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EXPERIMENT ON MEASURING THE OBSERVED RATE OF A MOVING CLOCK

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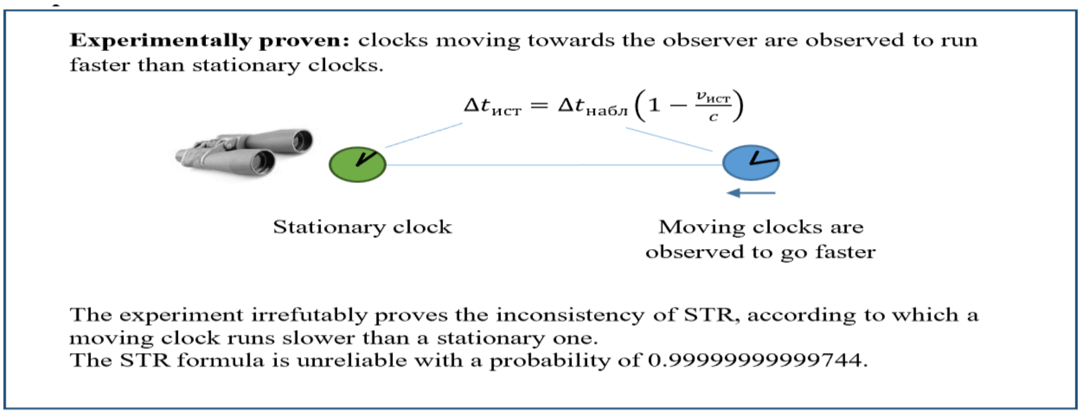
Abstract. *The paper presents the results of a practical experiment conducted at JSC "VNIIRA", which refutes the position of the special theory of relativity (STR), according to which moving clocks, due to their movement, in all cases, according to observations, go slower than stationary ones. An experimental fact, established experimentally, is that the clock moving towards the observer, according to observations, goes faster than his stationary clock. STR contradicts this experimental fact. The probability that the STR formula, which expresses the slowing down of the time of a moving clock, is unreliable is greater than 0.99999999999744, that is, it is practically equal to one. The hypothesis "STR is an erroneous theory" in accordance with the experiment is practically reliable. It has been experimentally proven that when observing the astronauts of a spacecraft moving towards the observer, their movements and speech will be observed accelerated by* $1/(1-v_{exp}/c)$ *times, where* $v_{ист}$ *and c are the speed of the spacecraft and the speed of light, respectively. STR predicts that in this case the astronauts' movements will be observed slowed down by* $1/\sqrt{1-(v_{exp}/c)^2}$ *times, thus STR predictions contradict the experimental data. The experiment was carried out using the Avrora-2 monopulse secondary surveillance radar manufactured by JSC "VNIIRA", which provides high-precision measurement of the time intervals between the moments of transmitting a request and receiving response signals from aircraft transponders. The practical value of this work lies in the fact that its results will help scientists of technical sciences, as well as specialists developing aviation and space technology, to avoid theoretical errors, and it is also possible to avoid accidents and disasters in aviation and space technology associated with the use of erroneous STR formulas. The paper presents reliable formulas that need to be used instead of the corresponding erroneous STR formulas.*

Graphical annotation



Keywords: *law of aberration, inertial frame of reference, observer, special relativity, STR, experiment, experimental refutation of STR, criticism of STR, mathematical statistics.*

1. Introduction

The first part of this work was published in [1]. In the first part, the formula of the special theory of relativity (STR) is considered, which connects the time interval counted from the observed clock readings on a moving object and the corresponding time interval from the observer's stationary clock

$$\Delta t_{\text{набл}} = \Delta t_{\text{ист}}\sqrt{1-\left(\frac{v}{c}\right)^2},$$

where $\Delta t_{\text{набл}}$ obs and $\Delta t_{\text{ист}}$ est are, respectively, the time intervals counted by the clock on the moving object and the observer's stationary clock;

v- is the clock speed;

c- is the speed of light.

In accordance with (1), according to observations, moving clocks go slower than stationary ones in all cases, regardless of whether the clock is approaching the observer or moving away from him. When *v* is replaced by – *v* in (1), that is, when the direction of the clock movement relative to the observer changes, the result in (1) remains unchanged.

In [there] it was theoretically proved that the observed time interval counted by the moving clock $\Delta t_{\text{набл}}$ obs is related to the corresponding time interval counted by the observer's stationary clock $\Delta t_{\text{ист}}$ ist by the formula [2-7]

when the clock approaches the observer:

$$\Delta t_{\text{obs}} = \frac{\Delta t_{\text{exp}}}{1-\frac{v}{c}}, \qquad (2a)$$

when moving away from the observer

$$\Delta t_{\text{obs}} = \frac{\Delta t_{\text{exp}}}{1+\frac{v}{c}}. \qquad (2b)$$

In accordance with (2a), when the clock approaches the observer, these clocks, according to the observed indications, go faster than the observer's stationary clock.

Formula (2) contradicts formula (1) of STR, which is set out in [8-11].

Thus, the problem arises of experimental verification of the validity of formulas (2) and, accordingly, (1).

To confirm the reliability of formulas (2), an experimental study was carried out, since, according to Henri Poincare, *"only experience ... can arm us with reliability"* [12, p. 116]. The theoretical foundations of the experiment are described in the author's works [1-7].

The experiment involved: 100 people, including the author of this work, including 8 doctors of science, 24 candidates of science, and 20 graduate students. Participants of the experiment work in 13 enterprises and organizations (12 in Russia, 1 in Uzbekistan).

The participants of the experiment took part, on the one hand, in the theoretical substantiation and theoretical verification of various aspects of the experiment, on the other hand, in the direct conduct of the experiment, discussion of its results, and comparison of the results obtained with the provisions of STR. The need for a large number of participants in the experiment is dictated by the enormous complexity of various theoretical aspects of the experiment, and above all by the enormous complexity of understanding SRT, with the results of which the results of the experiment were compared. All participants, in accordance with the task assigned to them, tried to solve the problems presented in the article, illustrating the inconsistency of STR (paragraph 6), but no one managed to solve them, which indicates the high complexity of STR and, with a high probability, its inconsistency. It is necessary to take into account the high qualifications and high level of theoretical training of all participants without exception, all participants in the experiment have higher education, many are postgraduate students or are applicants, among the participants there are 24 candidates of sciences, and 8 doctors of sciences.

2. The aim of the experiment

In the general case, relation (2) between the observed Δt_{obs}observed and the true Δt_{exp}time intervals has the form

$$\Delta t_{\text{obs}} = \frac{\Delta t_{\text{exp}}}{1 \pm \frac{v}{c}}, \tag{3}$$

where the plus sign in the denominator is when the clock moves away from the observer, the minus sign is when it approaches the observer.

This ratio can be rewritten as:

$$\frac{\Delta t_{\text{obs}}}{\Delta t_{\text{exp}}} = \frac{1}{1 \pm \frac{v}{c}}. \tag{4}$$

In accordance with expression (4), when the clock moves away from the observer

$$\frac{\Delta t_{\text{obs}}}{\Delta t_{\text{exp}}} = \frac{1}{1 + \frac{v}{c}}$$

This means that while the time interval Δt_{exp}, passes on the stationary clock, the interval Δt_{obs} will pass according to the indications of the receding clock. At the same time, Δt_obs is always less than Δt_{exp}, *that is, the clock moving away from the observer, according to their observed readings, runs slower than a stationary clock.*

When the clock approaches the observer in accordance with (4)

$$\frac{\Delta t_{\text{obs}}}{\Delta t_{\text{exp}}} = \frac{1}{1 - \frac{v}{c}}.$$

At the same time, $\Delta t_{\text{набл}}$ is always greater than Δt_{exp}, that is, the clocks approaching the observer, according to their *observed readings, go faster than stationary clocks.*

The purpose of the experiment was experimental verification of formula (4).

3. Experimental study

3.1. Concept of confidence interval

Let there be a random variable *X* with mathematical expectation *m* and variance *D*, which are unknown. Over the value of *X*, *n* independent experiments were carried out, which gave the results $X_1, X_2, \ldots, X_n$.

As an estimate for the mathematical expectation *m*, the arithmetic mean of the observed values is used

$$\widetilde{m} = \frac{\sum_{i=1}^{n} X_i}{n}.$$

The estimate for the variance *D* is found by the formula

$$\widetilde{D} = \frac{\sum_{i=1}^{n} (X_i - \widetilde{m})^2}{n-1}.$$

The standard deviation of the estimate $\widetilde{m}$ is

$$\sigma_{\widetilde{m}} = \sqrt{\frac{\widetilde{D}}{n}}.$$

In mathematical statistics, to give an idea of the accuracy and reliability of the estimate of the mathematical expectation (and other parameters), the *confidence interval* I_β and the *confidence probability* β are used.
The confidence interval is expressed as

$$I_\beta = \left(\tilde{m} - t_\beta \sigma_{\tilde{m}};\ \tilde{m} + t_\beta \sigma_{\tilde{m}}\right).$$

With a large number of measurements of a random variable *X*, the probability that the measurement will be within the confidence interval I_β is equal to β.
So, for example, with a confidence probability β = 0.95, measurements of a random variable will be within the interval

$$I_{0,95} = (\tilde{m} - 2\sigma_{\tilde{m}};\ \tilde{m} + 2\sigma_{\tilde{m}}).$$

With a confidence probability of β = 0,99999943, measurements of a random variable will be within the interval “with a statistical significance of 3 sigma”:

$$I_{0,9973} = (\tilde{m} - 3\sigma_{\tilde{m}};\ \tilde{m} + 3\sigma_{\tilde{m}}).$$

With a confidence probability of β = 0.99999943, measurements of a random variable will be within the interval “with a statistical significance of 5 sigma”:

$$I_{0,99999943} = (\tilde{m} - 5\sigma_{\tilde{m}};\ \tilde{m} + 5\sigma_{\tilde{m}}).$$

Statistical significance 7 sigma corresponds to a confidence probability β = 0.99999999999744.

$$I_{0,99999999999744} = (\tilde{m} - 7\sigma_{\tilde{m}};\ \tilde{m} + 7\sigma_{\tilde{m}}).$$

The last entry means that with the probability α = 1 – β = $2{,}56 \cdot 10^{-12}$ (this is a negligible probability) the measurements of the random variable will be outside the interval $(\tilde{m} - 7\sigma_{\tilde{m}};\ \tilde{m} + 7\sigma_{\tilde{m}})$. The probability α is the significance level.
To test the validity of relation (4), we formulate the null hypothesis (H0) as follows: the mathematical expectation of a random variable $Q = \frac{\Delta t_{\text{obs}}}{\Delta t_{\text{exp}}}$, which is the ratio of the time interval counted by the observed moving clock to the time interval counted by to the stationary clock of the observer, is equal to $\frac{1}{1 \pm \frac{v}{c}}$.

The values measured as a result of the experiment $q_1, q_2, \ldots, q_n$,

$$q_i = \frac{\Delta t^i_{\text{obs}}}{\Delta t^i_{\text{exp}}}.$$

represent a series of values of the random variable *Q*, which took place as a result of the experiment.
In mathematical form, the null hypothesis is written as follows:

$$m_q = \frac{1}{1 - \frac{v}{c}},$$

wherem_q is the mathematical expectation of the random variable *Q*.

In other words, the null hypothesis is a statement: the true mathematical expectation of the relation $\left(\Delta t_{\text{obs}}/\Delta t_{\text{exp}}\right)$,, that is, the left side of expression (4), is equal to $\frac{1}{1 - \frac{v}{c}}$, that is, the right side (4).

The alternative hypothesis (H_1) is a statement: the true mathematical expectation of the random variable *Q* is not equal to $\frac{1}{1 - \frac{v}{c}}$, that is, the right side of (4). Simply put, the alternative hypothesis (H_1) is that expression (4) is unreliable, false. If the null hypothesis is rejected, then the alternative hypothesis will be accepted.

In order to test the null hypothesis, we set the value of the confidence probability β, which we take equal to 0.99999999999744. This confidence probability under the normal distribution of the random variable Q corresponds to the statistical significance of 7 sigma.

Accordingly, the confidence interval is

$$I_{0,99999999999744} = (\tilde{m}_q - 7\sigma_{\tilde{m}};\ \tilde{m}_q + 7\sigma_{\tilde{m}}),$$

where $\tilde{m}_q$ is the estimate for the expectation m_q,

$\tilde{m}_q$ is the standard deviation of the estimate $\tilde{m}$.

Usually, the significance level of the criterion α=1-β is assumed to be 0.10; 0.05; 0.01. The more severe the consequences of a Type I error, the lower the significance level should be. We have chosen a significance level of α so small that a Type I error (i.e., the error of rejecting the null hypothesis when the null hypothesis is true) is an almost impossible event.

To test the null hypothesis, it is necessary to calculate the theoretical value of the mathematical expectation

$$m_q = \frac{1}{1-\frac{v}{c}},$$

that is, the right side of equation (4), and check if m_q falls within the confidence interval $I_{0,99999999999744}$.

If expression (4) is true, that is, if the null hypothesis is true, then this confidence interval $I_{0,99999999999744}$.will cover the true mathematical expectation $\frac{1}{1\pm\frac{v}{c}}$.with a probability of 0,99999999999744.

If the calculated value $\frac{1}{1\pm\frac{v}{c}}$ is outside the confidence interval, then the null hypothesis must be recognized as false, and the alternative hypothesis must be recognized as true. And this means that expression (4) is erroneous.

3.2. Method for calculating the confidence interval of the estimate for the mathematical expectation of the magnitude of the acceleration of the observed time course of a moving clock

To calculate the confidence interval for the estimate for the mathematical expectation of the magnitude of the acceleration of the observed time course of the moving clockI_β I_β, it is necessary, in the process of movement of the aircraft observed with the help of the radar, to make successive measurements of the time intervals between the moments of emission of responses from the transponders of the secondary surveillance radar located on the aircraft t_i^{sent}, except. In addition, measure the corresponding time intervals between the moments of receipt of these responses by the radar t_i^{inc} , and then perform calculations in accordance with the following procedure.

3.4. Experimental setup

As an experimental setup for estimating the mathematical expectation of the magnitude of the acceleration of the observed time course of a moving clock, a monopulse secondary surveillance radar (SSR) "Aurora-2", commercially produced by JSC "VNIIRA", was used.

3.4. Description of SSR

The SSR system consists of two main subsystems: the ground interrogator/receiver (also referred to as radar) and the airborne transponder [13].

The ground station includes a rotating antenna. The rotation speed determines how often information is updated. In the Avrora-2 radar, the antenna rotation speed is 1 revolution in 5 seconds.

The transponder on board the aircraft responds to ground station interrogations, allowing the ground station to determine the distance to the aircraft and bearing. The transponder is programmed with a fixed delay period during which the interrogation is decrypted and a response is prepared for transmission. This fixed delay period is taken into account by the ground receiver when processing the response.

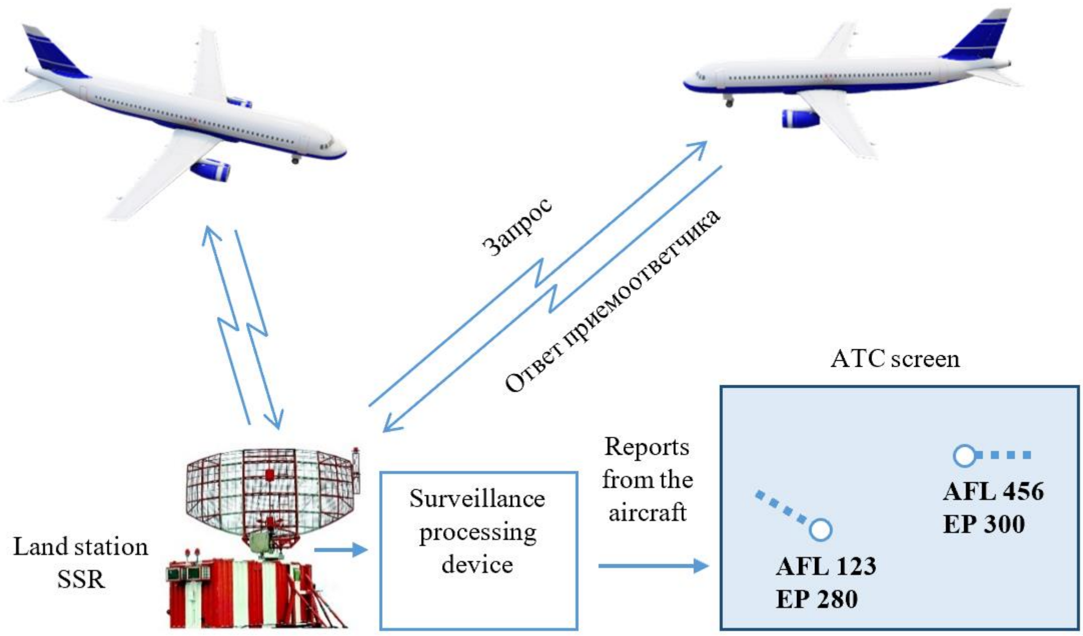


Fig 1. Secondary surveillance radar (SSR)

3. SSR components are shown in fig. 1. SSR determines the distance to the aircraft and the azimuth independently. The distance is determined by measuring the time until a response to the corresponding request signal is received. The azimuth of the aircraft from the radar is determined by the position of the rotating antenna at the time the response is received. The accuracy of the distance information usually does not change within the coverage area.

For the SSR system to function, the aircraft must be equipped with a transponder.

Based on the SSR data transmitted to the radar information processing system, the ground and vertical speed of the aircraft can be calculated and its future position can be predicted.

5. Initial data for calculation

During the flight of the aircraft, high-precision measurements are made of the i- times of requests by the SSR ground station t_i^{forb}, and the corresponding times of receipt of responses by the ground-based SSR receiver t_i^{arriv}. Knowing the time of the request and the time of receipt of the response, it is possible to determine the time of transmission of the response from the transponder on the aircraft t_i^{send} , taking into account the delay period Δt_{back}, during which the request is decrypted and the response is prepared for transmission.

The initial data for the calculation are recorded in table 1.

Table 1 uses the designation ID - aircraft identifier.

Table 1

Initial data

№	t_i^{forb} request time	$t_i^{приб}$ answer time	Movement parameters of the observed object ID: ____________				
			Azimuth	Distance	Height	Speed	Course
1							
2							

Requirements for recording initial data

In the table of initial data, data on an aircraft performing a horizontal straight flight at a constant speed is recorded. The table records the time of requests and responses when the aircraft is flying towards or away from the SSR. Record the data obtained with each review (approximately 1 time in 5 seconds).

The total time of aircraft observation for fixing experimental data must be at least 180 seconds.

For the experiment, it is necessary to record statistics for at least 12 aircraft flying preferably at different speeds (both high and low). Half of the aircraft must fly to the SSR, half from the SSR. The distance to the aircraft should be at least 120-150 km.

For each aircraft, a separate table is filled in (Table 1).

3.6. Measurement processing

1.Based on the request time t_i^{forb} and the time of receipt of the response t_i^{arriv} , the time of sending the response from the transponder of the aircraft t_i^{send}, is calculated,

$$t_i^{\text{send}} = \frac{t_i^{\text{forb}} + t_i^{\text{arriv}} - \Delta t_{back}}{2}.$$

where Δt_{back} is the delay period during which the request is decrypted and the response is prepared for transmission.

Calculate the time interval between the moments of departure of the *i*+*k* – and *i*-response

$$\Delta t_{\text{observ}}^i = t_{i+k}^{\text{send}} - t_i^{\text{send}}$$

The value of *k* is chosen so that the interval $\Delta t_{\text{observ}}^i$ is 10-30 seconds. In the experiment, the value of *k* was chosen equal to 3, so that the interval $\Delta t_{\text{observ}}^i$ was approximately 15 seconds:

$$\Delta t_{\text{observ}}^i = t_{i+3}^{\text{send}} - t_i^{\text{send}}.$$

Calculate the time interval between the moments of receiving the corresponding answers

$$\Delta t_{\text{or}}^i = t_{i+k}^{\text{arriv}} - t_i^{\text{arriv}}.$$

In the experiment, *k* = *3*, respectively

$$\Delta t_{\text{or}}^i = t_{i+3}^{\text{arriv}} - t_i^{\text{arriv}}.$$

Calculate ratio

$$q_i = \frac{\Delta t_{\text{observ}}^i}{\Delta t_{\text{or}}^i}.$$

The quantity q_i is the measured value of the rate of acceleration or deceleration of the observed clock rate on the moving aircraft.

For *n* values of q_i calculate the estimate of the mathematical expectation

$$\widetilde{m}_q = \frac{\sum_{i=1}^{n} q_i}{n}.$$

$\widetilde{m}_q$ is an estimate of the mathematical expectation of the amount of acceleration or deceleration of the observed clock rate on a moving aircraft.

Calculate the variance estimate

$$\tilde{D} = \frac{\sum_{i=1}^{n}(q_i - \tilde{m}_q)^2}{n-1}.$$

Calculate the standard deviation of the estimate $\tilde{m}_q$

$$\sigma_{\tilde{m}} = \sqrt{\frac{\tilde{D}}{n}}.$$

Calculate the confidence interval I_β estimates for the mathematical expectation of the value q_i, corresponding to the statistical significance of 7 sigma

$$I_\beta = (\tilde{m} - 7\sigma_{\tilde{m}};\ \tilde{m} + 7\sigma_{\tilde{m}}).$$

For such a confidence interval, the confidence probability β = 0,99999999999744, that is, almost equal to one.

Intermediate results of processing measurements are entered in table 2.

Table 2

Measurement processing

№	Δt_{or}^{i}	$\Delta t_{\text{send}}^{i}$	$q_i = \frac{\Delta t_{\text{observ}}^{i}}{\Delta t_{\text{or}}^{i}}$
1			
2			

The results of the calculation of the estimate of the mathematical expectation $\tilde{m}_q$, standard deviation $\sigma_{\tilde{m}}$ and confidence interval I_β are entered in Table 3.

Table 3

Calculation results

№	v, м/с	$\tilde{m}_q$	$\sigma_{\tilde{m}}$	I_β	η	Validation
1						
2						

3.7. Experimental verification of the hypothesis about the reliability of the formula expressing the change in the observed rate of movement of a moving clock

Experiment results.

The experiment in order to test the hypothesis about the reliability of formula (4) was carried out using the initial data recorded during the observation of real air traffic in the period from 06/29/2022 to 07/01/2022 using the Aurora-2 SSR installed at Sheremetyevo Airport. This is a modern monopules secondary radar (MSSR) of S mode with the function of extended surveillance in ADS-B 1090 ES mode. The period of rotation of the radar antenna is 5 seconds. Flights of 20 aircraft operating in the Moscow air zone were recorded. The aircraft operated flights AFL1401, AFL1124, NWS592, AFL018, DRU543, SDM6020, RWZ786, AFL1641, BRU951, AFL1500, THY3952, AFL042, SBI1028, 73053, SBI2567, SBI2067, THY814, AFL25135.

An average of 38 observed and true time intervals were measured for each aircraft. The average duration of the observed (and, accordingly, true) time intervals was approximately 15 sec. In the experiment, the time intervals between the *i*- and i+*3*-th radar surveys were measured. Each aircraft was observed for approximately 200 seconds.

During the experiment, a total of 757 measurements of the quantity

$$q_i = \frac{\Delta t_{\text{observ}}^{i}}{\Delta t_{\text{or}}^{i}},$$

which represents the amount of acceleration / deceleration of the observed passage of time of the moving clock.

The histogram of the measurement error $\Delta q_i = \tilde{m}_q - q_i$, where $\tilde{m}_q$ is the estimate of the mathematical expectation of the quantity q_i is shown in fig. 2.

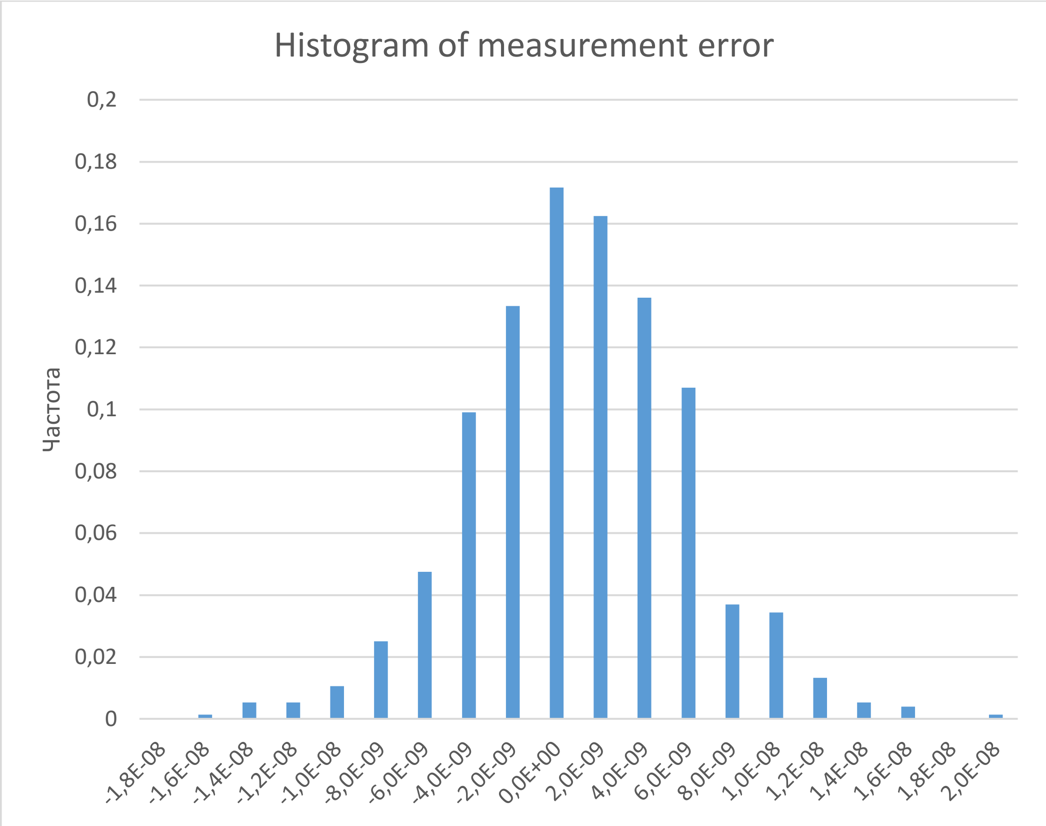


Fig. 2. Histogram of the measurement error of the magnitude of acceleration / deceleration of the observed passage of time of a moving clock

Testing the statistical hypothesis about the normal distribution of the measurement error Δq using the skewness and kurtosis coefficients showed that this distribution can be considered normal.

On fig. 3 shows the dependency graph

$$\mu = \frac{1}{1 + \frac{v}{c}}$$

from speed.

In the same figure, the “+” markers show the experimentally obtained values of $\tilde{m}_q$.

It can be seen from the figure that the experimental values of $\tilde{m}_q$ correspond to the graph μ with a high degree of accuracy.

Table 4 presents the experimental data, in accordance with which the confidence intervals for estimating the magnitude of the acceleration of the observed rate of a moving clock with a statistical significance of 7 sigma were calculated.

Column v represents the speed of the aircraft. The column $\tilde{m}_q$ contains an estimate of the expectation

$$q_i = \frac{\Delta t^i_{\text{observ}}}{\Delta t^i_{\text{or}}}$$

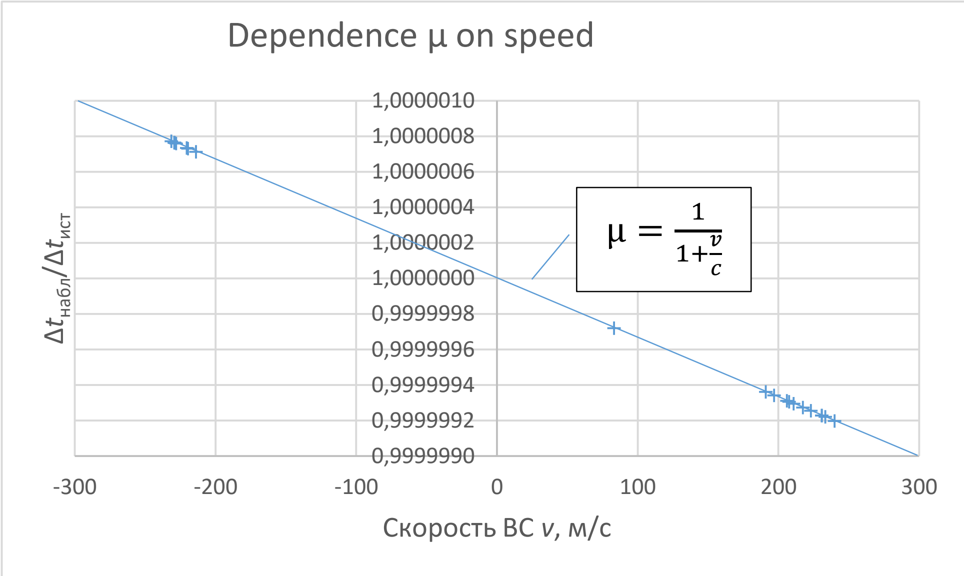


Fig. 3. Graph of the dependence of the acceleration/deceleration of the observed clock rate on the aircraft from the speed. Positive values of the speed correspond to the distance of the clock from the observer, negative values correspond to the approach of the clock to the observer.

In other words, $\widetilde{m}_q$ is an experimental estimate of the ratio of the observed interval, counted by the clock moving towards the observer, to the true interval.

Columns I_β show the lower and upper bounds of the confidence interval for the quantity m ̃_q at the confidence level β = 0,99999999999744.

The table shows that in all 20 cases the value of μ is within the confidence interval I_q. This suggests that the hypothesis of the reliability of expression (4) cannot be rejected.

Table 4

Validation of the expression (4) with a statistical significance of 7 sigma

№ п/п	v, м/с	$\widetilde{m}_q$	$\sigma_{\widetilde{m}}$	I_β: $\widetilde{m}_q - 7\sigma_{\widetilde{m}}$	I_β: $\widetilde{m}_q + 7\sigma_{\widetilde{m}}$	$\mu = \frac{1}{1+\frac{v}{c}}$	Con firm.μ	$\eta = \sqrt{1-\left(\frac{v}{c}\right)^2}$	Con firm.η
1	-231,37	1,0000007715	6,38E-10	1,0000007670	1,0000007759	1,0000007718	yes	0,999999999999702	no
2	-229,34	1,0000007652	6,15E-10	1,0000007609	1,0000007695	1,0000007650	yes	0,999999999999707	no
3	-229,04	1,0000007636	7,71E-10	1,0000007582	1,0000007690	1,0000007640	yes	0,999999999999708	no
4	-228,86	1,0000007633	4,58E-10	1,0000007601	1,0000007665	1,0000007634	yes	0,999999999999709	no
5	-227,98	1,0000007605	6,06E-10	1,0000007563	1,0000007648	1,0000007605	yes	0,999999999999711	no
6	-220,48	1,0000007350	1,01E-09	1,0000007279	1,0000007420	1,0000007354	yes	0,999999999999730	no
7	-219,61	1,0000007318	8,71E-10	1,0000007257	1,0000007379	1,0000007325	yes	0,999999999999732	no
8	-213,77	1,0000007126	7,39E-10	1,0000007074	1,0000007178	1,0000007130	yes	0,999999999999746	no
9	83,21	0,9999997202	8,67E-10	0,9999997141	0,9999997263	0,9999997225	yes	0,999999999999961	no
10	191,02	0,9999993628	8,87E-10	0,9999993566	0,9999993690	0,9999993628	yes	0,999999999999797	no
11	197,02	0,9999993429	5,32E-10	0,9999993391	0,9999993466	0,9999993428	yes	0,999999999999784	no
12	206,05	0,9999993129	7,11E-10	0,9999993079	0,9999993178	0,9999993127	yes	0,999999999999764	no
13	207,71	0,9999993072	7,99E-10	0,9999993016	0,9999993128	0,9999993071	yes	0,999999999999760	no
14	210,97	0,9999992966	7,31E-10	0,9999992915	0,9999993017	0,9999992963	yes	0,999999999999752	no
15	217,44	0,9999992743	7,20E-10	0,9999992693	0,9999992794	0,9999992747	yes	0,999999999999737	no
16	223,13	0,9999992557	1,22E-09	0,9999992472	0,9999992642	0,9999992557	yes	0,999999999999723	no
17	230,99	0,9999992292	8,89E-10	0,9999992230	0,9999992354	0,9999992295	yes	0,999999999999703	no
18	231,00	0,9999992294	6,39E-10	0,9999992249	0,9999992338	0,9999992295	yes	0,999999999999703	no
19	233,35	0,9999992218	5,88E-10	0,9999992177	0,9999992259	0,9999992216	yes	0,999999999999697	no
20	240,09	0,9999991994	7,26E-10	0,9999991943	0,9999992045	0,9999991991	yes	0,999999999999679	no

3.8. How to interpret the results??

The value $\widetilde{m}_q$ is an experimental estimate of the acceleration of the observed rate of the clock located on the aircraft, which is moving towards the observer (radar).

The interval $(\widetilde{m} - 7\sigma_{\widetilde{m}};\ \widetilde{m} + 7\sigma_{\widetilde{m}})$, calculated with a statistical significance of 7 sigma, is a confidence interval, beyond which the measurement of the observed clock rate acceleration is a negligible value of $22{,}56 \cdot 10^{-12}$.

In other words, with a probability

$$\beta = 1 - 2{,}56 \cdot 10^{-12} = 0{,}99999999999744$$

the true value of the change in the observed rate of movement of the moving clocks located on the aircraft is within the limits of the confidence interval calculated in the table.

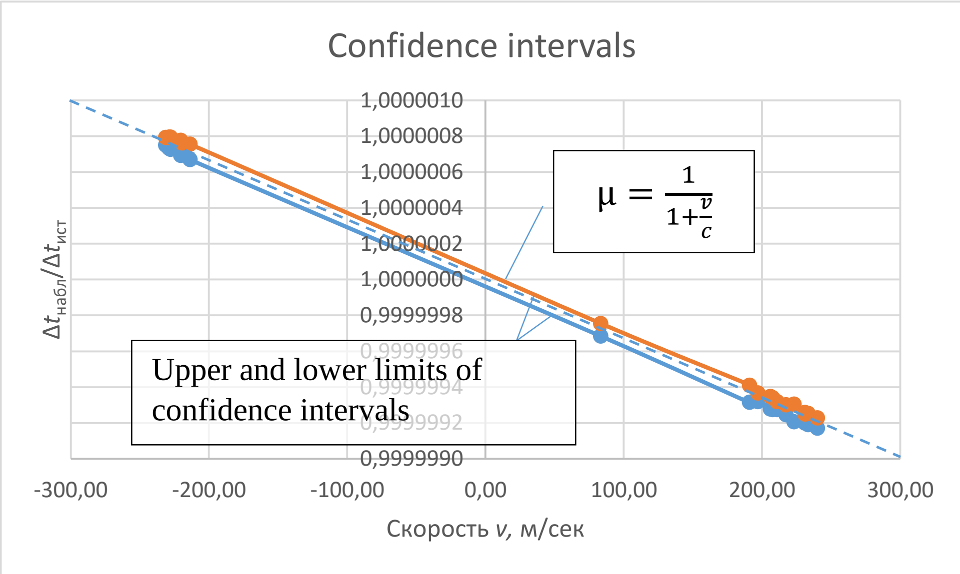


Fig. 4. Confidence intervals for the acceleration of the observed rate of clocks located on the aircraft with a statistical significance of 7 sigma

Confidence intervals of acceleration of the observed course of clocks located on the aircraft at their various speeds are shown in Fig. 4. Bounds of confidence intervals calculated with a statistical significance of 7 sigma are represented by two lines of the "upper and lower bounds of the confidence intervals". The true value of the acceleration of the observed rate of the clock on the aircraft, with a confidence level of 0.99999999999744, must lie between these lines.

What does the experiment show?

Column $\widetilde{m}_q$ in Table 4 is the expectation of the ratio of the measured time interval observed by the clock located on the moving aircraft to the corresponding time interval measured by the observer's stationary clock. In other words, the column $\widetilde{m}_q$ represents the number of seconds that have passed through the observed moving clock in one second of the observer's stationary clock.

The experiment shows that the clock moving towards the observer (with a negative speed in column v of the table) according to the readings observed by him goes faster than the stationary clock: in one second, according to the observer’s stationary clock, more than one second passes through the clock approaching him. So, for example, in accordance with line 1 of Table 4, at a speed equal to minus 231.37 m / s in one second, according to the observer's stationary watch, the readings of the moving clock change by 1.0000007715 seconds.

In addition, the experiment shows that the clock moving away from the observer (at a positive speed in column v of the table) according to the observed data goes slower than the stationary clock: in one second, according to the stationary clock of the observer, less than one second passes according to the clock moving away from him. In line 20 of the table, at an aircraft speed of 240.09 m/s in one second, according to the experiment, 0.9999991994 seconds passed by the moving watch.

The predictions made by formula (4) (column μ of the table) coincide with the experimental data with a high degree of accuracy.

3.9. Contradiction of the results of the experiment to the SRT formula

The experiment showed that when observing a clock that moves at a speed v along the line connecting the clock and the observer, the observed rate of movement of this clock $\mu = \frac{\Delta t_{\text{observ}}}{\Delta t_{\text{or}}}$ changes in accordance with the expression

$$\mu = \frac{1}{1 \pm \frac{v}{c}},$$

where Δt_{observ} and Δt_{or} are, respectively, the time intervals counted by the moving clock and the stationary clock of the observer;

the plus sign in the denominator - when the clock moves away from the observer, the minus sign - when they approach the observer.

The physical meaning of this result is that when the clock moves towards the observer, these clocks, according to observations, go faster than stationary ones. If the observed clock moves away from the observer, then, according to the observations, they go slower than the stationary ones.

In accordance with the results of the experiment, if from the space flight control center located on Earth, with the help of frame-by-frame video communication (or with the help of a hypothetical powerful telescope that allows you to see everything that happens on the ship through the window of the spacecraft), to observe the astronauts and the shooters located on clock ship, then when the ship moves towards the Earth at a speed of 0.5 c (half the speed of light), the coefficient of change in the observed course of time μ on the ship will be equal to

$$\mu = \frac{1}{1 - \frac{v}{c}} = \frac{1}{1 - \frac{0{,}5\,c}{c}} = 2,$$

the movements and speech of the astronauts, when observed, will look accelerated by a factor of two, just as if we were replaying a regular video recording at a double speed.

When the spacecraft approaches the Earth at a speed of 0.9 s, the movements and speech of the astronauts will be observed to be accelerated by a factor of 10; at this speed of speech reproduction, it will be impossible to understand it by ear.

If the spacecraft approaches the Earth at a speed of 0.99 s, the movements and speech of the astronauts will be observed accelerated by 100 times; the observed readings of the ship's clock would be 100 times faster than clocks on Earth.

If the spacecraft moves away from the Earth at a speed of 0.9c, then $\mu = \frac{1}{1 + \frac{0{,}9\,c}{c}} = 0{,}526$. In this case, the movements and speech of the cosmonauts, as well as the movement of the hands of the ship's clock, will be observed slowed down by a factor of 1.9.

However, it should be noted that the results of the experiment, as well as the conclusions drawn on their basis, contradict SRT.

Formula (1) SRT, according to which a slowdown in the observed readings of a moving clock should be observed, can be rewritten as:

$$\frac{\Delta t_{\text{observ}}}{\Delta t_{\text{or}}} = \sqrt{1-\left(\frac{v}{c}\right)^2}.$$

Denote the right side of formula (5)

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

The values of η are presented in the penultimate column of Table 4. It can be seen from the table that the values of η calculated for the corresponding velocities do not fall within the experimentally obtained confidence intervals.

The graph of the function η is shown in fig. 5. This figure clearly shows that the values of time dilation η calculated by the SRT formulas are *outside the confidence intervals*.
This indicates that the SRT formula (1) and, accordingly, (5) with a probability of more than 0.99999999999744 is not reliable.

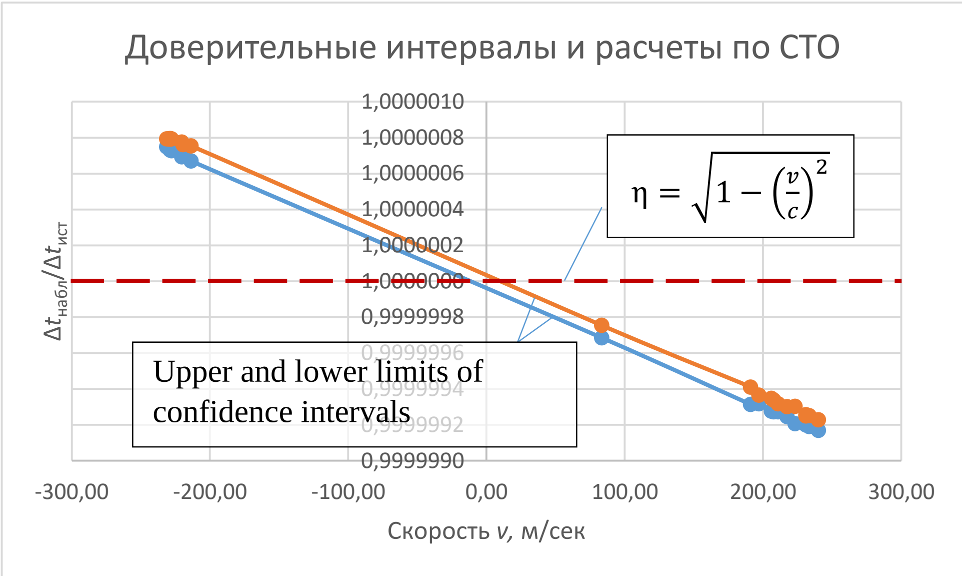


Fig. 5. Graph of the deceleration of the observed clock rate on the aircraft as a function of the speed η, calculated using the SRT formula. Positive values of the speed correspond to the distance of the clock from the observer, negative values correspond to the approach of the clock to the observer. The values of the slowdown of the observed rate of a moving clock calculated according to SRT in all cases of measurements are outside the experimentally obtained confidence intervals

4. Conclusions

The value $\widetilde{m}_q$ is an experimental estimate of the acceleration of the observed rate of the clock located on the aircraft, which is moving towards the observer (radar). In other words, $\widetilde{m}_q$ is the number of seconds elapsed by the observed moving clock in one second of the observer's stationary clock.

The experiment shows that the theoretical value of the acceleration/deceleration of the observed rate of the moving clock, calculated by the formula

$$\mu = \frac{1}{1 \pm \frac{v}{c}}$$

(the right side of formula (4)) in all cases of measurements is within the confidence intervals, which indicates that formula (4) with a probability of 0.99999999999744 is reliable.

The experiment also shows that the theoretical value of the deceleration of the observed rate of the moving clock, calculated by the SRT formula

$$\eta = \sqrt{1 - \left(\frac{v}{c}\right)^2},$$

(the right side of formula (1)) in all cases of measurements is outside the confidence interval. This proves that SRT formula (1) with a probability of more than 0.99999999999744 is erroneous, unreliable.

It was shown above that, in accordance with SRT, when the spacecraft moves away from the observer or when it approaches it (the latter is important), with the spacecraft's velocity *v* equal to 0.99 of the speed of light, the observed rate of the spacecraft's clock and the movements of the astronauts will slow down by 7.089 times. And at the speed of the ship equal to 0.9999 the speed of light, the movements of the astronauts and the course of the observed indications of the ship's clock will slow down by 70.7 times.

However, in accordance with the experiment that proved the truth of formula (3), when the spacecraft approaches the observer at a speed of 0.99 of the speed of light, the observer will record the acceleration of the observed readings of the ship's clock by 100 times, with an approaching speed of 0.9999 of the speed of light, the observed course hours of the ship will accelerate by 10,000 (ten thousand) times.

It should be noted that formula (1) follows directly from the so-called Lorentz transformations obtained based on the postulates of relativity and constancy of the speed of light [8]. Since, as the experiment showed, formula (1) with a probability of more than 0.99999999999744 is unreliable, this circumstance casts doubt on the entire SRT in its kinematic part. In other words, the experiment has shown that the results of SRT are highly likely to be unreliable. And if so, then it is necessary to draw a conclusion about the need for careful use of SRT formulas in satellite navigation systems, in space navigation systems, as well as in aviation and space surveillance systems.

Note that in this paper, questions of SRT only are considered and the questions of using the general theory of relativity (GR) are not touched at all. From the point of view of general relativity, the results of this work and the experiment performed may turn out to be correct.

5. Two problems in SRT, the solution of which is impossible because of its fallacy

Below are two simple SRT problems formulated by the author. The solution of these problems, in our opinion, is impossible because of the erroneousness and internal inconsistency of SRT. The best refutation of the assumption about the impossibility of solving these problems by SRT methods is, of course, the provision of their solution with SRT formulas and calculations.

Scientists in technical sciences face such problems in practice when they consider the issues of using SRT results in aviation and astronautics, including in satellite navigation systems (GLONASS, GPS, GALILEO). In each of the above tasks there are two ISOs. Solving problems from the point of view of one ISO leads to one answer, and solving them from the point of view of a second ISO gives a different answer, which contradicts the first.

Numerous attempts by the authors to get clarifications from representatives of theoretical physics on how to solve these problems turned out to be fruitless.

Nevertheless, the question is relevant and practically important: how to solve these problems in practice?

The use of erroneous formulas in the development of aviation and space navigation and surveillance systems leads to a deterioration in the performance characteristics of these systems, to an increase in the probability of their failures, and can lead to accidents, human casualties (catastrophes) and significant economic losses. That is why scientists - representatives of theoretical physics, who gave the technical sciences the special theory of relativity (having written textbooks for technical universities with a presentation of SRT) should take responsibility for the reliability of the results of SRT, which are used in practice in the development of aviation and space systems.

The presented problems require a solution and require representatives of theoretical physics to present understandable methods and algorithms for solving such contradictory problems.

5.1. Problem 1 about spaceships flying nearby

Let two identical spaceships 100 m long fly past each other in close proximity. The speed of movement is *v=0.99999c*, where c is the speed of light.

Each ship has 101 portholes, which are located at a distance of 1 m from each other. (For simplicity, we assume that the first and last windows are located in close proximity to the front and rear of the ship.) The windows are numbered so that the number of each window corresponds to the distance in meters from the front of the ship to the corresponding window: (A0, A1, A2, ... , A99, A100) – on ship A, (B0, B1, B2, …, B99, B100) – on ship B (Fig. 6).

Observers are located near each porthole. Watchers' clocks on each ship are synchronized.

Let the clocks on each of the ships go in such a way that the observers A0 and B100, located at the front and rear ends of the ship A and ship B (Fig. 6), being close at this moment in time, will record that the readings of the clocks A0 and *B100 are the same.*

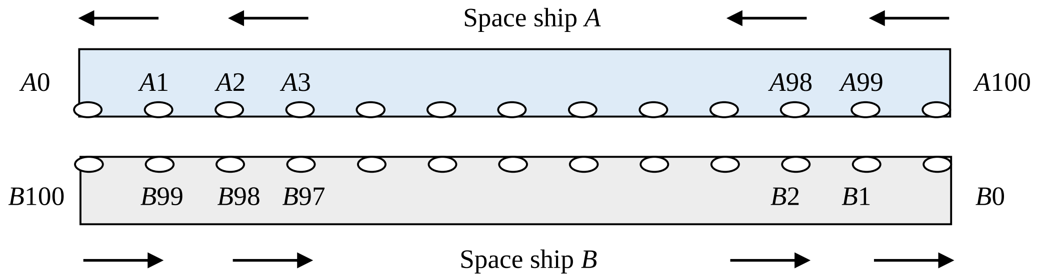


Fig. 6

In accordance with SRT, the linear dimensions of moving bodies decrease. In [11, p. 548], in particular, it says: "... the length of a solid meter ruler moving in the direction of its length when viewed from a resting coordinate system is $\sqrt{1-(v/c)^2}$. Thus, a *moving solid* ruler is *shorter* than the same ruler at rest, and the shorter the faster it moves.

In accordance with SRT, from the point of view of the observers of the ship A, the ship B moving past them will be shorter than their own ship A. The length of the ship B will be equal to

$$l_B = l_A\sqrt{1-(v/c)^2},$$

where l_A is the length of ship *A*, equal to 100 m.

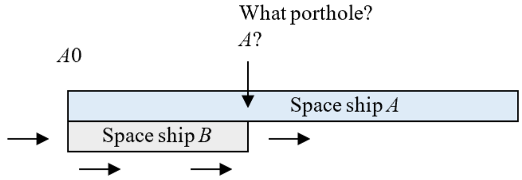


Fig. 7

Problem solving

1. Calculate which window of ship *A* will be near the front of ship *B* at the moment when the back of ship B is opposite the window A0? (Fig. 7)

2. Show that the found solution satisfies (does not contradict) the principle of relativity.

5.2. Problem solving 2 about clocks moving towards each other

Let two IFRs ***K*** and ***K′*** move relative to each other with a speed v so that the axes *X* and *X′* are in close proximity to each other, and the axes *Y* and *Y′*, as well as *Z* and *Z′* are parallel.

At the ends of two absolutely rigid rods of the same length, at points *O* and *A* (in the *K* frame) and *O′* and *A′* (in the *K*' frame), there are observers with clocks (Fig. 8, a). The rods are motionless, each in its own system.

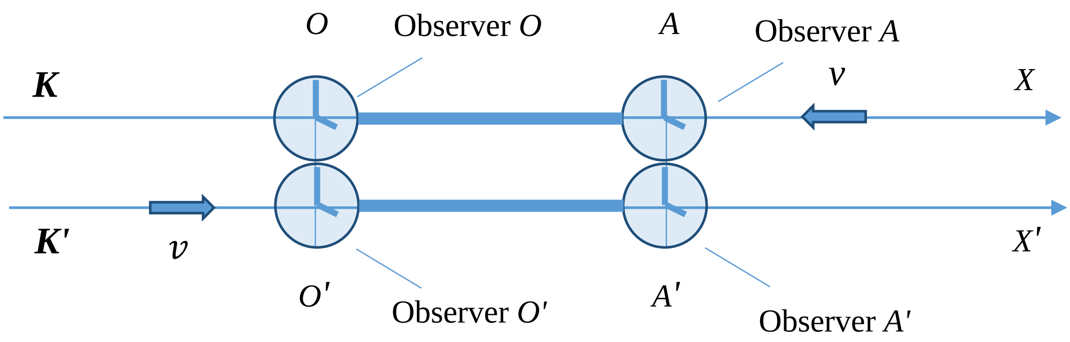


Fig. 8 a). ISO ***K*** and ***K***′. At the moment when the observer's O and O' as well as A and A' pass each other, the clock is reset to zero

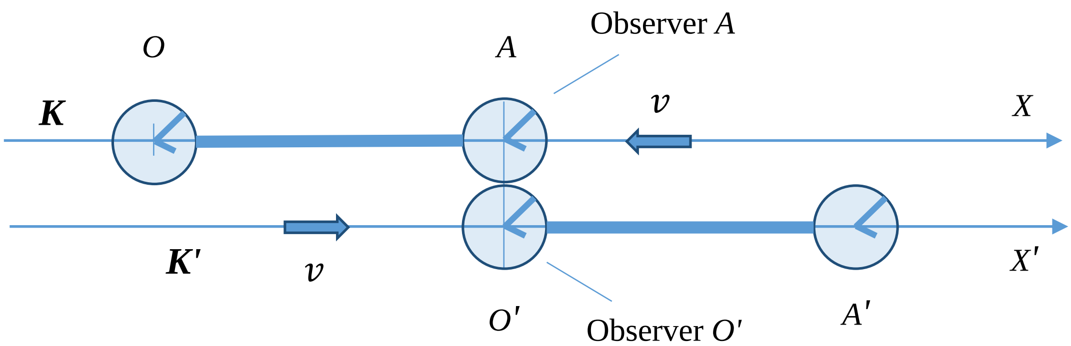


Fig. 8 b). The moment when the observers ***A*** and ***O′*** are in close proximity to each other and to the clocks ***A*** and ***O′.***

In ISO K the clocks O and A are synchronized, in ISO K' the clocks O' and A' are synchronized.

Let at the time shown in Fig. 8a, when observers O and O', as well as observers A and A', pass next to each other, they reset their clocks to zero. Since the lengths of the rods connecting the clocks in each IFR are the same, after zeroing the clock in each IFR will remain synchronously running.

Let the speed of movement v =0.9c(90% of the speed of light), and the distance $|OA|$is such that the clock A passes it with the speed v =0.9c in exactly 1 hour.

Thus, at the moment of the meeting of observers ***A*** and ***O′*** (Fig. 8 b), when they are in close proximity to each other and from the clocks ***A*** and ***O′,*** in the system ***K′*** the stationary clock ***O′*** will show exactly 1 hour.

Problem solving

1. Using SRT formulas, find the readings of the moving clock A when they are observed by a stationary observer O' from the system K' at the moment of meeting. It is forbidden to use the formulas of other theories, for example, the general theory of relativity.

2. In the solution, give the formulas by which the calculations are performed and the calculations themselves.

3. Show that the solution satisfies the SRT relativity principle [41].

4. Show that a moving clock runs slower than a stationary one [8, p. 19-20; 9, p. 156]. SRT states: “The clock, due to its movement, runs slower than at rest” [11, p. 549].

Comments to problem solving

The problem is solved using the obvious formula:

$$\Delta t_A = \Delta t_{O'}\sqrt{1-(v/c)^2},$$

where $\Delta t_{O'}$ is the time interval that has elapsed from the moment of resetting the clock to the moment of the meeting of observers O' and A, equal to 1 hour by clock O';

Δt_A is the desired time interval that has elapsed from the moment the clock was reset to zero until the moment the observers O' and A meet at the clock A;

v = 0.9c – movement speed.

5.3. Contradictions of SRT illustrated by problems

Problem 1 about spaceships flying nearby at the same moment of time illustrates a contradictory, that is, an event impossible from the point of view of formal logic, according to which different observers located in different IFRs, being nearby at the same point in space at the same time (at the same moment of time) will fix different lengths of the same material body.

In other words, the observers of ship A, being in close proximity to the observers of ship B, at the same time (if the time is counted according to the clock running synchronously on each ship, which are located next to each observer), according to SRT, will fix a different length of the same ship. And this, from the point of view of formal logic, cannot be.

Problem 2 about clocks moving towards each other illustrates a contradiction, according to which different observers located in different IFRs, being nearby at the same point in space at the same time (at the same time), according to SRT, will fix different readings of the same and the same clock located at this point in space. From the point of view of formal logic, this is impossible.

One of the ways to prove that SRT is a consistent theory is to correctly, using only SRT formulas and without resorting to other theories (including general relativity), solve the presented problems, and correctly prove that the resulting solution satisfies (does not contradict the principle of relativity.

The latter means that the solution must be obtained from the point of view of different ISOs, and in all cases this solution must be the same.

So, the signs of SRT inconsistency are that the measurement of the same physical quantities of the same body (body length, duration of time intervals observed according to the readings of the clock located on the body) from different ISOs lead to different, contradictory results. The contradiction is expressed in the fact that two observers from different IFRs who find themselves simultaneously in the same place in space, according to SRT, will receive different, contradictory (and impossible from the point of view of formal logic) results, namely: different lengths of the same body or different readings of the same clock at the same time. In other words, several observers who are in different IFRs, when observers from different IFRs meet each other at one point in space, according to SRT, must simultaneously fix different lengths of the same body; two observers moving relative to each other, observing the same clocks moving relative to them, when these observers and clocks meet simultaneously at one point in space, according to SRT, they should find that these clocks simultaneously show different times, which contradicts formal logic.

The very fact of the presence of "unsolvable" problems by SRT methods proves the internal inconsistency of this theory (the solution must be obtained exclusively by SRT methods, without using other theories).

6. Conclusion

Thus, the paper presents the results of experimental measurement of the observed rate of movement of a moving clock.

In accordance with the results of the experiment, the clock moving towards the observer according to observations goes faster than his stationary clock, when the clock moves away from the observer, according to observations, they go slower than the observer's stationary clock.

It has been experimentally proved that the time intervals counted according to the observed indications of the clock moving relative to the observer Δt_{observ} and according to the observer's stationary clock Δt_{or} are related by formula (3):

$$\Delta t_{\text{observ}} = \frac{\Delta t_{\text{or}}}{1 \pm \frac{v}{c}},$$

where the plus sign in the denominator is when the clock moves away from the observer, the minus sign is when it approaches the observer.

SRT has another formula (1)

$$\Delta t_{\text{набл}} = \Delta t_{\text{ист}} \sqrt{1 - \left(\frac{v}{c}\right)^2}.$$

This SRT formula in the entire history of the existence of this theory has never been subjected to experimental verification when observing moving clocks directly in the process of their movement.

The results of the experiment contradict SRT, according to which, according to observations, moving clocks always (regardless of the direction of movement) go slower than stationary ones. Practice, experiment are an irrefutable criterion of truth. Therefore, formula (3) is true, and SRT formula (1) is erroneous.

For the first time in more than a century of the existence of SRT, it was possible to conduct a practical experiment to measure the observed readings of moving clocks directly during their movement, which is perhaps one of the most important events not only in the history of SRT, but also in the history of physics.

A significant experiment was carried out using the Avrora-2 radar manufactured by JSC VNIIRA, which makes it possible to measure with high accuracy the time intervals between the moments of interrogation, the response of the transponder and the receipt of response signals by the ground station.

The experiment proved the inconsistency, the fallacy of SRT. With a probability of more than 0.99999999999744, the SRT formula (1), according to which the course of the observed readings of a moving clock in all cases (including when they approach the observer) slows down compared to the course of a stationary clock, is erroneous, unreliable.

7. Announcement of the author's planned publications

The long-term work of the author on the development of the "Theory of Aberration", which is the first alternative SRT theory, which is experimentally confirmed, is coming to an end. Fragments of the Theory of Aberration were partially published in works [1-7]. The theory of aberration makes it possible to solve problems that cannot be solved with the help of SRT or, when solving them, SRT leads to erroneous results. Unlike the incredibly complex SRT, aberration theory is relatively easy to understand. The theory of aberration has no paradoxes, does not contradict common sense. The theory of aberration has valuable practical applications in navigation and ATC, as well as in satellite navigation. Using the Theory of Aberration, inventions have been made for which patents have been obtained. Within the framework of the Theory of Aberration, for the first time, a previously unknown physical law of aberration of the body's magnitudes during its motion relative to the observer was formulated [3-5]. The discovery of the laws of nature is a rather rare event. In the entire history of mankind, only about a hundred physical laws have been discovered, only a few laws have been discovered by Russian scientists. Therefore, the discovery of the new law presented in the work is an important, significant event, both for modern physics and for science in general.

The theory of aberration correlates with SRT just as the heliocentric system of the world of Copernicus correlates with the geocentric system of Ptolemy.

The Ptolemaic system and SRT are incredibly complex. Apparently, only a few of the most outstanding minds among the theoretical physicists of our and the last century were able to understand its essence without getting confused in the paradoxes of SRT. The second common shortcoming of the Ptolemaic system and SRT is that these theories give erroneous results when solving practical problems. SRT leads to significant errors in solving a number of navigation and surveillance problems, and SRT cannot cope with some tasks at all.

The theory of aberration, in contrast to SRT, on the one hand, is relatively simple, understandable and not contradictory, and on the other hand, it gives more accurate answers when solving a number of problems that cannot be solved by SRT methods.

The publication of The Theory of Aberration is planned for the first half of 2023. The fact of publication can be found in the Scientific Electronic Library eLIBRARY.RU.

REFERENCES

1. Plyasovskikh A. P. et al. The using of special relativity in navigation and ATC // International Scientific Journal "Science and Innovation". Series A. Volume 2 Issue 2. 07.02.2023. – P. 46-61. URL: http://scientists.uz/view.php?id=3729
2. Плясовских А. П. О возможности движения тел со сверхсветовой скоростью. – LAP LAMBERT Academic Publishing, 2021. – 152 с.– ISBN 978-620-4-71514-8
3. Плясовских А. П. Закон аберрации и его приложения в навигации и управлении воздушным движением. – М.: Знание-М, 2022. – 70 с. – ISBN 978-5-00187-223-8.
4. Плясовских А. П. К вопросу аберрации при продольном движении материальной точки относительно наблюдателя // Современные научные исследования и инновации. 2022. № 2 [Электронный ресурс]. URL: https://web.snauka.ru/issues/2022/02/97670 (дата обращения: 10.02.2022).
5. Плясовских А. П. О законе аберрации // Естественнонаучный журнал «Точная наука». 2022. № 131. С. 30-42. URL: https://idpluton.ru/wp-content/uploads/tv131.pdf (дата обращения: 02.05.2022).
6. Плясовских А. П. Теория реальности, альтернативная специальной теории относительности // Современные научные исследования и инновации. 2021. № 11

[Электронный ресурс]. URL: https://web.snauka.ru/issues/2021/11/97082 (дата обращения: 28.11.2021).
7. Плясовских А. П. и другие. Эксперимент по измерению наблюдаемого темпа хода движущихся часов //Автоматика и программная инженерия. 2022, №4(42) URL: http://www.jurnal.nips.ru
8. Эйнштейн А. К электродинамике движущихся тел // Собр. науч. тр. – Т. 1. – М.: Наука, 1965. – С. 7-35.
9. Эйнштейн А. Принцип относительности и его следствия в современной физике // Собр. науч. тр. – Т. 1. – М., Наука. – 1965. – С. 138-164.
10. Эйнштейн А. О возможности нового доказательства принципа относительности // Собр. науч. тр. – Т. 1. – М., Наука, 1965. – С. 49-50.
11. Эйнштейн А. О специальной и общей теории относительности // Собр. науч. тр. – Т. 1. – М., Наука. – 1965. – С. 530-600.
12. Пуанкаре А. О науке. – М.: Наука, 1990. – 736 с.
13. Руководство по авиационному наблюдению. ИКАО, документ 9924 AN/474. – 2020. – 429 с.
14. Eshmuradov D. E., Elmuradov T. D., Turaeva N. M. Methods of Presentation of Aeronautical Information //Design Engineering. – 2021. – С. 12173-12181.
15. Eshmuradov D. E. et al. The Need To Use Geographic Information Systems In Air Traffic Control //Turkish Journal of Computer and Mathematics Education (TURCOMAT). – 2021. – Т. 12. – №. 7. – С. 1972-1976.