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Editorial

Quantum-Classical Mechanics as a Guide to Finding the Simplest Form of Life Organization and Looking Beyond the Horizon

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Modern science is only about four hundred years old, and it originates from the famous experiments of Galileo, which laid the constructive foundations for the natural science that is currently called physics [1]. Among other natural sciences, such as, for example, chemistry and biology, physics is the most rigorous natural science, that is, one that provides a very high reliability of its results and has the most powerful predictive power. These unique advantages of physics are explained by the fact that it investigates the simplest objects in nature, and for this reason it is able to successfully use the apparatus of mathematics to construct a physical theory that clearly correlates with physical experiment. Therefore, we can say with confidence that physics is not only the "mother" of other natural sciences, but also underlies all technological progress within human civilization. Moreover, the creation, for example, of classical mechanics, the first fundamental physical theory, predetermined the first industrial revolution, which created the prerequisites for the formation of a socio-economic formation, currently called capitalism. The creation of quantum mechanics in the twentieth century not only radically changed the ideas of physicists about the world around us, but also created such prerequisites for technological progress that can lead human civilization both to complete self-destruction and to almost unlimited prosperity. The creation of, for example, the Internet, it can be said without exaggeration, has led to a real revolution in human communications and relationships.

With all the above unique achievements, physics, represented by its two fundamental theories – classical mechanics and quantum mechanics, is the science of inanimate nature. According to its constitution, "not wanting to deal" with complex living organisms, physics "gave living nature" to biology. In the vast majority of cases, biology is forced to deal with living matter, which was "synthesized" in the evolutionary process over millions of years. The huge variety of living organisms created by nature, and the extreme complexity of each of them, leave almost no room for their rational, and even more accurate, study. The way out of such a difficult situation in biology could consist in a controlled artificial synthesis of the simplest living objects, when each "elementary" stage of the complication of the created new living object is recorded in the experiment as accurately as possible. This is currently being done in synthetic biology. However, the methods of synthetic biology, being exclusively empirical, essentially do not correlate in any way with the methods of physical experiment, and even more so with the methods of theoretical physics. A new living object is "sewn together" from some smaller, living objects. At the same time, the underlying causes of the organization of living matter remain far beyond the scope of rational, and even more accurate, study. This raises a natural question: "Is it possible to synthesize the simplest living object from non-living objects?" This question naturally creates a rational connection between biology and physics. And then a natural question related to the previous one: "What exactly distinguishes the living from the non-living?" or the question: "Where and how is the boundary between living and non-living?" Is this border narrow or blurry? If all this is summarized, then the briefly discussed topical question can be formulated as follows: "Where in physics is the boundary between living and non-living?" At first glance, this question seems to be formulated incorrectly: after all, as noted above, physics, by definition, studies only inanimate matter. The way out of this paradox lies in the fact that so far we have been talking only about the physics that was known to us until now. However, there is a new physics that contains a certain dynamic element of self-organization, which can be called the physical source of life. This new physics, more precisely, a new physical theory, called quantum-classical mechanics, and its probable application to the above question about the boundary between living and non-living matter, as well as a certain look beyond the horizon, will be discussed below.

As is known, quantum mechanics is inextricably linked with classical mechanics. Its justification is connected with the need to consider the interaction of a microparticle with a macroscopic classical measuring device [2]. The basic dynamical equation, the Schrödinger equation, was postulated by Schrödinger but actually derived from the Hamilton-Jacobi equation for action in classical mechanics by introducing the wave function in some form, which is now called the semiclassical approximation. The width of the levels, "inside which" the energy spectrum is continuous, is a sign of the partially classical nature of the dynamics in quantum systems. Quantum-classical mechanics is not a "mixture" of quantum mechanics and classical mechanics, but is a substantially modified quantum mechanics, in which the initial and final states are quantum in the adiabatic approximation, and the chaotic transient state due to chaos is classical. The Franck-Condon principle in molecular physics [3] makes it possible to avoid considering the dynamics of the transient state, which is unreasonably assumed to be insignificant. Classicality, which is immanently inherent in quantum mechanics itself, in molecular physics is supplemented by classicism, which is associated with the Franck-Condon principle. It is assumed that the quantum transition (fast jump) of an electron from the ground to the excited electronic state of the molecule occurs between the turning points of classically moving nuclei, where the nuclei are at rest. In fact, the classical nature of motion in molecular physics is not associated with the Franck-Condon principle, but with the chaotic dynamics of the motion of an electron and nuclei in a transient state.

As is known, the theory of quantum transitions in quantum mechanics is based on the convergence of a series of time-dependent

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perturbation theory [3]. This series converges in atomic and nuclear physics, as well as in molecular physics, provided that the Born-Oppenheimer adiabatic approximation and the Franck-Condon principle are strictly observed. If this condition is not met, the series of time-dependent perturbation theory diverges. It is obvious that in real molecules the adiabatic approximation is not strictly observed, which makes the application of the Franck-Condon principle unjustified in theory, and with it the entire physical picture of molecular transitions based on it. The only physical way to eliminate the singularity of a series of time-dependent perturbation theory in molecular physics is the postulate about the presence of dynamics in the transient electron-nuclear(-vibrational) state, which is ignored by the Franck-Condon principle, and that this dynamics is chaotic [4]. In this case, in the case of strong chaos, as in the case of the Franck-Condon picture of molecular transitions, the transition rates do not depend on the specific dynamics of the transient state, but depend only on the initial and final states taken in the adiabatic approximation. In the case of weak chaos, against the background of chaos, the regular nature of the dynamics of the transient state manifests itself. Chaos, which is weak in the case of large molecules, may be strong in the case of small molecules. Therefore, the Franck-Condon picture of transitions often gives good agreement with experimental data on optical spectra in conventional molecular spectroscopy of small molecules.

In photochemistry and nanophotonics, where, as a rule, we deal with large molecules, where chaos is not strong, but weak, elements of dynamic self-organization often appear in the chaotic dynamics of the transient state. A striking example of this is the well-known narrow and intense J-band of J-aggregates of polymethine dyes, which can no longer be explained on the basis of quantum mechanics, but finds its explanation in quantum-classical mechanics [5]. Thus, in the case of small molecules, the Franck-Condon principle gives the correct result, although an erroneous theory and an erroneous physical picture are used. In the case of large molecules, this erroneous theory and the erroneous physical picture no longer lead to the correct result.

The analogue of this situation is well known. This analogue is a collision between two pictures of the world, namely, geocentric and heliocentric [1]. As is well known, the correct picture is the heliocentric picture of the world, in which the Earth rotates both around the Sun and around its own axis. However, being on the surface of the Earth, the rotation of the Earth around its own axis is perceived by the observer as the movement of the Sun across the sky, which is well simulated by an erroneous geocentric picture. It is even customary to talk about the time of sunrise and the time of its sunset at a given point on the surface of the Earth. However, the exit from the surface of the Earth to a sufficiently large distance into space directly shows the fallacy of the geocentric picture of the world.

At present, quantum-classical mechanics and the corresponding physical picture of molecular "quantum" transitions are substantiated on its simplest example, namely, on the example of quantum-classical mechanics of elementary electron transfers in condensed media [4]. Here, chaos is introduced into the transient state by replacing the infinitely small imaginary additive in the energy denominator of the total Green's function of the system by a finite value. This chaos is called dozy chaos.

The existing quantum-classical mechanics of elementary electron transfers in condensed media is a fundamental analytical theory that has an analytical result on the shape of optical bands [4,5]. The next stage in the development of this analytical theory will be

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to complicate the system by organizing various aggregates [6], where the “elementary cell” in the theory and/or the starting point for the development of the theory will be the already solved problem of elementary electron transfers. The purpose of such complication and enumeration of all possible variants of aggregation will be to find the “molecule of life”, that is, that rather complex, but “minimal” structural configuration, in which elements of self-organization, both structural and dynamic, observed in theoretical optical spectra, are clearly manifested. Note that the “atom of life” here is the electron itself, which interacts with vibrations of nuclei and causes chaos in their movement, that is, dozy chaos, without which “quantum” transitions in molecules and condensed substances would be impossible [4–6]. Like the problem that I have already solved, this problem will have an analytical solution at all levels of complexity due to its “linear nature”. Of course, the analytical results will be cumbersome, but they can be quite easily programmed and studied using computers. Thus, it is the existing analytical approach in the new fundamental theory – quantum-classical mechanics, that opens up great prospects for the search and study of the simplest forms of life organization.

Note that, regardless of the work on the development of the theory of the search for the “molecule of life”, experimental studies on the search for and synthesis of the “molecule of life” are of interest, which at this stage can already be started to be carried out in parallel and quite independently.

It is assumed that the essential element of the “molecule of life” will be its primitive structural-dynamic organization, which will contain the memory of the self-organization of the “molecule of life” and the program of its some primitive dynamic function, and which can be interpreted as the embryo of what is commonly called genome. It may turn out that such a primitive genome-embryo will already provide some primitive life function useful for humans, but will not yet provide the possibility of reproducing the “molecules of life” through their reproduction. In other words, we are talking about much more primitive living objects that can be attributed to some chemical form of life in comparison, for example, with the simplest RNA viruses that are able to reproduce and therefore belong to the biological form of life.

The processes of synthesis of the “molecule of life”, both at the experimental and theoretical levels, will take place under the full control of researchers. Therefore, it is this fact that makes it possible in principle to elucidate at the level of physics the nature of the emergence of living things from non-living things and to apply the results obtained to the study, for example, of viruses or bacteria [7]. Obviously, such a formulation of the question gives enormous advantages over the standard methods of studying viruses and bacteria, when the history of their long evolution in nature remains essentially unknown and “behind the scenes” in our studies.

As is known, the creation of a new weapon is the simplest form of implementing the ideas of any new fundamental physical theory in practice. In the case of classical mechanics, these were guns firing bullets and cannons firing cannonballs. In the case of quantum mechanics, these were nuclear and thermonuclear bombs. In the case of quantum-classical mechanics, apparently, this will be something related to the “molecule of life”.

As in the case of quantum mechanics, there will obviously be a large number of peaceful applications, at the initial stage – in medicine, where the methods of quantum-classical mechanics will contribute to solving, for example, the problem of cancer [4,7], then also in the whole spectrum human life, including space exploration.

For example, in materials science, there will be “living” materials that will provide us with much more comfortable living conditions. The pinnacle of the development of applications of quantum-classical mechanics will be the creation of artificial living beings [8], which humanity will exploit in various areas of life, and which will be designed and created specifically for each specific task. At the same time, in view of the well-known primitiveness of such artificial living creatures, they will “with pleasure” perform the functions prescribed for them, just as, for example, our goats “do not mind” being a source of milk and meat for mankind. Unlike goats, the fact that we exploit them will be much more “humane”. Thus, in view of the emergence of an abundance of “new artificial labor force”, humanity will no longer need to exploit one part of it by another, in fierce competition, in wars, etc. etc.

Particularly relevant will be the creation of artificial living beings that will be radiation-resistant with respect to cosmic radiation. Without their help, it is impossible to imagine any effective exploration of outer space by mankind.

Among other things, quantum-classical mechanics gives impetus to the creation of the most effective form of socio-economic and moral organization of human civilization [9,10].

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References

1. Galilei, G. Dialogo Sopra i Due Massimi Sistemi del Mondo Tolemaico e Copernicano; Batifta Landini: Firenze, 1632.
2. Landau LD, Lifshitz EM (1977) Quantum Mechanics, Non-Relativistic Theory, 3rd ed.; Elsevier: Amsterdam, The Netherlands.
3. Davydov AS (1965) Quantum Mechanics; Pergamon Press: Oxford, UK.
4. Egorov VV (2019) Quantum-classical mechanics as an alternative to quantum mechanics in molecular and chemical physics. Heliyon Phys 5: e02579.
5. Egorov VV (2022) Quantum–classical mechanics: Nano-resonance in polymethine dyes. Mathematics 10: 1443.
6. Egorov VV (2017) Nature of the optical band shapes in polymethine dyes and H-aggregates: Dozy chaos and excitons. Comparison with dimers, H*- and J-aggregates. R. Soc. Open Sci 4: 160550.
7. Egorov VV (2020) Quantum-classical electron as an organizing principle in nature. Int. J. Sci. Technol. Soc 8: 93-103.
8. Egorov VV (2022) Physics & Life. Research Gate
9. Egorov VV (2017) Dozy-chaos end of the human civilization. Journal of Ultra Scientist of Physical Sciences (Section B) 29: 87–96.
10. Egorov VV (2022) Physics and Crises in Human Civilization.