

Adjustment of the Special Theory of Relativity according to the Ohm's Law

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Abstract It is shown that the whole practice of using Ohm's law in the theory of electrical circuits is actually a theoretical and experimental evidence for physical reality of imaginary numbers. Therefore, the current interpretation of the special theory of relativity, which denies physical reality of imaginary numbers, requires appropriate adjustment. The adjusted version of the special theory of relativity can explain the phenomena of dark matter and dark energy. Other exact sciences also require adjustment with regard to the principle of physical reality of imaginary numbers.

Keywords: *Ohm's law, Resonance, imaginary numbers, special theory of relativity, dark matter, dark energy, multiverse, supermultiverse*

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1. Introduction

The Special Theory of Relativity (STR), introduced in the early 20th century by Joseph Larmor [1], Nobel Prize winner Hendrik Antoon Lorentz [2], Jules Henri Poincaré [3], Nobel Prize winner Albert Einstein [4] and other outstanding scientists, is based on the following two postulates:

- 1st postulate, called the Principle of Relativity, and
- 2nd postulate, called the Principle of Invariant Light Speed.

However, the common interpretation of the second postulate of the STR cannot be considered perfect [5]. Indeed, the original formulation [4] "*the speed of light is independent of motion of the source*" proposed by Albert Einstein, has actually been extended by two more formulations non-identical to the original one:

- on physical unreality of imaginary numbers; and
- on non-exceedance of the speed of light (due to the supposed physical unreality of imaginary numbers),

which were added during the subsequent years.

These two additional formulation appeared in the STR as the relativistic formulas for hyper-light speeds corresponded to imaginary mass, imaginary time, and other imaginary physical values, the meaning of which no one could explain at that time.

In this regard, it is appropriate to bring to attention that imaginary numbers appeared in mathematics about 500 years ago in the works of Scipione del Ferro, Niccolò Fontana Tartaglia, Gerolamo Cardano, Lodovico Ferrari, and Rafael Bombelli [6]. [7] even claims that the imaginary numbers were discovered before them by Paolo

Valmes, who was burned at the stake under the sentence of the Spanish Inquisitor Tomás de Torquemada.

Although, in the subsequent years the works of the outstanding mathematicians, such as Abraham de Moivre, Leonhard Euler, Jean Le Rond D'Alembert, Caspar Wessel, Pierre-Simon de Laplace, Jean-Robert Argand, Johann Carl Friedrich Gauss, Augustin Louis Cauchy, Karl Theodor Wilhelm Weierstrass, William Rowan Hamilton, Pierre Alphonse Laurent, Georg Friedrich Bernhard Riemann, Oliver Heaviside, Jan Mikusiński and many others, established a perfect theory of functions for a complex variable, it could not explain the physical meaning of imaginary and complex numbers.

At present, imaginary and complex numbers are already widely used in all the exact sciences, such as optics, electrical engineering, radiotronics, mechanics, hydraulics, acoustics, etc. And yet, they also do not explain physical meaning of imaginary and complex numbers. Although nobody could explain physical meaning of imaginary and complex numbers in these sciences, as opposed to the STR, over the last 500 years, they did not deny it.

It should not come as a surprise that even not all physicists agreed with such a simple solution to a complex problem. Therefore, complex experiments MINOS were performed at the American Tevatron collider and OPERA experiments - at the European Large Hadron Collider. The purpose of these experiments was to detect neutrinos moving with hyper-light speed, thus proving physical reality of imaginary numbers. However, the physical community considered the results of these experiments as unreliable and they were ignored.

At the same time, other experiments were conducted in linear electric circuits, which can be repeated and verified in any electronic laboratory and which, therefore, are completely reliable [8,9,10].

Since most of these experiments have indisputably proved physical reality of imaginary and complex numbers, we shall give their brief description [11].

2. Physical Reality of Imaginary and Complex Numbers

2.1. Evidence for the Physical Reality of Imaginary Numbers using Ohm's Law

It is necessary to use Ohm's law at every step when studying any linear electric circuits. It turns out that this commonly known law confirms physical reality of the concrete (i.e. provided with an indication of the physical units: meter, kilogram, volt, etc.) imaginary numbers [8]. Let us make sure about this.

The theory of passive linear electric circuits uses only three different types of electrical components: resistors R , capacitors C and inductors L , for which the relationship between the electric current $i(t)$ flowing through them and voltage $u(t)$ applied to them is generally described as follows:

$$i_R(t) = u_R(t) / R \quad (1a)$$

$$u_L(t) = L di_L(t) / dt \quad (1b)$$

$$i_C(t) = C du_C(t) / dt \quad (1c)$$

Algebraic relationship (1a) is called Ohm's law. As we can see, relationships (1b) and (1c) between functions $i(t)$ and $u(t)$ are the differential and integral, and do not comply with Ohm's law. But, in one important for practice case – for sinusoidal currents $i(t)$ and voltages $u(t)$ – formulas (1b) and (1c) with the help of the symbolic method [12], which was proposed by Charles Proteus Steinmetz, and according to which the actual physical impact, is replaced by the stimulus corresponding to Euler's formula, which can also be converted into algebraic expressions

$$u_L(t) = j\omega Li_L(t) \quad (2a)$$

$$i_C(t) = j\omega Cu_C(t) \quad (2b)$$

in which the imaginary unit is designated as j , since designation i in the electric circuit theory is used for the electric current.

But, as evident, algebraic expressions (2a) and (2b) are compliant with the Ohm's law. Wherein, the electric resistance of the coil is a variable $X_L = j\omega L$, and the electric resistance of the capacitor is a variable $X_C = 1/j\omega C = -j/\omega C$. These electric resistances are measured with imaginary numbers with opposite signs, in contrast to the electric resistance of the resistor, which is measured with real numbers.

Therefore, the value of complex impedance for any AC circuit, which necessarily contains capacitors C and/or inductors L , apart from resistors R , will depend on the frequency. In this case, in accordance with Ohm's law, value of the flowing current will depend on the frequency.

And this dependence is easily detected with the help of instruments available at any electronic laboratory.

For example, complex impedance of the electrical circuit in which a resistor R , capacitor C and inductor L are connected in series, is equal to

$$Z(j\omega) = R + j\omega L + \frac{1}{j\omega C} \quad (3)$$

and a module of this complex impedance is equal to

$$|Z(j\omega)| = \sqrt{R^2 + (\omega L - 1/\omega C)^2} \quad (4)$$

Therefore, in accordance with the Ohm's law, the value of the electric current flowing through the test series-tuned circuit should be equal to $i(t) = u(t) / |Z(j\omega)|$, i.e. depends on frequency. And any experiment would confirm this dependence.

Otherwise, if the formulation of the second postulate of physical unreality of imaginary numbers was true, the value of current in any AC circuit should depend only on the value of resistors and should not depend on the value of capacitance and coil inductance. Therefore, when oscillation frequency of sinusoidal voltage applied to such series oscillatory circuit changes, the value of current would not change. However, any experiment would refute this assumption.

Thus, the evidence for physical reality of imaginary numbers, which physicists failed to receive in MINOS experiment at the Tevatron collider and in OPERA experiment at the Large Hadron Collider, has been long ago received by millions of engineers around the world, and is confirmed every day in any electronic laboratory.

2.2. Evidence for the Physical Reality of Imaginary Numbers as a Result of Resonance Studies

Additional analysis of the expressions (3) and (4) allows us to demonstrate another evidence for the physical reality of imaginary numbers. It is easy to note that since the algebraic sum $j(\omega L - 1/\omega C)$ at frequency $\omega_0 = 1/\sqrt{LC}$ becomes zero, the amplitude of the electric current oscillation at this frequency takes the maximum value. And this phenomenon, which was called resonance, was discovered by Galileo di Vincenzo Bonaiuti de'Galilei already back in 1602 [13]. And if the formulation of the second postulate of physical unreality of imaginary numbers was true, the resonance would not have existed in the nature.

Nevertheless, a perfect resonance theory [9] has still not been widely recognized. Indeed, attributes of resonance in electric LC-circuits are considered to be:

- extreme value of the forced constituent of response at the resonant frequency;
- zero phase difference between the exposure and the forced constituent of response at the resonant frequency;
- equality of resonant frequency and the frequency of natural (particularly, shock) oscillations.

However, in the simplest electric LCR-circuits these attributes manifest themselves only approximately. Therefore, in accordance with its current (and as shown below incorrect) interpretation in most of oscillation LCR-circuits:

- different real resonance frequencies [9] correspond to the first and second determinant attributes of resonance mentioned above;
- several (two for second-order circuits) real natural resonance frequencies [9] usually correspond to each of the above-mentioned determinant attributes of resonance;
- as shown by Leonid Isaakovich Mandelstam [14], resonance frequencies never equal to frequency of free oscillations.

However, the differences between the resonance frequency and the frequency of natural oscillations from frequency $\omega_0 = 1/\sqrt{LC}$ is small and typically does not exceed the experimental error. In MINOS and OPERA experiments (their purpose, same as for this study, was to prove the physical reality of imaginary numbers), differences between the speeds of light and neutrinos were also very small and did not exceed the experimental error. Nevertheless, over the next few months dozens of articles were published after publication of the results of the OPERA experiment, which analyzed the possible experimental error. They resulted in ICARUS experiment.

Although the results of theoretical and experimental studies of resonance in electric LCR-circuits, demonstrating the physical reality of imaginary numbers were published [8,9,10] a few years ago, they have not been confuted by anyone yet and not even commented. And this, obviously, is a confirmation of correctness of the presented evidence for physical reality of imaginary numbers.

There are also other proofs of the principle of physical reality of imaginary numbers [11].

3. STR Correction: Structure of the Multiverse

Since the Nature is united and consistent, then Science, which attempts to explain it, shall be internally consistent. Therefore, it is unacceptable to have various scientific theories (especially within one scientific discipline, for example, as the theory of relativity and quantum mechanics in physics) mutually inconsistent with each other. Hence, principle of physical reality of imaginary numbers, which was proved in the theory of electrical circuits, should be recognized as generally scientific, and all scientific theories based on this principle should be corrected.

Let us show, for example, how this could be done in the STR [15].

But first, let's note that, in addition to theoretical and experimental evidence for fallaciousness of the principle of non-exceedance of speed of light mentioned above, there is also another experimental evidence obtained previously in the form of Cerenkov radiation, for the discovery and explanation of which Pavel Alekseyevich Cherenkov, Igor Evgenyevich Tamm and Ilya Mikhaylovich Frank received the Nobel Prize in 1958 [16].

As for the STR, it should be actually used to explain the relativistic formulas for superluminal speeds. For example, the formula of Lorentz-Einstein:

$$m = \frac{m_0}{\sqrt{1 - (v/c)^2}} \tag{5}$$

where m_0 – is the rest mass of the moving body (e.g., an elementary particle);

m – is the relativistic mass of the moving body;

v – is the speed of the body;

c – is the speed of light.

As can be seen from the formula (5), relativistic mass m (e.g., of tachyons) becomes imaginary at superluminal speeds, i.e. at $v > c$ [17,18]. Since we have just proved physical reality of imaginary numbers, the tachyons, therefore, are physically real. And as far as they cannot be inherently detected in our universe, which we should call a tardyon for clarity (derived from the name of elementary particles, moving with sub-light speed – tardyons), they are apparently in other physically existent place which we should call a tachyon universe for clarity.

Herewith, this tachyon Universe according to the first postulate of the STR is an inertial reference system, i.e. the same laws of physics apply as in our tardyon Universe. Therefore, the inhabitants of a tachyon Universe perceive their Universe in the same way as we perceive our tardyon Universe. But for us, this tachyon Universe is invisible due to the condition $v > c$, as it is behind the horizon of events.

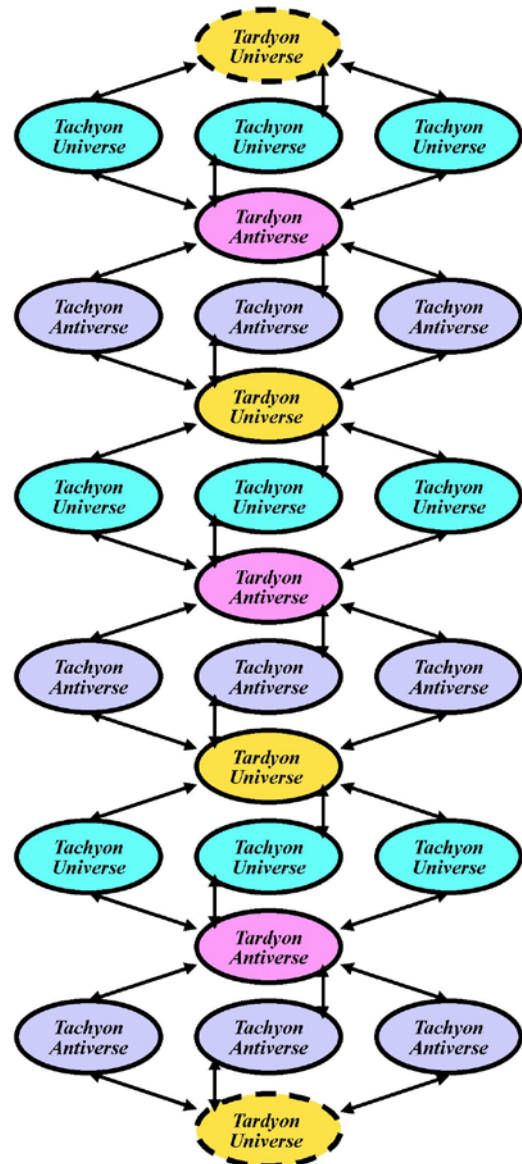


Figure 1. Possible closed structure of the hidden Multiverse

However, this circumstance has not been taken into account in the formula of Lorentz-Einstein.

Therefore, it should be corrected as follows:

$$m = \frac{m_0 \exp(iq\pi/2)}{\sqrt{1-(v/c-q)^2}} = \frac{m_0 \exp(iq\pi/2)}{\sqrt{1-(w/c)^2}} \quad (6)$$

where $q = \lfloor v/c \rfloor$ – is the discrete function “floor” of the argument v/c ;

$w = v - qc$ – is the local speed for each Universe, which can assume values only within the range $0 \leq w < c$;

v – is the speed measured from our tardyon Universe, which we should call as tardyon speed;

$\exp(iq\pi/2)$ – is the Euler’s formula of the discrete argument q .

Other relativistic formula of the existing version of the STR can be corrected in a similar manner.

Multiverse, in addition to tardyon and tachyon Universes, which have been mention above and which correspond to $q = 0$ and $q = 1$, also contains corresponding $q = 2$ tardyon Antiuniverse and corresponding tachyon $q = 3$ Antiuniverse. Then tardyon Universe will again correspond to $q = 4$, and tachyon Universe will correspond to $q = 5$. And so forth. But the same tardyon Universe can correspond to the values $q = 0$ and $q = 4$ It means, hiddent Multiverse should have a ring structure. Otherwise, it will have a helical structure. If it turns out, for example, that $q = 0$ and $q = 24$ (at Figure 1 and Figure 2 they are indicated with phantom outline) correspond to the same tardyon Universe, the hidden Multiverse will have a closed-loop structure as a kind of screw collar. Otherwise Multiverse will have an open structures, i.e. it will have edges.

Moreover, hidden Multiverse may include several similar Universes, number of which may be the same, but it also may be different (see, for example, Figure 1 and Figure 2).

Despite the fact that such structure of a hidden Multiverse contains not only Universes, but also corresponding Antiuniverses, their annihilation is reliably prevented by the order of alternation of different types of Universes described above. It should also be noted that the different names of the parallel Universes are used merely for convenience of explanation of their mutual spatial position in the hidden Multiverse. According to the first postulate of the STR, all Universes are identical in their physical properties for their inhabitants.

Finally, when explaining the structure of the hidden Multiverse, it should be noted that the nature should have some kind of a mechanism - which we do not know about it yet - for automatic adjustment of the mutual spatial position (in the corresponding multi-dimensional space) of Universes in the Multiverse. Same as in any system of automatic control, when this mechanism is in operation, the object of regulation (i.e. parallel Universes) slightly shakes under the influence of some unknown factors, i.e. it slightly changes its relative spatial position. Therefore, parallel Universes may sometimes contact each other in some places, and even partially penetrate into each other. Thus, transitional zones or portals appear in the places of these mutual penetrations, through which various kinds of micro and macro objects (but not planets, stars or galaxies) can permeate through one parallel Universe to another. Since the function $\exp(iq\pi/2)$ in equation (6) is periodic, mechanism of portals operation between different parallel Universes must be identical.

It should be noted that in pre-portal and behind-portal areas of the adjacent parallel Universes, environmental must be practically identical settings according to the law of communicating vessels. Therefore, the permeation through the portals into other parallel Universes may be relatively safe. For instance, mains are relatively safe. If one does not touch it.

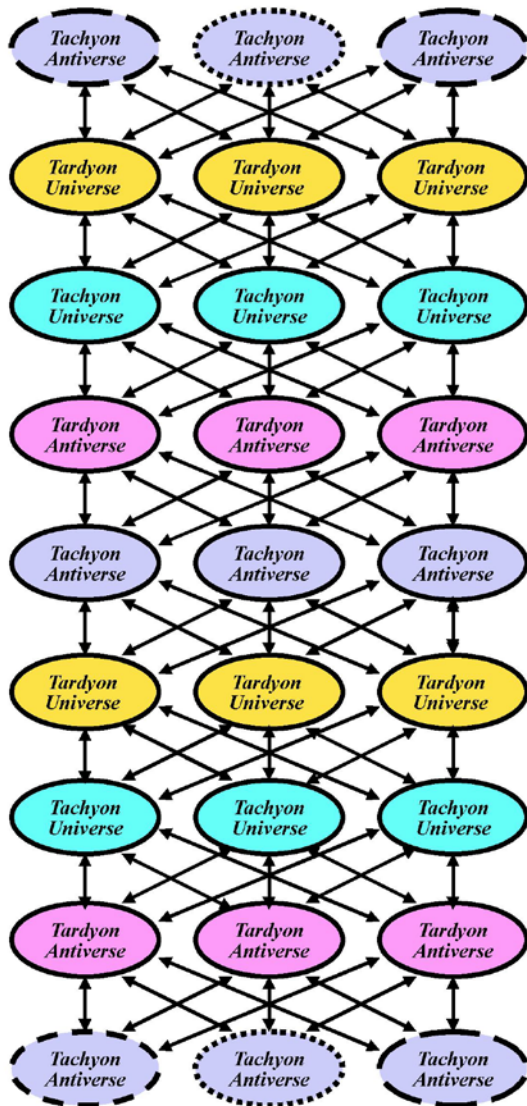


Figure 2. Another possible structure of hidden Multiverse

Thus, the principle of the physical reality of imaginary numbers implies the existence of the Multiverse [19], which is invisible to us. Which we would, therefore, call hidden. But the formula (6) implies that such hidden

4. Phenomenon of Dark Matter/Dark Energy

Consideration of the structure of the hidden Multiverse without explanation of dark matter discovered by Jan

Hendrik Oort and Fritz Zwicky in 1932-33 and dark energy discovered by Nobel laureates Saul Perlmutter, Brian P. Schmidt and Adam G. Riess in 1998-99 [20] is likely to be incomprehensible. Invisibility and inexplicability are the main features of this astrophysical phenomenon. And since even atoms of commonly known chemical elements were failed to be detected in dark matter and dark energy, this phenomenon would seem to destroy even the very concept of matter.

Indeed, all of these problems have been caused by scientists due to incorrect statement of task, which they have tried to solve in terms of the concept of Monoverse (which is an alternative to the concept of any Multiverse) corresponding to the assertions regarding the above-mentioned additional interpretations of the second postulate of the STR, which, however, as shown in this article, are erroneous and inconsistent with the fundamental laws of nature, such as resonance and Ohm's law.

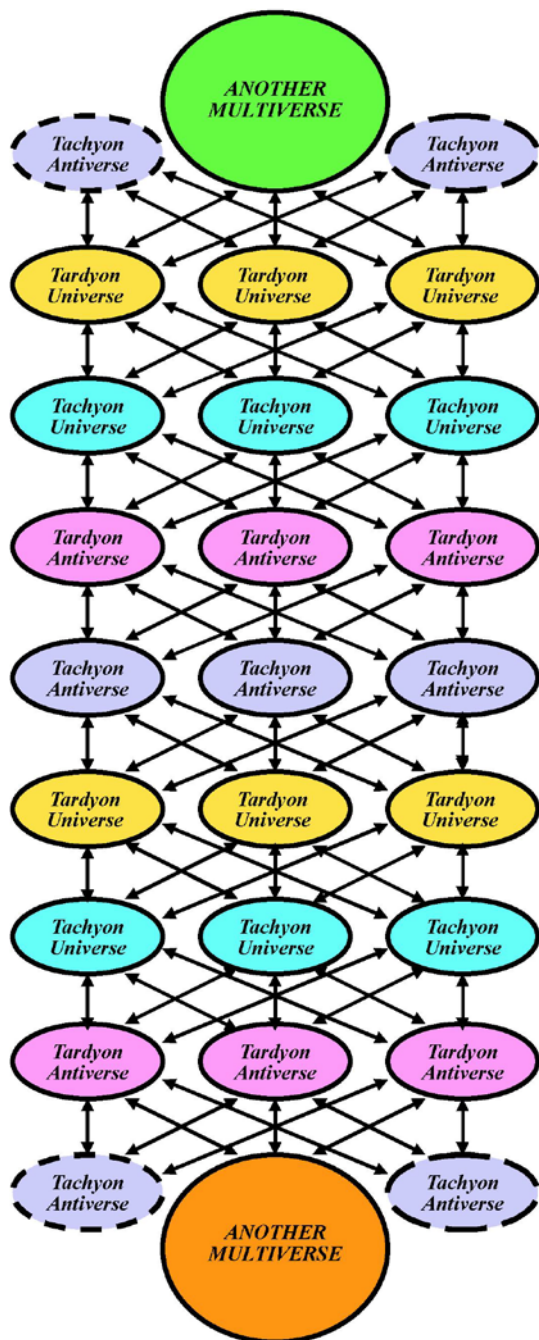


Figure 3. Probable structure of the actual hidden Multiverse

Within the concept of the Multiverse, task for explanation of the hidden nature of the phenomenon of the dark matter/dark energy is completely solvable [21,22]. The solution is as follows. Invisible dark matter and dark energy are other, except for ours, invisible parallel Universes of the hidden Multiverse [23]. In fact, they are experimental proof of its existence. Notably, the dark matter corresponds to our adjacent parallel Universes. They, according to our calculations using the data obtained by space stations WMAP [24] and Planck [25], are six. The dark energy corresponds to the rest of the parallel Universes of the hidden Multiverse, which are not visible for us due to obstruction by the adjacent Universes. Chemical composition of the matter, which makes up dark matter and dark energy, could be determined after the earth scientists could permeate through the portals with their instruments.

According to our calculations using the data obtained by space stations WMAP and Planck, our hidden Multiuniverse probably contains twenty two parallel Universes. But such structure of the hidden Multiverse, unlike structures shown in Figure 1 and Figure 2, can not be of a closed type. This circumstance gives rise to a very difficult question "What is there, behind the edges of our Multiverse". And apparently the only clear answer to this question may be AN assertion that there are other hidden Multiverses, which are not detectable not only in electromagnetic, but also in gravitational manifestations. And together they form Supermultiverse.

5. Conclusion

It is regrettable that many authors of scientific literature representing and popularizing modern physics are unaware of the fact that fundamental scientific laws, such as Ohm's law and resonance, incontrovertibly prove physical reality of imaginary numbers. Therefore, current versions of the theory of relativity, quantum mechanics and other exact sciences require adjustment.

In this context, outstanding and significant papers are considered to be scientific works of Melvin Schwartz [26], a Nobel prize winner of 1988, who proved that development of the theory of relativity is impossible without a deep understanding of not only issues of electrodynamics but also issues of electrical engineering, as well as works of Julian Seymour Schwinger [27], a Nobel Prize winner of 1965, who proved that development of quantum mechanics is impossible without deep understanding and solving of issues of electrodynamics.

Statement of Competing Interests

Author have no competing interests.

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