a result of these considerations, an idea arose: if Galileo's transformations are substituted into Maxwell's equations, and at the same time we obtain Maxwell's equations of the same form at the output, only in primed units, then this will be a mathematical confirmation of the principle of relativity. Now we can rightfully say "the principle of relativity of Galileo–Lorentz."

Having carried out such a procedure, Lorentz did not obtain Maxwell-prime [9]. At that time, absolutely incomprehensible results of Michelson with his optical interferometer were already known. When planning experiments with the interferometer, Michelson calculated the time t_1 of light propagation in the interferometer along the movement of the device (from the dividing plate to the front mirror and back), as well as the time t_2 of light propagation in the transverse direction (to the side mirror and back).

When making calculations, they proceeded from the fact that *a*) there exists a light-carrying medium, *b*) the speed of light does not depend on either the speed of the light source or the speed of the mirrors (the speed of sound does not depend on the speed of the whistle), *c*) the dimensions of bodies do not depend on the state of their motion.

As a result of the calculations carried out, it turned out that for a meter length of the arms of the device, the time t_1 is greater than t_2 by an amount sufficient to fix absolute motion. This means that if a system of bands is obtained in the interferometer, then when the orientation of the device changes, at the orbital speed of the Earth of 30 km/s, the bands will change their position on the screen, and thus it will be possible to record the fact of the Earth's movement relative to the ether. To his surprise, Michelson did not record a shift of the bands when the orientation of the device changed. The problem hung in the air.

When analyzing the situation with Michelson's experiment, first Fitzgerald, and then Lorentz, drew attention to the fact that the time t_1 of light propagation along the movement of the device is greater than the time t_2 of transverse propagation in proportion (these are simple calculations at the level of school physics)

$$t_1 = \frac{t_2}{G} \qquad (4.5),$$

where, for convenience of writing and reading formulas, we have denoted the radical with the symbol *G* (from the surname Galileo).

$$G = \sqrt{1 - \frac{v^2}{c^2}} \qquad (4.6)$$

Obviously, in the case of equality of the values of times t_1 and t_2 at different speeds, the interference pattern in Michelson's experiment will not depend on the orientation of the device, but how to physically obtain that equality? If Michelson's experiments do indeed indicate the actual equality of times t_1 and t_2, then what can lead to those times becoming equal? Several variants of the answer can be proposed. One such variant is the following: with increasing speed of movement, all bodies reduce their longitudinal dimensions in proportion to that same *G*.

$$l_v = l_0\, G \qquad (4.7)$$

where l_0 – length of a certain body at rest. l_v – length of the same body at speed v.

It is precisely in an attempt to equate t_1 and t_2 in magnitude that the famous radical appeared in the theory of relativity, and the relation (4.7) eventually received the name "Fitzgerald–Lorentz contraction." When taking into account the contraction of bodies according to formula (4.7), we elementarily obtain an explanation for the negative result of Michelson's experiments. The problem is only in explaining the cause of the contraction of bodies. In parallel, a second question arose: *a*) why does the law of inertia hold for moving bodies if some force is constantly acting on the bodies, which shortens their longitudinal dimensions? *b*) why doesn't the Earth fall to the Sun due to the action of this force? etc. In the case of planets, the forces must be simply gigantic.

Despite these problems, Lorentz tried to modernize Galileo's transformations for spatial coordinates, taking into account the contraction of bodies. One way or another, the contraction of moving bodies gave at least some explanation for Michelson's experiments, although there was no hypothesis about the cause of the contraction, and there was no explanation for the problem with motion by inertia.

If bodies are shortened, then the distances between marks on the axis of the moving system are also shortened, which means that the coefficient *G* in the coordinate transformations will be in the denominator. Galileo's spatial transformation took on a new form:

$$x' = \frac{x - vt}{G} \qquad (4.8)$$

If (4.5), (4.6), and (4.7) do not yet have a direct relation to the theory of relativity, then (4.8) is already the basis of some new theory. Over time, equation (4.8) received the name "Lorentz spatial transformation." Having substituted the new transformation (4.8) together with Galileo's time transformation $t'=t$ into Maxwell's equations, Lorentz again did not obtain Maxwell-prime. After this, he decided to simply select instead of Galileo's time transformation one such that together with (4.8) would finally obtain Maxwell-prime [9]. Thus, by selection method, another equation of the new theory appeared in physics, which later received the name "Lorentz transformation for the time coordinate":

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$$t' = \frac{t - \frac{v}{c^2}x}{G} \tag{4.9}$$

Equation (4.9) together with (4.8) and $y'=y$, $z'=z$ constitutes the mathematical basis of the new theory of relativity, which later received the name "special theory of relativity," STR. Thus, a new theory of relativity was built, built as a result of modernizing Galileo's theory. When substituting (4.8) and (4.9) into Maxwell's equations, Lorentz finally obtained Maxwell-prime, and thereby confirmed the principle of relativity by means of mathematics, that is, in a generalized version. Note that the appearance of the term "special" is argued by the fact that the new theory considers only inertial systems, but Galileo's theory also considers only inertial systems. Here it would be more correct to speak about a "class of special theories." In a word, another subtlety, which gives us reason to think a little... It was Poincaré who wrote down coordinate transformations in the form (4.8) and (4.9), and called them Lorentz's transformations.

4.4. Analysis of the mathematical part of the theory of relativity.

At this stage, we can already proceed to analyze the mathematical part of the new theory of relativity. We have no claims to equation (4.8); this transformation is built on the idea of body contraction with increasing speed. Nevertheless, another subtlety immediately emerges: the presence in the equation of information about the change in size of moving bodies automatically introduces a distinguished system in which the dimensions of bodies are maximal, that is, it automatically rejects the idea of the principle of relativity. Having written (4.8), Lorentz should have immediately rejected this equation because it contradicts the principle of relativity, and look for other options. And there were possibilities. For example, if in (4.8) and (4.9) the coefficients G are crossed out, then from these equations one can obtain $c'=c$, maybe Maxwell-prime can be obtained at the same time, but then Michelson's experiments remain unexplained...

It's a completely different matter with equation (4.9). It is precisely for its analysis that we presented the essence of the theory of relativity in all possible nuances at the beginning of the section. We proceeded from the fact that with timely emphasis on nuances there would be fewer incorrect arguments, incorrect objections, as is the case with points of view. In the numerator of this formula, there is a quantity x, which has the meaning of "spatial coordinate of an arbitrary point A." This means that through equation (4.9) in the moving coordinate system, Lorentz changed the basic property of the basic concept of physics – the concept of time. Now opposite each point x of system K in the moving system K' we have a different value of time, see Fig. 4.1. If one imagines the so-called "Einstein's train" of seven very long cars moving at high speed, then, according to (4.9), in the first car it will be Sunday, in the second Saturday, in the third Friday, etc.

Lorentz actually saw this difficulty, called it "local time" (something close to the modern time zone), and hoped that eventually the situation would be clarified in favor of (4.9). The main thing for him at that time was that the principle of relativity finally received its mathematical confirmation, and the principle always has incomparably greater weight than the concrete law.

Historically, it happened that at this moment Einstein intervened in the discussion on the topic of relativity, and stated that there was no error in (4.9), that everything there is correct, that such is the very essence of time, and therefore has the right to be present in the corresponding equations. It is Einstein who owns the famous "Time is the readings of the hands of my clock." Einstein substantiated such a conclusion through an analysis of the synchronization procedure, saying that no matter how we would conduct synchronization in a moving system, how hard we would try, what ingenious methods we would come up with, we would still obtain desynchronized chronometers for conducting measurements in accordance with the time transformation (4.9).

Einstein managed to convince many influential physicists that this is not a technical problem of experimenters, but a property of time itself, the essence of time itself, that it cannot be otherwise, that information about desynchronization should be introduced into the transformation of the time coordinate, that is, into one of the basic laws of physics. As a result, Einstein was recognized as the main co-author of the new theory, and the theory itself was called special. The authorship of Lorentz was gradually forgotten, Lorentz was left only with the authorship of the mathematical basis of the theory – the Lorentz transformations. Sometimes in the literature one can find an interesting clarification: "It is interesting to note that the transformation formulas obtained by Einstein coincide with the formulas previously indicated by Lorentz... Therefore, formulas (132.1) are often called Lorentz formulas [1], p. 458.

Another nuance. When analyzing (4.9), for some reason everyone missed the fact that this equation not only orders us to take into account the desynchronization of clocks through the term vx/c^2, but also additionally prescribes all processes in the moving system to go at an accelerated pace, since the radical G is in the denominator. This means that in the corresponding experiments, where there is no need to synchronize clocks, the accelerated course of physical processes should manifest itself, including chronometers of any design, and we know how atomic chronometers behave in airplanes (Hafele-Keating experiments) and how muons behave. Such an unexpected next conclusion we obtained from the elementary analysis of the Lorentz time transformation (4.9).

4.5. Theory of relativity and the principle of correspondence.

The principle of correspondence requires from new theories to give such results of calculations (for conditions under which the old theory gives good agreement with experiment) that differ little from the results of calculations according to the old theory. At the same time, an insignificant difference in the results of calculations is considered a consequence of more accurate results according to the new theory. On the other hand, if a new theory passes the test by the principle of correspondence, this does not automatically mean that it is correct. This is only a permission to discuss the essence of the new hypothesis, to analyze the ideas put forward, permission for discussion, this is an argument for allocating funds for experimental verification of the new theory.

If a new physical theory does not pass the verification by the principle of correspondence, it is automatically thrown out of the category of scientific ones. At best, it can be classified as science fiction. Verification of a new theory by the principle of correspondence can be carried out in various ways. The simplest, and most professional, is to compare the equations of the old and new theories. In the equations of the new theory, there should be terms that, under certain conditions, make a small correction to the equations of the old theory. If these terms are crossed out, then the equations of the new theory should turn into the equations of the old one. In this case, it can be argued that the new theory has passed the verification by the principle of correspondence, has passed the verification for its physicality, but whether it is correct or not is already another question, it is already a question of experiment.

Beyond any doubt, Galileo's theory of relativity gives correct results at low and medium speeds. This means that any new theory of relativity at low speeds should give calculation results that differ little from the results obtained according to Galileo's theory. If we compare the spatial transformations of Galileo and Lorentz, we can easily see that if we cross out the term v^2/c^2 (a term of the second order of smallness) under the radical sign, then Lorentz's equation will turn into Galileo's equation. This means that in the part of spatial transformations, STR passes the verification by the principle of correspondence and thus is allowed for further analysis.

The situation with the time transformation according to Lorentz, that is, the situation with equation (4.9), is fundamentally different. For convenience of analysis, we duplicate it here.

$$t' = \frac{t - \frac{v}{c^2}x}{G}$$

The problem is not only that, as already mentioned above, information about the experimental capabilities of researchers is recorded in the basic law of physics, and this is absolutely inadmissible, there is also a problem with the results of calculations themselves. As we already know, the quantity x has the physical meaning of the spatial coordinate of an arbitrary point, that is, it can take any value, including any large value in modulus, and this means that even at low speeds, the term vx/c^2 cannot be neglected. This term cannot be crossed out from the Lorentz time transformation.

For greater persuasiveness of our arguments, let's carry out simple calculations. Such calculations are the second way to verify new theories by the principle of correspondence. For a less prepared reader, it is visual and much more convincing.

Let in a stationary system K at point A with coordinate x=10^{16} *meters* (one-third of a *parsec*, a unit of length measurement in astronomy) at time t=100 *seconds* some event occurred. What will be the value of the time coordinate t' of this same event if the speed of the system is v=900 m/s (a modern airplane, the speeds of space rockets are an order of magnitude higher). The calculation should be carried out according to STR and according to Galileo's theory, and the results should be compared in order to verify STR by the principle of correspondence.

For simplicity, let's take c=$3 \cdot 10^8$ m/s. The radical G at such a speed is close to unity. The task conditions are chosen so that the calculations can be done mentally, so that there is no suspicion that there may be an arithmetic error in the calculations.

Galileo: t'=t=100 *seconds* (4.10)

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$$\text{STR:} \qquad t' = \frac{100 - \frac{900}{9 \cdot 10^{16}} 10^{16}}{G} = 0 \ \textit{seconds} \tag{4.11}$$

For the same distance *x*, only with a negative sign, that is, for *x*= -10^{6} *m*, Galileo gives the same 100 *seconds* (as for any distance), STR gives the result:

$$t' = 200 \ \textit{seconds} \tag{4.12}$$

Comparison of the results (4.10), (4.11), and (4.12) clearly demonstrates to us that the Lorentz time transformation does not pass verification by the principle of correspondence, because the results of strict calculations differ by orders of magnitude. For a relative assessment of the discrepancy in results, we have the right to divide (4.10) by (4.11), why not? And what will we get?

As the practice of the discussions shows, the comparison of the results (4.10), (4.11) and (4.12) for a very large number of opponents can be an insufficient argument against the calculations made according to the SRT. Thus, there is needed the further clarification of the essence of these results, in their vivid representation. Assume that two cosmic apparatuses are starting from the earth in the mutually opposite directions. In accordance with the investigators' idea and calculations, at a certain distance from the Earth, i.e. at a certain moment of time, we should decrease the apparatuses' speed in such a way that they would move to the circular orbits around the planets they are approaching. Both planets are accidentally located at an equal distance from the Earth, i.e. the engines should be started simultaneously according to the chronometer of the coordinate frame, which is connected with the Sun. In this case, the task of the relativity theory is to recalculate the necessary moment of time into the moving frame, in the given case even into two moving frames. Obviously, the time transformation should be used for this purpose.

On the contrary, if our investigators work within the frames of the SRT, then on the first spaceship moving in the direction towards the *x* axis, there will be sent from the Earth the instruction to start the engines in accordance with (4.11), i.e. instead of *t'*=100 there will be sent the command to start the engines at the moment *t'*=0, therefore, the on-board computer will simply freeze from astonishment, because it showed such a value as far as on the spaceport, during synchronization.

On the second spaceship, which is at the necessary moment *t*=100 located at the same distance from the Earth as the first one, but with the minus sign, according to (4.12) the engines should be started at the moment *t'*=200 in accordance with its chronometer. Obviously, our numbers are arbitrary, they only vividly illustrate the physical sense of the above obtained calculations in accordance with the SRT. If we make analogous calculations for a real situation, they will demonstrate us the same pattern, but not so vividly. The given analysis vividly demonstrates for us the value of the theory, which does not pass verification by the principle of correspondence, and why such a theory is not simply incorrect, but even it is not a physical theory at all.

For the completeness of the pattern, it is worth giving the results of calculations for more or less real speeds and distances. It is known that the Earth's speed in relation to the relict radiation is about $3{,}68 \cdot 10^5$ *m/s*. At the moment when we are reading these lines, we are moving in the direction towards the Lion constellation with this speed. The dimension of the Kuiper belt is about $1.5 \cdot 10^{13}$ *m*. It is three orders smaller than the dimensions of the Solar System. What will be the indications of the on-board atomic chronometer at the moment when the coordinate frames' origins coincided?

According to Galileo's theory, <u>all</u> chronometers in the moving frame show the same time as in the immovable frame, i.e. *t'*=*t*=*0*. In accordance with the SRT, in the moving frame in case of different values of the space coordinates, the chronometers show different time. For distance $x \approx 1.5 \cdot 10^{13}$ *m*, according to Lorentz's time transformation, we obtain the result of minus 61 *s*, and for the same distance, but to the left from the coordinate origin, we obtain the result plus 61 *s*. For the Oort cloud, which as if determines the dimensions of the Solar System, $x \approx 1.5 \cdot 10^{16}$ *m*, the results of the calculations will be three orders larger, i.e. 61,000 *s*, or ≈17 *hours*. Just these results of calculations do not allow the SRT to pass the verification by the principle of correspondence, i.e. they testify to its non-physical essence.

If the time transformation of the new theory of relativity does not pass the verification by the principle of correspondence, then the entire theory does not pass. This means that STR is not a physical theory, and we already know well the reason for this – in (4.9), the basic property of the basic concept of physics, the concept of time, is violated, see Fig. 4.1. The correct obtaining of results (4.10) – (4.12) once again justifies our presentation of the essence of the theory of relativity with its subtleties and in a somewhat large volume. The use for calculations of the time transformation (4.9), in which the basic property of the basic concept of physics is grossly violated, allowed obtaining a fantastic physical result, $c'=c$. As strange as it may sound, it is precisely the theory that gives us the calculation results (4.11) and (4.12) instead of results close to (4.10) that displaced the concept of ether from physics. And we need the ether for the formation of quanta in it as electromagnetic solitons... and we need solitons to explain the essence of corpuscular-wave dualism.

4.6. Experimental verification of the theory of relativity.

Obviously, at this stage, we will receive a large number of accusations of unprofessionalism, that "STR has passed experimental verification in thousands of experiments, and all conclusions from the theory are confirmed with great accuracy by the operation of nuclear power plants, nuclear and thermonuclear bombs, the operation of elementary particle accelerators," etc." It is quite strange to hear such accusations after calculations (4.10), (4.11), and (4.12).

Mathematically, any theory is fully contained in its equations. It is quite obvious that if some calculations are carried out without using at least one equation of a given theory, then the problem does not relate to this theory. STR is mathematically fully contained in the Lorentz transformations, and if in some problem a certain question is solved without using coordinate transformations, then the problem does not relate to the theory of relativity at all. For example, if in a problem it is necessary to calculate the electrical resistance of a piece of material according to a known potential difference applied to it, and according to the current flowing through it, then we can solve this problem, but we have no right to even mention the theory of relativity. No matter how much we might want to, no matter how much we wanted to confirm the theory of relativity with Ohm's law. By the way, Ohm's law describes a situation when negatively charged electrons move uniformly relative to a positively charged atomic lattice...

One of the experimental confirmations of STR is considered to be experiments with Michelson's interferometer, although in fact the Lorentz spatial transformation was obtained after these experiments, already taking into account Michelson's results. Actually, the spatial transformation was written to explain Michelson's results, and not Michelson's results were obtained as confirmation of the conclusion from STR. This should not and cannot be forgotten if the conversation is about experimental verification of STR.

The second experimental confirmation of the theory of relativity is sought through the transformation of time. Experimentally, this is carried out in experiments with short-lived elementary particles, such as muons or mesons, as well as in experiments using atomic clocks. All these experiments indicate the reality of slowing down the rates of physical processes in moving systems, and this contradicts the ideology of STR. Moving muons and pi-mesons actually live an order of magnitude longer than stationary ones. Until now, the explanation of these experiments has been offered to us through the manipulation of "points of view," through the use of inverse transformations. Above, we have already given an assessment of this technique, and what subtlety it is based on.

The most striking experimental confirmation of the conclusions drawn from STR is considered to be the operation of nuclear power plants, nuclear bombs, and elementary particle accelerators. The operation of nuclear power plants is based on the relationship between mass and energy, $E=mc^2$. In the world literature, no one has ever written this equation in the mathematical basis of STR, no one has ever added this equation after the Lorentz transformations, nevertheless, the equation is somehow attributed to the theory of relativity, and the operation of nuclear power plants is considered experimental confirmation of conclusions from STR [10].

For example, there are such processes in collision physics as Penning ionization or excitation. What is this about? A quantum system in an excited state has some internal energy E. In some cases, quantum systems can remain at excited levels for quite a long time (metastable levels), after which they transition to a lower level with the emission of a quantum of energy, but they can also transfer their energy to another quantum system through direct contact with it, and thus return to the ground state without emitting a quantum. This phenomenon is called "Penning excitation," it, in particular, underlies the operation of helium-neon lasers. The energy of such an excited quantum system will decrease by an amount ΔE without radiation and even without a change in the state of motion, and the mass of the system will accordingly decrease by some amount Δm. The connection between them is described by the equation $\Delta E=\Delta m\cdot c^2$. On what basis are we offered to add this formula to the mathematical basis of STR along with the Lorentz transformations? The indicated equation does not compare measurement results from different systems, it does not have primed units, it does not compare the points of view of different systems on the same physical fact, everything is considered in one coordinate system. The theory of relativity cannot be formulated for a single coordinate system.

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Exactly the same problem exists with the dependence of the body's mass on its speed – there all quantities are measured in system *K*, the formula itself was obtained by Lorentz long before the creation of STR, and was experimentally confirmed by Kaufmann in 1901. This equation is close in its essence to the equation of rocket mass change as fuel burns out, only with increasing rocket speed, its mass decreases. We have obtained yet another unexpected result: the connection between mass and energy, as well as the equation of increasing body mass with increasing speed, have no relation to the theory of relativity.

4.7. Independence of the speed of light.

Let us recall that to explain the results of Michelson's experiments, Fitzgerald, and later Lorentz, put forward the idea of body contraction proportional to the radical *G* in order to make the time of light propagation in different arms of the device the same. In the literature, even the term "Fitzgerald–Lorentz contraction" has taken root. If we consider this contraction to be real, then we have an elementary explanation for Michelson's experiments, and we get the right to include it in the spatial transformation, but there is a problem of explaining the cause of the force that shortens bodies, and the cause of motion by inertia. One cannot try to explain an old mystery with the help of two new puzzles. In order to avoid explaining the physical cause of contraction, Einstein proposed the idea of "independence of the speed of light."

According to this idea, there is no real physical contraction of moving bodies, hence the force necessary for such contraction is also not needed. Coordinate systems are equal, and the principle of relativity is fulfilled. Regarding the cause of the stability of the interference pattern in Michelson's experiments, the reason is that a quantum of light is such a special type of matter that its speed does not depend on the speed of the moving system. Quote: "...the same ray of light propagates in a vacuum at the speed of '*c*' not only in the reference system *K*, but also in every other reference system *K'*, moving uniformly and rectilinearly relative to *K* " [11]. So, the essence of the explanation of Michelson's experiments by means of STR: if the speed of a quantum does not depend on which arm of the interferometer it propagates along ($c'=c$.), then the time of propagation does not depend either, hence the reason for the independence of the interference pattern from the orientation of the device.

Who today can say how such a "physical" idea could have appeared in principle? In our assumption, it is not excluded that it appeared in the process of trying to transfer the equation of photon motion $x=ct$ to a moving system using the Lorentz transformations, and to calculate what the magnitude of the speed of light would be in the moving system. We will carry out these calculations. According to the principle of relativity, in a moving system, the law of photon propagation should have the same form as in a stationary one, only in primed units, that is, $x'=c't'$. In order to find the value of c', it is necessary to find through the Lorentz transformations the values of x' and t', divide them, and see what result we get for c'.

$$x' = \frac{ct-vt}{G} = \frac{(c-v)t}{G} \tag{4.13}$$

$$t' = \frac{t-\frac{v}{c^2}ct}{G} = \frac{(c-v)t}{c\cdot G} \tag{4.14}$$

From which

$$c' = \frac{x'}{t'} = c \tag{4.15}$$

We assume that it was precisely the result (4.15) that caused the birth of the following idea: if (4.15) is obtained strictly through the Lorentz transformations, then the expression $c'=c$ can be tried to be written as a postulate, as an incredible intellectual guess, and in the reverse procedure to obtain the Lorentz transformations. Let us recall that Lorentz did not derive his transformations, that he postulated the spatial transformation, and simply selected the time transformation so as to obtain Maxwell-prime.

On the one hand, after the results of calculations (4.10), (4.11), and (4.12), there seems to be no particular sense in looking for further arguments against STR, and on the other hand, the "independence of the speed of light" has penetrated so deeply into the consciousness of many, including many well-known physicists of our time, that it will not be superfluous to analyze an experiment in which historically for the first time an attempt was made to measure the speed of light, and with the help of a single chronometer. In this experiment, the problem of synchronization disappears, hence both the need and the possibility of manipulating points of view disappear. We mean Olaf Rømer's observations of Jupiter's satellites.

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Rømer noticed that the results of measurements of the orbital period of the satellite Io depend on the mutual position of Earth and Jupiter. If the Sun, Earth, and Jupiter are in a straight line, then the measured periods of Io's rotation at the points of the smallest and greatest distances from Earth to Jupiter coincide. If, however, Earth is moving away from Jupiter, then the measured value of Io's period increases by 15 *seconds*, and if it is moving towards Jupiter (after half a year), then the rotation period of Io decreases by approximately the same 15 *seconds*. The explanation for this fact was and is obvious: if Earth is moving away from Jupiter, then the measured value of Io's period increases due to the subtraction of Earth's orbital velocity from the speed of light, and vice versa. For some reason, Rømer did not try to use precisely these measurements to calculate the speed of light, but used data on the diameter of Earth's orbit and the time it takes light to traverse this diameter.

In 1991, V. Sekerin published a book in which he presented calculations of the speed of light based on observations of the magnitude of the rotation period of the satellite Io [12]. We will repeat these calculations in a somewhat different presentation, avoiding any postulates regarding the speed of light. The signal from Io, which we can count as the period of rotation, reaches us from the moment of its exit from Jupiter's shadow (plus the time for it to arrive at Earth) and ends with its repeated exit from the shadow, that is, we are dealing with an interruption of the signal for the time Io is in Jupiter's shadow, Fig. 4.3.

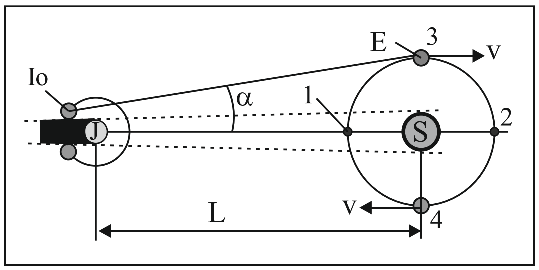

Fig. 4.3. Measurement of the rotation period *T* of the satellite Io by the moment of its exit from Jupiter's shadow.

S – Sun, *J* – Jupiter, *E* – Earth, *L* – distance from Earth to Jupiter in elongations, *v* – Earth's speed in orbit. At opposition points 1 and 2, the measured values of the period *T* coincide. In position 3, the measured value of *T* is 15 *seconds* more, and in position 4, 15 *seconds* less than *T*.

To simplify calculations, let's present this signal, firstly, as a long and continuous chain of photons (more than 42 hours, almost two days), and secondly, as if it propagates along one line with Earth's movement in elongations, although in reality there is approximately 9° between the direction of Earth's movement and the propagation of the signal from Io. In additional figures, we will present the signal from Io in the form of a long wavy line, Fig. 4.4. By analogy with the term "wave train," let's call the light signal from Io a photon train. "Obviously, in space, the photon train has a length of *cT*. The value *T* is the rotation period of Io, for example, measured at the points of opposition, as already mentioned above.

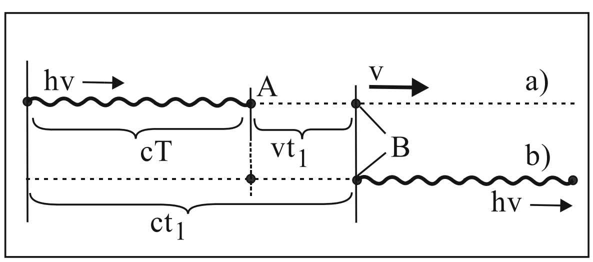

Fig. 4.4. Simplified scheme for measuring the period of Io, the distance from Earth to Jupiter is increasing. Earth and the signal from Io move along one line.

a) – start of measurements; the first photon of the photon train, the length of which equals *cT*, arrived at Earth, (point *A*), $t=0$. *b*) – end of measurements; the last photon of the photon train arrived at Earth, which by this moment has moved to point *B*. Measurement result: $t=t_1$.

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Let us assume we know the value of Io's rotation period. Let's first assume that we are taking measurements at the moment when Earth is moving away from Jupiter at maximum speed, that is, it is in position 3, Fig. 4.3. At the moment when the first photon of the train arrives to us (Io first came out of Jupiter's shadow, plus the time for the signal to propagate to Earth), we start the chronometer, that is, $t=0$. The last photon will arrive at point *A* in time *T*, but during this same time, Earth will shift a certain distance from point *A*. Until the last photon arrives at this new point, Earth will shift a little more by some distance, and so on, as a result, Achilles will catch up with the turtle at some point in time t_1, at some point *B*. At this moment, the chronometer will be stopped by the observer, and the period measurements will end (Io came out of Jupiter's shadow for the second time, plus the time for the signal to propagate). We emphasize that we are not postulating anything, we have not yet said a single word about adding or subtracting the speeds of light and the observer, or about the independence of photon speeds – we are simply stating an obvious physical fact.

We write the balance. The path that the last photon traveled during the measurement time t_1 equals ct_1. From Fig. 4.4, it can be seen that it equals the sum of cT and the distance vt_1, by which the observer shifted during time t_1:

$$ct_1 = c\,T + v\,t_1 \tag{4.16}$$

Or:

$$(c - v)\,t_1 = c\,T \tag{4.17}$$

We have obtained a seemingly completely unexpected result: equation (4.17) states that (4.16) already contains information about the dependence of the speed of light on the speed of Earth, that the speed of Earth must be subtracted from the speed of light. Note that in physical essence, (c-v) is the relative speed of photons and Earth.

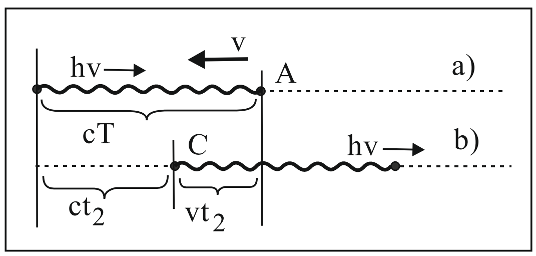

Fig. 4.5. Simplified scheme for measuring the period of Io, the distance from Earth to Jupiter is decreasing.

a) – start of measurements; the first photon of the photon train arrived at Earth (point *A*), $t=0$. *b*) – end of measurements; the last photon of the photon train arrived at Earth, which by this moment has moved to point *C*. Measurement result $t=t_2$.

Fig. 4.5 presents the situation when Earth is approaching Jupiter. As in the first case, measurements begin at the moment when the first photon of the cT train arrives at the observer, $t=0$. At some point in time t_2, the last photon of the train and the observer on Earth will meet at point *C*, since Earth during this time will manage to travel towards the signal a distance vt_2. We write the balance according to Fig. 4.5.

$$c\,T = c\,t_2 + v\,t_2 \tag{4.18}$$

$$c\,T = (c + v)\,t_2 \tag{4.19}$$

And this time we seem to have a surprise, and this time mathematics asserts that balance (4.18) contains information about adding the speeds of light and Earth. Comparing equations (4.17) and (4.19), we get:

$$(c - v)\,t_1 = (c + v)\,t_2$$

From which

$$c = v\,\frac{t_1 + t_2}{t_1 - t_2} \tag{4.20}$$

As we can see from (4.20), in order to calculate the speed of light from the observation data on Io's period, it is not even necessary to know its period *T*, it is sufficient to use the time values t_1 and t_2, measured in elongations. On the other hand, in physical sense, time t_1 equals the period *T* plus some addition Δt_1 due to the subtraction of speeds, and time t_2 equals the period *T* minus the addition Δt_2. So:

$$c = v\,\frac{T+\Delta t_1+T-\Delta t_2}{T+\Delta t_1-T+\Delta t_2} \tag{4.21}$$

It can be considered obvious that Δt_1 should be slightly larger than Δt_2, however, in the studies of Io's period, they were obtained approximately equal, $\Delta t_1 \approx \Delta t_2$, and it is believed that $\Delta t \approx 15$ *seconds*. With such simplifications, (4.21) takes the form:

$$c = v\,\frac{T}{\Delta t} \tag{4.22}$$

This is the simplified formula by which Sekerin calculated the speed of light based on observations of the duration of Io's rotation period. With modern values of T=152880 *seconds*, v=29765 m/s, and Δt=15 *seconds*, formula (3.22) gives the result

$$c = 303\,364\,880\ m/s \qquad (4.22),*$$

which with an accuracy of 1.2% coincides with the reference value of the speed of light, c=299,792,458 m/s. Such accuracy for this type of measurement is simply amazing. We also should not forget about the simplifications that we used in deriving formula (3.20). In particular, we did not take into account the existence of angle α between the line of observation and the direction of Earth's velocity, which is approximately 9°, Fig. 4.3, did not take into account the shape of Earth's orbit, the shape of the shadow cone from Saturn, the magnitude of Saturn's movement in its orbit during the measurement time, etc.

In his works, Sekerin denies the existence of the ether, and to explain experiments with measuring Io's period, he proposed the "Rømer effect," something close to the Doppler effect. It should be noted that this does not really affect his merits in this issue, that is, in the issue of priority in posing the problem. The above calculations and analysis were performed by us under the influence of Sekerin's work.

Conclusion on the section: after measuring Io's period and calculations based on these measurements of the speed of light, (4.22)*, the unacceptability of the idea of the "independence of the speed of light" becomes more than just obvious, not only from the point of view of logic but also from the point of view of direct experiment, which today can be repeated by graduate students in practically any astronomical observatory.

We see that the hypothesis that displaced the ether from physics is actually not just incorrect but is at a pre-error level, and we have a serious argument in favor of the assumption that quanta are solitons of the electromagnetic field, as demonstrated to us by experiments with the interference of quanta on two slits. It is precisely in order to draw this conclusion that we were forced to present the theory of relativity with all its subtleties, including experiments.

In work [13], we proposed a scheme for a modernized Michelson interferometer and presented corresponding calculations for the times of photon propagation along the arms of the interferometer. According to the concept and calculations, the experiment should record the fact of Earth's movement relative to the light-carrying medium, regardless of the presence or absence of the Fitzgerald–Lorentz contraction. In our time, with the availability of lasers, digital photo matrices, and computer technology, the experiment is not very complicated and not very expensive.

In conclusion, we also draw the reader's attention to a very strange fact that has remained unnoticed for more than a hundred years. The Lorentz spatial transformation contains information about the reduction of the sizes of moving bodies proportional to the radical *G*, and this is completely sufficient for a quantitative explanation of the results of Michelson's experiments. These simple calculations were made by Fitzgerald and Lorentz. The main problem is that with such an assumption, no "independence of the speed of light" is needed anymore. And vice versa – with the concept of "independence of the speed of light," the contraction of bodies becomes unnecessary, that is, with the "independence of the speed of light," the spatial transformation should be Galilean. We observe such a paradox: information about the contraction of material bodies proportional to *G* is introduced into the mathematical part of STR, and in the physical part, they pretend that it is not needed at all, it is enough that $c'=c$.

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4.9. Brief conclusions.

1. **The study of photon interference on two slits demonstrates that photons are wave formations limited in the transverse direction**. Such a result provides a basis for putting forward a hypothesis that photons have a soliton nature.

2. A light-carrying medium is necessary for the formation of solitons. The ability of photons to polarize and the high speed of their propagation indicate that the medium should have the property of a super-solid body. In a super-solid ether, the movement of any corpuscles is impossible, including the movement of ether elements, similar to how the movement of atoms is impossible in a diamond.

3. Ether elements are connected to each other by elastic forces, have the property of inertia, but do not feel the action of gravity.

4. Quanta of electromagnetic energy are probably 2*d*-solitons, generated by quantum systems, exhibit both wave and corpuscular properties, but cannot be at rest relative to the light-carrying medium.

5. The ability of some 3*d*-solitons to increase or decrease the concentration of ether elements within the space they occupy can be associated with the concept of electric charge. Electric charge is not a type of matter, but the ability of an elementary particle to deform the ether. Inside the solitons of the first type, the concentration of ether elements increases, and outside these solitons, accordingly, decreases. For solitons with the opposite charge, it is the opposite. Thus, electric fields are formed as a measure of ether deformation for compression and tension.

6. The size of the elementary cell of the ether can be associated with the concept of electric potential. Electric potential, both in magnitude and in sign, is an absolute concept, but only the potential difference acts on charged particles. Zero potential should be attributed to the ether undeformed by solitons, that is, to pure vacuum, without the presence of material bodies and physical fields. We have a close analogy with pressure in liquids – liquid flows only under the action of pressure differences.

7. We propose to associate the volume and types of ether deformation with the concepts of electric and magnetic fields, and the main material object in nature is precisely the ether.

8. What we call corpuscles in physics are actually 3*d*-solitons of the electromagnetic field. Unlike 2*d*-solitons, these wave formations can already be at rest relative to the ether. The electromagnetic energy concentrated in them can be called rest mass, electromagnetic mass. It is logical to call the inertial mass of the elements of the ether itself differently, for example, primary mass, protomass, or something in this spirit.

9. With increasing speed of 3*d*-solitons, the energy concentrated in them increases, and the mass increases, too, and the longitudinal dimensions decrease proportionally to the radical G. Such properties of solitons are obtained in the theory of solitons as an ordinary result. The reduction in the size of moving bodies proportional to G gives us an exhaustive explanation of Michelson's experiments, without additional assumptions, and the idea of the "independence of the speed of light" turns out to be both superfluous and non-physical, plus it is also refuted by experiment in experiments to measure the rotation period of Io.

10. The longitudinal dimensions of 3*d*-solitons decrease only at the stage of their acceleration, only at the moment of the action of force on them, and to restore their dimensions, it is necessary to reduce their speed to zero by an external force. Since solitons do not give back to the medium the energy concentrated in them, the law of inertia is fulfilled while simultaneously preserving the shortened longitudinal dimensions of physical bodies.

11. **Elementary calculations performed by means of the theory of relativity show that STR does not pass verification by the principle of correspondence, as a result of which it is a non-physical theory**, and a number of experiments, which in the literature are counted as supposedly confirming the conclusions from STR (the connection between mass and energy, the increase in the mass of moving bodies), actually have no relation to the theory of relativity.

12. A simple result on the study of photon interference on two slits highlighted a whole series of serious problems, but the proposed physical picture of the world is still far from complete. In concluding the discussion about photon interference on two slits, we emphasize that 2*d*-solitons can easily overcome a cluster of 3*d*-solitons without changing their characteristics (photons easily pass through window glass, and in the case of optical fiber, they overcome tens of kilometers).

13. When photons with large transverse dimensions try to pass through two slits simultaneously, a specific interaction of 2*d*-solitons occurs not with "solid corpuscles," but with a cluster of 3*d*-solitons, that is, an interaction of solitary electromagnetic waves of a somewhat different type occurs. In one case, a soliton freely passes through a diamond plate, through an optical fiber hundreds of kilometers long, and in another case, it cannot overcome a black film of micron thickness. It is obvious that the image of elementary particles as 3*d*-solitons of the electromagnetic field will lead to the construction of a substantially different physics of the microworld. We hope for a continuation of the conversation for this case as well.

14. By observing the periods of connection of Io (Jupiter's satellite), it is possible to calculate the speed of light with high accuracy. In this case, the addition and subtraction of the speed of light and the speed of the Earth's movement in orbit around the Sun are taken into account. **This is a direct experimental refutation of the "independence of the speed of light".**

Nature is always simple, and always consonant to itself **(Newton).**

5. Copyright Notice

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