Structuree of the Multiverse

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Abstract

We present theoretical and experimental evidence that complex frequencies of damped and free oscillations of any physical nature – mechanical, electromagnetic, hydraulic, acoustic, etc. – are physically real. This allows:

- answering the Hamlet's question of algebra: whether the solutions of algebraic equations on the set of complex numbers are physically existent or non-existent;
- developing the perfect theory of resonance at complex frequencies which is free of the inconsistencies of the theory of resonance at real frequencies;
- making a conclusion that the imaginary components of concrete complex numbers are hidden extra dimensions of the Universe.

Application of the principle of physical reality of complex numbers in the special theory of relativity allows explaining the results of the OPERA experiment, as well as proving that the rest mass of neutrino is zero.

The principle of physical reality of complex numbers also allows assuming that, apart from our tardyon Universe, there is the tachyon and other Universes in the Multiverse. It is shown that the Lorentz-Einstein formula is not applicable to these extra Universes, and a generalized formula which holds true for all Universes is suggested instead. We explain the structure of the Multiverse. We prove that there are doorways on Earth which allow transition from the tardyon Universe into the adjacent tachyon Universe and tachyon Anti-verse.

Keywords: complex numbers, hidden extra dimensions of the Universe, the OPERA experiment, tachyon Universe, tardyon Universe, Anti-verse, Multiverse.

1. Introduction

People live in the world of oscillations. Speaking about it in terms of everyday life, without oscillations people would not be able to see or hear, to warm up by the fire and to measure time, to use modern communication means and electricity. If we consider oscillations in general scientific terms, neither our Planet nor the Solar system, neither atoms nor molecules would exist without them, nothing would exist.

This determines the utmost importance of investigating oscillations as a physical object of research. In order to describe mathematically oscillation processes of any physical nature – mechanic, electromagnetic, acoustic, hydraulic, piezoelectric and so on – differential equations are used. The theory of oscillations usually studies relatively more complicated non-linear systems [1], described with non-linear differential equations. However, as shown below, simpler linear oscillation systems described with linear differential equations have not yet been investigated completely.

2. Mathematics is an experimental science

In the general case, processes in linear oscillation systems are described with the linear differential equation

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

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.

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

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

where $y(t)_{forc}$ is the forced component of response; $y(t)_{free}$ is the free component of response, which are found in a different way.

In the present paper, we shall consider only the free component of response $y(t)_{free}$, which is often referred to as the transitional process. In the simplest case, when a pulse action takes place, it is also referred to as an impact oscillation.

The particular type of the free component of response is usually found by generating and solving the so-called characteristic algebraic equation, which corresponds to the initial differential equation (1):

$$a_n p^n + a_{n-1} p^{n-1} + \ldots + a_0 = 0 \quad (2)$$

where p is a variable which, in case it takes a meaning in the form of complex numbers, is often referred to as complex frequency.

The solutions of the algebraic equation (2) are then used to denote the time function describing the transitional process. If the solutions $p_1 = -\sigma_1$ and $p_2 = -\sigma_2$ of the second-degree characteristic algebraic equation are real numbers, the transitional process is referred to as aperiodic, and is described with the following function of time:

$$y(t)_{free} = Ae^{-\sigma_1 t} + Be^{-\sigma_2 t}$$

If the solutions $p_{1,2} = -\sigma$ of the characteristic equation are multiples, the transitional process is referred to as critical and is described with the following function of time:

$$y(t)_{free} = e^{-\sigma t}(A + Bt)$$

If the solutions of the characteristic equation are complex conjugate numbers $p_{1,2} = -\sigma \pm i\omega$, the transitional process is referred to as oscillation, and the values p_1 and p_2 are referred to as complex frequencies of free oscillations. The corresponding transitional process is described with the function of time

$$y(t)_{free} = e^{-\sigma t}(A\cos\omega t \pm B\sin\omega t)$$

The solutions of characteristic algebraic equations of higher degrees can be any combinations of the above special cases, and, therefore, the corresponding transitional processes can include both aperiodic and critical, as well as oscillation components.

All of this is laid out in detail in the corresponding textbooks. However, not a single textbook explains why of the two well known and widely used algorithms of solving algebraic equations (using real number and using complex numbers), only one (on the set of complex numbers) is used to solve characteristic equations in the theory of linear differential equations.

This is a very important circumstance. The matter is that quadratic characteristic equations have no solutions on the set of real numbers for the case of a negative discriminant. This result is illustrated by their graphical solution (Figure 1)

$$\begin{cases} y = a_2 p^2 + a_1 p + a_0 \\ y = 0 \end{cases}$$

As can be seen, a negative discriminant corresponds to a parabola which does not intersect the ***p*** axis.

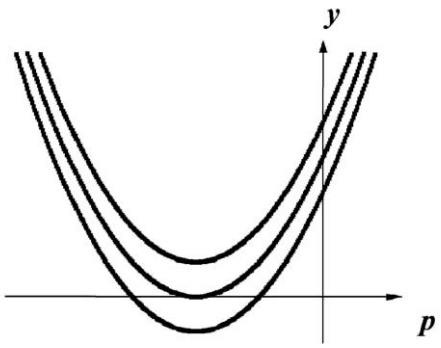

Figure 1*: Graphical solution of the quadratic equation on the set of real numbers*

The same quadratic characteristic equation for the case of a negative discriminant has solutions on the set of complex numbers (Figure 2c). This result can be illustrated by a graphical solution of the characteristic equation

$$\begin{cases} |y| = \left| a_2(\sigma + i\omega)^2 + a_1(\sigma + i\omega) + a_0 \right| \\ y = 0 \end{cases}$$

Positive and zero discriminants correspond to graphs given in Figure 2a and Figure 2b.

It turns out that one and the same characteristic equation with a negative discriminant has solutions if solved in accordance with one algorithm, and has no solutions if solved in accordance with the other algorithm. It is easy to see that these two statements are mutually exclusive. Consequently, only one of them can be true. But which one? It is impossible to prove the validity of one and falsity of the other in terms of pure mathematics. This is why, since a justified choice is impossible, both algorithms are still used in algebra.

In order to answer the given question, let us clarify the criterion of validity, i.e., what should be the meaning of the words "the solution exists" or "the solution does not exist"? Where does it exist? The answer is obvious – in nature, in the physical world we live in. Thus, the matter is the existence of the solution as a physical reality.

Then it is logical to conclude that in order to answer the question it is necessary to use a physical experiment. Let us remember in this respect that for the case of a negative discriminant, when the solutions of a characteristic equation are complex-conjugate numbers, oscillation transitional processes actually physically exist.

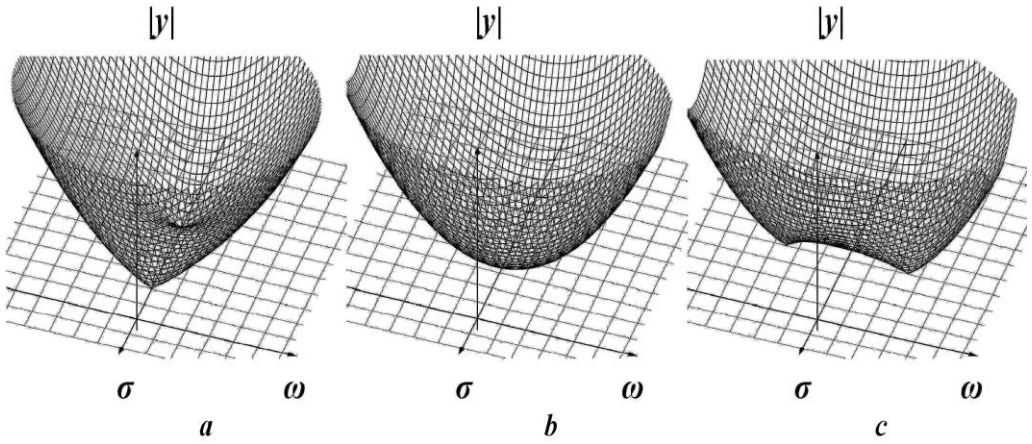

Figure 2*: Graphical solution of the quadratic equation on the set of complex numbers*

Using the algorithms of solving characteristic equations on the set of real numbers, it is stated that these equations have no solutions for the case of a negative discriminant. In other words, it is said that they do not exist in nature (as in Figure 1, where the upper parabola does not intersect the p axis). But then, the corresponding oscillation transitional processes should not exist in nature.

But they do exit! They exist in nature (e.g., tsunami), in science (e.g., in electrodynamics), in engineering (e.g., in radio engineering), and even in day-to-day-life (e.g., in any variations of a pendulum).

As can be seen, a question unsolvable in terms of pure mathematics – which of the two mutually exclusive algorithms of solving algebraic equations is correct – turned out to be easy to answer with the help of physical experiments.

In this respect, it would be appropriate to recollect a saying by Oliver Heaviside (1850 – 1925): "Mathematics is an experimental science", and get added evidence that it is true.

Consequently, the solution of algebraic equations (not only characteristic equations) on the set of complex numbers has to be recognized as the only correct solution which corresponds to the physical processes in the world around us. In other words, complex frequencies of free oscillations are physically real, including their imaginary components [2], [3]. This is why complex numbers must be referred to in a different way, for example, as implicit or hidden (see below) numbers.

Investigation of the forced component of response $y(t)_{forc}$ [4 – 8] also leads to the conclusion on the physical reality of complex frequencies.

It is also obvious that not only complex frequencies are physically real, but many derived quantities, as well. In electrical engineering, for instance, here belong complex impedance and complex admittance, complex voltage and complex current, complex power and complex energy.

3. Physical interpretation of mathematic results

Due to the above, an obvious question arises: how shall we understand the statement on physical reality of concrete (i.e., having a reference to a measurement unit – meter, gram, etc.) complex numbers? That is, to put it simply, how can we see them or otherwise feel them?

Unfortunately, we cannot. People do not have such sense organs. However, let us recollect that this is not a singular situation. People cannot see or touch the magnetic field, the electromagnetic radiation (except for the optical and thermal ranges), the electric current (if it is small enough), the black holes, the elementary particles, and many other things. Nevertheless, people believe in their existence based on the theoretical and experimental results obtained by scientists.

The case under consideration, however, has an important peculiarity – people do not feel only the imaginary component of concrete complex numbers, but do feel the real component. However, both components are explicitly mutually interrelated by the Euler formula

$$e^{ix} = \cos x + i \sin x \tag{3a}$$

which can be obviously transformed into

$$e^{(-\sigma+i\omega)t} = e^{-\sigma t}\left(\cos \omega t + i \sin \omega t\right) \tag{3b}$$

This circumstance is an indirect possibility to get evidence of the existence of the imaginary component of an oscillation process, since people do feel the real component.

Moreover, in the left part of formula (3) the exponent, as can be seen, contains the quantity $-\sigma + j\omega$, which is complex frequency, and which is, as has been proven above, a physically real complex number. Thus, the right side of formula (3) is also a physically real complex number. Furthermore, the statement is true even for the case $\sigma = 0$, i.e. with regard to sustained oscillations, as well. Oscillation processes, as is well known, take place not only in the world we see without microscopes or telescopes, but also in the macrocosm (e.g., rotation of celestial bodies around their stars) and in microcosm (e.g., rotation of electrons around the atomic nucleus). Therefore, these worlds should have their own physical realities, measured with complex and imaginary numbers.

Finally, since concrete imaginary numbers are physically real, they must measure something. In other words, they must correspond to certain dimensions, which, according to the Euler formula, are supplementary to the dimensions measured with real numbers. However, since we do not see or feel these dimensions, they are in essence hidden extra dimensions [9 – 11], similar in this respect to the hidden extra dimensions described in [12], and to those which are supposed to be discovered during experiments at the Large Hadron Collider. However, the hidden extra dimensions revealed and described in the present paper are different from those expected to be discovered at the Large Hadron Collider, as the latter, supposedly, exist only in the microcosm.

4. Explaining the results of the OPERA experiment

Recently, another confirmation of the physical reality of complex numbers has been suggested.

On 22 Sept 2011, 173 coauthors – researchers of the world's largest high-energy physics laboratory CERN (Conseil Européen pour la Recherche Nucléaire – European Organization for Nuclear Research) – published a report [13] on registering neutrinos which traveled faster than light during the OPERA experiment. Similar results were received [14] in 2006 in the American MINOS experiment (Main Injector Neutrino Oscillation Search); however, these results were ignored by most physicists due to a relatively lesser measurement precision.

However, these results are impossible according to the special theory of relativity (STR), because, according to the Lorentz-Einstein formula

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

relativistic mass m of a physical object having rest mass m_0 and moving with velocity v which exceeds the velocity of light c, turns into an imaginary number. However, the founder of the theory Albert Einstein (1879 – 1955) did not admit (or, rather, was not able to explain) the physical reality of imaginary numbers.

However, if the principle of physical reality of imaginary numbers is to be used in the STR, the result of the experiment will have to be recognized as possible and explicable [15], [16].

Indeed, after exceeding the speed of light c, neutrinos, in accordance with the foregoing, shift into a hidden extra dimension, or, in other words, into the *tachyon Universe* of imaginary numbers. At that, if their rest mass were non-zero, they would have become impossible to observe from our *tardyon Universe* of real numbers. However, since they were registered experimentally, they must have zero rest mass m_0 due to the equality $im_0 f(v) = i0 = m = 0$, according to which neutrino relativistic mass m at any velocity v is a real number.

Other tachyons having rest mass $m_0 > 0$ are unobservable from our Universe of real numbers. Therefore, the results of the OPERA experiment are a benchmark which allows proving not only the zero rest mass of a neutrino, but the existence of the tachyon Universe, as well.

5. The structure of the Multiverse (a hypothesis)

Acknowledgement of the existence of the tachyon Universe requires at least some basic principles of its structure to be explained. Let us assume that the fundamental principle is the similarity of the tachyon Universe of imaginary numbers and the tardyon Universe of real numbers, i.e., let us assume that the tachyon Universe is governed by the same major physical laws as the tardyon Universe, and, thus, it has its own elementary particles, atoms and molecules, its own planets and stars, and even its sensible beings, who must have already found the ways of visiting the Earth. The tardyon, the tachyon and other Universes altogether form the Multiverse.

However, the Lorentz-Einstein formula (4a), as well as other similar formulae of the STR, contradicts the above assumption. Indeed, the graph (Figure 3) which corresponds to function (4a) for argument $v = c$ has a gap. Two of its branches, corresponding to the tardyon Universe (when $0 \le v < c$) of real numbers and the tachyon Universe (when $v > c$) of imaginary numbers look differently. Moreover, the tachyon Universe corresponding to this graph, as can be seen, is dynamically unstable, as all physical objects in it have a superluminal speed $v \to \infty$, and as the velocity v increases, their relativistic mass m decreases down to

zero. Consequently, this tachyon Universe is physically unrealizable for physical objects with a non-zero rest mass m_0 .

According to the above principle of similarity of Universes, the tachyon Universe should have the corresponding formula

$$m = \frac{im_0}{\sqrt{1-(v/c)^2}} \quad \text{для которой} \quad 0 \le v < c \tag{4b}$$

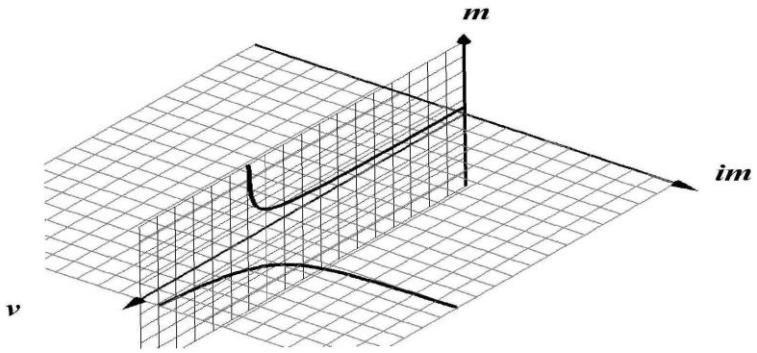

***Figure 3**: Graphs of function $m = f(v)$ for tardyon and tachyon Universes, corresponding to the Lorentz-Einstein formula*

Formulae (4a) and (4b) can be merged into the formula (where n is a certain function of the argument v)

$$m = m_0 \frac{(i)^n}{\sqrt{1-(v/c)^2}} \quad \text{для которой} \quad 0 \le v < c \tag{5}$$

where $n = 0$ for the tardyon Universe, and $n = 1$ for the tachyon Universe. Other formulae of the STR which describe relativistic effects can be generalized in a similar way.

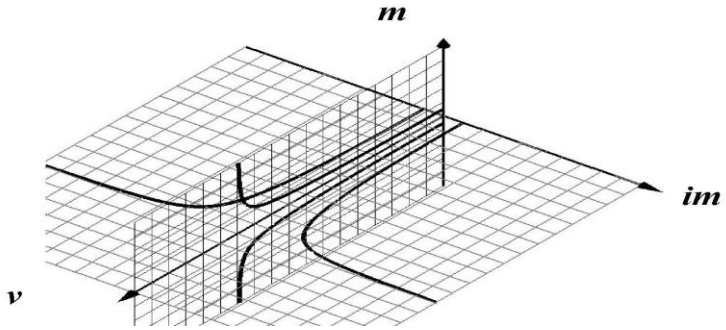

***Figure 4**: Graphs of function $m = f(v)$ for the Multiverse, corresponding to the formula (5)*

Graph of function (5) is given in Figure 4. As is seen, for the structure of the Multiverse to be complete, two more particular cases corresponding to $n = 2$ and $n = 3$ must be added to the graph. They are described with the formulae

$$m = \frac{-m_0}{\sqrt{1-(v/c)^2}} \text{ for which } 0 \le v < c \quad (4c)$$

$$m = \frac{-im_0}{\sqrt{1-(v/c)^2}} \text{ for which } 0 \le v < c \quad (4d)$$

where v is the local velocity for each Universe (but this velocity, for instance, for the tachyon Universe, measured, as in the OPERA experiment, from the conjugate tardyon Universe, will already be superluminal, since it is beyond the point of singularity $v = c$).

Further on, for $n = 4$ once again we get the law (4a), which corresponds to the tardyon Universe, and so on.

Thus, eventually, the Multiverse includes:

- our tardyon Universe, corresponding to formula (4a);
- the tachyon Universe, corresponding to formula (4b);
- the tardyon Anti-verse, corresponding to formula (4c);
- the tachyon Anti-verse, corresponding to formual (4d).

Transition from one adjacent Universe to another is made as a result of mathematical transformations descried with formula (5) at points of singularity $v = (n+1)c$.

6. Doorways into other Universes (a hypothesis)

Actually, transitions from one Universe into another for physical objects with a non-zero rest mass m_0 at points of singularity $v = c$ are physically impossible, because they would have to possess infinitely large energy to reach the speed of light.

This is why in the Multiverse transition from one Universe into another occurs in a different way – to be precise, through the doorways. The principle of their operation may be explained by the Euler formula, which for the tardyon Universe has the form (3a),

for the tachyon Universe – the form $e^{i(x+\pi/2)} = -\sin x + i\cos x$ (3c)

for the tardyon Anti-verse – the form $e^{i(x+\pi)} = -\cos x - i\sin x$ (3d)

for the tachyon Anti-verse – the form $e^{i(x+3\pi/2)x} = \sin x - i\cos x$ (3e)

As can be seen, oscillations in the adjacent Universes are in quadrature to each other.

What kind of oscillations are these? As we mentioned above, people live in the world of many various oscillations. The answer is obvious: since parts of adjacent Universes which open up for people on the surface of Earth through the doorways are relatively large and exist for quite a long period of time, these are infra-low-frequency oscillations (mechanical, hydraulic, electromagnetic, may be some other types of oscillations yet unknown) caused by the rotation of the Earth around its axis. In other words, these are resonance oscillations (they are confirmed by regular tides) of the Earth's surface.

Moreover, in places of geotectonic dislocations of the Earth surface, shock oscillations may appear at frequencies close to the resonance frequency. This is why the phase of resultant (resonance and shock) oscillations sometimes may turn out to be in quadrature to the dominant oscillations on the Earth surface. It is due to this that an adjacent tachyon Universe or tachyon Anti-verse may appear on certain relatively small patches of the Earth surface. Borders of these patches on the surface of Earth turn to be the doorways which close after the shock oscillations dampen; as a result, initial fragments of our tardyon Universe recover on these patches.

Apart from the abovementioned natural portals created by processes taking place on Earth, there obviously can be artificial portals (including those in other frequency ranges) created by rational inhabitants of parallel worlds who have learned the processes of natural doorway formation. It is very likely that UFOs are vehicles carrying on board devices for artificial doorway formation.

This is why deep space flights science-fictionists are so fond of will most likely be implemented not with the superluminal spaceships (these ships have not reached either the Earth, the Moon or Mars, at least, so far), but through movement of other vehicles through doorway labyrinths among parallel worlds.

7. Conclusion

Thus, analysis of solutions of linear differential equations which correspond to transitional processes in oscillation systems of any physical nature allowed proving the physical reality of complex frequencies and other concrete complex numbers. Since any physically real numbers, including imaginary and complex numbers, are always a measurement tool, this allowed proving the existence of hidden extra dimensions in the Universe.

Implementation of the principle of physical reality of complex numbers, in its turn, allowed correcting the STR, bringing it in compliance with the results of the OPERA experiment, as well as proving that the rest mass of a neutrino is zero.

Implementation of the corrected STR allowed developing a hypothesis on the structure of the Multiverse, where, apart from our tardyon Universe, three other Universes exist simultaneously. At that, the Lorentz-Einstein formula (and other formulae of the STR describing relativistic effects) is not applicable to these parallel Universes. Thus, a generalized formula which is true for all Universes is suggested instead. It is shown that on Earth the physical transition from one Universe into another is possible through the doorways, and the principle of their operation is explained.

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Alexander A. Antonov received PhD degree in Radio Electronics at St.-Petersburg Aerospace Instrumentation University, Russia. He was associate professor of Tula State University in Russia and leading scientist of Institute of Information Recording Problems of the Ukrainian Academy of Sciences. Now he is Director of Research Centre of Information Technologies "TELAN Electronics" in Ukraine, academician of the IAOI, author almost 200 patents.

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