Wave Model as a Physical Basis of an Algebra of Bio- and Nano- structures

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***Abstract* – Bio- and nano- structures have a feature in common – both display a long-range order over the distances significantly larger that the dimension of atom. While this cannot be explained on the basis of the Bohr atom model or quantum mechanics, the formation of complex long-range order structures can be explained in terms of wave model - waves spread all over the universe and can form complex interference structures. The set of waves can be considered as a universal algebra's generating basis, and the long-range structures can be regarded as elements of this algebra, generated by the set of waves. However, the wave model presupposes the existence of a carrier wave medium. To resolve the apparent contradictions with modern physics, it is shown that the wave model is consistent with the theory of relativity and Maxwell's equations. The last part is devoted to discussion of the stability mechanism of spherical waves and pathways formation of complex ordered structures.**

***Index Terms* – bio-structures, carrier of waves, long-range order, nanostructures, wave model.**

I. INTRODUCTION

Bio- and nano- structures share a common property – the long-range order over the distances significantly greater than the dimension of atom. So, for example, a snowflake is gigantic as compared with an atom, but it has a strikingly regular form. Even more amazing are the biological structures where the nature manages to pack up the information about a very complex organism into a tiny cell.

The phenomenon of long-range order cannot be understood within the realm of Niels Bohr's model of atom. Neither quantum mechanics can offer a satisfactory interpretation of this phenomenon. On the other hand, the wave model produces amazing results in the explanation of the complex order structures formation. The reason for this is that the waves, spreading over all the Universe and lasting forever, can really form complex interference structures. Also, the "primary elements", making up the "generating basis" of these structures are waves, which are described in terms of simple functions, and the interaction between which can be described in terms of certain rules. This approach allows us to describe objects with complex structure, proceeding from the most simple postulates and rules of inference and such a method is a manifestation of reduction of complexity. Engineering disciplines have accumulated rich experience how to build complex systems based on simple elements.

Thus, the world of computers and computer programs is based on operations over only two logical entities, *unity* and *zero* (or *true* and *false*), and this apparatus is sufficient to manage information of unlimited complexity. Boolean algebras are sufficient for modeling the World, but they are not the only ones to offer a modeling framework. The information we receive by phone, radio or TV, no matter how complex, can be mathematically represented as a function of time. Any function of time can be represented as a sum or as an integral of a set of simple functions of time, where the most convenient for this purpose are the harmonic functions. The representation of a function of time as a sum of harmonic functions is termed *Fourier decomposition* or *Fourier analysis*. The signal processing theory is based on Fourier analysis and, as a matter of fact, Fourier analysis is the theoretical basis of Radio and TV domain. The benefits from the application of Fourier analysis are that it is sufficient to explore the behavior of one sinusoidal component in order to draw conclusions about the behavior of functions of arbitrary complexity. The inverse process is also possible: by selecting an appropriate sum of sinusoidal components, it is possible to synthesize practically any function of time.

Similarly, any function which depends on spatial coordinates can be decomposed in harmonic functions. Mathematically, a hologram represents such a decomposition of an image into harmonic functions. By means of a hologram, it is possible to obtain a visual image of an object indistinguishable from the object itself. The idea to combine the decomposition into harmonic functions of time with the decomposition into harmonic functions of spatial coordinates comes up naturally. Such a combination would result in moving images which, ideally, would be identical with their originals.

Thus, an image of reality can be synthesized out of sinusoidal functions which depend simultaneously on temporal and spatial coordinates. These functions of space and time represent the waves. It is appropriate to say that harmonic functions, i.e. waves, represent a set out of which it is possible to synthesize any function of space and time. On the other hand, from a formal point of view, the objects surrounding us are also functions of space and time, as they are characterized by positions and dimensions which change in time. In other words, harmonic waves can be described as a certain set on the basis of which it is possible to simulate the world.

In study of the fundamental fields, quantum mechanics, or the theory of relativity, we easily come to understanding that all physical phenomena are related, in a way or another, to the wave processes. That is, wave processes are not just a tool for the formal description of the World similar to that by the Boolean algebras; wave processes have a much more

fundamental and intimate link with the physical reality.

The central issue arising in the use of such models is the existence of a carrier for the wave set. In case of Boolean algebras, this issue is resolved easily - everyone knows that this carrier is the computer, and without a computer no program can run. However, if we imagine that an artificial intellect residing in a computer attempted to solve the question of the existence of the carrier of Boolean algebra, such an intellect could not establish the existence of the computer. This is certainly true if the computer carries out only the operations of Boolean algebra and other parameters, such as the times of operations, are not provided. The idea stated here can be formulated the following manner: an intelligent agent residing on the carrier of the Boolean algebra would not be able to determine whether the carrier exists.

Reformulating the said above into the terms of wave functions, we can say that it is impossible to detect the carrier medium of the waves by using tools which, by their nature, are waves in the same medium. The electromagnetic waves and the fundamental particles can be transmuted into one another and those particles have wave properties. This raises the suspicion that both types of entities are waves in the same carrier medium. Hence, it is impossible to detect the carrier medium of the waves of matter by using tools built out of particles with undular properties. This is exactly the reason why the experiments aiming at the detection of a carrier for electromagnetic waves failed. But also, these experiments failed to prove the lack of a carrier medium of the waves in which we are concerned (including the electromagnetic waves). Actually, what such experiments could have demonstrated is the impossibility to detect the medium from within the medium.

The source of problems created by a medium-carrier is due to taking over the methods of hydrodynamics and acoustics into the theoretical considerations and practical experiments for detection of a medium-carrier. The tools used in hydrodynamics and acoustics are heterogeneous with respect to the medium. But such a method is not adequate for a medium of wave particles and fields, because both such particles and fields are also waves in the same medium. This idea will not appear crazy if we recollect that the fundamental particles of which we are made are also of a wave nature. Thus, it becomes obvious that, in order to work with a medium serving as the carrier of waves and fields, it is necessary to abandon the idea about "solid" tools and treat objects and tools on equal basis.

In order to overcome the difficulties which appeared in physics due to inappropriate treatment of tools as residing outside the phenomena, I have used a wave model [1], which is both an approach and a vision, according which the Universe is regarded as populated only by waves, so that the tools for measuring the attributes of one wave are other waves. The *wave model* implies consecutive development of methods allowing to use the waves as tools for examination of waves. Below we will try to explain these methods in brief and some of the results obtained by these methods.

II. WITHIN THE WAVE MODEL THE EXISTENCE OF MEDIUM-CARRIER FOR WAVES OF MATER DOES NOT CONTRADICT TO SPECIAL THEORY OF RELATIVITY

One of the objections against the existence of a medium to serve as a carrier for waves said to be “aether” was that, due to such a medium, it would be possible to select a distinguished frame of reference, and this would contradict to the principle of relativity and the relativity theory based on this principle. I will show below, that the existence of a wave medium-carrier or continuum does not contradict to special theory of relativity.

For description of physical processes, it is common to use a *frame of reference*, which is a system of spatial and time coordinates, with respect to which the behavior of bodies is described. A preferential role is played by the *inertial* systems of reference and one of the reasons for this is that the equations of motion in such systems are the most simple.

A frame of reference must contain scales for measuring time and length. Such scales consist of repeating intervals of time and length. A *standing wave* has the property of periodicity in both space and time and is described by an equation of the form

$$a = A\cos(-kx)\cos(\omega t). \quad (1)$$

Here, A is the amplitude of a parameter describing a wave (pressure, density, etc.), k is the wave number, and ω is the circular (cyclic) frequency. By choosing such a wave, we choose a metric, namely:

- The direction of the x-axis coincides with the direction of the wave propagation;
- The spatial scale is defined by the wavelength

$$\lambda = 2\pi / k;$$

- The temporal scale is defined by the period of the wave

$$T = 2\pi / \omega.$$

In other words, standing waves play the same role as rulers and clocks. If in a medium there is a wave-object described by the equation

$$a_0 = A\cos(-k_0 x)\cos(\omega_0 t) \quad (2)$$

then the measurement of its length in the frame defined by equation (1) consists in defining a number equal to the ratio of the length of the wave-object to the wave scale:

$$n = \lambda_0 / \lambda\,, \quad (3)$$

Similarly, a measurement of the period of the wave object consists in the definition of the ratio of the period of the wave object to the wave scale:

$$n = T_0 / T\,. \quad (4)$$

The wave object (2) can be decomposed into two waves running in opposite directions:

$$a_{01} = \frac{A}{2}\cos(\omega_0 t - k_0 x)\,, \quad (5)$$

$$a_{02} = \frac{A}{2}\cos(\omega_0 t + k_0 x). \quad (6)$$

If in the expressions (5) and (6), the frequencies and the wave numbers differ, so that that the correlations

$a_{01} = \frac{A}{2}\cos(\omega_{01} t - k_{01} x)$, and $a_{02} = \frac{A}{2}\cos(\omega_0 t + k_0 x)$,

where $\omega_{01} \neq \omega_0$ and $k_{01} \neq k_0$, the wave-object can be described by the equation:

$$a_0 = a_{01} + a_{02} = A_0 \cos\left(\frac{\omega_{01} - \omega_0}{2} t - \frac{k_0 + k_{01}}{2} x\right) \times \cos\left(\frac{\omega_{01} + \omega_0}{2} t - \frac{k_0 - k_{01}}{2} x\right). \quad (7)$$

This equation describes a standing wave in which the

maxima move with time. We shall term such a wave 'quasi-standing'. Thus, the parameters

$$\omega' = \frac{\omega_{01} + \omega_0}{2} \quad \text{and} \quad k' = \frac{k_{01} + k_0}{2}$$

can be perceived as the frequency and wave number of the moving wave-object (7).

The term $\alpha = \frac{\omega_{01} - \omega_0}{2} t$ in the first factor defines phase displacement of wave-object along the spatial coordinate *x*, and $\theta = \frac{k_0 - k_{01}}{2} x$ in the second factor, defines a retardation or phase displacement along the temporal coordinate. Then the displacement of the wave-object along the coordinate *x* for the interval Δt will then be

$$\Delta x = \frac{\omega_{01} - \omega_0}{k_0 + k_{01}} \Delta t.$$

Hence, the velocity of displacement of the wave-object is equal to

$$v_0 = \frac{\Delta x}{\Delta t} = \frac{\omega_{01} - \omega_0}{k_0 + k_{01}}. \tag{8}$$

Since

$$\omega = \frac{2\pi}{T}, \quad k = \frac{2\pi}{\lambda} \quad \text{and} \quad \frac{\lambda}{T} = \frac{\omega}{k} = c,$$

the equation (8) can be rewritten equivalently as:

$$v_0 = \frac{\lambda_0 \lambda_{01}}{T_0 T_{01}} \frac{T_0 - T_{01}}{\lambda_{01} + \lambda_0} = c^2 \frac{T_0 - T_{01}}{\lambda_{01} + \lambda_0} = c^2 \frac{k_0 - k_{01}}{\omega_0 + \omega_{01}}. \tag{9}$$

Recall that v_0 is the velocity of points with same phase move such as, for example, the maxima of a quasi-standing wave. The velocity v_0 defined by the equations (8) and (9) is related neither with the motion of the continuum, nor with respect to the continuum. But, in the absence of tools other than undular nature, only this velocity can characterize the motion of the wave-object (7).

If an observer moves with a velocity defined by equations (8) and (9), then from his/her point of view, the wave (7) will be a standing wave, and it will be described by an equation of the form (2) or by an equation of the form (1) if *n* = 1. Hence, in the system of a moving observer, this wave can be used as the wave which defines the frame. Thus, within the scope of our model, there can be a set of frames of reference that move relative to each other with different velocities, but all of them equal in rights.

Definition: a wave frame of reference is a frame of reference in which the period of a standing or quasi-standing wave at a fixed point serves as the scale of time, and the scale of length is the distance between two points with same phase.

As noted above, in an unlimited homogeneous medium no wave system offers any advantage above others. In other words, the principle of relativity is valid for the wave frames. However, there is one circumstance which can cast doubt on this statement. The velocity *c* of propagation of traveling waves described by the equations (5) and (6) is determined by the properties of the medium. Naturally, this suggests the idea to use a standing wave as a tool for determining the velocity *c* of a traveling wave. Then, knowing the velocity *c*, it is possible to determine the velocity of a wave frame relative to the medium. In fact, such an experiment would be similar to the experiment performed by Michelson and Morley in 1887 [2-4], in which an attempt was made to detect the velocity of the motion relative to the aether. If such an experiment would give a positive result, then this would allow to find the "true wave frame", in which the velocity of motion relative to the carrier medium is equal to zero. Such a system would be privileged in relation to other wave frames. In this case, the principle of relativity would not be fulfilled for the wave systems. Let us prove that this is not true.

*Theorem***:** the velocity *c* of a traveling wave has the same value in all wave frames.

We suppose that we have two wave frames, described by the following equations:

$$a = A\cos(-kx)\cos(\omega t). \tag{10}$$

and

$$a' = A\cos\left(\frac{\omega_1 - \omega}{2} t - \frac{k + k_1}{2} x\right)\cos\left(\frac{\omega_1 + \omega}{2} t - \frac{k - k_1}{2} x\right) \tag{11}$$

The velocity of relative motion of these systems is given by the equation:

$$v = \frac{\omega_1 - \omega}{k + k_1} = c^2 \frac{T - T_1}{\lambda_1 + \lambda}. \tag{12}$$

Let us suppose that some wave-object is at rest in the system defined by equation (11) and described in that system by:

$$a_0' = A_0 \cos(-k_0' x')\cos(\omega_0' t'). \tag{13}$$

The same wave-object will be described in a system defined by equation (10) as

$$a_0 = A_0 \cos\left(\frac{\omega_{01} - \omega_0}{2} t - \frac{k_0 + k_{01}}{2} x\right) \times \cos\left(\frac{\omega_{01} + \omega_0}{2} t - \frac{k_0 - k_{01}}{2} x\right). \tag{14}$$

Let us rewrite equation (14) taking the equation (12) into account:

$$a_0 = A_0 \cos\left(\frac{k_0 + k_{01}}{2}(vt - x)\right)\cos\left(\frac{\omega_0 + \omega_{01}}{2}(t - \frac{v}{c^2} x)\right). \tag{15}$$

The equations (15) and (13) describe the same wave-object. In equation (15), the value of $(vt - x)$ represents the instantaneous coordinate of the wave-object, as well as *x*' does in the equation (13). The transformation of lengths of line segments parallel to this coordinate should take place according to the same law as the transformation of this coordinate. Hence, the length of the moving wave-object (15) becomes $\lambda_0' = \lambda_0 - vT_0$, and its wave number becomes:

$$k_0' = \frac{2\pi}{\lambda_0 - vT_0}. \tag{16}$$

By applying similar reasoning for the frequency, we obtain:

$$\omega_0' = \frac{2\pi}{T_0 - \frac{v}{c^2}\lambda_0}. \tag{17}$$

The ratio of the circular frequency ω to the wave number *k* is equal to the velocity of the traveling wave *c*. Thus, the proof of the theorem formulated above is reduced to the demonstration of the relation

$$c = \frac{\omega_0}{k_0} = \frac{\omega_0'}{k_0'} = c'.$$

By using equations (16) and (17), we have:

$$c' = \frac{\omega_0'}{k_0'} = c^2 \frac{\lambda_0 - vT_0}{c^2 T_0 - v\lambda_0}.$$

With the help of equations (3), (4) and (12), we finally obtain: $c' = c$.

We have now proved that in a wave frame, the velocity c of a traveling wave does not depend on the choice of frame. Hence, the velocity of a traveling wave cannot be used for the definition of a velocity relative to the carrier medium, and all wave reference frames are equal in rights.

Thus, the use of wave frames leads us naturally to statements which serve as postulates for a special theory of relativity [5], namely:

- the relativity principle is valid: all inertial frames, i.e. systems which do not change their velocity, are equal in rights;
- the velocity of propagation of traveling waves in all inertial frames is the same.

From these postulates follow the Lorentz transformation laws which relate the length of a moving segment $\Delta x'$ and an interval of time $\Delta t'$ in its own frame of reference to the length Δx and an interval of time Δt in the laboratory system with respect to which it moves:

$$\Delta x' = \gamma \Delta x \qquad (18)$$

and

$$\Delta t' = \gamma \Delta t, \qquad (19)$$

Here $\gamma = \frac{1}{\sqrt{1-\beta^2}}$ and $\beta = \frac{v}{c}$.

The deductions of these expressions within the scope of wave model are given in the articles [6, 7] as well as, in a more elaborated manner, in the book [1]. From the given proofs, it follows that the Lorentz transformation laws are not related to the presence or absence of a carrier medium. Hence, presence of a medium-carrier of waves does not contradict to the special theory of relativity. Thus, it is possible to draw the conclusion that if also light and all the fundamental particles are waves in the same medium, then the existence of such carrier medium does not contradict to the theory of relativity. One more important consequence of the given reasoning is the conclusion that in different frames of reference the wave objects will look differently.

III. THE ELECTRICAL AND MAGNETIC FIELDS IN WAVE MODEL

The second serious argument against the existence of a medium-carrier for waves of matter emerged due to the failure of the attempts to get compliance between the properties of the electromagnetic fields and the properties of any medium. Maxwell used in his deductions a certain artificial model of the medium [8] which was too complex and improbable to be taken in serious. Here are the problems which arise in selecting a medium-carrier for the electromagnetic waves:

- The phenomena of polarization and other facts determine that light is transversal waves, but it is impossible to figure out a simple model of a medium with only transversal waves and no longitudinal waves; no longitudinal electromagnetic waves have ever been found;
- The velocity of electromagnetic waves (the light) is greatest possible; but from the theory of waves it is known, that it is the longitudinal waves which have the greatest velocity;
- If there existed a medium-carrier for electromagnetic waves (the aether) it would be possible to relate with it a distinguished frame of reference, and this contradicts to the principle of a relativity and relativity theory based on this principle;
- The experimental attempts to find a material carrier of electromagnetic waves failed.

On the basis of the arguments above, the point of view of [9] was accepted which sounds: 'The electromagnetic fields are not states of a medium, and are not bound down to any bearer, but they are independent realities which are not reducible to anything else, exactly like the atoms of ponderable matter'. This point of view was canonical until recently and it can be encountered practically in all textbooks on physics. However, such a vision does not reply to some questions, namely:

- There should exist a common approach to all types of waves irregardless of their nature, and it is certainly known that elastic waves are states of a medium and not 'independent realities which are not reducible to anything else';
- If the light gets from empty space into a certain transparent medium such as glass, it continues motion with smaller velocity, and it returns to previous velocity when it exists such medium. Hence, there should be a mechanism due to which the velocity of electromagnetic waves in vacuum has a constant value and it does not depend on the parameters of the electromagnetic waves, on their source, or on their history;
- To explain inertia and the effects of general relativity theory, it is necessary to assume that the vacuum is filled with some media (currently, this is supposed to be fields) [10];
- According to general relativity theory, the values of length and time depend on the magnitude of the gravitational field. The change of the scales of length and time in a gravitational field is referred to by the term 'curvature of the space–time continuum'. From this it again follows that the vacuum cannot be empty. The supposition arise that the electromagnetic fields and gravitational fields have something in common, i.e. that the 'gravitational aether' is somehow linked to the 'electromagnetic aether';
- The general relativity theory admits the possibility to create a relativistic propulsion device [11], which implies that vacuum is capable of exerting force and having inertia;
- Within the scope of accepted model of empty vacuum it is possible to understand the mechanism of repulsion, but the mechanisms of attraction are unimaginable.

Thus, the banishment from physics of a carrier for electromagnetic waves, did not solve the contradiction, but raised a series of new questions instead. In the book [7], I explained how it is possible to find answers to these questions and how to solve the problem about the wave medium-carrier in compliance with the Maxwell equations. I succeeded to prove within the scope of wave model, that the electromagnetic field is a property of an elementary medium-carrier. I proceeded from the following premises:

- There exists a continuous medium, which I termed continuum, in which there can be fluctuations in the form of drops in pressure and velocity;
- The only tool for examination of these fluctuations is the wave-tool representing a domain with a pressure (density) different from the pressure (density) within unperturbed

continuum.

On the basis of these premises it has been found out, how some wave-tool representing a surplus or a deficit of a continuum, will interact with drops in pressure and velocity in the medium. It turned out that the redundant quantity of a continuum in a wave-tool can be associated with an electrical charge, the pressure gradient - with an electric intensity, and the magnetic intensity – with the drop in velocity. It is shown, that the magnetic field is an effect of the relativistic contraction of the continuum from the point of view of a moving wave-tool. The proofs of these statements are not trivial; they can be found also on my site [12]. The relation between electric intensity **E** and magnetic intensity **B** is determined by Maxwell equations. The deduction of Maxwell equations, proceeding from the offered model, is also is given in my monograph [7]. It is necessary to emphasize, that Maxwell equations define the correlation between a pressure gradient and a drop in velocity of the medium, and not between pressure and velocity of medium as in the equations of acoustics.

IV. WAVES AS A BASIS FOR AN ALGEBRA OF THE REALITY PHENOMENA

In the formula (1) we did not impose any requirements on the amplitude and, thus, the obtained deductions will be valid for any amplitude, including the case when the amplitude is some function of spatial coordinates and time. The wave equation in spherical coordinates for a central-symmetric wave looks like this:

$$\frac{\partial^2(rp)}{\partial r^2}-\frac{1}{c^2}\frac{\partial^2(rp)}{\partial t^2}=0$$

The solution of this equation is, in particular, the harmonic (traveling), waves with the amplitude of pressure in the center p_A which can be described by expression:

$$p = p_A e^{i(-\omega t \pm kr)}, \qquad (20)$$

where the upper sign "plus" corresponds to the wave moving along the *r*, and the lower sign "minus" corresponds to a wave moving in the opposite direction. This solution coincides with the formula of the associated waves, which describe in quantum mechanics a free moving particle

$$\psi(r,t) = Ce^{i(-\omega t \pm kr)}. \qquad (21)$$

The explanations regarding the physical sense of a wave function and the amplitude can be found in any textbook on quantum mechanics and we will not go deeper into this topic. We will refer only to the quantum-classical correspondence principle [13, 14], according to which the physical phenomena in quantum mechanics are described by equations similar to classical mechanics with the only difference that classical parameters are exchanged with those of quantum mechanics. We will apply this principle in "to the contrary" manner. We consider a fundamental particle-wave (say, an electron) to be described by the sum of two traveling waves in continuum. These waves are harmonic and central-symmetric:

$$p = p_A \frac{e^{i(-\omega t \pm kr)}}{r}, \qquad (22)$$

where the upper "plus" sign corresponds to a divergent wave, and lower "minus" sign – to a converging wave.

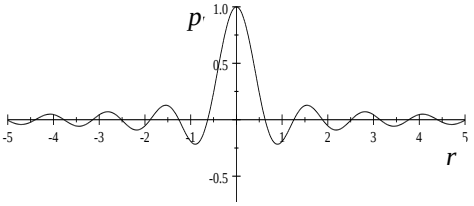

Fig.1. The diagram of function (23)

In case of the central symmetric wave the distinguished frame is the system bounded to the center of wave. The wave (22) can be rewritten in the trigonometric form:

$$p_S = \frac{p_A}{kr}\sin kr \sin \omega t, \qquad (23)$$

where p_A is the amplitude of pressure in the center of the spherical wave. The diagram of function (23) at $\sin\omega t=1$ is presented on fig. 1.

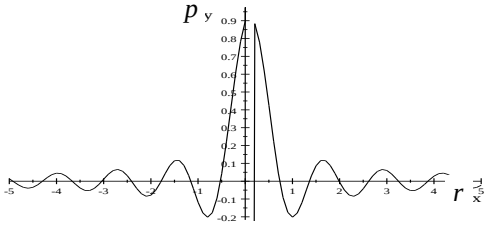

Fig.2. The diagram of function (23) at attempt to upset the balance between frequency and energy of a wave

This solution is unique among those, which do not have peculiarities at $r = 0$, while the oscillatory velocity is continuous and becomes zero in the center. The amplitude p_A / kr in the expression (8.15) defines the energy of a spherical wave, the factor $\sin kr$ defines a spatial distribution, and $\sin \omega t$ - the time dependence, while $\omega / k = c$. It means, that the expression (23) rigidly relates the energy of a spherical wave with its frequency. Any attempt to change one of these parameters leads to divergence (Fig. 2). This property of the function (23) is a key to the quantification riddle. According (23), the argument of sin and the denominator should be similar and such similarity should be absolute. The smallest difference conducts to divergence of the function p_S.

It is rather interesting, that this phenomenon is observed in technology as the *cavitation* phenomenon which destroys the screws of a ship. It is wrongly deemed, that cavitation is caused by bubbles formed due to a rupture of the medium, i.e. the consequence is taken as the cause [15, 16].

If two such stable spherical waves interact, the correlation between the argument of sin and p_A / kr are broken. The divergence is eliminated, if the interacting spherical waves reorganize so, that in their own frames of reference the correlation between the amplitude and the frequency is recovered. If with such reorganization a part of energy is radiated in the form of a traveling wave the resultant system becomes stable. For destroying such a system it is necessary the energy radiated at its formation to be returned. Thus, two spherical stable waves can form a stable system which, getting into a field of the third wave, or in a field formed by a collective state of several particles, can form a more complex stable state, and so on. We come to the conclusion that, the stable spherical waves form a set from which can be formed other stable states which also belong to set of stable waves. Out of these new states, other stable states which

belong to the same set can form and so on, ad infinitum.

The formulation above brings us to the idea that the waves can serve as elements of a carrier of a universal algebra. A universal algebra A = (*A*, *O*) is an ordered pair, where *A* is a set termed *carrier* of the algebra, and *O* is a set of operations of various *arity* (or, *rank*) over *A* with respect to which the operations is said to be "closed". Thus, the concept of *universal algebra* allows constructing a "closed world" of unlimited complexity. Within the context of this research, the term 'closed' means, that to build up a world of arbitrary complexity it is enough to proceed from elements of a chosen set, and this is the set of waves, which make up the set of generators of a universal algebra.

Similarity of the expressions (20) and (21) allows us to identify the fundamental particles with monochrome stable spherical waves in a continuum described by these expressions. It is known, that as a result of particles interaction, oscillatory systems are formed, which have spectrums of higher complexity. Even the atom of hydrogen consisting of three particles, i.e. proton, neutron and electron, already has a rather complex spectrum. The Plank constant serves as a coefficient in the relationship between energy and frequency. It is important to mention, that in the interaction of stable standing waves not only the amplitudes and frequency play a role, but also their phase, and this leads to indeterminacy of the relation.

It is necessary to remark, that in the formation of complex wave systems there exists a certain energy hierarchy: for creating or destroying complex wave systems, it is necessary less energy. The spectrums of simple oscillatory systems, atoms and molecules, are well studied. The offered algebraic approach is of interest at examination of the complex oscillatory systems in which the binding energy becomes comparable with the energy of fluctuations caused by thermal processes. The combination of stability of wave systems and fluctuations is a key to understanding of self-developing systems lying in the basis of life.

There is one more important circumstance related to wave systems, namely that the waves, basically outreach to the infinity. This means, that the wave systems can interact between themselves remotely, defining the structure of each other. This creates the probability of the reproduction (replication) of the wave systems in result of such actions. In my opinion, it is exactly this process which bears the key in the emergence of nanostructures and biological objects.

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