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QUATERNIONSTRUCTUREOFTHEHIDDENMULTIVERSEEXPLANATIONOFDARKMATTERANDDARKENERGY

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I. INTRODUCTION

More than 100 years ago outstanding scientists Joseph Larmor (1857 – 1942), Nobel Prize winner Hendrik Antoon Lorentz (1853 – 1928), Jules Henri Poincaré (1854 – 1912), Nobel Prize winner Albert Einstein (1879 – 1955) and others created Special Theory of Relativity (STR).

Since then and until present time, this theory has been criticized, in just and unjust ways. Sometimes this criticism acquired a well-defined political and opportunistic tone. This inevitably led to the development of some sort of immunity to STR criticism among physicists.

But, as noted by the author of the 'open society' concept Karl Raimund Popper [1], the conflict of opinions in the scientific theories is inevitable and is a prerequisite for the development of science.

II. INACCURATE STATEMENTS OF STR

Inaccurate statements of STR are included in the standard interpretation of the second STR postulate [2], which in addition to the original formulation "the speed of light is independent of motion of the source" proposed by Albert Einstein [3] currently includes two more formulations: on non-exceedance of the speed of light and on physical unreality of imaginary numbers, which were added during the subsequent years.

These statements are due to the inability of the creators of the STR to explain the nature of the

imaginary physical values, which appear in the relativistic formulas for hyper-light speeds.

The explanation of the physical nature of imaginary numbers is not a new problem in science. The issue of imaginary numbers appeared in mathematics about 500 years ago in the works of Scipione del Ferro (1465 – 1525), Niccolò Fontana Tartaglia (1499 – 1557), Gerolamo Cardano (1501 – 1576), Lodovico Ferrari (1522 – 1565) and Rafael Bombelli (1526 – 1572). Although, in the subsequent years the works of the outstanding mathematicians, such as Abraham de Moivre (1667 – 1754), Leonhard Euler (1707 – 1783), Jean Le Rond D'Alembert (1717 – 1783), Caspar Wessel (1745 – 1818), Pierre-Simon de Laplace (1749 – 1827), Jean-Robert Argand (1768 – 1822), Johann Carl Friedrich Gauss (1777 – 1856), Augustin Louis Cauchy (1789 – 1857), Karl Theodor Wilhelm Weierstrass (1815 – 1897), William Rowan Hamilton (1805 – 1865), Pierre Alphonse Laurent (1813 – 1854), Georg Friedrich Bernhard Riemann (1826 – 1866), Oliver Heaviside (1850 – 1925), Jan Mikusiński (1913 – 1987) and many others [4], established a perfect theory of functions for a complex variable, it could not explain the physical meaning of imaginary numbers.

Currently, imaginary numbers are also widely used in the exact sciences. But they still haven't explained physical meaning of imaginary numbers. Although nobody in these sciences could explain the physical meaning of imaginary numbers until present, they did not deny it.

The fact that imaginary numbers do not have any real physical content has been postulated in the STR. It explains additional formulation of the second postulate with arguments about impossibility to overcome the light speed barrier. However, first, the impossibility of overcoming any barrier is not an evidence for the lack of anything beyond this barrier. Second, described arguments do not take into account the possibility of existence of other mechanisms (for example, inability to go to the next room of our house by passing through the dividing walls does not exclude the possibility of such transition through a door and hallway) in the nature, which could overcome this barrier.

Therefore, current set of formulations of the second postulate did not seem enough convincing for all physicists, and they attempted to refute it using the MINOS [5] experiment at the American Tevatron collider and OPERA [6] experiment at the European Large

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Hadron Collider. However, the physical community considered the results of these experiments as not enough reliable and did not take them into account.

III. EVIDENCE FOR THE PHYSICAL REALITY OF IMAGINARY NUMBERS

However, around the same time results of other theoretical and experimental studies had been published, which proved the physical reality of imaginary numbers. Since the experiments in these studies were carried out in linear electric circuits, they can be repeated and verified in any electronic laboratory. Therefore, these experiments, in contrast to MINOS and OPERA experiments, are absolutely reliable and conclusive. And they have not been refuted by anyone yet.

Let us consider some of them.

a) Evidence using transient process analysis

Transient processes in oscillatory system of any physical nature occur, as the forced oscillations arise in such system at the time of external action, and the energy of such oscillations almost always turns out not to be equal to the energy of oscillations before the action. And since the energy stored in the oscillating system can not be instantly changed, the transient (or free) oscillations arise together with the forced oscillations. The energy of transient oscillations is equal to the difference between the energy of forced oscillations before action and after action. Therefore, transition process provides energy coordination of the oscillation process before and after the external action.

Usually no one is aware about the existence of rapidly decaying transient process, except in two cases:

- case when they distort extending signals in radio and electronic systems (such as television);
- case when an external action is very short, and free oscillations continue to exist after the end of action; these oscillations are called shock and include, for example, natural processes such as tsunami, sound of church bells, and many others.

Existence of shock oscillations, as shown below, evidences the physical reality of imaginary numbers. Let us present this evidence [7].

Processes in any linear oscillation system (e.g., radio and electronic), resulting from external actions are described by the differential equation (or system of such equations)

$$\begin{aligned}
 a_n \frac{d^n y}{dt^n} + a_{n-1} \frac{d^{n-1} y}{dt^{n-1}} + \dots + a_0 y &= \\
 = b_m \frac{d^m x}{dt^m} + b_{m-1} \frac{d^{m-1} x}{dt^{m-1}} + \dots + b_0 x &
 \end{aligned}
 \tag{1}$$

where $x(t)$ is the input action (or the input signal);

$y(t)$ is the response to the action (or the output signal);

$a_n, a_{n-1}, \dots, a_0, b_m, b_{m-1}, \dots, b_0$ are constant coefficients;

$n, n-1, \dots, 0, m, m-1, \dots, 0$ is the order of derivatives;

Solution of the differential equation (1) contains two summands

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

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

$y(t)_{forc}$ is the forced component of response.

We are interested in a free component of response $y(t)_{free}$, which is found in the solution of the algebraic, so called characteristic equation, corresponding to the original differential equation (1)

$$a_n p^n + a_{n-1} p^{n-1} + \dots + a_0 = 0 \tag{3}$$

where a_n, a_{n-1}, \dots, a_0 are same constants as in equation (1) coefficients;

$n, n-1, n-2, \dots, 1, 0$ are the exponents, value of which equals to the order of the corresponding derivatives in the differential equation (1);

p is a variable, which is often called a complex frequency when it accepts values in the form of complex numbers $-\sigma \pm i\omega$;

$i = \sqrt{-1}$ is the imaginary unit.

When the equation (3) is solved, i.e, its solutions are found, we can find its transient response component

$y(t)_{free}$ in the form of:

- $y(t)_{free} = Ae^{-\sigma_1 t} + Be^{-\sigma_2 t}$ if solutions $-\sigma_1$ and $-\sigma_2$ of the equation (3) are valid and different;
- $y(t)_{free} = (A + Bt)e^{-\sigma t}$ if solutions $-\sigma$ of the equation (3) are valid and equal;
- $y(t)_{free} = e^{-\sigma t} (A \cos \omega t + B \sin \omega t)$ if solutions $-\sigma \pm i\omega$ of the equation (3) are complex and conjugated.

In all cases A and B – are the so-called integration constants, which are resulted from the specified initial conditions.

If the oscillation system is described with the differential equation of the second order, as it occurs in practice in most cases. Mathematical formulas will be more complex for more complex oscillation systems. But as the result of the arguments similar to those presented in this article, the same conclusion will be made.

As it is seen, the transient process always exists in one form or another, as the solution of the algebraic equation (3) always exists on the set of complex numbers. But if engineers would solve characteristic algebraic equation (3) only on the set of real numbers, as they do it sometimes in mathematics, they would have to conclude that oscillatory transient processes should not exist in nature.

But they do exist! They are very easy to obtain in the laboratory by exposing the oscillation system to impulse action. Moreover, they exist in nature. These are tsunami, sound of the piano, and even swings, which swing after parents push them. And these are the most reliable and conclusive experiments.

Therefore, we conclude that algebraic equations are physically real only on the set of complex numbers. Consequently, physical reality of complex numbers (and, hence, imaginary numbers) can be indisputably confirmed with the existence of tsunami and other shock vibrations. Thus, the formulation of the second postulate of the STR on physical unreality of imaginary numbers is refuted.

b) Evidence using transient process analysis

The second proof of physical reality of imaginary numbers [8] is even more convincing due to application of the Ohm's law discovered in 1826, the deep meaning of which has not been yet realized.

In fact, while Ohm's law seems to be currently recognized and well-known even to schoolchildren, and it is currently proved daily by activities of millions of engineers around the world, nobody even suspects that it proves physical reality of imaginary numbers. Nevertheless, it does.

As it is known, the theory of electrical circuits includes two major sections:

- theory of DC circuits, in which Ohm's law is now understood as it was understood by Ohm himself;
- theory of AC circuits, in which Ohm's law is currently understood otherwise, since there are resistor resistance measured by real numbers, and inductive and capacitive resistance measured by heteropolar imaginary numbers.

Although the theory of AC circuits has long been known and used by millions of professionals applying the so-called symbolic method [9], all of them still consider the imaginary inductive and capacitive resistances to be something physically non-existent, that is only computing reception.

And these professionals still have not realized that Ohm's law, inter alia, proves physical reality of imaginary numbers. After all, if imaginary inductive and capacitive resistances were physically inexistent, the value of electric current flowing in electric circuits would not change in case of change of frequency of the applied sinusoidal voltage. For this reason, there would be no resonance, particularly, in electrical circuits.

However, it does exist. And, therefore, proves physical reality of imaginary numbers, which couldn't be proved by extremely difficult MINOS and OPERA experiments.

IV. INACCURATE STATEMENTS OF STR

Nature is unified and consistent. Therefore, all scientific theories, created with the purpose of knowledge of the nature should be coordinated and not contradict with each other (for instance, as the theory of relativity and quantum mechanics in physics). Hence, principle of physical reality of imaginary numbers, which has been proved in the theory of electric circuits, should be recognized as generally scientific. And all scientific theories concordant with this principle should be adjusted.

Let us show, for example, how this could be done in the STR [10].

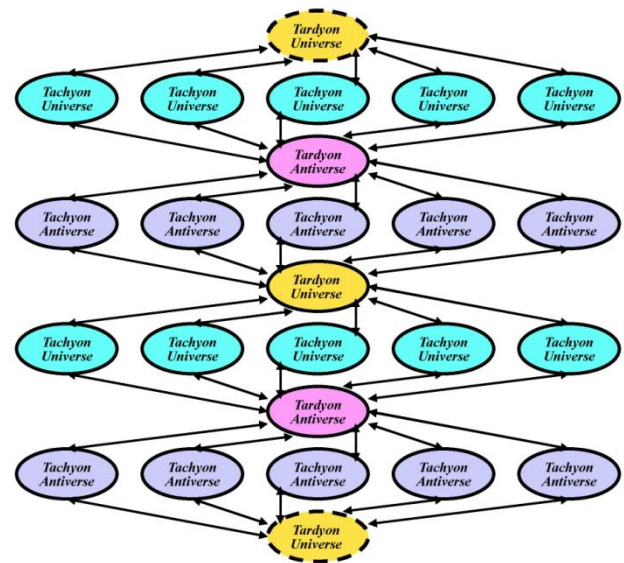


Fig.1 : Example of possible structure of hidden Multiverse, corresponding to the principle of physical reality of complex numbers

Obviously, adjusted version of the STR should explain the physical sense of relativistic formulas in hyper-light speed range (and also the assertion of the second postulate about non-exceedance of the speed of light is refuted), i.e. in case of $v > c$. For instance, the formula of Lorentz-Einstein

$$m = \frac{m_0}{\sqrt{1 - (v/c)^2}} \tag{4}$$

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, at the speed mass of the moving body (e.g., tachyons) in accordance with equation (4) becomes imaginary. But since we have just proved physical reality of imaginary numbers, the tachyons [11, 12], therefore, are physically real. Moreover, in accordance with their definition tachyons do not exist in our universe, which we should call tardyon for clarity, but somewhere else. And that is another real physically existent place, which we should call tachyon universe for clarity.

Thus, afore presented considerations show that not only tardyon universe is actually physically existent, but also tachyon universe and, consequently, a Multiverse, which includes both of them [13]. However, the Multiverse is invisible to us because, in accordance with the condition $v > c$, tachyon universe, which constitutes its part, is behind our event horizon. Therefore, we should call it as hidden Multiverse. Since, according to the first STR postulate, tachyon universe is an inertial reference system in the hidden Multiverse, same physical and other laws should apply, as in our universe. Consequently, tardyon and tachyon universes comply with the principle of similarity, these parallel (since, despite their immensity, they do not intersect in the corresponding multi-dimensional space) universes are suitable for mutual visits by their inhabitants

But the formula (4) of the Lorentz-Einstein does not correspond to this condition. Therefore, it should be adjusted as follows:

$$m = \frac{m_0(i)^q}{\sqrt{1 - (v/c - q)^2}} = \frac{m_0(i)^q}{\sqrt{1 - (w/c)^2}} \quad (5)$$

where $q = \lfloor \frac{v}{c} \rfloor$ is the discrete function "floor" of the argument $\frac{v}{c}$;

$w = v - qc$ is the local speed for each universe, which can assume values only within the range $0 \leq w \leq c$; v is the speed measured from our tardyon universe, which we should call as tardyon speed; c is the speed of light.

Other relativistic formulas of the existing version of the STR can be adjusted in a similar manner.

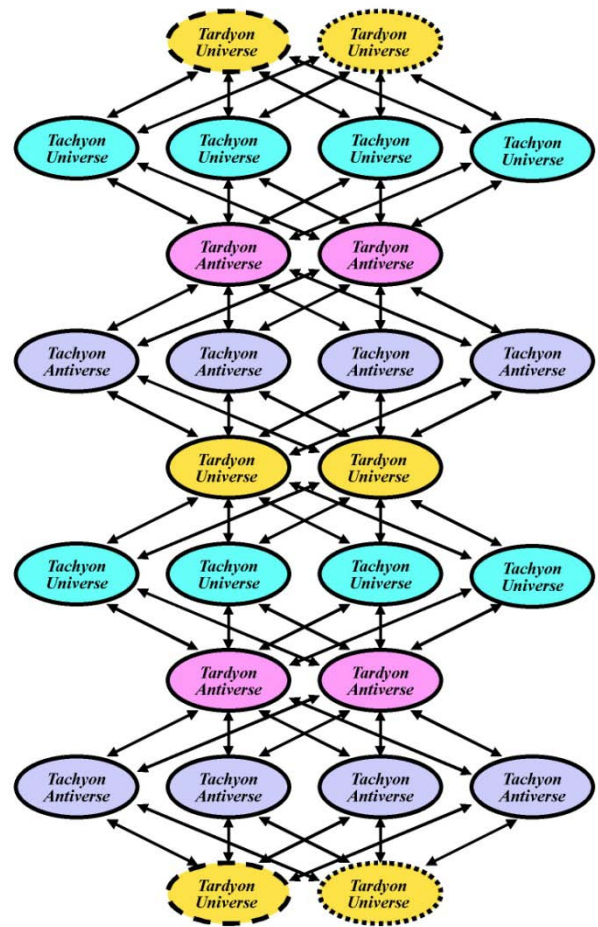


Fig.2. : Another example of possible structure of hidden Multiverse, corresponding to the principle of physical reality of complex numbers

But the formula (5) and other adjusted relativistic formulas implies that such hidden Multiverse, in addition to the corresponding $q = 0$ tardyon and corresponding $q = 1$ tachyon universes also contains at least two parallel universes: corresponding $q = 2$ tardyon antiverses and corresponding tachyon $q = 3$ antiverses. And universes and antiverses, both, tardyon and tachyon universes, can not be annihilated due to the indicated order of their alternation.

In fact, there can be much more universes in the hidden Multiverse, as it was shown by further studies. But no matter how many they are, structure of the hidden Multiverse should include alternation of universes and antiverses in order to avoid annihilation in the specified (or reverse) order. Moreover, such Multiverse at least in certain sections may comprise several parallel or coexisting similar universes or antiverses. Fig. 1 and 2 show examples of such structures. And since these are closed structures or, in other words, ring-type structures, the same universes corresponding to the beginning and end in such ring, are shown in phantom.

It should also be noted that this mutual spatial position of all universes in multidimensional space is provided by some mechanism of automatic adjustment which is unknown to us. If there was no such mechanism, our Multiverse would not be existent. As a result of this automatic adjustment due to the action of disturbing factors, which remain unknown to us, universes are continuously moving relative to each other. Besides, they can even partially penetrate into each other in some places, forming some sort of transition zones or portals, through which inhabitants of the adjacent universes would presumably be able to visit each other. Such transitions between parallel dimensions are likely to be relatively safe, since according to the law of communicating vessels characteristics of pre-portal and after-portal areas of space should be almost identical. Probably, there are a lot of such portals on Earth and in other places of our universe. And quite possible that many of them are not used by our neighbors.

V. ALTERNATIVE STRUCTURES OF THE HIDDEN MULTIVERSE, CORRESPONDING TO THE HYPOTHESIS OF PHYSICAL REALITY OF QUATERNIONS INACCURATE STATEMENTS OF STR

It is permissible to assume that not only complex but also hyper-complex numbers [14] are physically existent, since they also include imaginary numbers.

Quaternions $a + bi_1 + ci_2 + di_3$ containing three imaginary units i_1, i_2, i_3 connected by the following equations present the greatest practical interest among them

$$i_1^2 = i_2^2 = i_3^2 = i_1i_2i_3 = i_2i_3i_1 = i_3i_1i_2 = -1 \tag{6a}$$

$$i_1i_3i_2 = i_2i_1i_3 = i_3i_2i_1 = 1 \tag{6b}$$

Physical reality of quaternions may presumably be experimentally verified by research of oscillation processes in cavity resonators, similar to the research of oscillation processes in LCR circuits made by the author to prove physical reality of imaginary and complex numbers.

With respect to use of quaternions, formula of Lorentz-Einstein can be adjusted as follows:

$$m = \frac{m_0(i_1)^q(i_2)^r(i_3)^s}{\sqrt{1 - [v/c - (q + r + s)]^2}} = \frac{m_0(i_1)^q(i_2)^r(i_3)^s}{\sqrt{1 - (w/c)^2}} \tag{7}$$

where q is the total number of universes, penetration into which was made through a portal, corresponding to the imaginary unit i_1 , with increasing distance from our tardyon universe;

r is the total number of universes, penetration into which was made through a portal, corresponding to the imaginary unit i_2 , with increasing distance from our tardyon universe;

s is the total number of universes, penetration into which was made through a portal, corresponding to the imaginary unit i_3 , with increasing distance from our tardyon universe;

v is the velocity measured from our tardyon universe, which, therefore, can be called a tardyon velocity;

c is the speed of light;

$w = v - (q + r + s)c$ is the local velocity for corresponding universe, which can take values only in the range $0 \leq w \leq c$.

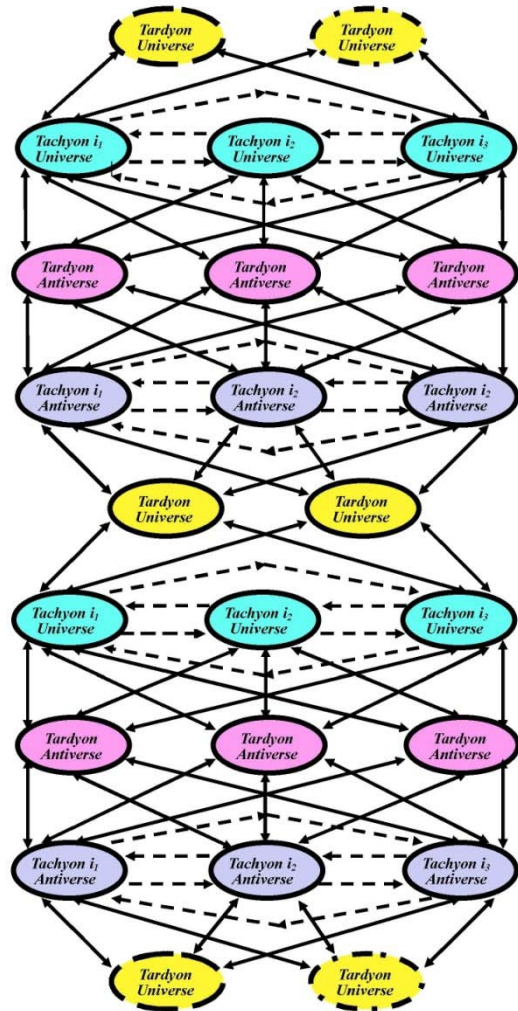


Fig.3. : The most probable structure of hidden Multiverse, corresponding to the hypothesis of physical reality of quaternions

Other relativistic STR formulas can be adjusted in a similar manner.

Example of the quaternion structure of the hidden Multiverse, corresponding to the formulas (7), (6a) and (6b) is shown in Fig. 3. As can be seen, in this structure, unlike structures of the hidden Multiverse shown in Fig. 1, 2 we observe appearance of extra portals. With respect to situations $i_1^2 = i_2^2 = i_3^2 = -1$ in these structures bidirectional portals are shown by double-ended arrows and with respect to situations $i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1$ and $i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1$ unidirectional portals are shown by single-ended arrows. Besides, unidirectional portals corresponding to different conditions $i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1$ and $i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1$, as well as to different imaginary numbers i_1, i_2, i_3 are different.

Therefore, quaternion structure of the hidden Multiverse, considering all these circumstances, is, actually, more complex than the structures of the hidden Multiverse mentioned above. As can be seen, such a complication of the structure of the hidden Multiverse leads to an increase in number of different types of universes and antiverses from four (for structures corresponding to the principle of physical reality of imaginary numbers) to eight (for structures corresponding to the hypothesis of quaternion structure of the Multiverse). And this order of alternation of tardyon and tachyon universes and antiverses excludes their annihilation.

Structural schemes of the hidden Multiverse corresponding to the hypothesis of physical reality of octaves can also be provided, but as shown below hypothesis of octave structure of the hidden Multiverse is not proved by astrophysical research.

VI. EXPLANATION OF THE PHENOMENON OF DARK MATTER AND DARK ENERGY

When discussing the structure of the hidden Multiverse it is necessary to mention the phenomenon of dark matter/dark energy [15, 16], which was called in this way not only because the relevant astrophysical research object is invisible, but also because it is absolutely incomprehensible. Even known to us chemical elements were not found in the dark matter/dark energy. This fact would seem to breaker the existing understanding of the term 'matter'.

But actually all these problems occurred only due to wrong formulation of the task - to search for the solution only within the concept of Monouniverse that corresponds to the expanded formulation of the second postulate of STR, which, as it was shown above, was incorrect.

If we instead take up the concept of the hidden Multiverse, everything would become comprehensible [17, 18]:

- dark matter and dark energy are invisible, as they correspond to the invisible universes of Multiverse;
- dark matter corresponds to universes adjacent to our universe;
- dark energy corresponds to the remaining parallel universes that are more distant from our universe;
- chemical composition of dark matter and dark energy of our tardyon universe can not be analyzed because the object of study, i.e. the matter itself is in other parallel universes;
- chemical and other composition of the dark matter and dark energy could be determined after transition of humans or robots with the appropriate tools through portals into other parallel universes.

Besides, data obtained from WMAP [19] and Planck [20] space stations allows us to do the following calculations:

- according to the Planck measurements, the Multiverse consists of $100\%/4,9\% \approx 20,41$ parallel universes (according to the earlier and less accurate WMAP measurements the Multiverse consists of $100\%/4,6\% \approx 21,74$ parallel universes);
- according to the Planck measurements, $26,8\%/4,9\% \approx 5,47$ universes among them are adjacent to our universe (according to the less accurate WMAP measurements their number equals to $22,4\%/4,6\% \approx 4,87$ parallel universes);
- according to the Planck measurements, $68,3\%/4,9\% \approx 13,94$ universes are more distant from our universe and, therefore, shielded by adjacent universes from us (according to the less accurate WMAP measurements their number equals to $73,0\%/4,6\% \approx 15,87$ parallel universes).

According to these calculations the structure of the hidden Multiverse shown in Fig. 3 contains twenty-two parallel universes. Besides, each tardyon universe in this structure is adjacent to six other parallel universes, namely, to three tachyon universes and three tachyon antiverses.

Therefore, it can be argued that the quaternion structure of the hidden Multiverse is confirmed by astrophysical research of WMAP and Planck spacecrafts, which proves physical reality of quaternions.

VII. CONCLUSION

Thus, the principle of physical reality of imaginary and complex numbers proved in the research of oscillation processes in linear electric circuits is a fundamental factor enabling to overcome errors of the current version of STR generated by its extending

interpretation of the second postulate. This research can be repeated and confirmed in any electronic laboratory. That is why, in contrast to the MINOS and OPERA experiments, it is indubitably true and probative. Similarly, physical reality of hyper-complex numbers can also be proved in the research of oscillation processes in cavity resonators.

Use of the notion of physical reality of imaginary numbers allowed offering the adjusted version of the STR, which explains their physical meaning. It is shown that imaginary numbers in astrophysics correspond to the existence of a few dozens of other parallel universes invisible from our universe, or, in other words, extra parallel dimensions. Thus, the adjusted version of the STR describes processes in all parallel universes of the hidden Multiverse, whereas the existing version of STR describes the processes only in one of the parallel universes (ours), which is a kind of zero in coordinate system.

The proposed concept of the hidden Multiverse made it possible to explain previously inexplicable features of dark matter and dark energy phenomena: their invisibility and failure to detect in them chemical elements that are available in our visible universe, since they correspond to invisible parallel universes of the hidden Multiverse. Dark matter and dark energy are actually an experimental proof of the existence of the hidden Multiverse as pursuant to the explanation of their nature given above. Besides, data obtained by WMAP and Planck spacecrafts confirm the quaternion structure of the hidden Multiverse and thus prove physical reality of quaternions.

REFERENCES RÉFÉRENCES REFERENCIAS

1. K. R. Popper, *Conjectures and Refutations, The Growth of Scientific Knowledge*, Routledge, London, (2002).
2. A. A. Antonov, Verification of the second postulate of the special relativity theory, *Global Journal of Science Frontier Research A: Physics and Space Science*, 14(3) (2014) 51- 59.
3. A. Einstein, *Zur Elektrodynamik bewegter Körper*, *Annalen der Physik*. 17(10). (1905) 891-921.
4. E. W. Weisstein, ed. *The CRC Concise Encyclopaedia of Mathematics*, 3-rd ed. CRS Press, Boca Raton, FL., (2005).
5. P. Adamson (Fermilab), N. Ashby (NIST), R. Bumgarner (USNO), Measurement of the Velocity of the Neutrino with MINOS, arXiv:1408.6267v1 [physics.acc-ph], (2014).
6. T. Adam et al. Measurement of the neutrino velocity with the OPERA detector in the CNGS beam, arxiv:1109.4897v4 [hep-ex], (2011).
7. A. A. Antonov, Solution of algebraic quadratic equations taking into account transitional processes in oscillation systems, *General Mathematics Notes*, 1(2) (2010) 11-16
8. A. A. Antonov, Adjustment of the special theory of relativity according to the Ohm's law, *American Journal of Electrical and Electronics Engineering*, 3(5) (2015) 124-129.
9. C. P. Steinmetz, E.J. Berg, *Theory and Calculation of Alternating Current Phenomena*, Electrical World and Engineer Inc., NY. (1900).
10. A. A. Antonov, Correction of the special theory of relativity: physical reality and nature of imaginary and complex numbers, *American Journal of Scientific and Industrial Research*, 5(2) (2014) 40-52.
11. S. Tanaka, *Theory of matter with superlight velocity*. *Progress of Theoretical Physics (Kyoto)*, 24(1) (1960) 171-200.
12. G. Feinberg, Possibility of faster-than-light particles, *Physical Review*, 155(5) (1967) 1089-1105.
13. A. A. Antonov, Cognition of the Multiverse as a factor facilitating the development of humanity, *Russian Physical Thought Journal*, 12(1) (2013) 6-77.
14. I. L. Kantor, A.S. Solodovnikov, *Hypercomplex numbers*, Springer Verlag, Berlin, (1989).
15. K. Freeman, G. McNamara, *In Search of Dark Matter*, Springer, NY, (2006).
16. I. Nicolson, *Side of the Universe: Dark Matter, Dark Energy, and the Fate of the Cosmos*, Johns Hopkins University Press, Baltimore, (2007).
17. Antonov A.A. (2015). Explanation of dark matter and dark energy phenomena. *Global Journal of Science Frontier Research A: Physics and Space Science*. 15(1). 33 – 38.
18. A. A. Antonov, Hidden Multiverse: explanation of dark matter and dark energy, *Cosmology*, 19 (2015) 40-61.
19. G. Hinshaw, D. Larson, E. Komatsu et al, *Nine Year Wilkinson Anisotropy Probe (WMAP) Observations: Cosmological Parameter Results*, arXiv: 1213.5226 [astro-ph/CO] (2013).
20. R. Adam, P.A.R. Ade, N. Aghanim et al. (Planck Collaboration) *Planck 2015 results. 1. Overview of products and scientific results*. arXiv:1502.01582v2 [astro-ph.CO] (2015).

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