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Verification of the Second Postulate of the Special Relativity Theory

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Verification of the Second Postulate of the Special Relativity Theory

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Abstract- This manuscript analyses disputable aspects of the second postulate of the special theory of relativity. To verify them, the electric circuit theory is used. The respective theoretical and experimental research has proved that the statement of the special theory of relativity which denies that imaginary and complex numbers have physical meaning is incorrect. It is demonstrated that this misstatement of the special theory of relativity is refuted even by the fact of existence of such natural phenomena as tsunami, tolling of church bells, and others. Explanation of the physical meaning of imaginary and complex numbers is suggested. It is also proved that another statement of the special theory of relativity – the principle of light speed invariance – is restrictedly true; that is, it is incorrect in its current interpretation, and correct with the adjustments suggested herein. All the formulae describing relativistic effects are conditionally correct; that is, they are correct only with regard to our tardyon Universe, and incorrect with regard to all other parallel Universes that form the Multiverse. Ways of correcting these formulae are suggested.

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I. Introduction

Any scientific theory is based on certain principles that are accepted for granted, on faith. In mathematics, these principles are referred to as axioms; in other sciences, as postulates or dogmata. However, contrary to mathematics, in other sciences these principles eventually become obsolete and are substituted with new principles.

In this respect, Karl Raimund Popper (1902–1994), the author of the 'open society' concept, wrote [1] that due to the short lifetime of all scientific theories, struggle and the replacement of scientific truths are inevitable and are an essential condition for the advancement of science. Thus, even such a universally recognized scientific theory as the special theory of relativity (STR) cannot be regarded as a truth, tout court.

Naturally, since the time the theory was developed by Joseph Larmor [2], Nobel Prize winner Hendrik Antoon Lorentz [3], Jules Henri Poincaré [4], and Nobel Prize winner Albert Einstein [5], as well as other prominent scientists, the battle of opinions has continued. It was criticized from the very beginning by Nickolay Y. Zhuckovskiy, Oliver Heaviside, Nikola Tesla, Nobel Prize winner Joseph John Thomson, Nobel Prize winner Svante August Arrhenius, Nobel Prize winner Walther Hermann Nernst, Nobel Prize winner Ernest Rutherford, Nobel Prize winner Frederick, Nobel Prize winner Percy Williams Bridgman, Léon Nicolas Brillouin, and many other outstanding scientists.

So far, over 500 scientific works [6] criticizing the STR have been published. Among the latest, publications [6 – 9] can be cited. There could have been more if influential pseudoscientific circles had not interfered in the scientific research process. For instance, in the USSR alone, three decisions banning criticism of the STR were taken:

- In 1934 by the Central Committee of the All-Union Communist Party (of Bolsheviks) resolution on discussion of relativism;
- In 1942 by the Presidium of the Academy of Sciences of the USSR resolution on the theory of relativity;
- In 1964 by the classified resolution of the Presidium of the Academy of Sciences of the USSR, which prohibited any scientific councils, journals, or departments from accepting, considering, discussing, or publishing any research criticizing the STR.

II. The Current Interpretation of the Second Postulate of the Special Relativity Theory

In the twenty-first century, the scientific critical thought even went beyond the theoretical scope: MINOS [10] and OPERA [11] experiments were performed. In order to refute the second postulate of the special theory of relativity, these experiments attempted to prove that a neutrino could move at a superluminal speed. However, the physical scientific community considered these experiments insufficiently valid, and their results were ignored. Moreover, the ICARUS [12] experiment was disproved the results of the OPERA experiment.

However, if we recall that the second postulate of the STR deals with the velocity of light, and not a neutrino, it is not quite clear how these experiments could have proved or disproved it. It turned out that there are three different wordings (see Fig.1) of the second postulate of the STR, which are assumed to be equivalent (but, as will be demonstrated below, are not):

1. The above-mentioned official wording, referred to as the principle of light speed invariance. According to

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it, the velocity of light in vacuum is independent of the state of motion of the emitting body and/or an observer and is constant in all inertial systems;

2. Another frequently used phrasing, referred to as the principle of unbreakable light speed barrier. It states that any material object moving in free space cannot exceed the velocity of light;
3. The third formulation, widely used not only in the STR, but also in physics in general, which states that imaginary (and, therefore, complex) numbers have no physical meaning.

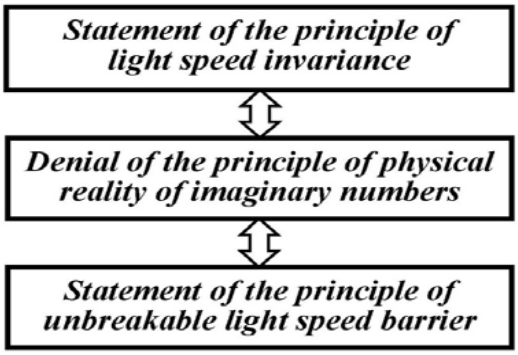

Figure 1 : The essence of the second postulate of the special relativity theory.

Consequently, the MINOS and OPERA experiments, in fact, aimed at disproving not the principle of light speed invariance but the principle of the unbreakable light speed barrier.

It is noteworthy that in the list of formulations of the second postulate of the STR, the third phrasing is compulsory, because, contrary to the principle of light speed invariance, which was proved experimentally, the principle of the unbreakable light speed barrier was proved theoretically, based, moreover, on denial of the principle of physical reality of imaginary numbers. The reasoning was approximately as follows: "The velocity of any physical body cannot break the light speed limit because at superluminal speed, in accordance with the relativistic formulae, their parameters would be measured with imaginary numbers. However, both the former (superluminal speed of physical bodies) and the latter (physical parameters of these bodies measured with imaginary numbers) are physical nonsense." Therefore, it was assumed that all three phrasings of the second STR postulate define it from different angles and are consistent.

Moreover, these three wordings of the second STR postulate seem to agree with the contemporary knowledge level. Indeed, imaginary and complex numbers have been used in mathematics for over 500 years [13] and in electric circuit theory for almost 200 years [14]; however, over these centuries, understanding of their physical essence has not improved. Therefore, it was acceptable to assume that this question in science would remain unanswered forever. This assumption, eventually, developed into a statement, which took the form of the third formulation of the second STR postulate.

Finally, the STR maintains that the principle of the unbreakable light speed barrier is true because in order to exceed the velocity of light, physical bodies with non-zero rest mass require infinitely large energy; however, there are no such energy sources in nature. The impossibility of breaking the light speed barrier follows from other formulae describing relativistic effects, as well.

Thus, there may be the impression that the second STR postulate in the interpretation discussed above is convincingly substantiated and agrees with common sense.

III. Verification of the Third Formulation of the Second STR Postulate in its Current Interpretation

However, this is not so, because there is experimental evidence that convincingly disproves the third phrasing of the second STR postulate. These experiments do not involve elementary particle physics, where it is difficult to verify them as they require unique and very expensive equipment; they concern oscillation process physics within electric circuit theory and can be verified using the equipment of any radio electronic laboratory. Therefore, experiments involving electric circuit theory can be easily validated and understood (thus enabling further new experiments) by any electronic engineer.

Let us prove it.

It is well-known that processes in linear electric circuits are described with linear differential equations (or systems of linear differential equations)

$$a_n \frac{d^n y}{dt^n} + a_{n-1} \frac{d^{n-1} y}{dt^{n-1}} + \ldots + a_0 y = b_m \frac{d^m x}{dt^m} + b_{m-1} \frac{d^{m-1} x}{dt^{m-1}} + \ldots + b_0 x \quad (1)$$

where $x(t)$ is the input action (or the input signal);
$y(t)$ is the response to the action (or the output signal);
$a_n, a_{n-1}, \ldots a_0, b_m, b_{m-1}, \ldots b_0$ are constant coefficients;
$n, n-1, \ldots 0, m, m-1, \ldots 0$ is the order of derivatives.

The solution of equation (1), as is known, is the sum of two components

$$y(t) = y(t)_{forc} + y(t)_{free} \quad (2)$$

where $y(t)_{forc}$ is the forced component of response $x(t)$;

$y(t)_{free}$ is the free (or transient) component of response $x(t)$.

Investigation of both components, as shown below, allows the principle of physical reality of imaginary and complex numbers to be proven, that is, refuting the third formulation of the second STR postulate.

a) Verification using resonant oscillation processes

For the task of verifying the third formulation of the second STR postulate using the forced component of response $y(t)_{forc}$, let us resort to precise (contrary to the conventional approximate) analysis of its parametric variations in resonant processes and demonstrate that the theory of this commonly known phenomenon still has certain unexplained peculiarities relevant to the solution of the problem.

Here, let us recall that resonance in electric circuits is commonly understood as a physical phenomenon, with the result that, as the frequency of harmonic action $x(t)$ approaches the resonance frequency of the electric circuit under investigation:

1. The amplitude of the forced component of response $y(t)_{forc}$ takes an extreme value;
2. The phase shift between the action $x(t)$ and the forced component of response $y(t)_{forc}$ vanishes;
3. The resonance frequency of the forced component of the response $y(t)_{forc}$ is equal to the frequency of free oscillations $y(t)_{free}$.

However, a phenomenon with these characteristics turned out to exist only in electric LC-circuits; in electric LCR-circuits, resonance has different behaviour.

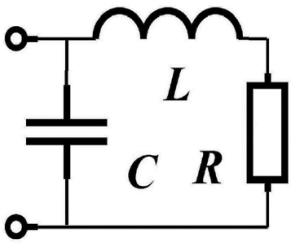

Figure 2 : Electric LCR-circuit where resonance at real frequencies is investigated

Indeed, since the complex admittance of, for instance, the series LCR-circuit plotted in Fig. 2 is

$$Y(j\omega) = C\frac{\omega R/L + j(\omega^2 - 1/LC)}{\omega - jR/L} = C\frac{\omega 2\sigma_0 + j(\omega^2 - \omega_0^2)}{\omega - j2\sigma_0} \quad (3)$$

investigation of this function in terms of its compliance with the above listed attributes of resonance makes it possible to find a set of two (not one!) first resonance frequencies,

$$\begin{cases} \omega'_{res1} = 0 \\ \omega''_{res1} = \sqrt{\omega_0\sqrt{\omega_0^2 + 8\sigma_0^2} - 4\sigma_0^2} = , \\ = \omega_0\dfrac{\sqrt{Q\sqrt{Q^2+2}-1}}{Q} \neq \omega_0 \end{cases} \quad (4a)$$

as well as another set of two (once again, not one!) second resonance frequencies

$$\begin{cases} \omega'_{res2} = 0 \\ \omega''_{res2} = \sqrt{\omega_0^2 - 4\sigma_0^2} = , \\ = \omega_0\dfrac{\sqrt{Q^2-1}}{Q} \neq \omega_0 \end{cases} \quad (4b)$$

and one frequency of free oscillations

$$\omega_{free} = \sqrt{\omega_0^2 - \sigma_0^2} = \omega_0\frac{\sqrt{4Q^2-1}}{2Q} \neq \omega_0 , \quad (4c)$$

where $j = \sqrt{-1}$; $\omega_0 = 1/\sqrt{LC}$;

$2\sigma_0 = 1/RC$; $Q = \dfrac{\omega_0}{2\sigma_0}$.

As can be seen, in this case the frequency of free oscillations ω_{free} turned out to be equal to none of the computed resonance frequencies ω'_{res1}, ω''_{res1}, ω'_{res2}, and ω''_{res2}. Although, based on common sense, free oscillations must seemingly exist at the most energy-efficient frequency, that is at the resonance (but one and only) frequency. In the early twentieth century, Leonid Isaacovych Mandelstam [15] made huge efforts to find the reasons for the inequality $\omega_{free} \neq \omega_{res}$, but in vain. It is even less clear why resonance frequencies corresponding to different attributes of resonance (and different electric LCR-circuits) turned out to be different.

Similar results can be obtained after precise investigation of any other electric LCR-circuits.

As can be seen, the expressions (4a) and (4b) differ noticeably from the formula usually given in textbooks $\omega_{res} = 1/\sqrt{LC}$. This circumstance, naturally, requires an explanation. However, in order to avoid explanations, textbooks always give approximate formulae that disguise the problem.

Moreover, the approach is explained quite persuasively: the difference between the results of calculations using precise and approximate formulae is insignificant and does not exceed the experimental error. Besides, practical radio electronics does not require calculations that are more precise.

However, in MINOS, OPERA and ICARUS experiments, the speed of a neutrino differed from the velocity of light just as insignificantly, and the difference was comparable to an experimental error, as well. Nevertheless, these experiments were analysed in dozens of scientific publications within less than six months. At the same time, both situations – the experiments on establishing the precise speed of a neutrino and the experiments on defining the precise resonant frequencies in electric circuit theory – as a

matter of fact, concern one and the same problem, namely, the problem of disproving or, on the contrary, confirming the third formulation of the second STR postulate.

Refs. [16-22] demonstrate that the above singularities of resonant processes in electric LCR-circuits at real frequencies are accounted for by the fact that, actually, resonance is observed not at real, but at complex frequencies. If the real resonance frequency and real frequency of free oscillations in the above-mentioned definition of resonance were substituted for the complex resonance frequency and complex frequency of free oscillations, all inconsistencies of the current interpretation of resonance would be dismissed.

However, the new theory of resonance has its pitfalls, as well. Thus, according to the theory of resonance at complex frequencies, resonance can be observed not only in the well-known situation under harmonic action on electric LC-circuits but under the impact of exponential radio pulses on electric LCR-circuits, and even under the impact of exponential video pulses on electric RL- and RC-circuits. These statements are quite extraordinary, and, therefore, require additional explanation and experimental verification.

Before describing and explaining these experiments, let us explain why they have not been performed earlier, or, even if they have been performed accidentally, no signs of resonance were detected.

The reason is that resonance is a regularity that defines the characteristic of parameters of the only forced component of response $y(t)_{forc}$ as the complex action frequency $x(t)$ changes. However, due to actual processes in electric circuits, the response $y(t)$ usually contains, along with the forced component $y(t)_{forc}$, the free (or transient) component $y(t)_{free}$, as well.

At the same time, in passive linear electric circuits the transient process is always a damped one. Therefore, during investigation of resonance in an electric circuit under harmonic action, separation of forced $y(t)_{forc}$ and transient $y(t)_{free}$ components of response occurs by itself in the course of time. However, in other cases both the free $y(t)_{free}$ and the forced $y(t)_{forc}$ components (comparable in terms of their duration) are observed simultaneously, which prevents resonance from being detected.

Therefore, it is obvious that in order for the corresponding experiments to be convincing enough, special measures to reduce the interference of the free component of response $y(t)_{free}$ must be taken. This can be achieved, for example, by using certain initial conditions or by choosing such signal source parameters that make the duration of the transient process much shorter or, on the contrary, much longer than the duration of the forced component of response $y(t)_{forc}$.

Now, it is time to explain one of the experiments published in [17 – 22], which proves the existence of resonance at complex frequencies.

As can be seen (see Fig. 3a), in a wellknown implementation of resonance in the electric LC-circuit under the impact of input sustained sinusoidal oscillations U_{inp}, in accordance with its immittance function

$$Z(0,\omega) = j\omega L + \frac{1}{j\omega C} = jL\frac{\omega^2 - \omega_0^2}{\omega} \qquad (5)$$

the forced component of output voltage $U_{outforc}$ at the resonance frequency $\omega_{res} = \omega_0$ is zero. The voltage drop of the forced component of response $U_{outforc}$ in the electric LC-circuit is zero because non-zero voltage drops of the forced component of response at the capacitor U_{Cforc} and at the inductance coil U_{Lforc} are equal in magnitude but opposite in sign. Therefore, the output voltage U_{out} has only the transient component of response $U_{outfree}$.

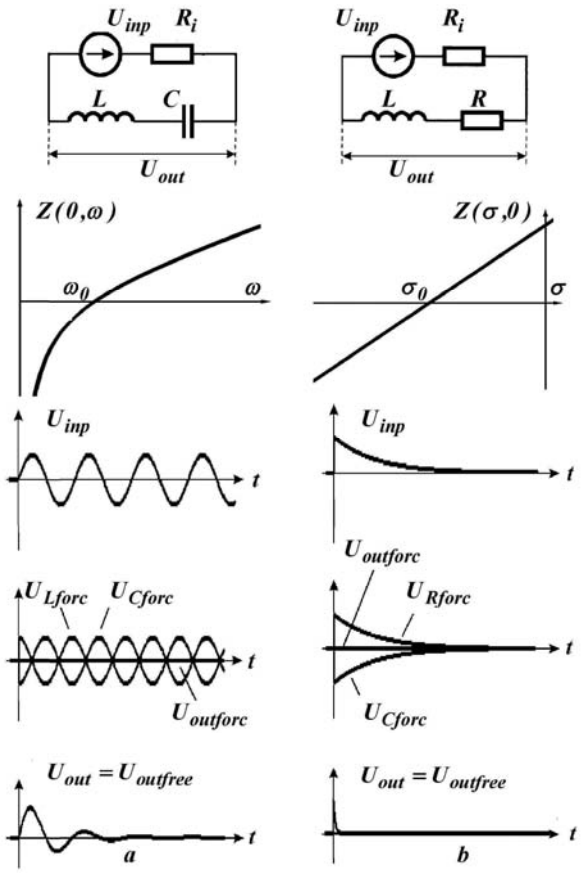

Figure 3 : Signalograms in LC- and RL-twoterminals at resonance at complex frequencies.

This is a well-known experiment. It is described only for comparison with a yet unknown experiment that proves the existence of resonance in an electric RL-circuit (see Fig. 3b). In the latter, as can be seen (note that the following paragraph reproduces the text of the

previous paragraph almost word-for-word), under the impact of input exponential pulses U_{inp}, in accordance with its immittance function

$$Z(\sigma,0) = R + \sigma L = L(\sigma_0 + \sigma) \quad (6)$$

the forced component of output voltage $U_{outforc}$ at the complex resonance frequency $\sigma_{res} = \sigma_0$ is zero. The voltage drop of the forced component of response $U_{outforc}$ in the electric RL-circuit is zero because non-zero voltage drops of the forced component of response at the resistor U_{Rforc} and at the inductance coil U_{Lforc} are equal in magnitude but opposite in sign. Therefore, the output voltage U_{out} has only the transient component of response $U_{outfree}$.

A similar explanation of resonance can be provided for an electric RC-circuit under the impact of exponential video pulses, as well as for an electric LCR-circuit under the influence of exponential radio pulses (i.e., damped sinusoidal oscillations). Here, note, this will be true resonance, when voltage drop in the electric LCR-circuit is zero, and which is achieved only under the impact of damped sinusoidal oscillations. If sustained sinusoidal oscillations are applied to the electric LCR-circuit under consideration, zero voltage drop is impossible, which is well known.

Experimental evidence of the physical reality of resonance at complex frequencies can also include the patent [16], which gives an example of practical application of resonance.

All these experiments prove the physical reality of resonance particularly at complex frequencies and the physical reality of complex frequencies themselves as well as that of other complex physical quantities and thus refute the third formulation of the second STR postulate.

b) Verification using transient oscillation processes

To prove the principle of the physical reality of imaginary and complex numbers, it is also possible to resort to investigation of oscillation transient processes [23].

The particular types of transient processes is found, if not by operational method, by solving the characteristic algebraic equation

$$a_n p^n + a_{n-1} p^{n-1} + \ldots + a_0 = 0 \quad (7)$$

where a_n, a_{n-1},... a_0 are the same constant coefficients as in equation (1);

$n, n-1, n-2, \ldots 1, 0$ are the exponents that are equal to the order of respective derivatives in the differential equation (1);

p is a variable that, in case it takes values in the form of complex numbers $-\sigma \pm j\omega$, is often referred to as the complex frequency.

However, contrary to algebraic equations in mathematics, which are solved using both real and complex numbers, characteristic algebraic equations in the electric circuit theory are always solved only on the set of complex numbers.

Why?

The reason is that, as engineers know, transient processes in electric LCR-circuits always exist, that is, at any combination of electric elements L, C, R. When the solution of a second-degree characteristic equation is found in the form of two different real numbers, the transient process is an aperiodic one. When the solution of the seconddegree characteristic equation is two equal real numbers, the transient process is a critical one (it would be better to refer to it as borderline). When the solution of the second-degree characteristic equations is two different complex numbers (i.e., a pair of complex-conjugate numbers), the transient process is an oscillation one. For a characteristic equation of a higher degree, the transient process will be described with a certain combination of aperiodic and/or critical and/or oscillation components.

If characteristic equations were to be solved using real numbers, oscillation processes would be non-existent in nature (i.e., not only in electric circuits), because transient oscillation processes have no corresponding solutions in the form of a combination of real numbers.

However, transient processes have always existed, and they are well known. These are, for instance, shock oscillations in the form of the sound of piano strings and the tolling of church bells, tsunamis, or Indian summers, as well as numerous other types of transient processes in nature, science, and technology.

Consequently, transient oscillation processes prove the physical reality of complex frequencies and, therefore, complex numbers of any physical nature.

The principle of the physical reality of imaginary and complex numbers is a general scientific principle; thus, it is true not only for the electric circuit theory [16 – 23], but also for the STR [24 – 27], quantum mechanics [28], [29], and other sciences.

Therefore, it has been proved indisputably that the third formulation of the second STR postulate in its current interpretation is incorrect.

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IV. Verification of the Second Formulation of the Second STR Postulate in its Current Interpretation

Now, let us analyse the second formulation of the second STR postulate. On the one hand, it follows from the third (just refuted) formulation, which raises some doubts regarding its validity. However, on the other hand, the second formulation of the second STR

postulate seemingly follows from the impossibility of using infinitely large energy sources to break the light speed barrier, and, thus, on the contrary, evokes some trust.

Therefore, verification of the second formulation of the second STR postulate in its current interpretation also appears to be necessary.

a) Physical nature of imaginary and complex numbers, hidden dimensions

Before moving on to the second formulation of the second STR postulate, it is necessary to complete the discussion on its third formulation and to find out the nature of physically real imaginary and complex numbers. In other words, how can these numbers be counted, seen, touched or felt?

Unfortunately, they cannot, because people do not have such senses. However, people do not feel either the magnetic fields or X-rays, do not see UV-rays, do not hear infra-low-frequency sounds, and cannot touch a black hole. Nevertheless, all these phenomena can be registered with respective devices.

Thus, it can be assumed that in the future people will also learn to register a yet unknown physical reality measured with imaginary numbers. So far, we can only note that since there are numbers that correspond to this physical reality, it can be measured somehow. In other words, it corresponds to some hidden dimensions [30] – [34], which got their name by analogy to the hidden dimensions described in [35].

The possibility that this unknown physical reality is in another parallel Universe (or Universes), which, however, somehow coexists with our parallel Universe, cannot be ruled out.

b) Parallel Universes

Despite the fact that we have no reliable information about these parallel Universes, we can assume that they actually exist and that their inhabitants have been visiting the Earth. Therefore, the similarity principle can be applied to parallel Universes. According to it, the same physical, chemical, biological, and other laws of nature govern both our Universe and other parallel Universes, although some divergence is possible (for instance – see below – time in them flows in different directions and/or with different speeds).

Parallel Universes (including our Universe) that correspond to dimensions in the form of real numbers will be hereinafter referred to as tardyon Universes (using the name of subluminal elementary particles), and parallel Universes that correspond to dimensions in the form of imaginary numbers will be referred to as tachyon Universes (using the names of superluminal elementary particles).

However, in this case relativistic formulae turn to be incorrect. Indeed, it follows from the principle of the physical reality of imaginary and complex numbers proved above that relativistic formulae, for instance,

$$m = \frac{m_0}{\sqrt{1-(v/c)^2}} \tag{8}$$

where $m0$ is the rest mass;

m is the relativistic mass of a moving body;

v is the velocity of a body (e.g., a neutrino);

c is the speed of light;

have different formulations at subluminal (for a parallel tardyon Universe) and superluminal (for a parallel tachyon Universe) speeds (see Fig. 4a). Consequently, formula (8) and other relativistic formulae do not comply with the similarity principle.

In order for these formulae to comply with the similarity principle, they must be adjusted, similarly to formula (8), as follows:

$$m = \frac{(i)^k m_0}{\sqrt{1-(v/c-k)^2}} = \frac{(i)^k m_0}{\sqrt{1-(w/c)^2}} \tag{9}$$

where $k = \lfloor v/c \rfloor$ is the discrete 'floor' function of argument v/c;

$w = v - kc$ is the local, for each Universe, velocity which can take values in the range $0 \le w < c$;

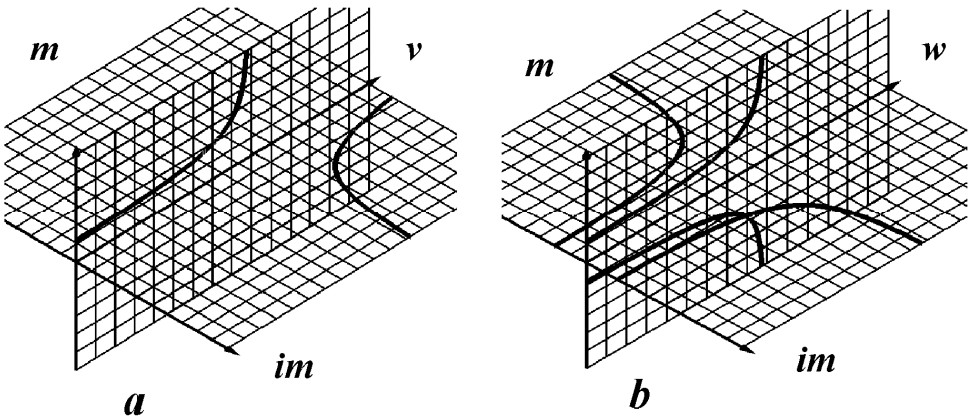

Figure 4 : Graphs of relativistic mass corresponding to formulae (8) and (9)

v is the velocity measured from our tardyon Universe, which, hence, can be referred to as the tardyon velocity.

Then, as can be seen (Fig. 4b), our tardyon Universe corresponds to the case $k = 1$, and the tachyon Universe to the case $k = 2$. However, Fig. 4b indicates that there must be at least two more parallel Universes, which correspond to $k = 3$ and $k = 4$. It is reasonable to refer to them as the tardyon Antiverse and the tachyon Antiverse, because they correspond to dimensions in the form of negative real numbers (or measurements) and negative imaginary numbers (or measurements). Moreover, according to the principle of physical reality of complex (not only imaginary) numbers proved above, there must be numerous other parallel Universes corresponding to non-integer values of the parameter k : the tardyon–tachyon, tachyon–anti-tardyon and others.

c) *Correction of the second formulation of the second STR postulate*

The adjusted relativistic formula (9) allows it to be noticed that the second formulation of the second STR postulate in its current interpretation is incorrect. Moreover, it prompts the possible corrections.

The second formulation of the second STR postulate is incorrect if the current formula (8) is used or if in formula (9) the term 'speed' is understood as the tardyon velocity v, which can actually exceed light speed.

However, it will be correct if formula (9) is used instead of formula (8) and if the term 'speed' in the latter is understood as the local, for each particular parallel Universe, velocity w.

Therefore, it can be stated that the second formulation of the second STR postulate in its current interpretation is conditionally correct (only with the above adjustments).

d) The Multiverse structure

However, the explanation suggested above raises some questions and appears incomplete until they are answered. The first question that needs clarification is whether physical objects with nonzero rest mass (including people) can move from one parallel Universe into another, and if they can, how these transitions (including those by people) can be made.

However, before answering these questions, it is reasonable to explain the possible structure of the Multiverse [36-40], which includes the abovementioned parallel Universes.

Obviously, it is determined by factors, many of which are unknown to us. However, we can assume that it also depends on the range of the parameter k in formula (9). If the range is $-\infty \le k \le +\infty$, the Multiverse has an unclosed helical structure. If $1 \le k \le 4$ and the corresponding tardyon Universe at $k = 4$ coincides with the tachyon Universe at $k = 1$, the corresponding Multiverse structure can be characterized as ringed. And, finally, if e.g. $1 \le k \le 12$ and the corresponding tardyon Universe at $k = 12$ coincides with the tardyon Universe at $k = 1$, the corresponding Multiverse structure can be referred to as spiralringed.

However, in any structure, any tardyon Universe will be adjacent only to a tachyon Universe and a tachyon Antiverse; any tachyon Universe will be adjacent only to a tardyon Universe and a tardyon Antiverse; any tardyon Antiverse will be adjacent only to a tachyon Universe and a tachyon Antiverse, and so on. This structure of the Multiverse makes it possible to prevent situations in which a tardyon Universe and a tardyon Antiverse, or a tachyon Universe and a tachyon Antiverse, are adjacent, thus making their annihilation impossible.

It is also noteworthy that when a transition from any parallel Universe to an adjacent parallel Universe is made, according to the respective adjusted formula for relativistic time (similar to formula (9)), the time flow direction (for an external observer) changes to $+\pi/2$ or $-\pi/2$; when a transition to the corresponding Antiverse is made, the time flow direction (once again, with respect to an external observer) changes to π. However, in each parallel Universe the local time flows only in one direction – from the past to the future. In addition, the possibility that time can flow at different velocities in different parallel Universes cannot be ruled out.

e) Portals

Finally, let us answer how elementary particles, living beings, and any other physical bodies can make transitions from one parallel Universe into adjacent parallel Universes. It turns out that nature provided another means for this, different from that mentioned in the STR, which does not require the light speed barrier to be broken. It is the use of portals.

This is similar to the way in which we do not have to break through the wall to move from one room of a house into another; it is more convenient to use the doors that were designed for the purpose.

This explanation leaves no doubt that the second formulation of the second STR postulate in its current interpretation is incorrect.

We just have to understand the nature of portals and the mechanism of their formation. Portals are passages between adjacent parallel Universes. They appear spontaneously because adjacent parallel Universes are not locked relative to each other but sort of float in the fourth spatial dimension. Therefore, adjacent parallel Universes sometimes contact each other and even penetrate each other. In this case, quite large territorial formations appear at the points of their mutual penetration, and there the abovementioned parameter k gradually changes per unit from the value corresponding to one parallel Universe to the value corresponding to another parallel Universe.

Therefore, transition through a portal is similar to, for instance, transition from air into water and backwards during sea bathing. However, people who accidentally get into portals (e.g., when walking in the woods), having found themselves in an unfamiliar location, usually think they are lost, and instead of hurrying back to the portal exit, start wandering around. The portal, meanwhile, may close, and then the unfortunate traveller may have to stay in an alien parallel Universe forever.

V. Conclusion

The second STR postulate has not one but three different formulations, which are assumed to be equivalent:

- The official wording, referred to as the principle of light speed invariance;
- Another phrasing, referred to as the principle of the unbreakable light speed barrier;
- The third formulation, widely used not only in the STR but also in physics in general, which holds that imaginary (and, therefore, complex) numbers have no physical meaning.

The manuscript demonstrates that, in fact, these formulations are not identical. Moreover, the second STR postulate:

- Is incorrect in its third formulation;
- Is conditionally correct is its second formulation; that is, it is incorrect in its current interpretation and correct in its adjusted interpretation;
- Is correct in its first formulation, because it has been verified experimentally.

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