The nature of the speed at which light propagates

Absolute and relative speeds
of the n-wave level of the Universe

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1. Introduction

Thanks to the Dynamic Model (DM) of elementary particles, the *true physical meaning* of a number of fundamental parameters-constants *known in physics*, including the speed of light "*c*", was revealed.

It turned out that the speed, equal to $2.99792458 \cdot 10^{10}\ cm \cdot s^{-1}$, is the *basic speed of the wave exchange* of matter-space and motion-rest (*matter-space-time*, for short) at the atomic and subatomic levels. And in a broader sense, the speed "*c*" is the *fundamental period-quantum* of the speed field of the material-ideal exchange of matter-space-time and the *modulus* of speed of an *arbitrary level* of the basis-superstructure of the Universe.

The disclosure of the physical meaning of the speed "*c*" helped to clarify its role in the famous formula for the equivalence of the mass and energy of particles $E = m_0 c^2$.

How we came to an understanding of the role of the speed of light "*c*" in this formula, as well as to reveal the broader physical meaning of this speed, as a fundamental period-quantum of speed in the Universe, is shown in this work.

2. Dependence of the internal energy of particles on the speed of light

The speed of light "c" is included in the famous "relativistic" expression for the energy of a moving particle, $E = mc^2 = \dfrac{m_0 c^2}{\sqrt{1 - \upsilon^2 / c^2}}$, where m_0 is the so-called *rest mass* of the particle. For the case of a particle at rest, $\upsilon=0$, this expression determines the *internal energy* of the particle

$$E = m_0 c^2. \tag{1}$$

Equality (1) is considered in physics as the *principle of equivalence* of mass and energy. This principle was first formulated in a *universal form* by Albert Einstein in 1905.

Before Einstein, the concept of the relationship between energy and inert properties of a body, depending on its mass, was developed in the works of a number of other researchers. The following famous scientists were involved in the discovery of the formula $E=mc^2$: Heinrich Schramm (1871), Nikolai Umov (1873), and Oliver Heaviside (1889). Heaviside gave the formula a modern form.

The relativistic expression for the energy of a moving particle was obtained as a result of transformations of *mathematical spaces* (fictitious, empty). Therefore, the nature of the dependence of the *energy* of a body *at rest* on the *speed* of electromagnetic *waves* (light) propagating in the surrounding space was not understood and remained until now, namely, until the discoveries made within the framework of the theory of DM on the wave nature of the origin and behavior of elementary particles, an *insoluble riddle* that physicists never tried to solve. And still, they do not try to do it.

More than a hundred years have passed since the appearance of formula (1). However, adhering to the existing fully formed ideas about the structure of elementary particles (Standard Model), and as a result, not knowing the true nature of the speed with which, in particular, light propagates, and not understanding the role of this speed in the formula, physicists, nevertheless, do not raise a discussion on this topic, generally avoid discussion.

The question is not asked, what is the nature of the relation between the rest mass of a particle m_0 and the speed of light "c", which, as follows from (1), determines the huge value of the internal energy of a particle at rest? Although it should be clear, knowing the answer to this question is fundamentally important for understanding the true nature (internal structure) of the "elementary" particles that make up bodies.

Indeed, why exactly the *speed* of light "c" - the speed of propagation of light waves - plays the *main determining role* in the value of the *internal* energy of a *motionless* particle?

Why are two **qualitatively different** parameters, "c" and m_0, **characteristic** for **different levels** of the Universe, **subtle-material** and **dense-material**, that is, respectively, for *fields-spaces* (electromagnetic waves, "c") and *micro-* and *macro-formations* (material objects, m_0), determine the *internal energy* of particles?

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Modern physics states only the existence of an *inextricable relation* between the *internal energy* of a particle and its *rest mass m_0*. And the speed of light squared c^2, although it is another physical parameter from the physical parameters included in the formula $E = m_0 c^2$, which are *equivalent in influence* on the value of internal energy, unfortunately, is considered simply as a *coefficient of proportionality* [2].

And this, without hesitation, is taken for granted, without any explanation, without giving the term c^2 in formula (1) at least some physical content, without justification, for what such reason, the **physical parameter**, the speed of light squared, became called as the **coefficient of proportionality**, and why it is still considered as such.

This natural question has not been raised and is not being raised to this day, although knowledge the answer to it is extremely important for understanding the reason for the dependence of the internal energy of particles on the speed of light, isn't it?

Indeed, the presence of a **physical parameter** in any **physical** formula has a definite **physical** meaning. For example, in classical mechanics, the kinetic energy of a body is equal to $E_k = mv^2/2$ and v^2 is a parameter that characterizes the motion of a body, that is, it has a quite definite physical meaning, characterizes its speed. And it never occurred to anyone to call speed a coefficient of proportionality, since that would be sheer absurdity.

Therefore, it is obvious that the presence of the *speed of light* in the formula for the **internal energy** of a particle (1) unambiguously indicates that the processes occurring in the particles are natural for them, precisely at this extremely high speed ($\approx 3 \cdot 10^{10}\, cm \cdot s^{-1}$!). What are these mysterious dynamic processes taking place inside the particles that determine the enormous value of their internal energy?

The reason for the lack of an answer to this question, as well as to the question "why", this problem has not caused and still does not cause due interest among physicists, in our opinion, is **associated** with those **subjective ideas** about the **structure of elementary particles and atoms**, which were proposed by physicists in the study of behavior these micro-objects as new experimental data are obtained and the need to explain them.

Namely, all the hypotheses put forward about the structure of atoms and particles included in them were based and are based on an **inadequate paradigm**, which the theories of **modern physics** still **adhere to**. The main concepts of this paradigm were considered by us in [1, 3]. Let me remind you the meaning of its main components.

The **philosophical basis** of modern physics is **materialistic** one-sided **ideas** about the structure of the Universe, which do not take into account the **dual nature** of the World, as well as **adherence to formal** (metaphysical) **logic**.

As a **method** of choosing basic concepts for hypotheses, and with them any theory begins, the **game of imagination** is adopted in physics – an arbitrary introduction as a theoretical basis of **abstract-mathematical postulates**. *Quantum mechanics*, for example, is based on seven postulates!

Let us briefly consider the essence of the concepts of the structure of atoms that have existed in physics until now. Let's start with the idea expressed by J. Thomson, and then subsequent ones, up to the modern concept of the structure of atoms that dominates in physics.

3. Models of the structure of the atom

The first model of the atom was proposed by **J. Thomson** in 1904. According to this hypothetical model, an atom is a positively charged sphere with electrons embedded in it.

Further, in 1911, **E. Rutherford** put forward a hypothesis according to which the positive charge and practically the entire mass of an atom are concentrated in a small part of its volume – the nucleus, around which electrons move.

In 1913 **N. Bohr** in the development of Rutherford's ideas proposed his theory of the structure of the atom – the *planetary model*. This model is based on two postulates, according to which an electron can rotate around a nucleus only in certain stationary orbits. While in these orbits, it does not emit or absorb energy.

And in 1905, when the *principle of equivalence* (formula (1)) was formulated, and in subsequent years, the question posed above about the *influence* of a speed equal to the speed of light on the *internal energy* of particles did not arise. It seemed, apparently, absurd to make such an assumption due to the unreality of the indicated influence in atoms, the structure of which was represented by the above hypothetical models.

The *modern* model of the structure of the atom is *quantum mechanical*. It is based on the **Schrödinger** wave equation, which he *postulated* in 1925, and on other *postulates*. From the previous models, the modern atomic model has left only the *atomic nucleus*. The idea that the atomic nucleus consists of *protons* and *neutrons* was first expressed in press by **D. D. Ivanenko** (1932) and immediately afterwards developed by **V. Heisenberg** (1932).

The constituent parts of the nucleus – *protons* and *neutrons* (united under the general name *nucleons*) – were accepted to consider to be composed of *quarks*, hypothetical mystical particles proposed in 1964 by **M. Gell-Mann** and **J. Zweig**.

Fictional particles – *quarks* – formed the basis of the modern *Standard Model* (SM) of elementary particles.

4. Standard Model of elementary particles

The SM was developed within the framework of *quantum field theory* (QFT), consistent with both *quantum mechanics* and *special relativity*. But the SM is inconsistent with *general relativity*, which describes gravity. The CM cannot combine theories describing *strong*, *weak* and *electromagnetic* fundamental interactions with the theory describing *gravity* (i.e., with general relativity).

Obviously, it is impossible *in principle* to create an adequate general field theory ("theory of everything") on the basis of the above theories, which are built on abstract-mathematical postulates. Therefore, the ending to which physics has come is natural.

For these and many other reasons, it is widely accepted that CM "*will not be the final theory*" and "*any efforts should be undertaken to finds hints for new physics*" [4].

Experimenters and theorists around the world are actively trying to find ways to go *beyond* the *modern paradigm* of *elementary particle physics*, but they just can't find it. Why? The answer, in our opinion, is also very simple.

There are many ideas for improving and even replacing the CM. According to credible theorists, the most promising theory in this direction is string theory and its derivatives.

In the SM, particles are considered points. In string theory, "string" is the only fundamental building block for all particles. There are various string theories, including superstring and heterotic string theories. There is also a generalized string theory called M-theory, which unites all string theories. M-theory holds that all matter in the Universe is made up of combinations of tiny membranes, etc.

However, string theories are far from complete, if ever; many problems with their development still remain open. Moreover, on the way of developing these theories, new problems appear and pile up over time.

In our opinion, all the efforts of theorists are doomed to failure as long as they continue to adhere to the same inadequate paradigm common for all physical theories, the essence of which is mentioned above.

In accordance with the Standard Model, in elementary particles consisting of quarks, no dynamic processes occur with a speed equal to the speed of light "c". The speeds of movement of nucleons in the nucleus are considered small, on average about $0.1c$.

Therefore, for the SM, the question posed above about the effect of the speed of light on the internal energy of particles is also *inappropriate in principle*. There is nothing to discuss if we adhere to the SM of the structure of elementary particles, which dominates in physics.

Thus, the physical parameter c^2, accepted as the coefficient of proportionality in formula (1), continues to be considered as such until now.

Apparently, one does not want to *revise* the basic concepts accepted in physics, and, consequently, most of the key branches of physics, following which physicists with enormous efforts for more than 100 years have created modern theories of the structure of the *atom*, *atomic nucleus*, *elementary particles* and other theories.

However, we will still have to reconsider them. With the understanding of their limiting role for the development of physics, the established dubious ideas will be discarded. This process has already begun.

5. Dynamic Model of elementary particles

To solve the problems considered here and other problems accumulated in physics, it is necessary to get rid, as follows from the above, from the existing model and the usual theoretical ideas about the structure of elementary particles, since these ideas are based on fictional abstract-mathematical postulates. This is what we did.

As follows from the data obtained over the past decades, a promising theory, "*hints for new physics*" [4], is the Dynamic Model of elementary particles (DM) [5, 6].

The DM theory is a part of a new general theory of physics developed by us – the Wave Model (WM).

WM *adheres* to the *adequate paradigm* considered in [1, 3], proposed to replace the existing one, inadequate. Its essence, in short, is as follows.

In accordance with the WM, the philosophical basis of physical theories should be adequate to reality. This criterion is met by *dialectical philosophy* and *dialectical logic* – *dialectics*. The latter is in the basis for the WM.

Dialectics considers the Universe as a binary material-ideal system, in which there is a unity and an inextricable relation between the *ideal* (*immaterial*, *spiritual*) and *material*.

Naturally, the *method* of choosing *basic concepts* for hypotheses and theories should be, respectively, a *dialectical approach*, which consists in reconciling the adopted basic concepts with the concepts of *dialectical philosophy* and *dialectical logic*. The dialectical method does not allow the introduction of any abstract postulates, that is, it excludes subjectivism and fantasy.

According to the DM, elementary particles are *pulsating* micro-objects formed during the *densification* of a *subtle-material* wave *vortex* field-space. This means that the particles are *dynamic*, not static *formations*. Being an interference micro-formation of a wave field-space, a local three-dimensional vortex, an energy bunch, a particle is essentially a spherical *micropulsar*.

For example, the proton (the most stable elementary particle), a continuously pulsating wave formation, is a vivid example of a "perpetual motion machine" created by nature itself from a wave vortex field-space and "fed" by the energy of this space during its long existence. According to some data, the lifetime of a proton is about 2.9×10^{29} years [7].

Within the framework of the DM wave concepts, a number of key discoveries have been made, including the discovery of previously unknown fundamental parameters-constants – fundamental frequencies, ω_e и ω_g, which determine the course of processes in Nature, respectively, at the atomic and subatomic and mega (gravitational) levels [1].

DM also found out the unknown earlier true essence (nature) of formula (1) $E=m_0c^2$ [2]. Logically and consistently revealed the nature of the speed with which light propagates, and its role in this formula.

And also, together with the theory of the Shell-Node model of atoms, DM revealed the nature of a number of other fundamental parameters-constants known to physics, in particular, the mysterious nature of the so-called fine structure constant "alpha" (α) [8].

6. The nature of the speed with which light propagates

Excitations of the surrounding space, generated by the *pulsations* of the *wave spherical shells* of particles at a frequency $\omega_e = 1.869162214 \times 10^{18}\, s^{-1}$, *propagate* with the *basic wave* (phase) *speed* "c" equal to the speed of light.

At *this speed* at the *frequency* ω_e, which is the *fundamental frequency* of the atomic and subatomic levels of the Universe, the continuous wave exchange of *matter-space-time* with other particles and with the surrounding field-space takes place.

Thus, it follows from the DM that the physical constant "c" is one of the fundamental constants (parameters) of particles along with such fundamental constants as the *associated mass* of a particle m and its *exchange* ("electric") *charge q*.

Formula (1) determines the *internal dynamic energy* of *pulsating* microformations, which are particles of the subatomic level.

So, the DM theory solved the problem, explained the physical meaning of the product of mass by the square of the speed of light in the aforementioned expression (1), and clarified the role played by the speed "c" for the internal energy of the body.

Additional data on the formula $E = m_0 c^2$ are contained in [2]. In particular, this work contains a derivation of this formula based on the concept of the binary nature of wave motion as a mass process that occurs simultaneously at two levels: the level of the basis and the level of the superstructure.

7. Fundamental period-quantum of the field of speed of exchange

Taking into account that the *speed of light* is the *basic* (beam) *speed of the wave process*, let us consider the physics of mutual *transformations* of the *basis* and *superstructure*, for example, in the wave process at the *galactic field level* [9].

We believe that the *propagation* of waves (including the light range) with the *basic speed "c"* occurs similarly to the propagation of any material waves, for example, sound waves in an ideal gas. And the *absolute speed* of each object is a *multidimensional* (multilevel) *speed*, regardless of any reference frames, since it is determined by the speeds at all interconnected levels (micro-, macro-, mega-) in the Universe.

During a certain period of time, for some reason, the beam speed of the basis wave may increase. The latter does not affect the *total energy* of the wave system, which remains *equal to zero*. This is due to the fact that in the process of raising the field of motion, the rest field also increases by the same amount. Indeed, an additional *increase in kinetic energy*

in Nature is *compensated* by an *increase in potential energy* by the same amount, but opposite in sign.

When the beam speed reaches the speed of light "*c*" and exceeds it, the *superstructure begins to form*. The latter is realized in the form of *two mutually perpendicular longitudinal-transverse* waves of the oscillatory type.

The *resulting speed* of such a system, as the vector sum of the *initial speed "c"* of the beam and the *additional* speed of the *superstructure* υ, forms a *helical cylindrical* wave (Fig. 1) with a right or left *spiral* trajectory.
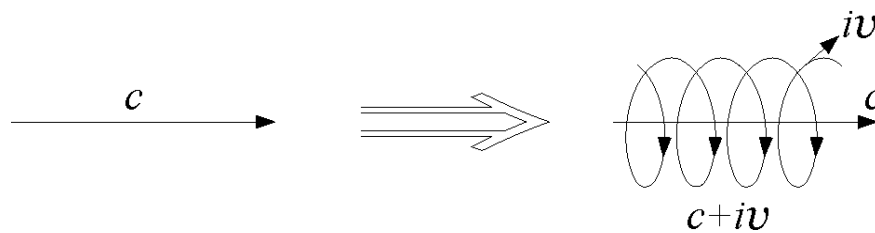

Figure: 1. Conversion of radial velocity "*c*"; $i\upsilon$ – circular frontal speed.

Thus, when the superstructure is formed, the *beam speed* of the wave is *converted* into a *helical* speed. Consequently, the *absolute speed* of an object-satellite moving along a helical trajectory will be equal to

$$\hat{C} = c + i\upsilon, \tag{2}$$

where $i\upsilon$ is the *frontal kinetic* speed of the *superstructure*, which negates the base speed. And the *speed module* is

$$\left|\hat{C}\right| = \sqrt{c^2 + \upsilon^2}, \tag{3}$$

In turn, when the *frontal speed $i\upsilon$*, like the *beam* speed υ, exceeds the speed of light "*c*", that is, the *superstructure wave* becomes the *base wave*, another superstructure appears, etc. As a result, the *absolute speed* of the *n*-wave level of the Universe takes the following form

$$\hat{C} = nc + i\upsilon. \tag{4}$$

The above allows us to assert that the *speed of light* "*c*" is the *fundamental period-quantum* of the speed field of material-ideal exchange of matter-space-time and the speed modulus of an *arbitrary level* of the basis-superstructure is determined, with an accuracy of the period "*c*", according to formula (3).

At significant *absolute* speeds, the mutual speed of the nearest galaxies can reach speeds comparable to the period-quantum of the speed "*c*", as is observed in astronomy. Apparently, the motion of galaxies with approximately light speeds is partially *closed* on the wave motion of the microworld *basis*.

8. Conclusion

So, thanks to the **Dynamic Model**, the following is established:

1) Speed "c", equal to $2.99792458 \cdot 10^{10}\ cm \cdot s^{-1}$, is the **basic speed of propagation of waves generated** by the wave spherical **pulsating shell** of particles in the surrounding field-space.

The basic speed "c" is a **fundamental** physical **parameter of particles**, and along with their mass **determines the internal energy** of particles $E = m_0 c^2$.

2) Speed "c" is the **fundamental period-quantum** of the speed field of the material-ideal exchange of matter-space-time.

3) The **absolute speed** of the n-wave level of the Universe is $\hat{C} = nc + i\upsilon$.

4) The **modulus of speed of an arbitrary level** of the basis-superstructure is $\left|\hat{C}\right| = \sqrt{c^2 + \upsilon^2}$

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