

The Problem of the Origin of Biologic Life and the Problem of Reductionism of Biology to Physics (Quantum Mechanics)

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Abstract

The problems of the origin of biologic life (beginning from genetics) and of the reductionism of biology on all the levels to physics, including quantum mechanics, are analyzed. We consider also the increasing of the discussions between the supporters of various meta-theoretical (semi-scientific and semi-philosophic) approaches to the problem of the origin of life – between the hypothesis of the self-organization of the matter from the lower levels into the higher levels and the hypothesis of the supreme intelligent design (of the creative force of the reality) in the origin of the alive (genetics). Finally, the research program for young researchers connected with the biophysical problems, typical for the alive organisms, is exposed.

Keywords: relationship between physics and biology; problem of origin of biologic life; reductionism

Introduction

There are a lot of attempts to explain scientifically the origin of the biologic life. And between them there is no succeeded attempt in explaining the origin of the biological life in terms of physics and other sciences (including mathematics and natural sciences). The first question in this problem is connected with the definition of the life: what is the difference between the alive and the non-alive?

We can initially indicate the most important peculiarity of the alive or living, beginning from the most visible ones, – the ordering and the metabolism (exchanging by the matter and information with the environment), and then note the self-reproduction (beginning from the alive cells) and the genetics with its capacity to mutations.

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This report is delivered basing on the continuation of the earlier author's paper [1] and partly also on the author's papers [2,3].

As to "great" and "grand" problems of physics. There is an extensive introduction in the large number of open problems in many fields of physics, published by V.L.Ginzburg in [4], which is rather interesting to study. Inside this large list of open problems of modern physics (and in a certain degree of modern natural sciences), represented by V.L.Ginzburg repeatedly in Russian editions, some of them are marked him "great" or "grand" problems. Between them there is the relationship between physics and biology and, specifically, the problem of reductionism.

The main problems in this great problem, according to V.L.Ginzburg, are connected with the explanation of the origin of the biologic life and *the origin of the human abstract thinking* (but the second one, as to me, is connected not with biology but with the origin of the human spiritual life which is far beyond natural sciences). V.L.Ginzburg assumes that for a possible explanation of the origin of the biologic life one can naturally imagine a certain jump which is similar to some kind of phase transition (or, may be, certain synergetic process). But there are other points of view too.

More detailed comments on the complex of problems connected with the origin of the biologic life. Now let us analyze, in a condensed way, one of the great natural problems marked in [4] – *the problem of the reductionism of biology to physics* (including, first of all, the problem of the physical and chemical explanation of the origin of the biologic life).

Explanation of the origin of the biologic life in terms of physics and, in general, of natural sciences \leftrightarrow there is an initial problem of the origin of the genetics, genetic code (or at least a small set of several codes) which is unique for all the terrestrial biosphere, and the defense mechanisms for the defense of the organism development during cell reproduction,...

\leftrightarrow there is an inevitable choice (dilemma): *either* a natural process like a certain jump which is similar to some kind of natural phase transition in the matter (or like to synergetic process, or even like the irrational many-world interpretation), *or* a supreme intelligent design of a creative basis in the being (or a Creator).

Any attempt of the natural origin is failed. And not only because the self-origin of only one self-reproducing cell has not a scientifically reliable explanation in the limits of the modern physics (the probability of the chance formation of the protein configuration, containing still **500** nucleotides, is extremely small, i.e. near $1/10^{950}$, and for the cell formation it is necessary at least **250** different proteins). There are no scientific explanations yet even for the following facts and no answers for the following problems:

How a numerous quantity of the chemical reactions could take place in a very limited space volume for create one protein molecule?

How there were created the conditions, which were necessary for uniting some components and at the same time were unfavorable for uniting other components, and how then the successive creation of a protein (or RNA or DNA) molecule can happen?

If even a principal possibility of the formation of the simplest protein components (DNA) had been shown in the known Oparin, Miller (etc) experiments under the special laboratory conditions, all the same it is very remote from the conditions of the primordial earth or of the unstable cosmos. So, no terrestrial or cosmic origin of cells (moreover, with the genetic structure) are impossible!

And how one can explain that

(a) The genetic information in the DNA can be read only by the specific ferments, for the creation of which the special information is also coded in the DNA.

(b) The biochemical process of the protein synthesis is the most complicated process between all known biochemical processes in the cell, and also some protein is already necessary for the protein production.

Then, the genetic code is beforehand required for the information transfer from the DNA to the protein, and such code is almost universal for the whole terrestrial biosphere.

c) And finally, the genetic code has the vitally necessary control system, which is, in its turn, is coded in the DNA.

It is impossible to explain all these facts in the natural way.

(d) And how one (or almost one) main genetic code for the whole terrestrial biosphere had been originated?

Nobody could elaborate somehow working model of the origin of even one self-reproducing cell yet.

The first main part of this problem of the origin consists in the absence of the answer to the following question: *how* had been originated the conditions, which are vitally necessary for living systems now, during that time when the life had been absent but which are created by only living systems! So, it is absolutely unclear: what had been earlier – habitat with is necessary for the life, or the alive organisms in the medium which had not supported the life.

The second main part of this problem consists in the mystery of the origin of the enormous quantity of the coded genetic information with the presence of the special uncoding mechanism.

Finally, there is no doubt that *the whole terrestrial biosphere is a wonderfully balanced eco-system of the irreducible complexity and integrity*. The interaction of all its components (flora, fauna, micro-organisms and habitat) is such that the disappearance of even if one of them will bring to the disappearance of the whole biosphere.

So, it is not surprising that during the last ten (or somewhat more) years the number of scientific papers dedicated to the critics of the natural evolutionary biologic and pre-biologic theories has become to increase [5-8].

There some, may be, naturalists who do still hope that certain unknown synergetic processes can initiate the self-organization of the non-living matter into the alive organisms.

But now it is known (see, for instance, [9]) that all concrete macroscopic systems with known history of their origin, which are more highly ordered than their environment, were created not by rare occasional fluctuations, but under the direct influence of external forces or as a result of bifurcations caused by some non-linearity and external forces in the open systems.

Moreover, I. Prigogine denied that revealed by him processes of local decreasing of entropy can explain the origin of the alive from the non-alive [10]: “The point is that in a non-isolated system there exists a possibility for formation of ordered, low-entropy structures at sufficiently low temperatures. This ordering principle is responsible for the appearance of ordered structures such as crystals as well as for the phenomena of phase transitions.

Unfortunately this Principle cannot Explain the Formation of Biological Structures”.

Returning to the *direct* analysis of the problem of the reductionism of biology to physics in the narrow sense (“if the biology (at least molecular biology and genetics) can be totally explained in terms of physics (and chemistry)”), I can recommend to pay a particular attention to the discussion on the special problem of the principal possibility of the explanation of the cell self-reproduction in terms of quantum mechanics, initiated by E. Wigner [11], then continued by M. Eigen [12] and afterwards analyzed by M.V. Vol’kenstein [13].

Firstly, Wigner *ab initio* considered (see, for instance, [11]) that the spontaneous self-appearance and spontaneous *self-reproduction of even simplest biologic macro-molecules and one-cell organisms do evidently contradict to quantum mechanics*, namely which describes the casual probabilistic currency of events (in the standard Copenhagen interpretation). He had shown that the probability of the existence of self-reproducing states is practically equal to **0**, with the help of the following considerations:

The complicated system, the evolution of which is supposed to occur by itself casually, can be described by the Hamiltonian, being a stochastic symmetric matrix like $H_{mn} = H_{nm}$ with the statistically independent elements (by the way, namely this property permitted for von Neumann to show that the second principle of the thermodynamics follows from quantum mechanics).

As usual, let the organism’s state in the space of states be described by the vector (wave function) \mathbf{v} , and the similar vector of the feeds be \mathbf{w} , then the general vector of the state of the organism and feeds will be $\Phi = \mathbf{v} \times \mathbf{w}$, and after the reproduction – will be $\Psi = \mathbf{v} \times \mathbf{v} \times \mathbf{r}$, where the vector \mathbf{r} characterizes feed removals and coordinates of two organisms in the surroundings.

Let the space of the organism is N -dimensional, and the vector r is R -dimensional.

If the evolution matrix S , which creates the final state as a result of the interaction between the organism and feed, is disordered and stochastic (according to the Copenhagen interpretation of quantum mechanics), then

$$v_k v_{\lambda} r_{\mu} = \sum_{k' \lambda' \mu'} S_{k \lambda \mu, k' \lambda' \mu'} v_{k'} w_{\lambda' \mu'} \quad (1)$$

The $N^2 R$ equations correspond to this equation. The number of unknowns $N+R+NR$ for $N \gg 1$ is much less than the number of equations. *Therefore it* would be a miracle if these unknowns could satisfy the written relation (2). So, if the interaction S does not specially “arranged” in such a way that it would guarantee the self-reproduction of the organism, then the probability of the multiplication would be practically equal to 0.

Strictly speaking, the situation is more complicated: it is necessary to consider a lot of states of the alive organism and the unitarity of the S -matrix, and instead of equality of (1) it is necessary to use inequalities, which are connected with the demand that the general probability of the states for two alive organisms would be explicitly more than $1/2$. However, even considering all this, the main conclusion will remain the same.

Then M.Eigen had shown that the possibility of the cell self-reproduction cannot be explained on the basis that the evolution matrix is essentially stochastic but the presence of some “instructions” on the molecular level causes certain limitations on this “alive” kind of matter. So, it is necessary a certain adaptation of the statistical approach to biological processes. Really, macromolecules of nucleic acids and proteins are informational: there is written in them a certain text which has a definite physical sense. A message, written in DNA, is programming the synthesis of proteins, i.e. the heredity of the organism. And the protein texts are responsible for the variety of forms of protein functioning.

Therefore the cell self-reproduction etc can be explained by quantum mechanics if and only if the evolution matrix (the S -matrix of the process) is *specially instructed* for this aim [12].

Further M.V.Vol'kenstein in his analytic review [13] had expressed his expectation that M.Eigen in his future study of the pre-biologic evolution can find the possibility of such special instruction. But up to now nobody had revealed such possibility! As to me, I can see only a certain similarity (of course, partial) between two kinds of processes (with are more intellectual than naturalistic, by the way): between the process of the human writing and reading of certain scientific files in modern computer devices and the process of the supreme-intelligence-design writing and further functioning of certain genetic programs (including the genetic program of the cell reproduction) in cells of alive organisms.

More on the Relationship between Physics and Biology

For physicists the following question is quite natural: are there known laws of physics sufficient for explaining the biological phenomena or not? M.V.Vol'kenstein [13] was the first who had analyzed and resolved the principal difficulties appearing during the construction of the physical theory of the main biologic phenomena:

Firstly, the usual formulation of a physical law is causal – it answers to the question: “because of what?” And a biological law is usually formulated teleologically, finalistically, in a goal manner: “for what?” However, this controversy is only apparent. Any physical law can be expressed by the correspondent variational principle, i.e. can obtain the finalistic description. Let us recall the Le chatelier law, the Lentz rule and the principles of Maupertuis and Fermat. We can reformulate the second law of thermodynamics in the form

$$(\delta S)_e \equiv 0, \quad (\delta^2 S)_e < 0, \quad (2)$$

considering the goal of the evolving system to be to attain maximum entropy. Moreover, we can transcribe known physical laws from causal to finalistic terms, and vice versa. Of course, the predominant finalism in biology can be understood as a consequence of the extreme difficulty of finding a causal explanation for the biological phenomena.

Secondly, the law of evolution of matter in an (almost) isolated system to the maximum disorder and the law of evolution of living systems to the highly ordered organism (the modern theory of the progressive biological macro-evolution) are in a real contradiction between them.

Biological evolution and phylogenesis (and also ontogenesis) do not agree with equilibrium thermodynamics. Schroedinger was the first who gave a qualitative treatment of the thermodynamic properties of an organism [14]. The order in an organism is maintained by the outflow of entropy into the environment. And if we isolate an organism together with the environment needed for its existence, the entropy in the complete isolated system will increase. The situation is quite similar to the phenomena of crystallization of a liquid in a coolant. So, the contradiction between the high degree of order in a living organism and the second law of thermodynamics is eliminated at least formally on this level. Still this does not explain biological macro-evolution from simple to more complex species, phylogenesis and ontogenesis since there are two different kinds of systems: homogeneous with $dS_{\text{total}} \geq 0$ but with $dS_{\text{internal}} \leq 0$. In connection with this a question arises: or we have two irreducible types of physical laws or there is one type of them but over different situations.

Linear thermodynamics is unable to explain the process of growth and differentiation of cells, and appearance of new structures. The development of nonlinear non-equilibrium thermodynamics for open dissipative systems or synergetics, in principle, could give perspectives to explain the biologic macro-evolution, as hoped M.V.Vol'kenstein [13]. However, biology deals with extremely complex integral non-equilibrium systems (cells, organisms, biocenosis and the biosphere which in addition compose the unitary system). And now we do not possess yet sufficient biological knowledge to formulate clearly the corresponding physical problems.

On all the levels of biologic constructions (macromolecules, cellular organoids, cells, separate organs and systems of inter-connected organs, organisms as a whole) we see the exact and definite self-regulation of the alive organism in the space and time. At a certain degree such self-regulation regards also all the terrestrial ecosystem (noosphere). The especial interest for the physics of the alive represents the manifestations of such self-regulation:

- clear definiteness of the mean values of life durations and periods of the development for any species of the organisms and of their variations in various climates and geographic conditions;
- large interval of periodic oscillation processes in the alive organisms (with periods from milliseconds till tens of years);

- time and space distributions of correspondent molecules (which is important for the regulation of biologic processes);
- synchronization of biorythms of all organisms of the terrestrial biosphere and its concordance with geophysical and cosmic rythms).

All these phenomena till now are not studied systematically by physical methods. It is natural that cybernetics, information theory, theory of automatic regulation and synergetic principle are began widely utilized in biology and ecology. And moreover, quantum mechanics is also beginning to utilized not only on the atomic and molecular level of biologic processes in the alive organisms, but even in the limits of the modern considering the alive organism as a macroscopic quantum system as a whole. Moreover, for explaining the physical mechanism of the origin of the biological life and of the biologic macro-evolution we need to explain firstly the mechanism of appearing genetical information, coded in the DNA together with the uncoding of all necessary genetic programs which are necessary for the phylogenesis of the organism from the initial cell. Up to now all this way is open and far from resolving.

Conclusions

The presented paper does deepen and extend the substance and conclusions of my preceding papers [1-3], published earlier concerning the philosophic aspects related with the *origin* of the Universe and life.

Some big problems of physics and natural sciences (for instance, the open problem of the origin of the whole Universe and of the biological life inside it, have been gradually concentrated the attention of the researchers, if not scientifically but at least philosophically, to those problems as to the grand or great problems. And there was started to increase the discussion between the supporters of various meta-theoretical (semi-scientific and semi-philosophic) approaches to the problems of the origin of life and the whole Universe – between the hypothesis of the self-organization of the matter from the lower levels (beginning from the 0-th level, i.e. vacuum) into the higher levels and the hypothesis of the supreme intelligent design (the creationism).

And to the first doctrine there was adjoined in the XXIc the meta-physical doctrine of the parallel other universes with some kind of interaction between them or with an irrational spontaneous passage of the matter from them to our Universe – those hypothetical universes are or the exactly same as ours, or with other space-time dimensions, or with other values of the physical constants. These discussions concern the origin of biologic life on the level of genetics. On other levels of the biologic life, i.e. of the alive organisms, for phenomena, which are not connected with genetics, biology seems to be reduceable to physics (quantum mechanics).

Such phenomena, as the unresolved problem of the origin of the biosphere and the competition of various meta-theoretical approaches to possible interpretations and even of the worldviews of researchers in the study of this great and problem, are known to be the important peculiarities of the history of natural sciences in XX-XXI cc. Finally, we expose the research program for young researchers connected with the problems of with the biophysical problems, typical for the alive organisms:

1. Coherent excitations (static and dynamic correlations of excitations) in dissipative and non-dissipative systems, typical for the alive organisms.
2. Synergetic phenomena of quantum chaos and self-organization in non-dissipative and dissipative systems, which are modeling the systems, typical for the alive organisms.
3. Decays of meta-stable states and the transitions between them in dissipative systems, typical for the alive systems.
4. Resonance biologic phenomena in the range of the mm electromagnetic radiation.
5. Time analysis of tunneling for particles, many-particle systems and aggregates and also photons in the non-dissipative and dissipative systems, typical for the alive organisms.

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