

RESEARCH ARTICLE

The Special Theory of Relativity in a Complex (Biocentric) World. Photons, Particles, Tachyons

V. V. Lyahov

Institute of Ionosphere of the Republic of Kazakhstan, 050020 Kamenskoye Plateau, Almaty, Kazakhstan.

Received: 13 August 2026 Accepted: 28 August 2026 Published: 23 October 2026

Corresponding Author: V. V. Lyahov, Institute of Ionosphere of the Republic of Kazakhstan, 050020 Kamenskoye Plateau, Almaty, Kazakhstan. Email: v_lyahov@rambler.ru

Abstract

It has been proposed that, in order to adequately describe Nature, one must make full use of complex numbers; that is, all physical quantities must be complex-valued. The impact of such an approach on the special theory of relativity is investigated. Photons, particles, and tachyons in a complex-valued (biocentric) World.

1. Number Systems and Physical Quantities

Only the natural, integer, rational, and real number systems are suitable for measuring physical quantities. The complex number system is sometimes used—specifically, only the real part, with the imaginary part discarded; the phase is occasionally used as well. However, it is not possible to use quaternions, hypercomplex numbers, p-adic numbers, or cardinal numbers for the same purposes. These number systems play an important role in mathematics and theoretical physics and are used in the study of the micro- and megaworlds, but they cannot be applied to the measurement of physical quantities.

We believe that, in order to adequately describe Nature, it is necessary to make full use of complex numbers; that is, we believe that all physical quantities have complex values [1–7]. The imaginary part is unobservable, yet it is inherently part of a physical quantity, acting as a sort of hidden parameter, and manifests itself only indirectly by causing the system to move along one path or another. In other words, the imaginary part of a quantity is its “soul,” causing the system to move in different directions under identical external conditions depending on the nature of this “soul.” In this sense, it can be said that Nature is a living being.

2. The Basic Principles of the Special Theory of Relativity

It is generally accepted that the special theory of relativity (STR) is based on two postulates: 1) Einstein’s principle of relativity and 2) the principle of the finiteness of the speed of light (in a vacuum $c = 3 \cdot 10^8 \text{ m/s}$). As Einstein himself did [8] and as shown in physics textbooks, such as [9], we consider a spherical electromagnetic wave that began to propagate from the origin at time t . The wavefront equation in the K system is given by:

$$x^2 + y^2 + z^2 - c^2 t^2 = 0 \quad (1)$$

Einstein’s principle of relativity extends Galileo’s principle of relativity to electromagnetic phenomena; therefore, the law governing the propagation of electromagnetic waves must be the same in another inertial reference frame K' , and thus:

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = (x')^2 + (y')^2 + (z')^2 - c^2 (t')^2 = 0 \quad (2)$$

The latter relationship is possible if the speed of light is an invariant, i.e., the same in any inertial reference frame. So far, no restrictions have been placed on the value of the speed of light. Furthermore, in formulating SRT, it is required that the coordinate and time transformation formulas be linear. This requirement is motivated by the homogeneity of

Citation: V. V. Lyahov, The Special Theory of Relativity in a Complex (Biocentric) World. Photons, Particles, Tachyons. Journal of Religion and Theology 2026;8(3):46-49.

©The Author(s) 2026. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

space. One might question the obviousness of this conception of space, but let us accept this assumption. Next, let us write the linear transformations of coordinates and time in general form:

$$x' = \alpha(v)(x - vt), \quad (3)$$

$$t' = \beta(v)t + \gamma(v)x. \quad (4)$$

Substituting (3) and (4) into expression (2) yields:

$$\alpha(v) = \beta(v) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}},$$

$$\gamma(v) = -\frac{v}{c^2 \sqrt{1 - \frac{v^2}{c^2}}}$$

Substituting the last expressions into (3) and (4), we obtain the Lorentz transformation formulas:

$$\begin{aligned} x' &= \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}, \\ y' &= y, \\ z' &= z, \\ t' &= \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}}. \end{aligned} \quad (5)$$

System K moves along the x-axis.

Using the Lorentz transformations (5), in the case of relativistic dynamics, it is easy to derive a formula for the relativistic mass:

$$m(v) = \frac{m}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (6)$$

3. Special Theory of Relativity in a Complex-Valued World

The works of Einstein and his followers tacitly assumed that all quantities are real. We, however, propose the thesis that physical quantities are complex-valued. In this case, all statements of STR, including formulas (1–6), remain unchanged. But if complex numbers correspond to all physical quantities, they must be ordered. We have carried out an ordering of the set of complex numbers [6].

3.1 Non-Archimedean Complex Number Lines

In standard physics and geometry, only Archimedean lines are considered—that is, lines that contain only a countable number of non-overlapping segments. All points on standard Archimedean lines are real.

The desire to follow the logic of defining the concept of a number as a ratio of two quantities, combined with the resulting ordering of the set of complex numbers, leads to each physical quantity being located on a corresponding non-Archimedean complex number line (see Fig.

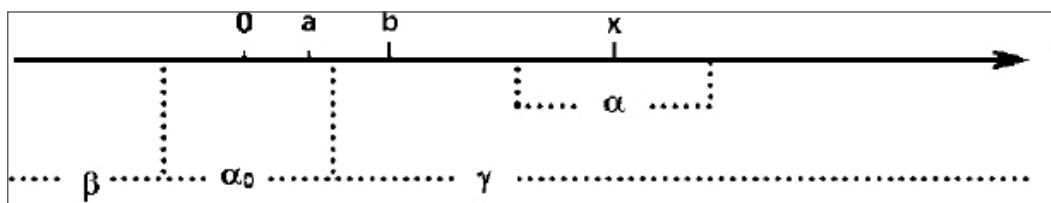


Figure 1. Non-Archimedean complex number line

The set of standard numbers on the non-Archimedean complex number line (see Fig. 1) constitutes the usual Archimedean real number line. On these number lines, we can choose any values for any quantities. We can also move along the line—for example, in time-related problems—in the direction of increasing time. However, we are unable to perform the same procedure on the non-Archimedean complex number line. This object is accessible only to the Higher Power—the Mind of the Universe—but not to us. We can only explore possible paths of movement along the non-Archimedean complex number line. The number of such paths is infinite, and only the Mind of the Universe chooses a specific path. Thus, in our model, the infinitely small yet finite quantities that constitute

the monads of standard numbers—as well as the non-Archimedean complex number line itself—are the tools of the Mind of the Universe. We, however, have access only to the Archimedean real number line. The significance of the imaginary components can be assessed only post factum, by studying the results to which the motion and development of the observed material system lead.

4. On the Problem of Tachyons

Regarding a specific problem in the theory of special relativity: the problem of hypothetical particles traveling at superluminal speeds—tachyons. The rest mass of tachyons, m_0 , is assigned an imaginary value so that the total mass (which is an essential

characteristic, since tachyons are always in motion) $m = m_0 / \sqrt{1 - v^2 / c^2}$ is a real quantity when $v > c$. If $v = c$, then $m = \infty$ —the light barrier separates the existence of the world of tachyons from that of the real world.

If, however, the quantities are complex in nature with a small imaginary part, then the real part of the mass $m = m_0 / \sqrt{1 - v^2 / c^2}$ may cross the light barrier such that

$\text{Re}(m)$ is finite when $\text{Re}(v/c) = 1$ (see Figs. 2 and 3). The abscissa axis shows the real part of the velocity in (m/s), while the ordinate axis shows the real and imaginary parts of the mass, normalized to one. The imaginary part of the total mass is small compared to the real part to the left and right of the barrier, becoming negative and equal in magnitude to the real part at the barrier.

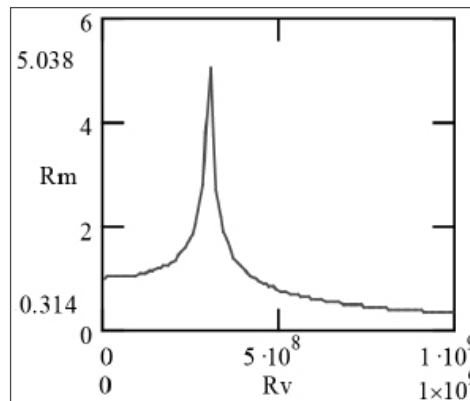


Figure 2. Relationship between the real part of mass and the real part of velocity

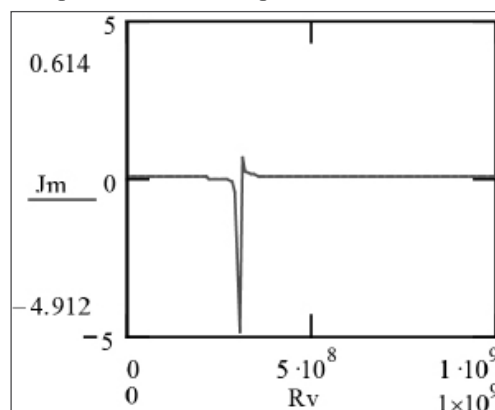


Figure 3. Relationship between the imaginary part of mass and the real part of velocity

The calculations were performed for the following values:

$$\text{Im}m_0/\text{Re } m_0 = 10^{-2}, \text{Im}c/\text{Re}c = 10^{-4}, \text{Im}v/\text{Re}v = -10^{-2}. \quad (7)$$

As these ratios decrease, the transition barrier becomes sharper and increases in amplitude, approaching the typical picture observed in the real world, while remaining fundamentally finite if the imaginary parts are small but finite. The possibility arises of crossing the light barrier while preserving the real value of mass and, in a sense, connecting the sublight and superlight worlds.

In other words, bodies can move at superluminal speeds while still possessing a real mass. Rest mass—both before and after the light barrier—is, like all other quantities, a complex quantity. This is the difference between complex-valued SRT and traditional SRT, in which superluminal tachyons possess an imaginary rest mass.

The graph (Fig. 2) shows that the energy of the “complex-valued tachyon,” just like that of the “classical tachyon,” decreases as its velocity increases in the initial region after reaching a certain velocity $\text{Re}c = 3 \cdot 10^8 \text{ m/s}$. As the real part of the velocity of light continues to increase, the energy may level off.

In the standard STR tachyons remain hypothetical objects—their existence has not been confirmed experimentally—but they help explore the limits of the applicability of physical theories (such as the special theory of relativity) and are used in models of quantum physics and string theory. So, in the complex-valued world, these superluminal objects have just as much a right to real existence as subluminal objects.

5. Conclusion

Thus, to construct the special theory of relativity, the second postulate effectively requires the principle of the invariance of the speed of light, but not the principle

of the finiteness of the speed of light. The principle of the finiteness of the speed of light apparently arose later, during the interpretation of the relativistic root. In this process, arguments regarding the competing concepts of long-range and short-range interactions were invoked. In a complex-valued world, the speed of light in the second postulate of SRT should be understood as its complex value, while the real value of the speed of light, as shown in Figures 2 and 3, successfully overcomes the light barrier. For example, for the values of the imaginary parts of the quantities in (7), this complex value of the speed of light is:

$$c = \text{Re}c + i \cdot \text{Im}c = \text{Re}c + i \cdot 10^{-4} \cdot \text{Re}c \quad (8)$$

In other words, the theory of relativity does not require the speed of light to be the ultimate limit, and in a complex-valued world, bodies can move at superluminal speeds while still possessing real mass. We must be prepared to discover superluminal speeds in nature. Since the imaginary parts of quantities are inaccessible to humans, we cannot influence their magnitude and cannot engineer superluminal motion. Rest mass, both before and after the light barrier, like all other quantities, is a complex quantity. This is the difference between complex-valued SRT and traditional SRT, in which superluminal tachyons possess an imaginary rest mass.

A similar problem arises with photons. Since the relativistic mass of a photon (6) moving at the speed of light c tends to infinity, the rest mass of the photon was assumed to be zero. Although this resulted in an indeterminacy of $0/0$, which still needs to be resolved, this was not done, and the assumption of a zero rest mass for the photon was adopted. In a complex-valued world, it turns out that with appropriate imaginary components, for example (7), the mass of a photon can be a finite quantity. In other words, the imaginary components of a complex-valued world can transform a particle (object) from the status of a boson to that of a fermion. If the motion of photons (light) is described by Maxwell's equations, and the motion of a photon is described within the framework of quantum electrodynamics, then the motion of a

fermion is described by the Schrödinger equation in the non-relativistic case and by the Dirac equation in the relativistic case.

In a complex valued world (in a biocentric Universe), under the influence of the World Mind, the various branches of knowledge accumulated by humankind can come together and merge in remarkable ways. The World Mind keeps all phenomena within its field of vision and allows us to move from one piece of the mosaic to another.

6. References

1. Lyahov, V. V., Nechshadim, V. M. Complex numbers and physical reality. arXiv preprint physics/0102047. 2001.
2. Lyahov V.V., Neshchadim V.M. Models of Plasma Kinetics and Problems with Their Interpretation in the Current Paradigm, Nova Science Publishers, Inc., NY., 2018.
3. Lyahov V.V., Neshchadim V.M. Complex-valued physics: plasma waves. Horizons in World Physics, v. 312, Nova Science Publishers, Inc., NY., 2024.
4. Lyahov V.V. Physics is the science of inanimate nature. And if nature is alive!? Journal of Religion and Theology, V. 7, I. 23.05. 2025.
5. Lyahov, V.V. On the Complexification of Physics: Toward a Theory of the Moon's Motion. Trinity Academy, Moscow, El No. 77-6567, Pub. No. 29668, September 21, 2025, in Russian.
6. Lyahov V.V. Biocentric Universe, Non-Archimedean Complex Number Axis, Laws of Conservation. Journal of Religion and Theology, V. 7, 4. 01.12. 2025.
7. Lyahov V.V. In a Biocentric Universe, there is no such thing as "Dark Matter." The Plasma and Mind of the Biocentric Universe. Journal of Religion and Theology, V. 8, 2. 01.05. 2026.
8. Einstein, A. Zur Elektrodynamik der bewegter Körper. Ann. Phys., 1905, 17, 891-921.
9. Levich, V.G. Course in Theoretical Physics, Vol. 1, Fizmatgiz, Moscow, 1962, in Russian.