CONSCIOUSNESS AND MATTER

INFORMATION-MEASURING APPROACH.
GENERALIZED PRINCIPLE OF COMPLEMENTARITY.

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A wide range of problems of the relationship between consciousness and matter are discussed. Particular attention is paid to the analysis of the structure and properties of consciousness in the framework of information evolution. The role of specific (non-computational) properties of consciousness in the procedure of classical and quantum measurements is analyzed. In particular, the issue of "cloning" of consciousness (the possibility of copying its properties onto a new material carrier) is discussed in detail.

We hope that the generalized principle of complementarity formulated by us will open up new ways for studying the problems of consciousness within the framework of the fundamental physical picture of the world.

FUNDAMENTALS OF THE INFORMATION APPROACH TO THE DESCRIPTION OF SPECIAL PROPERTIES OF CONSCIOUSNESS IN THE FRAMEWORK OF THE THEORY OF MEASUREMENTS AND THE POSSIBILITY OF THEIR PRESERVATION

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Foreword

The present essay, like any other popular science work, contains conflicting requirements. It should be understandable to readers who are non-professional in the discussed sphere (i.e. it should be popular). At the same time, it must be scientific - the conclusions it contains must follow from generally accepted experimental facts or logically rigorous theoretical arguments. And we know many excellent examples of popular science presentation of even very complex physical ideas and theories. The sole purpose of any such successful work is the most simple and understandable presentation of facts and conclusions, widely known to professionals in this field of knowledge.

However, the question of how to include consciousness in the general picture of the world description does not yet have an answer in modern science. Moreover, the Nobel Prize laureate R. Penrose wrote a series of books for the sole purpose of proving it [1-4]. And as a result, he concluded that in order to understand the essence of consciousness within the framework of rigorous science, a "new physics" is needed. Therefore, for a scientific answer to the question posed, we need, at the minimum, to perform the following steps:

- Propose our own version of such "new physics"
- Provide experimental and theoretical arguments to support the reasonableness of our hypotheses
- Determine on the basis of this new approach the nature of the human consciousness from a fundamental point of view
- Draw conclusions about the properties of consciousness, which can be experimentally confirmed.

But even this is not enough to answer the question of the possibility of preserving the basic properties of consciousness - its "cloning". The point is that the term “preserve” itself implies a number of different interpretations. The final answer will depend on which of them we choose. Therefore, in addition to the "new" physics, we will have to analyze all these interpretations and choose the one that allows an unambiguous experimental verification of the fact of such "preservation". And if no such interpretation exists so far, then we will have to develop a new one, in accordance with the "new" physics.

It is not possible to do this without attracting complex scientific terminology and without bringing unobvious logical arguments to substantiate the new principles. We are fully aware that the work we have written is far from the standards of popular science presentation. But, choosing between rigor and validity, on the one hand, and simplicity and clarity, on the other, we had to somewhat sacrifice “simplicity” in favor of “rigor”. For a better perception of the text, sometimes at the end of a section, we briefly formulate its main provisions, which you can “take their word for”, trusting your intuition.

We are convinced that there are no physical and logical errors in our arguments. Of course, they lack rigorous mathematical proofs that are inconsistent with the format of this essay. In order to partially compensate for this shortcoming, the text contains many references to fundamental scientific works, the results of which we used.

With that said, our essay pursues by necessity not one but three conflicting goals: popularity, scientific rigor, and novelty of results and conclusions. In accordance with them, its structure is divided into three main parts. First, from the standpoint of "everyday" common sense and well-known laws of evolution, we will discuss those features that distinguish consciousness from other products of evolution. Then we will conduct a rigorous scientific and physical analysis of the possibilities of "measuring" the properties of consciousness within the framework of the "new" physics. And finally, based on the results obtained, we will formulate an answer to the question of the possibility of preserving the basic properties of consciousness on a new material medium - its "cloning".

Introduction

Before answering the formulated questions, we must understand what exactly is meant by human consciousness, and in which case there is reason to talk about his presence in a particular material object. And in this we will be helped by the colossal amount of knowledge accumulated by mankind over the past hundreds of years of its existence.

First of all, let us note that in the biological evolution of life on Earth, consciousness arises in living organisms with a developed nervous system, as one of the mechanisms aimed at the survival of an individual. Therefore, we will conduct further analysis of consciousness, first of all, as the study of its specific properties that contribute to the survival.

As for other survival mechanisms, most of them can be restored by humans after their destruction. There are already prostheses of limbs, sensory organs, speech apparatus, etc. It is safe to say that as technology develops, their functionality will not differ from the original so much that the owner himself will not feel any difference with the copy after replacing an organ of his body (or even the whole body).

In addition, it turns out that long before the development of modern society and technology, such an opportunity, known as regeneration, was available in the flora and fauna of the planet. And only as the structure and functions of the organism became more complex, it was almost completely lost in mammals. Nevertheless, modern researches related to stem cells give hope for the possibility of its restoration. Regenerated organs and limbs, which have fully retained all their individual functions, in a certain sense, can be interpreted as their "revival".

If we talk about individual cells of the body, in human tissues and organs (with the exception of the heart muscle and brain neurons) they are repeatedly renewed (from 7-10 days - cells of the cornea of the eye, up to 1-10 years - cells of the skeleton). Hence, we can conclude that nature itself has already "taken care" of the possibility of transferring each of these mechanisms to a new material carrier practically "without losses."

We can say that every morning we wake up with a slightly different body, a slightly different brain, and slightly different thoughts and feelings compared to the moment when we fell asleep. But each of us is absolutely sure that this is "what we are". If someone begins to

convince us that yesterday we died, and today our saved consciousness was rewritten on a "new matrix" (as it is often depicted in science fiction novels), then the majority will indignantly reject such an assumption. But no one will be able to refute it.

Generalizing the law of evolution to more complex structures (for example, species or social structures), we can note that a similar phenomenon is observed there as well. In this case, the individuals themselves act in the role of "cells of the body", the death of which occurs almost imperceptibly to preserve the life of the structure, the survival of which they serve (racial and species differences, religion, art, science, state, ideology, wars, etc.).

Therefore, we can confidently assert that for mechanisms created by evolution for survival, ways of preserving their individual properties ("cloning") either already exist or will be created in the near future due to the exponential development of technologies in the modern world. On this way it is necessary to solve a great number of complex scientific and technical problems. But all of them do not extend beyond the framework of the ideology which envisages such a principal possibility.

In that case, what prevents us from confidently asserting that in the coming decades, the consciousness, as a survival mechanism created by evolution, will be reproduced in laboratories? The answer to this question lies in the special properties of consciousness that are not inherent in any other survival mechanism in any of the living organisms. People knew about this special property of consciousness thousands of years ago. Their ideas about it led to the emergence of the term "soul", and the apparent incompatibility with the properties of the rest of the (material) world – led to numerous myths and legends trying to somehow explain its incredible properties.

The first scientific discoveries were unable to clarify this issue. Back in the first half of the 17th century, Descartes wrote [5] that “Consciousness does not possess any of the properties of the material world. Its main characteristic is the ability of thinking, which separates it from the entire material world as a whole". Almost four centuries after Descartes, Roger Penrose (Nobel Prize laureate in physics) writes about the same issue [2]: “… some essential component of human understanding cannot be modeled by any computational means. ... the measurement procedure needs a radical revision - it is possible that along the way, the very foundations of theoretical physics will have to be subjected to significant changes".

Thus, the question of the possibility of "cloning" consciousness can be divided into *three fundamentally important questions*:

- In what case will we consider that consciousness was preserved after death of a person on a new material carrier ("matrix")?
- Is it possible in principle to create such a “matrix”? And how it can be done?
- Is it possible to record the old consciousness on a new "matrix" - "keep" a copy of it? And how it can be done?

The answer to the first question we have actually given in the paragraph above. Like other "prostheses", in order to preserve consciousness, it is enough to endow a new artificial "organ" with all the observed properties of the lost one. Moreover, it is not at all necessary to copy the atomic or large-scale structure of this organ. If, for example, all the capabilities of an amputated hand, including its appearance and links with the rest of the organs of the human body (the same consciousness, for example) are accurately reproduced, then neither the people around, nor the person himself (waking up in the morning) will be able to detect this substitution.

Therefore, in relation to consciousness, we will assert that it is "preserved" if neither the owner himself, nor the people around, can in any way prove the opposite.

The answer to the second question lies in the sphere of modern technology and algorithms. The colossal efforts of scientists around the world have led to the fact that almost all functions of human consciousness can be reproduced in computer models. The so-called "Turing test",

carried out annually, has already provided precedents in which these models answered questions from experts in a manner indistinguishable from humans. Through the efforts of neuroscientists, the functions of both individual neurons and some structures responsible for these functions have been studied with great precision. We are not specialists in these areas and will not discuss them further in this work.

However, until now it has not been possible to model the main property of consciousness, which makes it special among all the mechanisms of survival.

No matrix with programs written on it will be able to control its own actions. It will not be able by itself to select the tasks from those that it is able to solve. And, apparently, it will not be able to realize itself as the same person, "who woke up in the morning in a different body."

Therefore, *the answer to the third question* is the key to obtaining a complete answer to the question of the relationship between material and non-material properties of consciousness. It is the analysis of the possibility of “putting the soul” into the “matrix” prepared for this purpose, that we will pay attention in the final part of our work.

The structure of the essay contains 3 main sections:

• *In the first section*, we will consider a general information approach to describing the evolution of matter and, within its framework, the evolution of consciousness as one of the mechanisms and objects of evolution. The properties of consciousness as an information structure fighting for survival with other similar structures will be analyzed. A simple classification of the survival mechanisms of information structures based on the possible types of interaction between them will also be proposed.

• *In the second section*, we will show that, in addition to classical properties, consciousness has specific properties - the phenomenon of "self-consciousness" and the phenomenon of "freedom of choice", which distinguish it from other evolutionary mechanisms.

Next, we will discuss the evidence of the fact that the presence of these phenomena not only does not have an adequate model in the modern physical worldview, but also, in principle, contradicts it. Therefore, the modeling of closed systems, including "self-aware" matter, requires a fundamentally "new" physics for its description.

We will show that in order to describe the specific properties of consciousness, it is necessary to apply a generalized approach to the description of the observation procedure itself. The foundations of this approach and this principle are associated not with the specific properties of matter, but with the logical structure of the procedure for the observer's comprehension of its results.

• *In the third section*, within the framework of the new concepts, we will clearly define the conditions that must be fulfilled for the possibility of preserving consciousness as an information structure. In this case, we will require the preservation of not only the "classical" (algorithmizable) properties, but also new description parameters that determine the choice of the observer in similar experimental situations. Thus, an answer will be given to the question of the possibility of preserving consciousness after the death of a person on a new material carrier.

And, finally, *in the conclusion*, we will formulate both the main conclusions of the work and those further research tasks that seem to us the most important.

1. Information approach to the description of the evolution of life and consciousness

The history of origin of the nervous system in the process of biological evolution of animals has been studied in detail. As it became more complex, it consistently acquired new functions and properties, improving the mechanisms of survival associated with it. The simplest

motion reactions in coelenterates "grew up" to manifestations of higher nervous activity in humans. Somewhere along this path, the animal's brain "learned" to be self-aware, predict the future and choose its own destiny.

The question of where exactly to draw the line between conscious and unconscious behavior is usually solved at the level of studies of biophysical and biochemical processes in the brain of an animal. Wherever artificial stimulation occurs in the brain of animals, many of the forms of their subsequent behavior are consistent with the sensory states that were experienced. The authors of the "Cambridge Declaration on Consciousness" [6] consider this to be a manifestation of intentional (conscious) behavior.

With this approach, the simplest conditioned reflex of an earthworm differs from the mental activity of the brain of a mathematician who is proving a new theorem, only in the complexity of the molecular mechanisms that implement these functions. And if we can restore the worm's behavioral reflex as accurately as we like (for example, by implanting a simple microcircuit with a behavior algorithm written on it), then it can be considered to be principally possible for the human brain as well.

But the problem of preservation after death can neither be solved by the hypothetical possibility of asking directly the "resurrected" consciousness - who it perceives itself to be. In the Turing test, machine algorithms have repeatedly succeeded in misleading experts and imitating the consciousness of a non-existent person [7]. Therefore, the answer to the question about the possibility of "cloning" consciousness, first of all, requires an experimental proof of the ***phenomenon of awareness***. In fact, such an experiment should to identify such features in the subject's behavior which, in principle, cannot be modeled by an arbitrarily complex algorithm.

The paradox of this task is not associated with the physical structure of the brain and the complexity of the processes occurring in it. It concerns the logical contradiction inherent in the question itself.

We need to describe the properties of an object that cannot be described by any algorithm!

The only way to get around this contradiction is to come up with a new way of describing the properties of the observed object, not related to its algorithmization. To discover and describe these features, the "new physics" mentioned by R. Penrose is needed. At the same time, it is obvious that the solution to the logical paradox of the problem of "measuring the immeasurable" must be sought not at the physical, but at the information level of understanding the properties of consciousness.

But do such properties of consciousness really exist, or they are a consequence of errors and approximations of an inaccurate description of what is happening "in reality"? Maybe it only seems to a person that he "chooses" and "realizes", but "in fact" all these events are predetermined by the exact values of the physical parameters of the elementary particles that make up his brain?

The answers to these questions will be obtained in the second part of this essay. As will be shown, modern physics is faced with a similar paradox when describing the measurement procedure (both classical and quantum). To solve it, we will apply a new information approach, first to the description of the quantum measurement procedure, and then to the observer's consciousness as an element of this procedure. But first, from this (information) point of view, let us consider the evolution of the mechanisms of survival of the animal world on Earth, at the top of which is the human consciousness.

1.1. The primacy of the information component in the evolution of living organisms

The term evolution is understood, first of all, as the biological evolution of the living organisms on the planet Earth. However, the simplicity of the basic principle of evolution - the survival of those who "took care" of their own survival, makes possible a generalized view of the

use of this term. So, recently, a whole list of various applications of the theory of evolution has emerged:

- Chemical evolution or prebiotic evolution
- Biological evolution
- Molecular evolution
- Human evolution, or anthropogenesis
- Socio-cultural evolution
- Social evolution
- Stellar evolution
- The emergence and evolution of galaxies
- Differential evolution

They differ from each other, first of all, by the multitude of objects competing with each other and changing their properties for better survival. But not only by this.

In any of the evolutionary niches, it is always possible to distinguish both objects that are fighting for survival with each other, and building elements - "bricks" from which they are built. For example:

- In chemical evolution, such “building blocks” are atoms of chemical elements and the simplest inorganic molecules, and competing objects are those of macromolecules (RNA precursors) that have the ability to reproduce themselves under certain conditions.
- In biological evolution, competing objects are the already different types of RNA and DNA molecules (which defeated the rest of the macromolecules at the stage of chemical evolution). And the "building blocks" are amino acids from which they are built.
- In social evolution, competing objects are different ways of organizing human communities, and their constituent elements are people themselves.

In all these cases, you can always replace some of the elements that make up the object of evolution, with others that are identical to the first ones. Individual differences in elements do not affect either the properties or the survival of the object itself. His "death" occurs not when all the elements perish, but when the main connections between them are destroyed.

For example, in chemical evolution, all competing macromolecules are composed of the same "eternal" atoms. In biological evolution, all competing RNA molecules are composed of the same "eternal" amino acid residues. And even in social evolution between social structures there is a struggle not for the bodies, but for the "souls" of people who can be used by the new social structure in a new capacity.

From these and many other examples follows an almost obvious, but very important for further consideration conclusion: in all cases, the object of evolution is not the matter itself, but only the model of organizing of the elements of which it consists. And the struggle "not for life, but to the death" in the process of evolution is not between material objects, but between the ways of organizing their elements.

We will further refer to such methods of organization as the information structures (IS), and the struggle for existence between them – as the information evolution. When the IS is destroyed, the elements of the structure themselves often survive and can again become an element of a completely different IS, according to the laws of which they will function. Moreover, there are precedents in which IS is preserved even with the complete destruction of all of its previous carriers. For example, a philosophical worldview or religious dogma can “survive after death” in a “preserved form” - in dusty tomes stored in library archives. But as soon as a certain person - "an element of the structure" reads them, and makes his serving to the "revealed truth" the goal of his existence, the corresponding IS will get a chance for revival.

As the simplest example of information evolution we can consider the well-known Conway's Game of Life [8]. Simple rules of transition between successive moves of the game determine the probability of "survival" of various structures, their relationships (competition, symbiosis, etc.), as well as their mechanisms of reproduction (Figure 1). By changing the rules of the game even slightly, we can control cellular evolution. Those structures that previously perished under the onslaught of more viable competitors can now take over the entire living space.

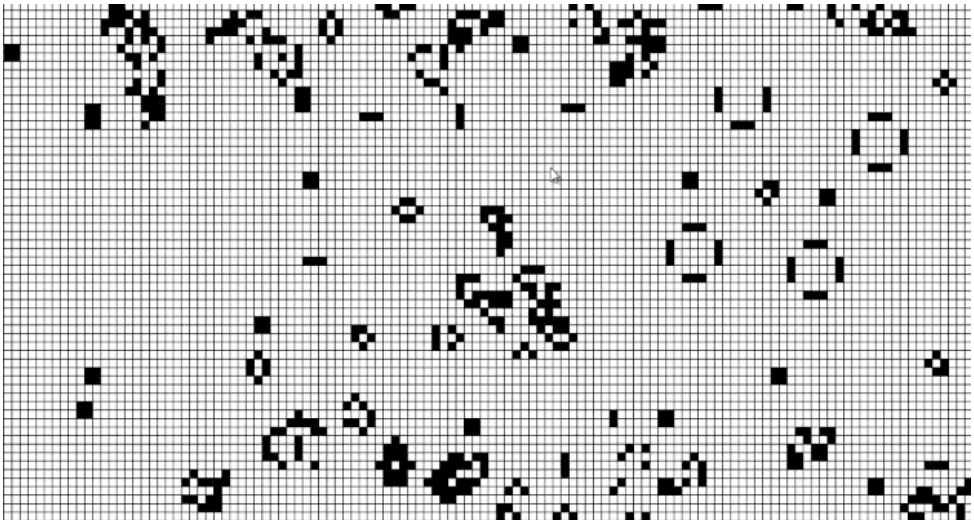


Figure 1 Example of implementation of the evolution of cellular automata in the game "Life"

It does not matter at all what kind of material carrier implements this structure - painted cells on a sheet of paper, an electronic microcircuit in a slot machine chip, or a mathematical algorithm written by its creator on paper.

Therefore, we will associate the question of the possibility of preserving and reproducing the basic properties of consciousness not with the resurrection of the brain itself, but with the possibility of reproducing the information structure that was recorded on it, as on a material medium. And also with the possibility of experimental proof of the fact that this is the same information structure.

The second question about the possibility of identification of the stored IS turns out to be not as simple as it might seem at the first glance. At least, in fundamental physics, it has been solved only recently.

For example, the current in a superconducting ring can be considered an IS, the elements of which are a set of Cooper pairs of electrons.

And the experimentally proven possibility of quantum teleportation [9] makes it possible to count on the possibility of "reproduction" for each of the electrons of such a pair. We can endow another electron in another place with absolutely identical properties that cannot be distinguished from the properties of the first in any of the precise experiments.

But even if we could measure and absolutely accurately restore the quantum state of each of the electrons, the superconducting state of the current would be destroyed. In quantum mechanics, it is rigorously proven that measuring the states of each of the elements of a quantum structure separately is guaranteed to destroy these states, and information about the correlations between its elements is irreversibly lost.

This gives us reason to doubt that a human brain, in which all the properties of each of the neurons are restored absolutely accurately, will be able to function at all.

Further (in the second section) we will show that a similar quantum effect of information entanglement of state of elements of consciousness arises in a human consciousness as well. But

its reason lies not in the presence of some hypothetical quantum structures in the human brain (as supporters of the ideas of quantum biology believe), but in the fundamental contradiction of the phenomenon of "self-description", which is considered the main attribute of human consciousness.

- The main essence of the law of evolution is the survival of the information structure (IS), in which its material carriers of the same type are united.
- IS is preserved (survives) in case if material carriers are replaced by others, but it is destroyed (perishes) in case if information links between them are destroyed.
- At the same time, the material carriers themselves, as a rule, "survive", and can be used in the construction of another or the same IS.
- Control of evolution is possible by means of purposeful changing of the external conditions, as a result of which the probability of reproduction of some IS increases, while for others - decreases.
- Precise preservation of the properties of each of the elements of the IS may not be sufficient to reproduce all of its properties

1.2. Classification of information structures as objects and mechanisms of evolution

Human consciousness plays an important role, primarily, in the survival of biological and social IS. These structures ensure their reproduction in new organisms or in the same human organism during its lifecycle. Moreover, their material carriers (atoms, molecules, elementary particles and physical fields) not only can, but are forced to change for successful and reliable reproduction of ISs. In this section, we will discuss the types of possible mechanisms for the reproduction of ISs related to consciousness, and propose new, information principles for their classification.

The colossal variety of information structures currently existing on the planet, their complex and intricate interrelationships confirm the thesis that nature is trying everything that it can "invent". And only later from the "invented" chaos, evolution selects the most viable options. When we talk about human consciousness, we must take into account that it represents a vast set of different ISs. Every human desire, every thought or sensation is conditioned by a certain molecular mechanism with which the corresponding structure is connected.

Apparently, most of them can be not only described individually, but also reproduced on an artificial material medium. A person who has a cardiac pacemaker instead of a destroyed or defective mechanism of nervous regulation of cardiac contractions may eventually get used to it and not notice this substitution. His pulse, as before, will become more rapid with excitement, and slow down during sleep, he will also fell an "ache in his heart" when watching Shakespeare's tragedies. Of course, if the mechanism of these sensations is studied and recorded on a programmable microcircuit that controls the operation of a pacemaker.

In order for this IS to be preserved, the mechanism of reproduction and inheritance of its individual characteristics, which are beneficial for the survival of an individual, is no longer necessary. The development of modern technologies will make it possible to test the operation of various control algorithms for this mechanism and choose the most suitable one. Moreover, for different tasks facing a person, different algorithms can be chosen. In this evolutionary niche, new "types" of ISs related to heart control may appear: a "mountaineer's heart" mode or a "musician's heart" mode, for example.

We have cited this still fantastic example in order to show that due to the complication of ISs, only their adaptation to the constantly changing external conditions of "habitation" occurs.

And fundamentally new opportunities and new properties of IS appear due to one of the three options: origin of new material carriers (microcircuit), reproduction mechanisms (copying the algorithm to an electronic medium) or survival and selection mechanisms (testing properties on a computer model).

Therefore, in order to study a fundamentally new property of consciousness, which distinguishes it from all other ISs, we must, first of all, understand what new evolutionary factors contributed to its emergence. Next, we will build a simplified IS hierarchy. But we will pay attention not to their functional and analytical purpose, as is usually done, but to the three main elements of their evolutionary structure: material carrier, reproduction mechanism and survival mechanism.

On the example of the game "Life" we can conclude that the main guiding factor in the evolution of IS are the external conditions (rules of the "game"), according to which it occurs.

It is currently considered proven that all living organisms on Earth, without exception, use the DNA replication mechanism to reproduce their genetic structure. We can assume that other mechanisms of self-reproduction could have arisen in the “primordial soup” on Earth, but they certainly lost have the struggle for the survival of the “life of RNA-DNA” [10]. Therefore, in spite of all the variety of biological species that have originated, from the point of view of information evolution, they can all be attributed to one ***class (A):***

• Object of information evolution - IS, recorded in the genetic code on the DNA molecule.
• Mechanisms of survival of IS - programs of chemical formation (protein synthesis) of molecular structures and organs, recorded in the genetic code.
• Reproduction mechanism - DNA replication mechanism.

One of the first qualitative leaps in the evolution of IS occurred in connection with the emergence of the simplest mechanisms of nervous self-regulation. First, in the form of unconditioned, and then conditioned reflexes [11].

But if the former are completely determined by the genetic code, the latter are adaptive and reflect changes in the organization of the body's nervous system when it finds itself in new conditions. Unconditioned reflexes are transmitted genetically and their individual properties can be considered "preserved in the descendants". At the same time, the conditional reflexes originate in the process of adaptation to external conditions and are destroyed irreversibly along with the death of their carrier. That is why unconditioned reflexes, as an IS, can be attributed to class A, but conditioned reflexes form a fundamentally new ***class (B)***:

• Object of information evolution - IS, not recorded in the genetic code, but formed in the nervous structure under the influence of external living conditions.
• Mechanisms of survival of IS - programs of chemical reacting recorded in the long-term memory of the nervous system of an animal.
• Reproduction mechanism - indirect use of the DNA replication mechanism.

Conditioned reflexes originate due to random or artificial external influences that are not associated with the genetic characteristics of the organism. However, they are individual for each separate specimen. Perhaps that is why the specific properties of these ISs are considered the very first manifestations of the conscious behavior of animals.

It can be said that the development of each new conditioned reflex is associated with the emergence of a new IS of a non-genetic type, which “cares” about the survival of its carrier, but does not have its own mechanisms of survival and reproduction.

In this case, we can speak of an information analogue of the symbiosis of two different types of IS. Genetic IS of type (A), recorded in the genetic code, uses IS of type (B), formed in the nervous system under the influence of external stimuli, for its survival. On the other hand, IS

of type (B), formed as a conditioned reflex, and uses the mechanism of reproduction of the genetic structure to create favorable conditions for the emergence of its new copies.

A fundamentally new ***evolutionary class (C)*** in the evolution of ISs arose together with the emergence of a new (not genetic) mechanism of their reproduction. Let's call it conditionally "education". The essence of the new mechanism is in the fact that the “parent” (or “teacher”) artificially creates for the student the conditions necessary for the development of the necessary (in his opinion) conditioned reflex.

The "carrot and stick" method, used by many of the animals in raising their own and others' young, is one of the teaching mechanisms - the reproduction of the corresponding IS on a new material medium even before the death of the previous one.

The emergence of a new method of IS reproduction has led to seeming paradoxes of behavior in the world of animals and humans. If for IS of classes (A) and (B) the only way to preserve oneself in the next generations was the survival of its carrier - the individual, who after reproduction will inherit this IS in the genetic code, for IS of class (C) the situation changes. For them, the life of an animal itself does not always turn out to be the highest value, and almost always it ceases to be the only one.

As a result, the actions of an animal in critical situations may contradict the aim of survival and reproduction of the individual itself. Inexplicable from the standpoint of "common sense" actions of all kinds of "heroes", "recluses", "fanatics", "collectors", etc. are just some of the examples of how the IS, which has originated in the human nervous system, takes care of its survival and reproduction, in spite of the survival and reproduction of its material carriers (humans).

The features of IS of the class (C) are the following:

• The object of information evolution - IS, not recorded in the genetic code, but formed in the nervous structure.

• Mechanisms of survival of IS - programs of behavior recorded in the long-term memory of the nervous system of the animal.

• Reproduction mechanism - education and training.

Some of the ISs of the class (C) in the process of information evolution create and use more complex mechanisms of reproduction, which are no longer associated with individual learning, but with social structures. But now we will not analyze in detail all possible varieties of such IS.

The next ***class D*** in the IS hierarchy will be conditionally called “creative”. With the development of the nervous system, the release of brain resources and the division of labor, it turned out that some of the conditioned reflexes can originate not randomly, under the influence of external unfavorable circumstances, but as a result of the conscious activity of the human brain. A person gets the opportunity not only to adapt to the surrounding conditions of existence, but also to adapt them to his new IS. New ISs, completely incredible and not viable from the point of view of common sense, but successfully reproducing and surviving in artificially created "habitats" began to appear.

At present, there are a huge number of such ISs of the class D. Let us mention only some of the most prominent examples.

- ***Fake religions*** based on fake documents and existing on a par with "natural" religions in the legislative and social niches. The most famous of these fake religions is Pastafarianism - "The Church of the Flying Macaroni Monster" [12].
- ***Mathematics***. It was only at the very beginning of its existence that mathematics occupied a subordinate position and served the cause of survival of other dominating IS. In the

present period of its development, mathematics is self-sufficient, has its own, independent of the rest, mechanisms of reproduction and survival in the environment of competing IS. It no longer serves, but "allows" the rest of the sciences to use its achievements. Not without a selfish motive, of course.

- ***Nationalism***. Initially, the idea of superiority of one nation over the rest was an auxiliary mechanism for the survival of IS associated with the characteristics of this nation. But with time it became self-sufficient. Nationalists of all nations support each other, although this contradicts the very idea of one nation surviving at the expense of others.

The features of IS of the class (D) are the following:

• The object of information evolution - IS, formed in the nervous structure of the brain or in the social structure as a result of the conscious activity of people.

• Mechanisms of survival of IS - rules and programs of conscious behavior aimed at changing the external environment.

• Reproduction mechanism - artificially created tools (ideology, books, public institutions).

The proposed classification of ISs according to three properties (object, survival mechanism, reproduction mechanism) is conditional. Within each of the classes, subclasses and species can be distinguished, similar to the classification of objects of biological evolution. Our goal was not to build a complete classification, but only to illustrate this possibility.

We hope that the approach described in this section opens the way to building a rigorous mathematical theory of information evolution, which will allow us first to understand the laws of the “chaos of ideas and senses” that increasingly threatens the existence of all mankind. And then - to learn how to control this chaos.

- The main structural differences in ISs are determined by three factors: material medium; survival mechanism; reproduction mechanism.
- The emergence of a new class of IS in the process of information evolution is possible with the emergence of a new type of one of these factors.
- This leads to a radical restructuring of the interrelationship between ISs, both within a new class, and between ISs of different classes.
- Usually ISs of a new class originate at first as an auxiliary mechanism of survival and reproduction, but then they become dominant.
- The release of the resources of consciousness has led to the emergence of a new "creative" class of IS. There is currently no rigorous mathematical theory of the information evolution of this class of IS. The dynamics of their development is chaotic and unpredictable.

1.3. The meanings of life of humans and humanity in the framework of information evolution in the consciousness of an individual and in society

The problem of the "meaning of life" is still one of the most topical for a human being. Its detailed analysis requires both a mathematical formalization of the concept of "meaning" and the attraction of a non-classical (algorithmic) approach to the physical essence of "life" itself. This question extends far beyond the scope of this essay. Nevertheless, we will give a very short and simplified classification of the meanings of human life, arising from the classification of ISs evolving in his consciousness.

In the consciousness of every person, there is a large set of elementary ISs belonging to different classes (described in the previous section). Philosophers, psychologists,

psychotherapists and psychiatrists are engaged in a detailed analysis of the stages and mechanisms of this "internal" evolution of consciousness. We will not even try to discuss in this essay the huge amount of knowledge associated with their work. Instead, let us single out the property of consciousness that is usually associated with the concept of the "meaning of existence."

Formally, it can be considered that the meaning of a particular individual's life is the main result of his activity (if it turned out to be successful) or the main desired result (if it was not achieved). But within the framework of the information evolution model, the main result of the activity of any, no matter how complex, IS is its survival and reproduction. Therefore, in human consciousness, the sense should be considered as survival and reproduction of the IS that dominates in the complex structure of the elements of consciousness.

As long as the primitive man spent all the resources of his time, strength, intellect on the struggle with the hostile world around him, the question of the meaning of life did not arise. Similarly, it apparently does not arise among animals in their natural habitat. But with the development of technology and availability of free time, opportunities arose for performing "optional" actions. The task to occupy the "liberated mind" resulted in origination of the question of the meaning of being in the global understanding and the meaning of the life of an individual. On the basis of many diverse and contradictory answers to the question about the “meaning of life”, we can also observe information evolution.

Let us illustrate this statement with some examples.

• ***(A) - "Sensing" individual***

At the first stage of the history of the “evolution of the meanings of life”, all ISs of consciousness were of an auxiliary nature. Their functionality and usefulness were assessed by a person according to the only possible criterion - the state of the “sensors of well-being”. If such a person was in warm, comfortable and calm conditions, and was sexually satisfied, his perceived "meaning of life" was to maintain this state of comfort. This sense was natural and justified, and allowed saving as much as possible resources for any unforeseen situations.

But with in case of a surplus of resources, the simplest (and natural) sense is to get more good - stronger signals from the “sensors of well-being”. And the development of technology and society makes it possible to reproduce this "sense" not by genetic means, without caring about the survival of its individual material carriers. Thus, such ISs as alcoholism, drug addiction, sexual and food addiction have emerged and have been flourishing for several millennia. As well as many other mental disorders that are considered diseases.

At the same time, such “harmless” hobbies of people as sports, art, collecting, fiction and many others can also be attributed to the same class of “meanings”, as dominating ISs in the consciousness of a person,. It is unlikely that the adherents of these "meanings" will insist that their actions contribute to their survival. But their actions and fanatical devotion to the chosen meaning, of course, contribute to the emergence and survival of this very meaning of life, as an IS, in the consciousness of other people.

The shortest description of this type of meaning is contained in the well-known ancient saying: "Bread and circuses!" It follows from it that in this case, the resource of consciousness is first spent on survival (bread), and all its remnants - on pleasures (spectacles).

• ***(B) – “Believing” individual***

A natural limitation for meanings of life of type (A) is the sensitivity threshold of pleasure sensors. With an increase in the surplus resource, a "sensing" person very quickly reaches the maximum of physiological benefit and remains dissatisfied. The rest of the resources of consciousness require a sphere of application. And it can be very quickly found in the world around him.

Unlike “meanings” of type (A), in this case ISs, which become dominant in the consciousness of believers, have learned to create their own mechanisms of pleasure and displeasure. And they often suppress the primary "sensors of well-being" inherent in a person by biological evolution. Thus, for example, the physiological suffering of true believers in Christ (up to the appearance of ulcers on the body) brings them unspeakable satisfaction. And its mechanism was formed in their consciousness by the very same faith that became the meaning of their life. Those who do not believe in anything or believe in something different simply cannot understand them.

When we talk about faith, we are not limited to religion. Belief in the fundamental laws of physics, or in "life after death", or in positive effects of jogging, or even in oneself and one's purpose in this world are also ISs that we can classify as class (B).

• **(C) –** ***“Seeking” individual***

Further freeing of resources made it possible for people to form new mechanisms and structures in their consciousness. One of them allowed the emergence and development of a fundamentally new class of dominant ISs, which we conditionally called "seeking". Such a person does not believe in the first truth “caught in his path”, but tries to conform to some of his own, deeper truths, and chooses the proper one, as he believes. And even if such person, having tried Buddhism, Christianity, Judaism, Islam, etc. in his soul, settled on faith in the "Flying Pasta Monster", then not this particular idea became his "meaning of life", but the individual and incomprehensible idea, that determined this choice.

• ***(D) - "Creating" individual***

And, finally, as a subtype of type (C), we should single out the class of IS, conventionally called by us "creating". They are distinguished by the presence in the consciousness of the mechanism for creating a new IS, if attempts to select one of the existing meanings were not satisfactory. Representatives of this class of meanings include geniuses ... and madmen.

This is not a complete list of types of different meanings of human life. Note that the sequence of “meanings of life” presented as an illustration is constructed according to the degree of complexity of the mechanisms of survival and reproduction of the dominant IS. However, this ranking does not at all imply a qualitative assessment on a scale of "better - worse". The fact is that the conditions for the dominance of one or another IS (and the corresponding meaning) are determined both by external physical circumstances ("great glaciation", "world war", plague epidemic ...), and by interaction with ISs of the social level (state structure, religion, scientific and technological progress, etc.).

Therefore, with a change in these factors, the conditions for the dominance of the "meanings of life" in the consciousness of people also change. The meaning that in some conditions leads to the survival of both the dominant and subordinate IS, in others - leads to their guaranteed perish. Metaphorically, we can say that information evolution is a dispassionate and cynical "person". It has nothing to do with our aspirations and dreams. It does not reckon with them, but only gives a chance to survive “here and now” to those of them who “clung to life” stronger than the rest.

The human community as a whole can also be considered as a material carrier of a complexly structured IS, between the elements of which a fierce struggle for "survival" is still being waged. At the same time, the history of mankind provides vivid examples of the struggle both between elements of ISs of the same class - the states, religions, economic doctrines, scientific directions, etc., and between different classes of ISs (globalization, "human rights", etc.). And until one of these ISs (or the symbiosis of several ISs of different classes) becomes dominant and subordinates the rest, it is too early to talk about the “global” sense of human existence.

- Within the framework of information evolution, the meaning of life is the survival and reproduction of the dominant IS in the human consciousness.
- The evolutionary hierarchy of different classes of "meanings of life" can be based on the same principles as the previous one.
- Almost all "zigzags" both in the fate of an individual and in the history of human society can be explained by the dominance of certain ISs, which originated as a result of external factors, or accidentally in the consciousness of a person or in society.

1.4. Natural mechanisms of preservation of classical properties of consciousness

The classification of IS types within the evolutionary process (as well as the associated “meanings of life” of people) proposed in the previous section is not just one of the varieties of “mind games”. It gives a positive answer to the question of the possibility of preserving some properties of consciousness after the death of the host organism. At least in that part of it, which concerns the natural mechanisms of survival.

Moreover, such preservation is a product of the evolution of consciousness as an information structure. And the death of biological "matrices" is not only possible, but in some cases is necessary for the effective operation of these mechanisms. A much more detailed analysis and argumentation of these conclusions is given in the excellent book [49].

Above, we noted that human consciousness is not only an IS, which is aware of itself as a single person, but itself consists of a large number of independent ISs which interact with each other, compete for survival and dominance within the framework of a common consciousness.

In addition, almost each of them uses their own, unrelated to this consciousness, mechanisms of survival and reproduction. Therefore, we can talk about the symbiosis between ISs of two different information niches (human consciousness as an individual, and ISs, for which the main material medium is the society).

Very often (alas, too often in the history of mankind) it turns out that such an IS of the social level of organization is not only not interested in preserving individual elements of its structure (humans), but also has mechanisms for their constant renewal (generational change, “purge of the ranks ", reboot).

Even if we talk only about biological evolution and the struggle for existence of various genetic codes of DNA, it turned out that for the successful survival of this IS, and its adaptation to changing conditions, regular renewal of material media (individuals of the species) is beneficial.

And the natural "desire" of consciousness, as an integral IS, to preserve as long as possible and multiply on other material media (in the brains of other people) turned out to be not realized by any of the currently existing natural evolutionary mechanisms. Apparently, in the natural course of information evolution, this IS (human consciousness) lost the battle for domination to other, easier organized, but more "tenacious" genetic and social information structures. However, possibly, it has not yet begun this struggle "seriously".

Summing up the analysis of the natural mechanisms of survival of information structures within the framework of information evolution, we can draw the following conclusions:

- Human consciousness can be considered as a complex system of individual ISs, the preservation of which is not ensured by the mechanism of biological reproduction
- However, within the framework of the information evolution, numerous mechanisms have emerged and are successfully functioning for the preservation of individual properties of human consciousness (constituting its IS) in the minds of other people after his death.
- They are formed either in the consciousness of people itself, or in the dominant social ISs, elements of which they are.
- All these mechanisms are algorithmizable (computational). Therefore, they also allow artificial preservation ("prosthesis") of separate properties of consciousness on other material carriers (robotic devices).
- At the same time, consciousness as a whole and its specific (non-computational) properties of freedom of choice, awareness, etc. are not preserved.

2. Human consciousness as a quantum object with non-computational properties

The possibilities of preserving consciousness as a whole, with an accurate restoration of all its properties, seem realistic. In order to do this, we need to follow a completely understandable and almost obvious sequence of procedures:

- Analyze each of the observed properties of consciousness in various experiments and describe it as accurately as possible (by a deterministic or stochastic model).
- Develop a mathematical algorithm for the functioning of this model (algorithmize it).
- Select a suitable material medium (microcircuit, sensors, actuating mechanisms, etc.) and implement the developed algorithm on it.
- Provide the necessary connections between the mechanisms that implement each of the properties.

Many of the directions of research of human consciousness in modern science are developing along this, or similar paths. In general, such list of procedures is the subject of study in robotics. And there are already mass-produced robots that fully implement some of the functions of human consciousness programmed into them.

But the main problem with this path is that there is a property of consciousness (or a class of such properties) that cannot be algorithmized. And not because humanity does not possess enough resources to build an appropriate "robot", but because it is impossible in principle.

In attempts to link this fact with the rest of the (materialistic) worldview, such philosophical categories as the soul, freedom of choice, and self-awareness arose. The second chapter of this essay is devoted to the analysis of this problem and our suggestions for solving it.

2.1. Non-computability as a special property of consciousness in the works of R. Penrose

Typology of models of consciousness

The deepest analysis of the relationship between the models of consciousness and physical worldview, as we see it, was carried out by R. Penrose [2]. He proposed to classify various approaches to modeling this phenomenon according to belonging to one of the 4 classes:

A. Any thinking is a calculation; in particular, the sensation of meaningful awareness is nothing more than the result of performing the appropriate calculation.

B. Awareness is a characteristic manifestation of the physical activity of the brain; although any physical activity can be modeled through some set of computations, numerical modeling as such cannot generate awareness.

C. Awareness is the result of appropriate physical activity in the brain, but this physical activity cannot be adequately modeled computationally.

D. Awareness cannot be explained in physical, mathematical, and generally scientific terms.

Penrose himself advocates option "C", which he divides into two subtypes:

"Some supporters of the option C argue that our modern physical understanding is absolutely adequate ... Others, on the contrary, believe that modern physics, in fact, does not have the proper means to implement the required type of non-computability."

- All existing models of consciousness can be divided according to two parameters:
  - computability of basic functions (possibility of writing an algorithm)
  - necessity of physical activity of the brain for functioning
- Models of a "computational" consciousness allow its reproduction either on an artificial matrix (A), or on a copy of the human brain (B)
- Models of "non-computational" consciousness contradict the possibility of its reproduction within the framework of existing physical laws and require their "renewal"

Non-computational properties and phenomena of consciousness

In the first chapter of the essay, we showed that all the properties of human consciousness that can be described and algorithmized can be reproduced on other material carriers (at least in principle). The question remains open as to whether other properties exist.

The fact that some functions of human consciousness are not yet amenable to description, modeling and reproduction is not a reason to consider this impossible. The following phenomena can claim the role of such functions:

- *The phenomenon of self-awareness* is the ability to feel one's own state and tell others about it. But where is the criterion that a "robot" can feel its state, and it is not just the data of the sensors transmitted to the screen?
- *The phenomenon of freedom of choice* - the ability to make a decision on the choice of one of the possible actions. But this property is possessed by both natural mechanisms (chemotaxis in amoebas) and artificially created control systems with feedback.
- *The phenomenon of creative activity* - but what is meant by “creativity”? Where is the line that distinguishes creative tasks from routine ones?

And no matter how we complicate the mechanisms that implement each of these functions, the question will always remain open: “Do the constructed mechanisms really recognize themselves, freely choose and solve creative problems? Or is it just a clever imitation of what is “actually” happening in the consciousness of a human?"

R. Penrose proposes to draw a line between the "real" properties of consciousness and their "imitation" formally, giving a mathematical criterion for this distinction.

By default:

- He classifies non-computational tasks as creative tasks. That is, those whose solution cannot be algorithmized (written as a program running on a computer of sufficient power).

- The self-awareness tasks are those of the systems with sensors, the result of self-description of which cannot be "calculated" in advance.
- The free-choice tasks are those of the control systems, whose result of choice is not predictable by external observers, no matter how well they study the properties of the system.

The adoption of this definition immediately rejects options "A" and "B" in the classification described above. It also crosses out any, even fundamental, possibility to create an algorithm that makes decisions in a way indistinguishable from consciousness. That is, able to solve "creative" problems. In other words, he denies the possibility of imitating consciousness by both Asimov's robots and bio-robots; all of whose functions are computational (can be programmed).

Further, he devotes most of his work to the proof of the following two theses:

- Non-computational tasks exist in reality, and the possibility of their solution is an integral part of human consciousness.
- In the modern physical worldview, there is no opportunity to model the processes associated with the solution of non-computational problems.

As an argument for the first of these conclusions, Penrose uses the Gödel's theorem (and proves it in a new, algorithmic way). In particular, it proves the assertion that "In order to establish a mathematical truth, mathematicians do not use deliberately grounded algorithms."

To prove the second of the conclusions, he considers the paradoxes of quantum theory as the most fundamental and reliable way of describing processes in the material world. As a result of this analysis, he comes to the conclusion that the reduction of the quantum state of the observed system is not computational. According to his hypothesis, it is this item that is responsible for the phenomenon of awareness of the result of observation in the observer's brain.

2.2. Features of the information approach to the description of events in physical systems and human consciousness

Having agreed with the main conclusions of R. Penrose that the special properties of human consciousness are associated with their "incalculability", we propose a different, information approach to solving the problem of their modeling. We believe that neither new physical phenomena that can be discovered in the depths of the brain, nor any complex artificial mechanisms that recreate these phenomena, can in principle solve the logical contradiction inherent in the very attempt to "describe the indescribable."

In order to do this, it is necessary to change, first of all, the very method of describing such phenomena. As a consequence, in this case, a "new physics" will inevitably arise, to describe new objects - observers with the ability to freely choose observations and understand their results.

The basics of the information approach

to the analysis of the observed events and properties are the following:

- We focus on analyzing the information needed to conduct a certain type of observation and the information obtained as a result of this observation. In this case, we believe that neither the physical features of the observation mechanism, nor any other circumstances should affect the result.
- If this is not the case, then we are dealing with a poorly prepared and poorly conducted measurement. In physics, a “well-prepared” measurement is one in which the hypothesis of equidistribution over all possible microstates is fulfilled. This means that in the initial state of the device there are no regularities, except for those contained in the initial information about the measurement being carried out.

- The question of the choice of the dimension itself (its type) remains beyond the scope of this hypothesis. Moreover, this question generally remains outside the framework of fundamental physics and the theory of physical measurements. It is believed that an "ideal" observer can ***freely choose*** any type of measurement, regardless of the properties of the observed object and independently of other observers. And if this is not the case, then we are dealing with a "bad" observer.

But the latter means that the free choice of an ideal observer is the very uncomputable procedure that we have adopted above as the criterion of awareness. Thus, the main property of consciousness is already implicitly present in the physical theory, but formally excluded from its mathematical apparatus.

And from this it follows that in order to build a "new physics" of uncomputable processes, we do not need to change existing laws or invent new ones. It is sufficient to “simply” perform the following steps:

- Include in the consideration a new procedure - the choice of the type of observation by each of the observers who are part of the closed system.
- Associate the parameter "freedom of choice" with it.
- Require the consistency of this "freedom of choice" with the fundamental laws of physics.

The laws derived from the last requirement will make it possible to describe uncomputable processes in the surrounding world. First, we will demonstrate a number of "non-obvious" properties of consciousness, using the example of considering some of the paradoxes of fundamental physics. In particular, we will show that the contradictions contained in them are associated not only with "special properties of matter", but primarily with the illegitimate exclusion from the analysis of measurement the results of the freedom of choice of the observer; or associated with its illegitimate idealization.

The fact is that all our notions about the processes taking place in the surrounding world are based only on information obtained as a result of their observation. Therefore, the models used to describe observation mechanisms (including models of consciousness) must be interpretations of the very results of these observations.

A vicious circle arises:

– to describe how we observe the world around us, it is necessary to build a model of the observation procedure;

– but to build such a model, we need to use the results of other observations;

– for which, in turn, you need to build a new model.

In physics, it leads to the so-called problem of quantum measurement - the impossibility of describing the reduction of the wave function (obtaining a specific macroscopic result) by means of quantum mechanics itself.

In mathematics it leads to Gödel's theorem, which in a generalized form is formulated as the impossibility of constructing a complete and at the same time consistent axiomatic theory. In any non-contradictory theory, there will always be true, but unprovable statements.

In the theory of consciousness it leads to the prediction paradox. In a simplified version, it is reduced to the statement that a person, in principle, cannot predict its future. As soon as a person tries to do this, even taking into account all the nuances and peculiarities of his mentality, the realization of this prediction will change his state so much that it will make the prediction wrong.

In economics it leads to the paradox of the non-computability of the "true" value of goods. The presence of an algorithm for calculating the true value will make any transaction

meaningless, since both parties of the transaction will consider the exchanged goods to be of equal value and will not receive any benefit from the transaction.

We gave a more detailed analysis of this problem in the works [13, 14].

Attempts to “break” this vicious circle by arguing that the world “in fact” is arranged this way, and not otherwise, lead to meaningless disputes and paradoxes. We will analyze some of them (physical) in the next section.

Note that the modern physical theory comes to similar conclusions in case of necessity. Even one of the basic fundamental physical principles - the Heisenberg uncertainty principle - was originally obtained not as a quantum property of matter, but as a logical incompatibility of procedures for measuring the coordinates and momentum of particles using an electron microscope [15]. Then it turned out that the detected incompatibility does not depend on the design of the device, but is of a general (information) nature.

Models of consciousness within the framework of the information approach

We fully agree with the conclusions of R. Penrose about the need to create a new (generalized) physical theory for the possibility of including the phenomenon of consciousness in it. However, the method of such a generalization proposed by R. Penrose does not seem to us to be perspective.

The point is that the discovery in the human brain and the description of a hypothetical macroscopic process responsible for the reduction of the wave function does not solve the problem of non-computability. The discovery of a new type of information field will contain the same contradictions, unless the very principles of its description are changed.

We believe that the very attempt to find out what consciousness is “in reality” (from the point of view of fundamental physics) is erroneous. First of all, because the main contradiction of the theory of consciousness (description of the indescribable) is associated with its inherent logical, and not physical properties. No information structure can, in principle, describe itself and predict its behavior, be it a mathematical algorithm, a human brain, or an axiomatic theory.

Therefore, all existing models are reduced, one way or another, to the description by one part of the brain of the state of another part of it. Or to the description of the properties of one part of the universe by another part of it (an idealized observer). Any attempt to construct a consistent description of a closed structure (the whole consciousness or the whole universe) leads to its incompleteness (due to the generalized Gödel theorem).

Such an incomplete description inevitably must use additional parameters of the measurement procedure. We believe that they are related to the phenomenon of “freedom of choice”. Next, we will analyze in detail the properties of this measurement parameter and the prospects for its inclusion in the generalized measurement theory – the "new physics", about which R. Penrose wrote.

In the meantime, we will limit ourselves to a clear illustration of the difference between the information approach and the generally accepted approach within the framework of the quantum measurement problem. In Figure 2, a diagram of a hypothetical closed “universe” is shown, some parts of which act as observers and, possibly, possess consciousness.

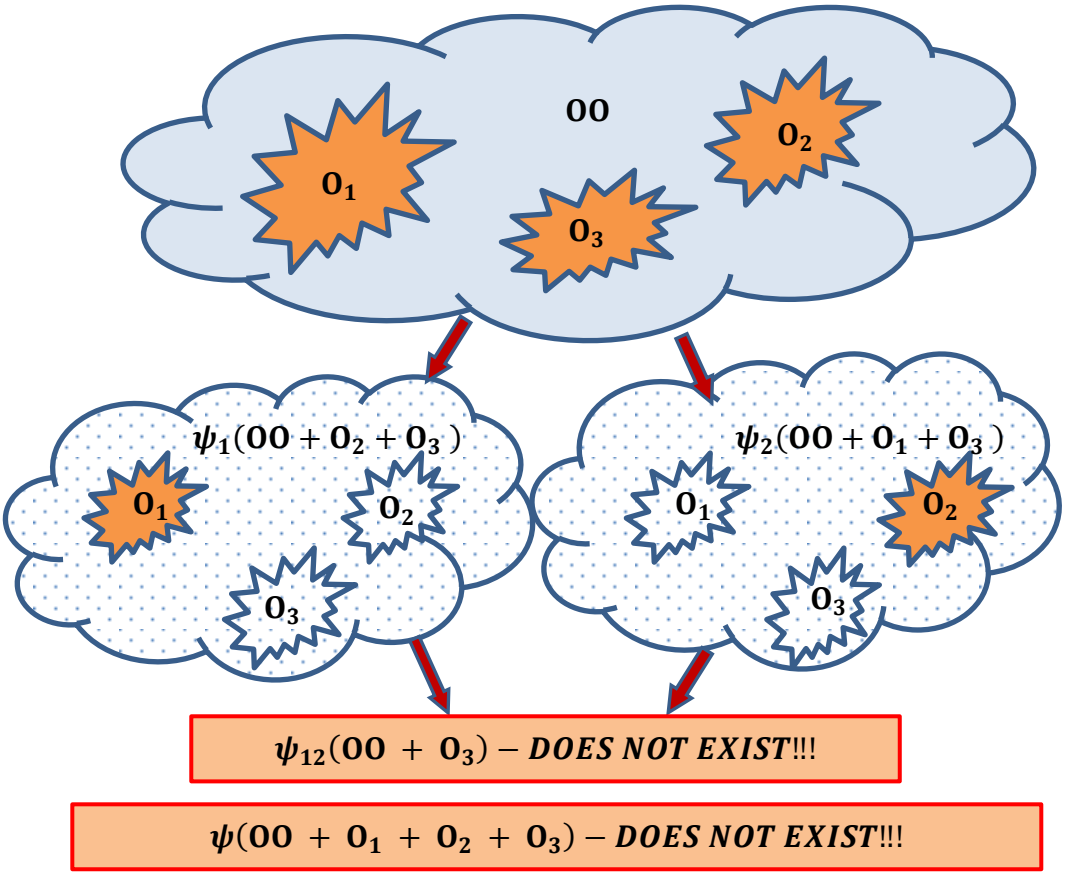


Figure 2 Illustration of the generalized principle of relativism in the problem of quantum mechanical measurement

Within the framework of the quantum mechanical formalism, we can correctly describe the state of the rest of the universe $(OO + O_2 + O_3)$ measured by the observer O_1. Or the state of the rest of the universe $(OO + O_1 + O_3)$ measured by the observer O_2. But these will be different descriptions of different parts of the universe.

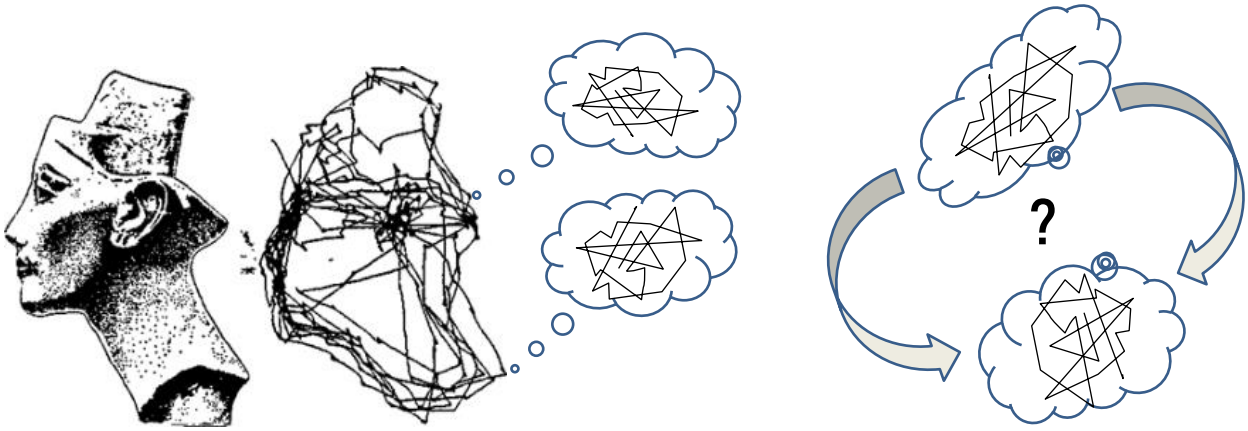
In the general case there is no consistent description of the remaining part of the universe by both observers simultaneously $\psi_{12}(OO + O_3)$. Similarly, there is no consistent description of the entire universe, including the observers in it $\psi(OO + O_1 + O_2 + O_3)$.

Let us provide one more classic (and, perhaps, more visual) illustration of the impossibility of full observation of "oneself" by human consciousness [16]. Figure 3(a) shows the observed object (face profile) and the movement of the pupil of the eye of the person observing it.

Figure 3(b) shows the movement of the pupil of the eye of the second observer, observing the movement of the pupil of the first one. Observing each of the points of the trajectory (two of them are shown in the figure), the pupil of the second observer "probes" it, making chaotic movements around, until the image of this point is formed in his consciousness.

If now the first observer tries to describe the movement of the pupil of the second one, observing it, it will lead to a paradox (Fig. 3(c)). Thus, any attempt to "look at oneself from the outside" through the eyes of an outside observer is doomed to failure. And not because it requires huge resources, but because it is impossible in principle.

Of course, it is possible to design a device that rigidly connects the movements of the pupils of two people watching each other. Then, formally, the trajectory of one of the pupils will automatically determine the trajectory of the other pupil. They will "kind of" observe each other. But such a rigid connection will limit the freedom of choice (movement of the eyeball) of each of the observers and make their choices (trajectories of the pupils) confused.



(a) (b) (c)

Figure 3

(a) Object and movement of the pupil of the eye observing it
(b) Movement of the pupil of the eye of the second observer observing the pupil of the first one
(c) Attempting to observe the movement of the pupil of the eye observing the movements of your eye is doomed to failure.

Thus, no tricks will be able to get around the logical contradiction of the phenomenon of self-description. It turns out to be impossible in principle to include the observer itself as a physical object in the description of a closed system.

The only way out is to build a "new physics" that accepts this impossibility as one of the fundamental laws of nature.

In the above example, the following statement seems natural: "in fact" the pupils of both observers move along some definite trajectories, which they themselves cannot comprehend. This is certainly true, but only due to the fact that they make inaccurate measurements of each other.

- In the human consciousness, there are a number of non-computational functions: awareness, freedom of choice, creativity, etc.
- Neither new physical phenomena, nor any complex artificial mechanisms imitating these functions, can in principle solve the logical contradiction inherent in the very attempt to "describe the indescribable."
- The only way to solve this problem is to introduce parameters of non-computational functions as additional parameters of the state of consciousness.
- The already known laws of physics make it possible to associate them by equations with the physical parameters of the description of the observed system.
- Thus, a new "generalized" physics can be obtained, which allows us to describe a closed system in which non-computational functions are present (properties of the observer's consciousness)
- Until now, the mathematical apparatus of physics excluded the possibility of considering such systems

2.3. The principle of generalized relativism as the basis of the "new" physics and theory of consciousness

Our proposed information approach to the analysis of the phenomenon of "consciousness" allows us not to oppose the first three variants of Penrose's classification to each other. Within the framework of this approach, we can only say that each of these models is the result of observations of a certain type. In each specific case, only one of the possible observations occurs, and consciousness is in one of the possible states.

Consider an observation in which the observer O_1 describes the world around him (including observers O_2 and O_3) as accurately as possible and receives the result $\psi_1(OO + O_2 + O_3)$. In this case, the dynamics of the actions of the observer O_2 turns out to be a computable function. All his thoughts, feelings, his own observations, etc. (In fact, his consciousness) are not only predictable (computational), but also controlled by the quantum Zeno effect [17]. Models of consciousness O_2 in this case refer to type "A" or "B".

If, on the contrary, accurate observations of the surrounding world are carried out by the observer O_2, then the wave function $\psi_2(OO + O_1 + O_3)$ does not include any parameters of his consciousness. He can arbitrarily choose which further measurements to take. The models of his consciousness belong to the non-computational type "C".

Thus, it makes no sense to discuss the inconsistency of models of different types: "A", "B" or "C". They describe the results of fundamentally incompatible measurements (and associated events).

Let us emphasize that the two alternatives of observations in a closed system shown in Fig.2 (observer O_1 or observer O_2) are not just different ways of describing real events. These are different sets of events, of which only one "actually" occurs. And the case when both observers try to observe each other will result in the third set of events, the properties of which we will discuss later.

A ***similar problem*** of incompatibility of observations arises in physics.

The centuries-old debates about the nature of light - a particle or a wave, were solved by N. Bohr's principle of complementarity [18]. It follows from it that in some dimensions light behaves like a stream of particles, and in others it behaves like a wave. Moreover, the first and second experiments are fundamentally incompatible. Therefore, all arguments about the nature of light “in fact” lose their meaning. In some experiments it “becomes” a wave, and in others it becomes a particle.

The Heisenberg uncertainty principle asserts not only the impossibility of simultaneously accurately measuring the coordinate and momentum of an elementary particle, but also the impossibility of its simultaneous existence in these two states (with the exact coordinate or with the exact value of the momentum).

In the same way, human consciousness not only can be described in two different ways (computational and non-computational functions), depending on how it is observed. But it can also exist only in one of two states incompatible with each other. The first state is computable and does not have a free choice function (all kinds of robots and biorobots). The second state, itself observes the surrounding world and "chooses" the method of observation at its own discretion. Obviously, each of these two states of consciousness has different properties ((and requires different conservation mechanisms within information evolution).

Let us note that the concept of two opposites (both in physics and in the theory of consciousness) is greatly simplified. In reality, there may still be a large number of intermediate ways of observing a particle or consciousness. For their description it is required to apply the mathematical apparatus of weak quantum measurements [19].

We will generalize N. Bohr's principle of complementarity and the methodology of weak quantum measurements as applied to modeling of consciousness in Section 2.3.

Further, we will discuss some of the classical paradoxes of quantum mechanics. However, we will focus not on the physical properties of the observed quantum objects, but on the possibilities of observing these properties by idealized observers.

Quantum problems of the "cat", Wigner and his friend

The problem of quantum measurements is clearly manifested in the well-known paradox of the Schrödinger cat [20]. The closed box contains a radioactive atom with a half-life of 1 hour and a "hellish device" that links the decay of the atom with the death of the cat. It follows from quantum mechanics that the state of an atom should be described as a superposition of two states (decayed and non-decayed atom) until it is measured by an observer. But then the state of the cat should be described as a state of superposition as long as the box is closed.

An improved version of this thought experiment was proposed by E. Wigner [21]. In this experiment, "Wigner" himself sits inside a box and observes the condition of the cat. At the same time, his "Friend" (Schrödinger) is outside the box and does not know what happened inside until he opens the box (Fig.4).

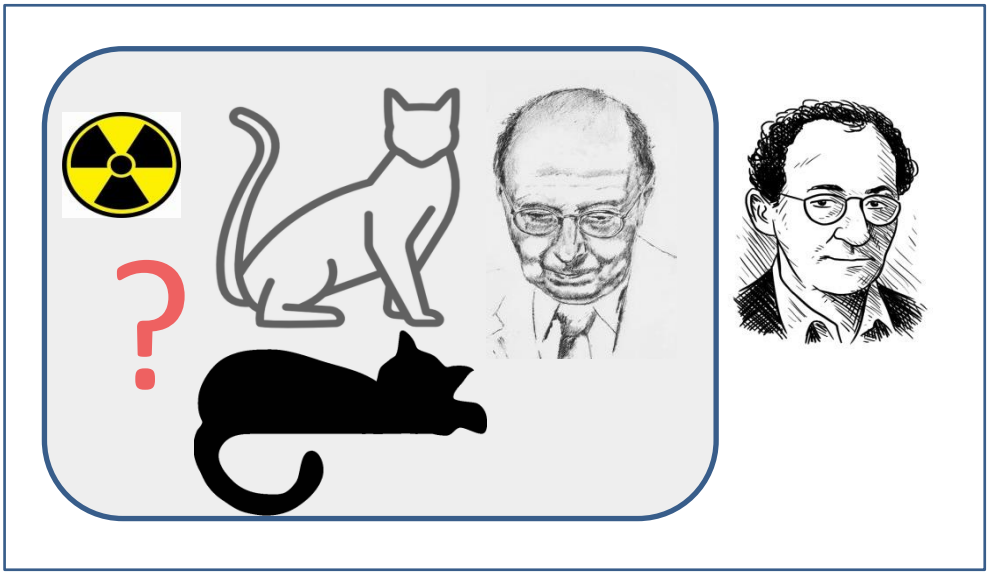


Figure 4

In this case, it follows from quantum mechanics that not only the cat, but also "Wigner" himself, and all his thoughts about the cat are in a state of superposition of two states: "dead cat + sad Wigner" and "live cat + happy Wigner". And only after Wigner's friend (WF) opens the box, the cat and Wigner will instantly find themselves in one of these two states.

Let us demonstrate that in this case such properties of consciousness are manifested, which in principle cannot be reduced to the physical properties of its material carrier; and that the aforesaid interpretation of what is happening in the consciousness of "Wigner" and his "Friend" is far from reality. In order to do this, let us consider a simplified analogue of this experiment. The so-called Elitzur-Vaidman "Bomb paradox", described and analyzed in detail in [2].

Usually, when describing this paradox, the trajectory of a photon in a Mach - Zehnder interferometer is considered (Fig.5). In it, a system of two semitransparent mirrors (STM_1 and STM_2) and two non-transparent mirrors (upper and lower mirror - UM and LM) rigidly fixed on a common platform creates an interference between two components of the light wave emitted by the source "S". As a result of optical interference, all of the light enters the lower detector (LD).

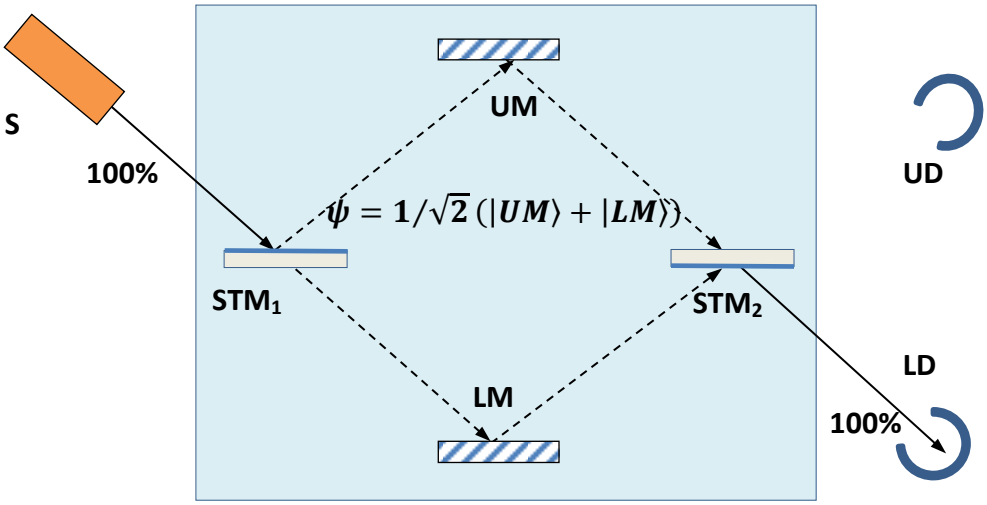


Figure 5

If the source emits light one photon at a time, then each photon, according to the laws of quantum mechanics, after STM_1 transfers into a state of superposition of two states: $\psi = 1/\sqrt{2}\,(|UM\rangle + |LM\rangle)$. It seems to "split and move simultaneously" along two paths possible for an ordinary particle - reflecting from both the upper and the lower mirror. As a result of interaction with STM_2, such photon will “become whole” again and with a probability of 100% will enter the LD detector, as in the case of a light wave.

The essence of the "Bomb paradox" is that the photon "behaves" in a completely different way if one of the non-transparent mirrors (LM) is attached to the bomb fuse (Fig.6).

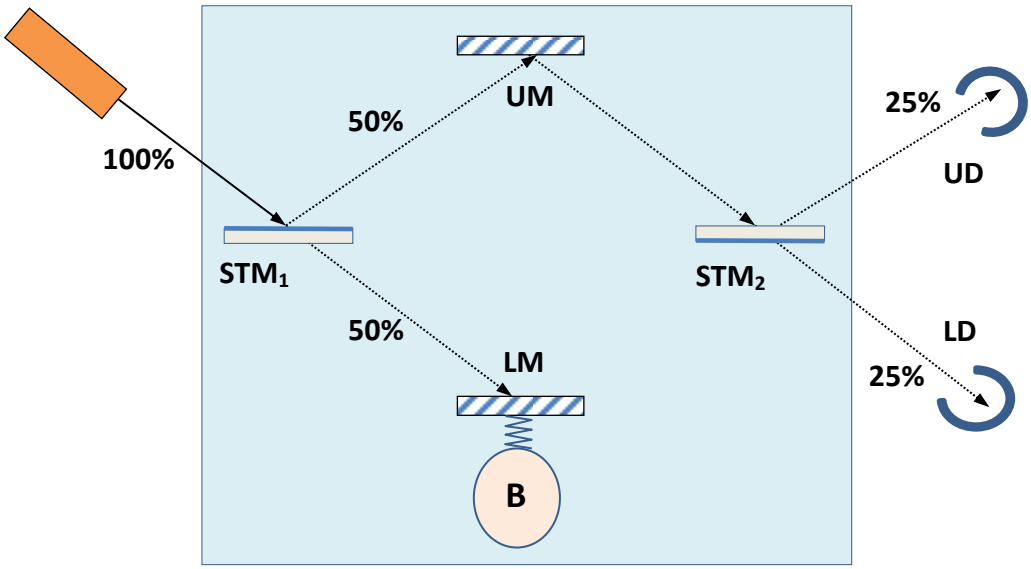


Figure 6

In this case, the LM with the fuse attached to it becomes a detector that can detect which of the two possible paths the photon took. If it is the lower one, the bomb will explode, and the photon will not fly anywhere further. If it is the upper one, the LM will remain motionless, and the bomb will remain intact. This photon is then reflected from STM2 or flies through it with equal probability.

Thus, out of 100% of bombs with operational fuse, 50% will explode, and 50% will not. For half of them (25% of the total), the photon will hit the upper detector. But it would not have

been able to get there if the fuse had jammed (Fig.5). Therefore, we will know for sure that these 25% of the bombs are operational, even without "touching" them with a released photon. By carrying out repeated tests with unexploded bombs, we can bring the number of bombs that are operational suitable, but not exploded, to 1/3. And in certain modifications of this experiment [22] we can even reveal 50% operational bombs without detonating them.

Two important conclusions follow from this experiment:

- The state of a quantum object (photon) and related classical objects (mirrors and detectors) depends not only on the result of the measurement performed, but even on the presence (or absence) of the possibility of performing it.
- Changing this possibility requires changing the properties of a macroscopic object that is part of the experimental setup (fuse).

Thus, the phenomenon of "freedom of choice" (FOC) can be rid of the taint of mysticism and formalized in physical terms. If, in the discussed experiment, an observer is placed next to the bomb, then his FOC can be considered as the change of properties of the actuator (fuse).

Formally, one can put an identity sign between the macroscopic description of the surrounding world by this or that observer and the multitude of his capabilities (what he can do with this world).

It can be assumed that the human consciousness, having made a choice ("to be or not to be"), even unconsciously frees some executive mechanisms (muscles) and binds others. Thus, any change in the information state of consciousness (decision making, awareness of the result, etc.) is inevitably associated with macroscopic changes in the state of physical bodies in the surrounding world.

The difference between the description of these phenomena of conscious activity from the description of ordinary physical events is only that they are not computable (according to the laws of fundamental physics), and are controlled by the observer's FOC. Next, we will illustrate (on a qualitative level) how the FOCs of various observers can be related to the state of the surrounding world and to each other.

The "bomb paradox" can be interpreted as an experiment with "Schrödinger's cat in Wigner's interpretation" if we assume that

• STM1 act as the "hellish device" (actuator) (A)
• Two mirrors LM and UM, rigidly connected to each other, act as the "cat" (C)
• STM2 act as Wigner (W)
• UD and LD, also rigidly interconnected, act as Wigner's friend (WF) (Fig.7).

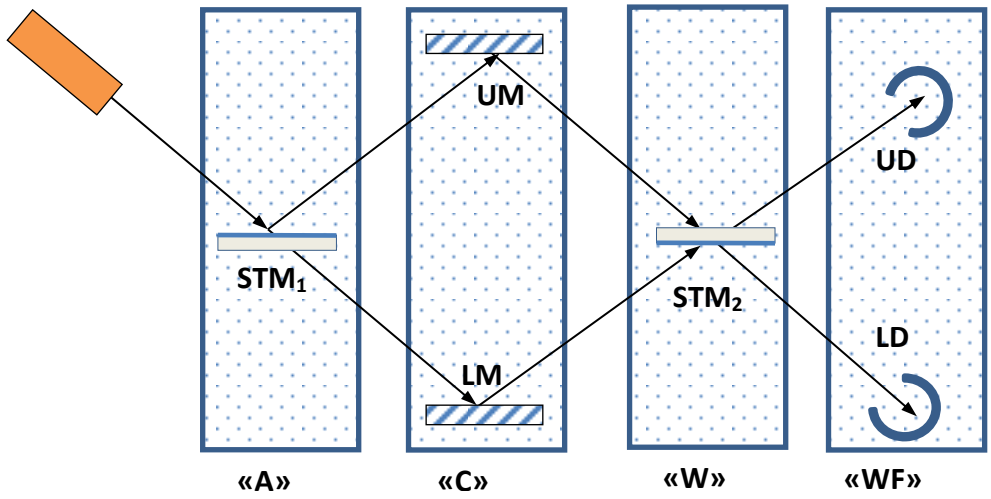


Figure 7

In this interpretation, both the state of the "cat" and the results of observations of "Wigner" and "Wigner's friend" are directly related to the speed of the corresponding mirrors.

If, for example, a photon flies through STM_1 without obstructions, then "A" will be activated. Then the photon will be reflected from the LM, and the pair of mirrors (LM + UM), due to recoil, will begin to move downward – and the "cat" will be dead. If "A" will not be activated (the photon will be reflected from the STM_1), then it will be reflected from the UM as well. A pair of mirrors (LM + UM) will begin to move upward and the "cat" will remain alive.

In this interpretation, "W" has several choices.

- Remove STM_2 from the path of the photon
- Fasten STM_2 firmly on the same platform with the rest of the mirrors ("A" and "C")
- Release STM_2 (putting it on a spring like a fuse).

In the information interpretation of the states of his consciousness, these options mean:

- "Wigner" does not "look" at the "cat"
- "Wigner" is looking at the "cat", but cannot comprehend what he sees (the macroscopic parameters of his state cannot change)
- "Wigner" can "look" at the "cat" and realize the result of what he sees.

The same can be said about the "cat" and about the "WF". If there is a separate observer near each of the mirrors, then each of them has the possibility of one of three variants of behavior. But in fact, much more variants, if we take into account the possibility of installing semi-rigid springs or allowing the movement of the mirror only in one direction (up or down).

Even in such a simple experiment, there are 6 macroscopic objects. And if each of them can "freely choose" one of 3 options for mounting the sensor, then in total we will obtain 3^6 = 531441 options for conducting the experiment. And not a single pair of them will be compatible with each other.

If, for example, we release STM_1, (A), then the collapse of the wave function of the photon occurs after interaction with it. In this case it is impossible to speak about any superposition of the states of "C" or "W" or "WF". But if all 4 mirrors are rigidly fixed on one platform, then the collapse of the state of photon occurs only after hitting the LD or the UD.

Of these two different experiments, only one can happen. Therefore, the answer to the question "Is the "cat" in a true state of superposition?" depends on what method of fixing the mirrors is actually implemented.

The proposed information interpretation of paradoxes is very close to the well-known theory of decoherence [23]. According to this theory, the collapse of the wave function occurs not at the moment when we receive information about the state of a macroscopic object (open the box with a cat), but at the moment of the first of the macroscopic (and therefore irreversible) changes in the device. Our interpretation differs in the point that the possibility of decoherence turns out to be controllable. It depends on the choice of the observer and its change requires a "transition to another Universe" (in the spirit of Everett's many-worlds interpretation [24]).

Probably, any exotic information connection can be implemented with proper special devices. For example: ""W" knows that "WF" does not know about his intentions", or a similar situation. Such experiment will correspond not only to a different awareness of the participants of the events, but also to a different physical state of the sensor system, which will not coincide with any of the half a million others.

For those readers who have more trust in formulas, we will give an additional argument that "Wigner", which is in the box with the "cat", cannot be in a state of superposition if he has already looked at the "cat". Conversely, he cannot see the cat either alive or dead while in a state

of superposition. This is due to the fact that the two of its different states can only be implemented using different devices; and considering that they are possible simultaneously (but from different points of view) is a gross mistake.

It is commonly considered that after "W" has looked at "C", their quantum states are entangled. “WF” can write it down as a superposition of two pure states:

$$\psi_{WF} = 1/\sqrt{2}\,(|\mathrm{C-\ dead; W-\ sad}\rangle + |\mathrm{C-\ alive; W-\ happy}\rangle)$$

And only after the photon hits the UD or the LD (WF opens the box), a collapse occurs.

To prove that our conditional “cat” (a pair of mirrors) was in a state of quantum superposition inside the box, STM_2 and its careful adjustment (alignment of the optical lengths of two possible paths of the light wave) are required. To do this, all the mirrors are placed on one rigid platform, thereby leaving "Wigner" no opportunity of observing the "Cat".

If we still allow "Wigner" to observe the "cat" - to measure the speed (or impulse) of STM_2 relative to the mirrors (UM + LM), then in order to conclude whether the cat is "alive or dead", this must be done with the accuracy of

$$\Delta p_{\mathrm{STM2}} \leq p_{photon}.$$

Due to the Heisenberg uncertainty principle, this will lead to the uncertainty of the vertical coordinate of STM2 by the value of

$$\Delta y_{\mathrm{STM2}} \geq \frac{\hbar}{\Delta p_{\mathrm{STM2}}} \geq \frac{\hbar}{p_{yf}} = \frac{\lambda}{2\pi}$$

p_{yf} is the vertical component of the photon momentum.

Uncertainty of the position of the STM_2 of the order of the wavelength will lead to the fact that the phase difference of the two waves interfering on it will be random, and the photons will hit the UD and LD detectors with equal probability. In this case, "Wigner's friend" will not be able to find out, only on the basis of this observation, whether the cat is "alive or dead".

Thus, it follows from the Heisenberg's uncertainty principle that the state of the "cat" can be measured either by "Wigner" himself or by his "friend". Each of these measurements excludes the possibility of performing the other one. Even if both observers "Wigner" and "Wigner's friend" want to look at the "Cat" at the same time, only one of them will be able to do it. At the same time, the other observer will either realize the failure, or remain under misapprehension regarding the result obtained.

All our other reasoning about different scenarios for conducting quantum mechanical experiments can also be described by the formulas of quantum mechanics. In most cases, this has already been done in numerous works devoted to quantum informatics and the analysis of quantum mechanical paradoxes. No matter how much we try to find a contradiction in the laws of quantum mechanics with the experimental results, it will be impossible.

At the same time, we would like to draw the reader's attention to another important point that is usually overlooked. Different information about the properties of the parts of the measuring system requires different mechanical connections between the parts of the installation. Otherwise, this information is incomplete (or false).

- Obtaining the result of a quantum mechanical measurement presupposes an irreversible and unpredictable change in one of the parameters of the macroscopic state of the observer (the speed or coordinates of the mirrors in this example).
- There may be several different variants of the experiment, in which one or another part of the experimental installation acts as an observer. These options are not realizable simultaneously (technically)
- The state of the observer (and the corresponding part of the installation) changes unpredictably and irreversibly. This change can be described by the information parameter "freedom of choice" of the measurement option.
- Paradoxes arise from the idealization of the properties of the observer and the illusion of the possibility of simultaneously carrying out two incompatible measurements.

Information analysis of the EPR experiment (on the way to generalized relativism)

From the previous analysis it follows that in the Universe there can be only one "Demon of quantum measurement" (DQM), which will carry out all the necessary measurements and describe the rest of the Universe with a complex wave function. To organize all these measurements, he will have to, at minimum, turn all other thinking creatures into "robots", limiting not only their freedom of choice, but also generally excluding the possibility of performing any independent measurements by them. Only in this case the part of the Universe observed by the "Demon" will approach the ideal of a complete and accurate quantum-mechanical description. It will then be computable and predictable. All of its past and all of its future will be described by the equation of evolution of the measured wave function.

Of course, this fantastic scenario is possible only for very simple "micro-universes" in which the experimenter has a sufficiently complex organization to act as the "Demon". Such situations are considered "ideally performed" experiments in quantum mechanics. But as soon as we consider situations in which there are at least two observers, they are forced to "negotiate".

Let us analyze the relationship between two observers trying to simultaneously control and observe a "micro-universe". In order to do this, we will discuss another quantum mechanical paradox - the Einstein-Podolsky-Rosen experiment (EPR). In contrast to the "Schrödinger's cat" experiment, in the EPR the observers are equal in rights and symmetrical.

In the Bohm's interpretation [25], in this experiment, pairs of particles with a resultant zero spin fly in opposite directions from the source (Fig.8). This information means that a pair of particles, prior to the measurement the spin projections, is in a state ψ_0 that can be represented in different ways:

$$\psi_0 = 1/\sqrt{2}\,(|y\uparrow; y\downarrow\rangle + |y\downarrow; y\uparrow\rangle) = 1/\sqrt{2}\,(|+\boldsymbol{\alpha}\uparrow; +\boldsymbol{\alpha}\downarrow\rangle + |+\boldsymbol{\alpha}\downarrow; +\boldsymbol{\alpha}\uparrow\rangle)$$
$$= 1/\sqrt{2}\,(|-\boldsymbol{\alpha}\uparrow; -\boldsymbol{\alpha}\downarrow\rangle + |-\boldsymbol{\alpha}\downarrow; -\boldsymbol{\alpha}\uparrow\rangle)$$

At equal distances from the source, two observers can measure the projection of the spin of their "own" particle to any of the directions perpendicular to its velocity. To do this, they must turn their Stern-Gerlach device (SGD_1 or SGD_2) around the x-axis to the appropriate angle.

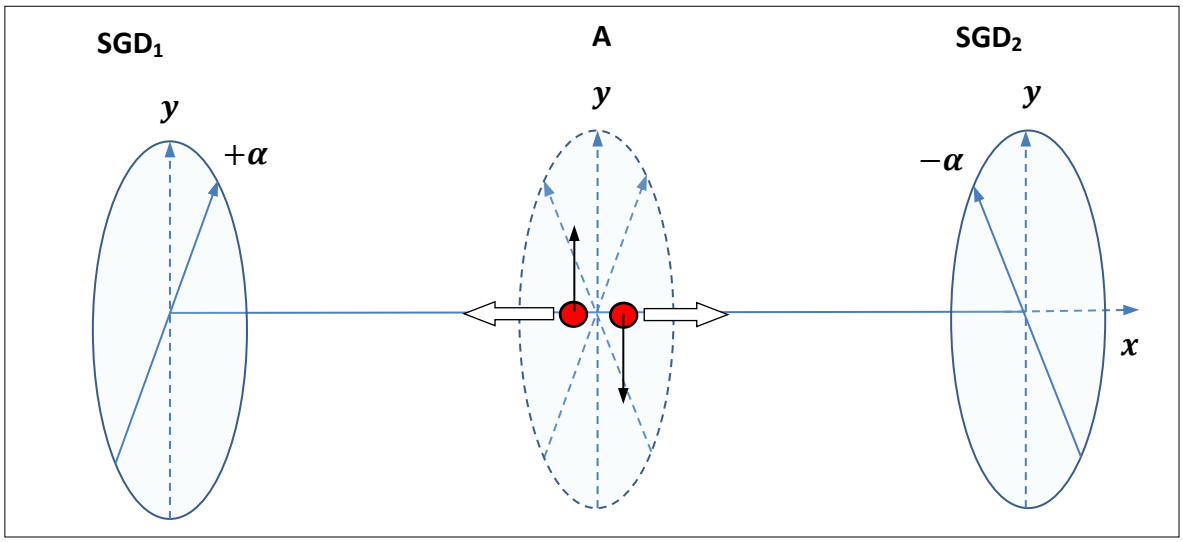


Figure 8

SGD (in s very simplified form) is a device that, using magnetic fields, interacts with a passing particle in a certain way. At the exit from the SGD, the particle has one of two spin values ("↑" or "↓") in a direction that depends on the orientation of the SGD and is chosen by the observer.

The paradox of the quantum-mechanical description arises when it turns out that a measurement carried out in SGD1 above one of the particles, instantly changes the quantum state of the other particle as well, in accordance with the obtained result. This conclusion contradicts the concept of the maximum speed of propagation of interactions equal to the speed of light.

In this experiment, as in the previous case, the "obvious" assumption about the independent and free choice of one of the three possible dimensions by each of the observers requires careful analysis. Of course, each of the two people orienting their device may want "anything", but will they be able to realize their desire without interfering with the measurement of another observer? Analysis of the previous experiment showed that sometimes it is impossible.

In order to perform the measurement $\langle +\alpha \rangle$, the first observer needs to track the relative orientation (relative angle) of the source of particles A and SGD_1 during the entire flight of the particle from the source. The easiest way to achieve it is to place both devices on a rigid platform (shown in blue in Fig.9). In addition, the observer must partially "free" his device, allowing it to rotate around the axis $+\alpha$. Only in this case SGD_1 will be able to carry out the measurement, having received the moment of inertia from the absorbed particle $\overrightarrow{\Delta J_{\uparrow}}$ or $\overrightarrow{\Delta J_{\downarrow}}$, depending on the measurement result.

The second observer performing the measurement $\langle -\alpha \rangle$ (pink platform) must do the same. Then it turns out that in order to carry out a pair of measurements, the SGDs should be rigidly fixed on a common platform and be able to rotate around the axes chosen by the observers.

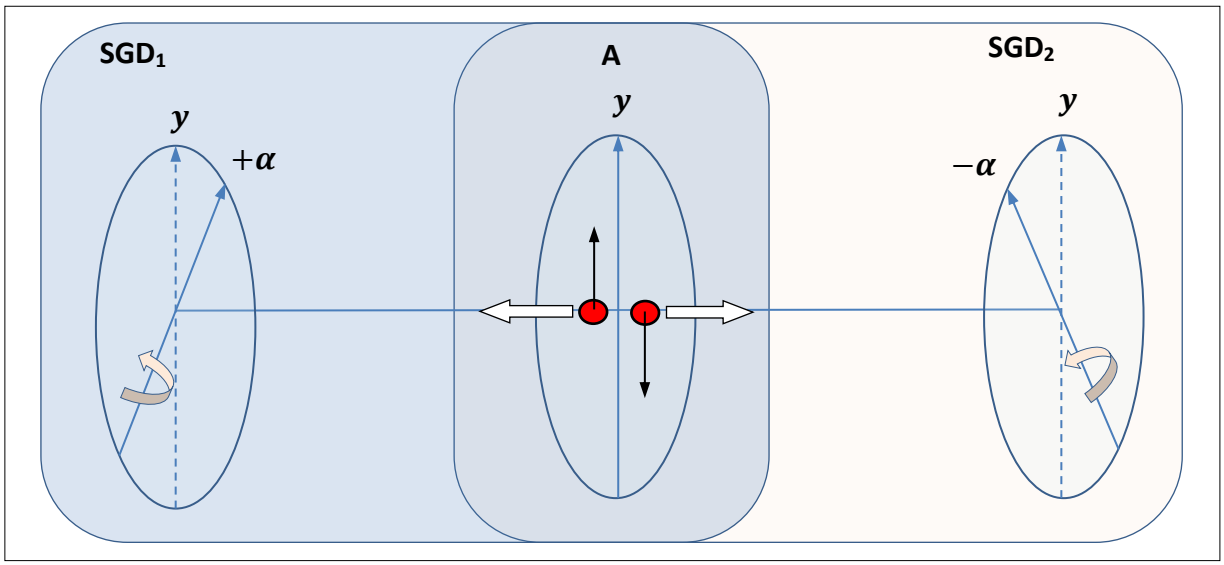


Figure 9

As it has been shown above, the collapse occurs not after the measurement, but after the occurrence of opportunity to perform the measurement. And there is no mysticism in this fact (or superluminal interaction). Already at the moment of separation of particles SGD_1 and SGD_2 are

- associated with source A,
- oriented in a certain direction and
- free in order to ensure the possibility of rotation (measurement of spin projection) in the selected direction.

At this moment, the "selection" of one of the 4 measurement results takes place is in accordance with the calculated probabilities:

$$|+\alpha\downarrow;-\alpha\uparrow\rangle;\ |+\alpha\uparrow;-\alpha\uparrow\rangle;\ |+\alpha\downarrow;-\alpha\downarrow\rangle;\ |+\alpha\uparrow;-\alpha\downarrow\rangle.$$

After the particle enters the SGD, it is not a collapse that occurs, but a usual (classical) measurement of the already existing projection of the particle spin.

The physical explanation of such an "effect at a distance" of the SGD fields on the spins of scattering particles can be quite difficult. Apparently, the rigid connection between the platforms and the axes of the possible rotation of the devices, written down in the form of conservation laws, allows only one of 4 variants of projection of the spin of particle.

One can write a solid scientific work (or even a dissertation) on this problem, but its result will be predictable. The laws of quantum informatics are effective in the point that they allow neglecting the physical implementation of the measurement procedure. It always turns out that the observed state of a quantum object changes just as much as the information about it has changed. Or the information about the possibility of obtaining information (the bomb paradox). Or something else, even more exotic.

Therefore, the information model of consciousness does not require analysis of the state of neurons, biocurrents, memory mechanisms and other things that neurophysicists and neuroscientists are interested in. The information properties of the observer's consciousness are primary both in the models of the observed physical objects and in the models of consciousness itself. An attempt to describe (even hypothetically) the state of matter unobservable by anyone (its state "in reality") is a step into the abyss of logical contradictions, mentioned above in this work.

Generalized complementarity principle

In the process of analysis of the previous experiment, we showed that the “Wigner” can act both as an observer (if the mirror is released) and as an observed object (if the mirror is fixed) in different experiments. The question of his “real” role loses its meaning, because "in reality" either the first or the second experiment can be performed, but never both of them simultaneously.

This result is very similar to one of the basic principles of quantum mechanics - N. Bohr's principle of complementarity (described above). It states, in particular, that light can be either a wave or a particle, but can never be both. By virtue of an obvious analogy, we can formulate a "generalized principle of complementarity", which no longer refers to the properties of inanimate particles, but relates to the properties of the observer:

In **different experiments**, a subject and his consciousness can play different roles - either an observer freely influencing the surrounding world, or an observed object described like all other quantum objects. The rest of the intermediate cases are related to the sphere of weak quantum measurements, which we will discuss below. Asking whether a subject has freedom of choice “in fact” is as senseless as asking about the “true” nature of light. We have the right to speak only about the freedom of choice of a subject only in a specific experimental situation and only in relation to certain parameters of its description.

In a **single experiment** involving two or more observers, their measurements cannot be simultaneously accurate. In this case, their FOC is limited by the choice of the other observer, and their quantum state cannot be described as mixed (the choice of a certain measurement is not random). Ignoring this fact leads to two incompatible quantum-mechanical descriptions (as viewed by each of the observers, who believe that it was him who made the measurement first).

We will never be able to offer a quantum description of this experiment that is equally valid for all observers, but we can require self-consistency of their descriptions. This requirement, formulated as a mathematical principle, can be called the principle of generalized relativism.

Summing up this analysis, we can say that with the symmetric role of two observers, their choice remains free, but:

- The choice of each of the observers determines only a part of the macroscopic parameters of the experimental installation. In this sense, his “freedom of choice” is limited by the choice of the other observer.
- This means that after flying from the source, a pair of particles is in one of the possible pure quantum states, but each of the observers does not know exactly in which one, but can only estimate their probability. To do this, he must know the choice of the other observer (what measurement he has performed and in what way he has modified his SGD for this purpose).
- The measurement results are influenced by physical changes in the environment (modifications in the device) that allow this measurement to be performed.
- But in order to calculate the new state of the observed objects, it is sufficient to know only the information about the choice of the observer.
- In this sense, it is the consciousness that determines the future of the observed system (in case of presence of appropriate executive mechanisms).

2.4. From observing the surrounding world to controlling it - the quantum Zeno effect in the theory of consciousness

The essence of the quantum Zeno effect [17] is in the fact that the observer, carrying out a sequence of quantum measurements, can control the state of the observed object. In this case, in a paradoxical way, not only the observer can follow the movement of the quantum object, but the object itself follows the "look" of the observer.

Let us illustrate this phenomenon by the example of measuring the spin of an electron with the help of the SGD. Fig.10 shows the sequence of measurements of spin projections in the case when the observer “follow by gaze” (turns the device) clockwise by 90^0.

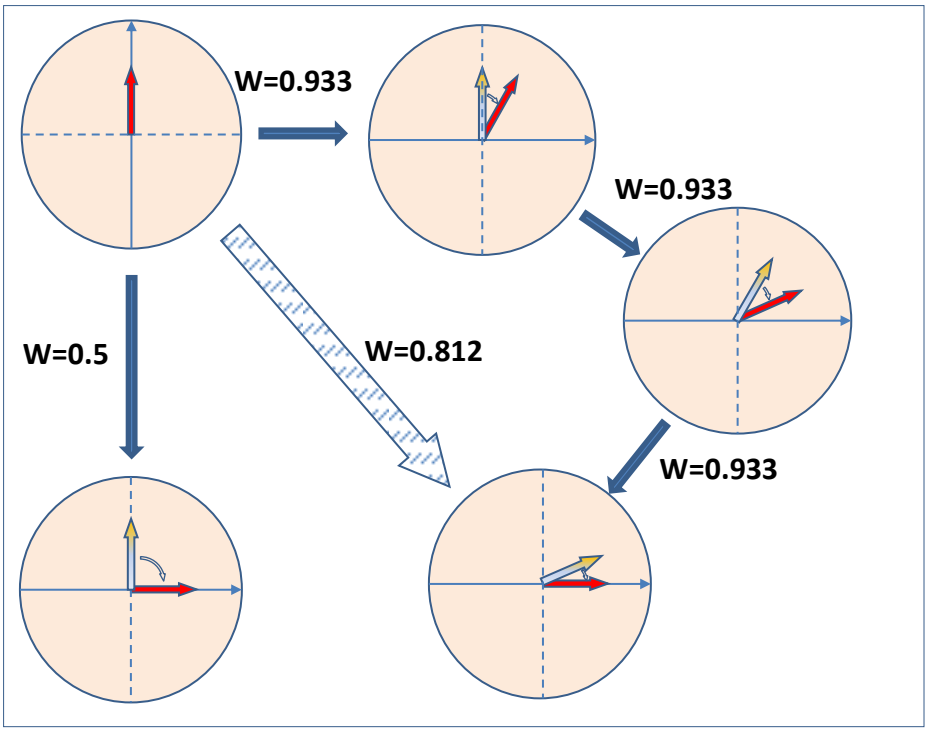


Figure 10

If he does it in one step, the probability of getting the spin direction to the right is 0.5. If he breaks down the operation into three stages, then at each of them the probability of the spin turning to the right is 0.933, and in general equals 0.812. By breaking the measurement (turning the observer's look) into a larger number of individual measurements, one can achieve the probability of a clockwise rotation of the spin close to 1. That is, the observer can "force" the electron spin within the limit of quasi-continuous measurements to follow his "look" with almost absolute accuracy!

The element of "mysticism" is removed from this phenomenon as soon as we remember that each new "look" of the observer requires a readjustment of the measurement system. The impact on the quantum state of the electron occurs already in the process of preparing a new measurement (irreversible changes in the macroscopic parameters of the device).

In order to understand this phenomenon, its “everyday life analogue” can be useful. Many teachers have mastered the technique of "pulling" the examinee for a good grade. If the student does not know the answer to the question (with a probability of 0.5 he answers "yes" or "no"), then

- The teacher asks a simpler question, to which the probability of a correct answer is much higher (0.933).

- It may turn out that new information is already contained in the question itself, and the student's state changes even before his answer. For example, hearing the question: "Does a transformer operate on alternating or direct current?", the student learns that a current is needed for operation of a transformer, and that there are only two versions of such current.
- Having given the correct answer, and having received confirmation from the teacher, the student thereby receives additional information that he initially did not have.
- Therefore, he gives a correct answer to the second, more difficult question, with a high probability (0.933) as well.
- And, finally, having received another portion of information from the teacher who asked the question and confirmed the correctness of the second answer, the student with a probability of 0.933 gives an answer to the main question, about which he knew nothing at the beginning of the examination.
- As a result, with a probability of 0.812 (instead of 0.5), he gets a good grade.

This “everyday life” manifestation of the quantum Zeno effect has no physical interpretation within the framework of quantum mechanics. But from an information point of view, it is completely equivalent to it. In fact,

- The observer, turning the SGD to a smaller angle, "asks the electron a simpler question." Having given this “correct answer” with a probability of 0.933, the electron “receives confirmation” from the SGD, as a result of which its state changes and becomes 1/3 closer to the desired one.
- After two intermediate measurements (questions), the observer gets the required "answer" to the main question as well with a probability of 0.812.

It follows from this that even in case of describing classical phenomena (room temperature suppresses the manifestations of the quantum properties of separate particles in human brain), the mathematical apparatus of quantum mechanics can be useful.

Of course, the description of such information systems also requires a "new mathematics", which has not previously been used in solving physical problems. Below we will discuss its possible options.

- Any observation of a quantum system changes its physical state.
- By choosing a certain sequence of such observations, we can transfer the observed quantum object into the desired state with almost full guarantee.
- The reverse is also true - any conscious influence of the observer on the surrounding world can be considered as certain information about his choice.
- Communication of two subjects can be considered an information analogue of physical interaction of two bodies. Both any question, and any answer to it (even a false one) change the state of consciousness of both subjects.
- Accepting the general principle of relativity, physicists have already “accepted” the fact that the question of what event “in fact” happened earlier makes no sense.
- **The principle of generalized relativism** is in the absence of a dedicated observer. Each of them can describe the surrounding reality as a result of own fuzzy quantum measurements, controlled by consciousness. The question of how the surrounding world is arranged "in fact" makes no sense.

2.5. The "new" mathematics for the "new physics"

Information generalization of the theory of weak quantum measurements

In quantum experiments, it is not always possible to accurately measure the desired parameter of the quantum state of an object. Even in "classical" slit experiments, the accuracy of measuring the coordinates of a passing particle depends on the width of the slit. R. Feynman in his theoretical calculations used the concept of "Gaussian slit", which has an infinite width, but with the probability of a particle passing smoothly decreasing from the center [26]. Nature has provided a ready-made tool for the analysis of such weak quantum measurements.

If a charged particle flies over the surface of a crystal (Fig.11), it can transfer energy to only one of the atoms in each row of the crystal lattice [27]. The sequence of excited atoms corresponds to the measured trajectory of the particle (red line).

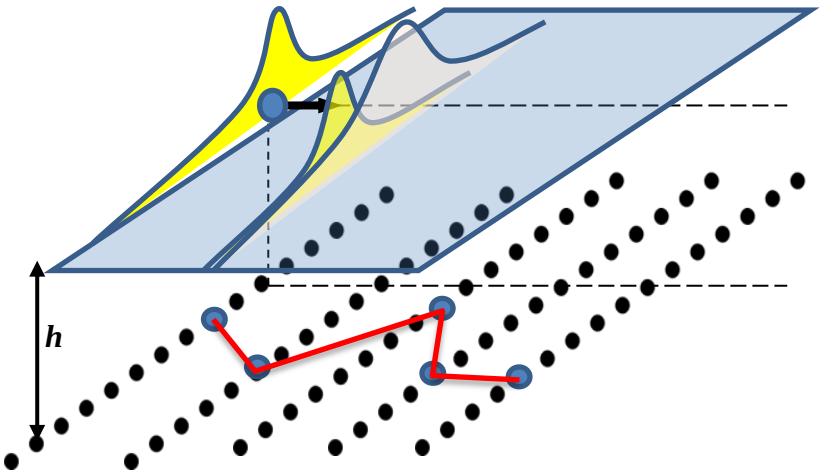


Figure 11

Each atom of the lattice corresponds to a "Gaussian slit" and these "slits" overlap. In contrast to an accurate measurement, the wave function is compressed not into a dot, but by a certain value, determined by the measurement inaccuracy (probability of “error” associated with the overlapping of slits). We can adjust this parameter of inaccuracy by changing the height of the passage of the particle h.

The new wave function (next yellow area) depends both on the previous function and the obtained inaccurate result. In order to calculate its new value (position and width), it is sufficient to know with what probability any of the possible results of inaccurate observation could be obtained.

In the classical theory of probability, similar problems are solved using the Bayes formula. Imagine, for example, that you can take one of three balls out of a black box, look at its color, and put it back. By repeating this procedure many times, you will almost certainly be able to guess how many black and how many white balls are in the box. But the measure of your confidence will never reach 100%. Without going deep into mathematical calculations, we note that after each test, the distribution of probabilities of one of the 4 combinations in the box - (BBB); (BBW); (BWW) and (WWW) is getting narrower.

It turns out that the whole theory of weak quantum measurements can be built on the basis of the quantum analogue of the Bayes' formula [28], and ordinary (accurate) quantum measurements are obtained as an idealization of weak ones. Therefore, it is perfect for analyzing information states of consciousness. Drawing an analogy with the paradoxes discussed above, we can say that the crystal has "prepared a lot of questions" for the charged particle. And the particle randomly "chooses" which of them to answer positively.

Examples of practical applications of the information approach to modeling human consciousness in economic systems

Using this information approach, the authors of the essays obtained a quantum-mechanical generalization [29] of the Black-Scholes-Merton formula [30] (calculation of the "fair" price of options), the classical version of which was awarded the Nobel Prize in Economics in 1997. In this generalization, transactions between traders play the role of weak measurements of their quantum states, in accordance with the conclusions of another our works [31, 32]. As a result, it turned out that the classical formula should be replaced by the solution of a system of two operator equations, in which the type of operators is determined by the terms of transactions.

We also proposed a classical version of an owner's consciousness model. The outcome of each transaction (choice) is uniquely determined by its state. In this simplified case, we managed to construct the space of economic states of the owner and to obtain the laws of the classical dynamics of a company, completely analogous to the laws of classical mechanics. For this work [33] in 2010 we were awarded the "Majorana Prize".

Subsequently, we showed [34, 35] that the basic formulas of the classical dynamics of economic systems (as well as physical ones) are a consequence of the relativistic approach to the description of their properties in the space of information states.

Concluding this brief review, let us note that economic models are the most appropriate for analyzing the properties of human consciousness. First of all, because they can be easily formalized and statistically processed. Of all the types of observations of the surrounding world, in the economic space we can limit ourselves to only those observations that are related to the conclusion of transactions. As in the examples above, the owner's state changes not only as a result of the conclusion of the transaction, but also when an opportunity arises to conclude it. Or as early as at the moment of receiving information about these events.

In addition, the quantum nature and relativism in economic systems are fundamentally important properties that determine the main effects in their dynamics, in contrast to physical systems, which are mostly classical.

We have provided these examples only to illustrate the possibility of practical application of the information approach in the field of knowledge, which is directly related to human consciousness. However, in these economic models (as in most models of other authors), the choice is described by a computable probability distribution (deterministic, in case of classical models). In the next section of the essay, we will briefly describe the "new mathematics" that will allow, within the framework of the theory of weak quantum measurements, to describe the non-computational properties of consciousness.

- In quantum mechanics of accurate measurements, complete freedom of choice of two (or more) observers results in paradoxes and contradictions.
- In real situations, the free choice of each of the subjects is limited by the choice of other subjects and the lack of all information about the properties of the surrounding world.
- Therefore, the mathematics of fuzzy quantum measurements (including continuous measurements) is the tool that can be used to describe the dynamics of a system with several observers.
- It is essential that the influence of the result of a fuzzy measurement on the properties of the observed system is completely and unambiguously determined by the obtained inaccurate information and does not depend on the mechanism of its acquisition.
- The theory of fuzzy quantum measurements must be generalized to consider not only random, but also regular choices.

Complexity theory - a mathematical apparatus for describing uncomputable events

The construction of a "new" physics for the inclusion of consciousness, as a component of the description of the measurement procedure, presupposes the inclusion in this description of new mathematical objects that will ensure compliance with the non-computational properties of consciousness.

We encountered one of the attempts to find such objects in the already somewhat forgotten work of 1983 "How random is a coin toss?" [36]. In this work, the authors demonstrated that both in nature and in mathematics there are completely deterministic (computable), but at the same time random processes.

All signs of the number "Pi" can be calculated by a simple algorithm and can be written down in binary code (using 0 and 1). This binary sequence of characters is certainly computable. But at the same time, it is completely random. It has not been possible to find any other regularity in it for many centuries. According to the authors, the existence of such "deterministic (computable) and at the same time random" phenomena in nature, results the prospects for the emergence of the "new physics".

And we are not going to argue with them. Our aim will be to prove the existence of opposite processes - "uncomputable, but at the same time regular". We believe that they are associated with special properties of consciousness. In particular, with the phenomenon of the "freedom of choice".

From quantum measurements to the complexity theory

Analogously to the authors of the above-mentioned work, we need, first of all, to define the notions of regularity and randomness. In classical physics, this is done using the concept of entropy and the Shannon's formula to calculate it. According to this formula, the measure of randomness can be determined only for a sufficiently large sequence of similar tests.

As an example, we can consider throwing a pair of dice one thousand times. Each of them can fall to one of its six faces, which gives a total of 36 options. And if each variant occurs approximately $1000/36 \approx 28$ times, then we can assert that the dice are "correct", and the sequence of their falling is random. But what if all 28 «6+6» results occur in the first half of the experiment, but will never occur later? Or it will be not 28, and not 27, but 24 «6+6» results? Can this be considered as an accident, or we are dealing with "wrong" dices? Answers to these questions can only be given by a specialist in mathematical statistics. And only with a certain

degree of confidence (with a measure of credibility of this hypothesis), which an expert can estimate using more complex formulas.

In physics, the situation is even more confusing. Most statistical models use the equidistribution hypothesis, according to which all admissible microstates of a system are equally probable both before and after the measurement. The information obtained as a result of the measurement only reduces the number of admissible microstates. But their number reaches such a huge amount that it is impossible in principle to test the hypothesis of equidistribution (for the entire time of the existence of the Universe, the system will never be in most of the admissible microstates!!!).

Nevertheless, in classical statistics, this hypothesis leads to correct results, and still remains in physics textbooks as one of the basic postulates. But as soon as we start analyzing quantum measurements, new problems arise. To solve them, it is necessary to change the rules for calculating probabilities themselves (to introduce the amplitudes of probabilities, notions about the wave function, collapse, quantum entanglement, superposition, etc.).

The quantum information theory that emerged along this path successfully solved all the problems associated with the description of ordinary quantum measurements, although it left some dissatisfaction among the "conservatives". However, the need to include an active element (an observer with his freedom of choice) in the description of the measurement procedure requires a fundamentally new mathematical approach.

Such an approach can be provided by the algebraic information theory - the so-called "complexity theory" proposed by A.N. Kolmogorov [37] and developed by his students and followers.

According to this theory, we can consider as a regularity any algorithm that can reduce the record of the totality of the results obtained. In the above example, 24 results «6»+«6» in the general sequence of tests can still be considered a regularity, but 23 - can no longer be considered a regularity.

This is due to the fact that in order to write down this regularity (of the number 24), 5 bits ($2^4 < 24 < 2^5$) of information are required. At the same time, the reduction in the length of the record of the entire sequence, taking into account this regularity (calculated using the formulas of combinatorics), is less than 5 bits.

Thus, the whole theory of probability and mathematical statistics can be obtained as special cases of the theory of complexity. They work well only for statistical regularities observed in large sequences of similar tests. But as soon as we try to describe other types of regularities (similar to information connections of the results of choice ***in a single*** experiment), paradoxes and problems arise.

When analyzing observations of computable processes, they can still be solved by introducing quantum rules for calculating probabilities. But to describe the special properties of consciousness, we should, apparently, abandon "half measures" and directly use the mathematical apparatus of the theory of complexity. The authors of the work [36] came to the same conclusion, but they did not succeed in further progress in solving this problem.

If you notice the regularities and write down the sequence shorter and shorter until it becomes impossible, the remaining (maximally compressed) sequence will be random, and the set of compression algorithms will be a set of regularities which it contained. Almost all modern archiving programs work on this principle and write the entire regular part into the "prefix", and the random part - into the "suffix" of the archived data array. The length (in bits) of the maximally compressed sequence (taking into account the "prefix" length) is called its complexity.

Returning to Figure 3(a), we can see that the trajectory of the pupil of eye of the person observing the profile is regular. Writing it down as a sequence of coordinates and compressing it as much as possible, we obtain:

- in the "prefix" - information about the shape of the observed object;
- in the "suffix" - random and chaotic deviations of this trajectory from the exact lines of the profile.

It is natural to assume that the procedure for the selection by the observer's consciousness of regularities ("prefix") in the chaos of all sensations is directly related to the phenomenon of "awareness" of the result of observations. It is these results that are included in the parameters of description of the surrounding world.

An indirect confirmation of the fact that the complexity theory is capable of describing non-computational processes in consciousness is that the complexity itself is an uncomputable function. Kolmogorov's "Theorem on non-computability of complexity" says that no matter how we compress any data set, we will never be able to rigorously prove that it is no longer compressible.

If, for example, we get a very long and random (taking into account the farthest correlations) sequence of decimal digits, we will never be able to prove that it will not occur when calculating the π. Therefore, it is not random in the algorithmic sense. The essence of this proof in its logical structure repeats Gödel's theorem and leads to the same conclusions as the analysis of the properties of the observer's consciousness.

We have shown that the complexity theory can be used to construct the geometric space of the set of observable information states [38], and its generalization to arbitrarily complex algorithms corresponds to the principles of relativism [39].

Unfortunately, the limited volume of the essay does not allow us highlighting in more detail all the advantages provided by the application of the theory of complexity, as the most general version of the information theory, in comparison with its particular variant - the theory of probability.

2.6. Conclusions on Section 2

In this section, our primary aim was to demonstrate that the special, non-material properties of consciousness are not some inaccurate approximate description of the "true" physical properties of the human brain and that no new discoveries of fundamental physics will allow them to be reduced to another "equation of matter".

Moreover, physics itself, by "consciously" excluding these properties from consideration, limits the range of problems it solves. In cases when such exclusion is impossible (availability of several observers with the possibility of independent choice), this leads to paradoxical conclusions regarding the properties of the observed objects..

We also tried to show that human behavior (and even fate) cannot be correctly described as a predetermined or random sequence of events typical for the world of computable processes and phenomena.

At this point, it is appropriate to quote the work of the Russian writer F.M. Dostoevsky (however, said on a completely different occasion): "Am I trembling creature or whether I have the right?" - exclaims his character [40]. Anyone who thinks about the predetermination of their destiny can exclaim in the same way. Almost the entire second chapter of this essay was devoted to proving that a person has the right to:

- Know that his thoughts, desires and actions are uncomputable and unpredictable, neither precisely nor probabilistically (as long as he is aware of his choice and can change it)

- Know that his conscious choice (regular and purposeful behavior) influences the uncomputable part of the dynamics of the surrounding world.
- Understand that the patterns of his behavior (the chosen aim) are independent of the properties of the surrounding world. The properties of the external world (including the choice of other people) only limit the possibilities of choosing an aim.
- Understand that the “choice of the aim” cannot be predicted by the person himself. But it can be realized. Apparently, this unpredictable, but realized regularity is called “predestination”.

We apologize to the reader for a certain pretentiousness of these "rights". But questions about the predetermination of human destiny, its predestination and the ability to control it have been too acute for the last couple of thousand years. And we are happy with the fact that modern science can finally give an unambiguous answer to them.

All these conclusions strictly follow from the analysis of the results of numerous quantum-mechanical experiments and emerging paradoxes. In this essay, we tried to show at the popular (as far as possible) level that it is these special uncomputable "rights" that are the only way to get out of the logical deadlock of physical paradoxes.

Unfortunately, a complete information model of consciousness does not yet exist. But the obvious manifestations of its special properties in the theory of quantum measurements, and the existence of mathematics capable of describing them as uncomputable mathematical objects, give us hope for the emergence of such a theory in the near future. Further, we will use only some of the obvious properties of the information model of consciousness to answer the question of the possibility of "cloning" consciousness on a new material medium.

3. Possibility of copy and preserving special properties of consciousness

To answer this question, we will have to (forcedly and consciously) repeat many of the conclusions obtained in the previous sections, in new verbal formulations. We would like to assure the reader that this was done not with the aim of "confusing" him, but only as an attempt to once again more accurately express in words the logical connections between the special properties of consciousness and the "new" physics.

Truly rigorous and unambiguous formulations of our conclusions (like all other results of real science) will become possible only in the form of new mathematical equations, the need for which was grounded by us previously. This will require writing many works in a different (not popular) format. In the meantime, as our “excuse” we can cite a quote that R. Feynman used in a similar situation: “There are nine and sixty ways of constructing tribal lays/ And every single one of them is right!" [41].

From the generalized principle of complementarity (Section 2.3) it follows that in different situations the role of consciousness can vary in a wide range - from an object fully observed and controlled by an external "Demon of Quantum Measurement" to the role of this "Demon" itself.

It is fundamentally important that with a change in the role of consciousness, its real physical properties also change. From complete controllability by the external "Demon of Quantum Measurement" in the first case, to the possibility of complete control of the state of the observed system in the second case. The latter follows from the theoretically described and experimentally proven "quantum Zeno effect" (Section 2.4).

Thus, the question of the possibility copying and preserving special properties of consciousness has several different answers, depending on the specific situation and the physical status of consciousness in this situation.

But the answer is further complicated by the fact that consciousness itself is a complex structure of various information properties and mechanisms. In one and the same experimental

situation, some structures of consciousness can act as an ideal "Demon", while others - the role of ideally observed objects.

Therefore, this entire section is divided into two parts.

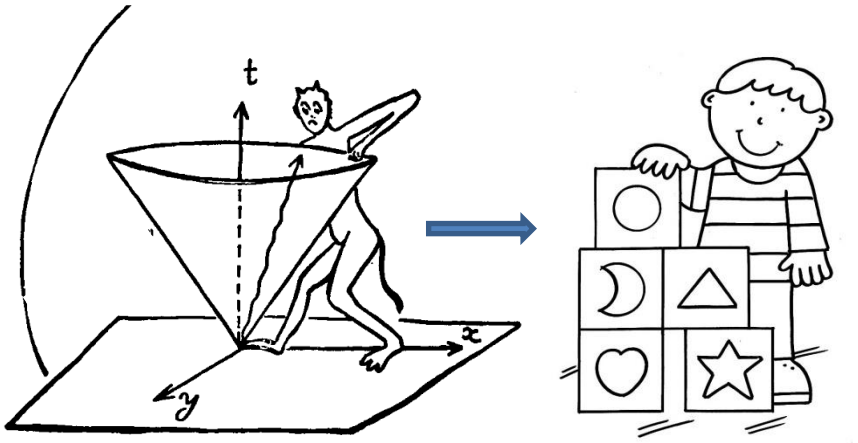
- In the first part we will discuss the possibilities of preserving both consciousness as a whole and its individual properties in an ideal situation - the one that corresponds to clear quantum measurements and idealization of the properties of the observer.
- In the second part we will discuss the possibility of preserving consciousness as a whole or its individual properties in conditions of weak measurement - when this consciousness (or a set of its properties) simultaneously both observes the surrounding world and acts as the observed object from the side of other consciousnesses.

The totality of all possible states of consciousness and the analysis of the possibility of copying and preserving special properties of consciousness in each of them will be the most complete answer to the question posed by the organizers of the competition. And an unambiguous answer "Yes" or "No" cannot exist in principle, no matter how much some readers would like it to happen.

3.1. Possibilities of preserving the properties of consciousness in case of ideal (precise) quantum observation

Observation by the ideal consciousness of objects of the surrounding world

In this case, the observer's consciousness is an active element of the system. The consciousness itself determines the type of observation and accordingly changes the structure of the installation (with the help of executive mechanisms, completely subordinate to the free will of the observer). In fact, it acts as a "Demon of Quantum Measurement" (Fig.12).



a) b)

Figure 12

a) An ideal observer can completely predict and control the future of any accurately observable quantum system [42]

b) The ability of human consciousness to change the surrounding world with the help of executive mechanisms can be described as the quantum Zeno effect

Actuators (sense organs, limbs, sensors, devices, etc.) are also observed objects, but their observation occurs almost continuously. Due to the quantum Zeno effect, the trajectory of their state is completely subordinated to the "will" of the observer. And even if certain "mistakes" of control happen, they are usually neglected.

The border that we can draw between the observer and the observed object is conditional. Usually it is "marked" at the point where reliable control of "executive mechanisms" ends and the probabilistic control begins.

If, for example, a person is young, healthy and active, he does not think about his movements or emotions. In his mind, desires are framed as changes in the surrounding world. The border between the "demon" and the "outside world" is where his body ends.

But if a person is “weak and old,” then his body itself and its sensations become probabilistically controlled. A person has to take into account not only what he wants to change in the surrounding world, but also how he needs to change his own executive mechanisms for this purpose (need of sleeping, healing, finally implanting new teeth ...).

A “Demon”, accurately observing the entire Universe, cannot exist in principle (for this, the “Demon” himself would have needed to have a much more complex structure than this Universe). But even an ordinary person can accurately observe its separate isolated parts. This is what happens in any well-arranged quantum experiment. This will become possible for more complex systems after the creation of a full-fledged quantum computer. The state of the memory cells (qubits) of such device will be absolutely accurately observable, controllable, and computable.

Complete information about the quantum state of the observed system represents a complete description of the properties of consciousness of an ideal observer. This and only this information limits the freedom of his choice of subsequent actions. No other properties of the mechanisms providing this choice, or performing it, are of importance. In none of the subsequent experiments in which consciousness plays the role of an ideal observer, they will not be able to manifest.

- Therefore, to preserve the properties of consciousness in the role of an ideal observer of a certain system, ***it is necessary and sufficient*** to preserve the exact quantum state of the observed system.
- ***It is possible to achieve this*** within the framework of the procedure of quantum teleportation of its properties.
- The consciousness of the new ideal observer will “see” the same, will be able to make the same “choices”, and in all subsequent experiments it will not differ from the previous copy.
- It will possess "self-awareness" by means of the consciousness preserved after death. But only in relation to the accurately observed part of the Universe.

Observation of human consciousness by an ideal external observer

In this case, human consciousness acts in the passive role of an accurately observable quantum object. As in the previous case, no "Demon" able to observe the entire consciousness of a person as a whole can exist. Although it is much smaller than the Universe, the number of elementary particles in human brain (and the degrees of freedom associated with them) is still too large (10^{26}) to accurately describe it.

But an accurate (in the quantum-mechanical sense) description of individual information structures of human consciousness is quite real. For example, the properties of consciousness associated with the game of chess. In this case, it is possible to accurately predict the opponent's moves (or the probabilities of these moves) by a much more experienced opponent (Fig.13).

a) b)

Figure 13

a) Observer can act as the "Demon of quantum measurement" of relatively simple quantum systems [42, 43]

b) Accurate observation of the in-game behavior of a weaker opponent allows controlling his "freedom" of choice and turns the "chess" function of his consciousness into an analogue of such system

Such a more experienced player "prepares a quantum experiment" by creating a position on the board. And then, with the predicted probability, he obtains its result, observing the move of a less experienced player. If it turns out that he did not foresee something, and the opponent's moves are not random, but contain some unexpected regularity, then it will only mean that the "quantum measurement" was inaccurate. An experienced player failed to "suppress" the possibility of freedom of choice of the opponent and the whole situation should be attributed to "weak quantum measurements".

Note that the quantum parameters of the "chess" state of consciousness represent completely real physical quantum properties, and not a "game of mind". As in the experiment with the "Schrödinger's cat", a "sad" observer is a very real parameter of the quantum description of one of the degrees of freedom of a physical object. We absolutely do not need to find out what elementary particles and processes in the human brain force him to become "sad", but it is sufficient to know that in the experiment this parameter of description manifests quantum properties.

Moreover, the very elementary particles of which the human brain consists can be considered as "executive mechanisms" and not require the exact preservation of their quantum state in the considered case. It is sufficient for us to know that they implement the "chess" degrees of freedom of consciousness in some way.

Therefore, the border between the consciousness itself and the matter can be drawn much deeper, without referring the matter to the properties of consciousness. And then the possibility of preserving all consciousness as a whole, as an accurately observed quantum object, becomes more real. The number of degrees of freedom can already be estimated as 10^{10} (the number of stable connections in the neural networks of the brain). But with the current development of technology, even such a task is still beyond the scope of human capabilities.

Summing up, in the case of the ideal external observer, we can state the following:

- To preserve the properties of consciousness as an ideally observable object (by an external "Demon" - observer), ***<u>it is necessary and sufficient</u>*** to preserve its exact quantum state.
- ***<u>It is possible to achieve this</u>*** within the framework of the procedure of quantum teleportation of its individual information properties. For the preservation of the entire consciousness as a whole, there are not yet enough resources provided by modern technologies, but in principle it is also possible.
- A new copy of consciousness through the eyes of an ideal external observer will "look" the same, "behave" the same way and "choose" actions with the same (predictable and computable) probability.
- In all subsequent experiments performed by an ideal external observer it will not differ from the previous copy.
- The accurate quantum state of all qubits of a quantum computer in conjunction with the computation algorithm, quantum teleported to another quantum computer represents an example of preservation of "consciousness" in an accurately observable quantum state.

3.2. Possibilities of preserving the properties of real consciousness in case of weak quantum observation

For two of the above mentioned cases of ideal observation, a clear and unambiguous answer was obtained about the possibility of preserving such consciousness. Both in the case of observing the surrounding world, and in the case of observing the consciousness itself by external observers from this world, such preservation is possible in principle. But it requires huge resources, so far inaccessible to the humanity. Nevertheless, the exact preservation of separate properties of human consciousness on a new carrier is possible even now.

However, we are primarily interested in the possibility of preserving not some idealized states of consciousness, but the real consciousness of real people. As shown above, such situations arise every time when there are at least two non-ideal observers in a closed system. At the same time, in the life of an ordinary person (not a "quantum" experimental physicist) such situations happen all the time (Fig.14). Therefore, in this section, we will obtain the answer to the question - about the possibility of preserving a non-ideal (in the sense of quantum measurements) state of a person's consciousness.

Figure 14 Two non-ideal observers possess an "entangled" freedom of choice

Let us once again define the concept of the "non-ideal" state in an understandable everyday language. It means that a person's freedom of choice is limited not only by external circumstances and natural phenomena, which (in principle, with unlimited resources) can be predicted accurately or with some probability. Therefore, they are computable, as the behavior of an arbitrarily complex observable quantum system is computable. The freedom of choice of a

non-ideal observer is also limited by the choice of other people or artificially created consciousnesses, which are principally uncomputable and unpredictable.

In order to describe the properties of such “non-ideal observers”, the theory of weak quantum measurements, generalized with the help of the complexity theory, is required. In the mathematical formalism of weak quantum measurements, measurement operators of a new type [44] are introduced. They, in contrast to operators of accurate measurement, contain is a fuzziness parameter that depends both on the physical properties of the experimental installation and on the choice of other observers. Usually this choice is described as random, with some probabilistic distribution function, thereby greatly simplifying the problem, but excluding from it the "most interesting" point - the interrelationship between the choices of two or more observers.

We will not proceed deeper into the analysis of these possibilities, because to answer the main question, we only need one experimentally proven fact:

In the case of weak quantum measurements (as in the case of clear ones), the physical state of the observed system is uniquely determined by the entire set of the obtained results. However, while in the case of a complete clear measurement, only the last result is needed, in the case of weak measurement, their entire infinite sequence should be taken into account. In real measurement, only the last measurements are taken into account, neglecting the very weak influence of those that were taken "long ago."

Thus, it is also possible to perform the weak measurements of ordinary physical objects as accurate as you like; as well as their as accurate as you like copying to another matrix (using the mechanism of quantum teleportation). However, in the case of active consciousness being part of the observed system, this is not true. By reproducing the results of all weak observations, we will be able to preserve only the computable part of the state, and the freedom of choice of the observed consciousness will remain “free”.

We will be able (at least in principle), as in the case of clear measurements, to reproduce as accurately as we like all the circumstances and all the limitations of the subject's free choice, but there will always be some part of his uncomputable and unpredictable behavior, which can be described as: "I just wanted to."

A rather strange situation arises:

- On the one hand, reproducing all the physical properties of consciousness (using a sufficiently long sequence of weak measurements), an external observer can never claim that the new copy "wants the same thing", since its freedom of choice is uncomputable in principle.
- On the other hand, the observer will never be able to assert that the new copy of consciousness “wants something else”. This is also impossible in principle for the same reason of non-computability of the freedom of choice.

It is in this (Gödelian) sense that it should be considered principally possible to preserve the preservation of the consciousness of a real person on a new material medium.

The properties of consciousness are characterized by the parameters of both the external description and the internal one. But if the former are unambiguously determined by the set of results of weak observations of this consciousness from the outside, the latter, on the contrary, are the results of observations of the external world by the consciousness itself.

In the case of clear measurements, these two states of consciousness were fundamentally incompatible, but in the case of weak measurements, it is possible for both properties to manifest simultaneously. Therefore, in order to preserve consciousness as a whole, we need to ensure accurate reproduction of both the first and second results of observation.

At the same time, the preservation of the internal parameters of the description (self-awareness), as well as external ones, is possible only in the Gödelian sense. In the language of the heroes of fantastic book, waking up in the morning, we cannot be 100% sure that we did not become different overnight, but we will never be able to 100% prove this, as there are no regular (computational) differences from the behavior of the previous copy of consciousness in any experiment.

3.3. The "Devil" is in the details

After proving the fundamental possibility of preserving consciousness as a whole (in the above sense), a natural desire arises to implement it as soon as possible. However, there are many "technical" problems along the way, some of which we will discuss in this section.

Let's start with the fact that even if we restrict ourselves to the “information” degrees of freedom of consciousness, their quantity (10^{10}) is still too large for weak observation during a sufficient time. We do not yet know how many results in a sequence of such measurements will be needed to describe each of them, but taking into account all the interconnections between individual information "particles" of consciousness, this will become a real catastrophe. The point is that the answers to separate questions posed to the consciousness by an external observer can be entangled, as in the case of quantum degrees of freedom. Then it turns out that the quantity of bits of information required to record the state of consciousness is of order $2^{10^{10}}$.

The only way out that gives hope to cope with this problem is the technology of quantum computers. Since each qubit in the memory of such computer already possesses quantum properties, 10^{10} qubits will be sufficient to record all the results. Using the quantum Zeno effect and the entire set of results of weak measurements of human consciousness, it will be possible in principle to transfer this set of qubits into the same weak state, as the consciousness of the subject.

To date, the capacity of quantum computers is limited to 2^7 qubits. Even this amount allows solving some tasks beyond the capabilities of conventional computers. It can also allow us to store in the memory of such quantum computer some of the simplest properties of consciousness. However, even in this case, we will only be able to model the computable part of the information about these properties.

As it gas been shown above, this is not enough to preserve the special properties of consciousness. But we can guarantee that the material matrix, endowed with the capability of uncomputable "free choice" will "behave" in a manner indistinguishable from its predecessor after recording all this information on it.

It can be assumed that the ***deep learning neural networks*** may have such ability [45]. At least their properties seem to us non-computational (by the very essence of this learning mechanism). And some of the existing versions (chess program [46]) show all the external signs of "creativity", "freedom of choice" and "awareness".

Although modern technologies are just approaching the realization of the possibility of preserving individual (simplest) properties of consciousness, the evolution of information structures, which have mentioned in the first section, already contains mechanisms that can ensure such preservation at the information level. We will discuss them in the next section.

3.4. Evolutionary mechanisms of copy and preservation of certain properties of consciousness

We have shown above that an accurate (in a strictly physical sense) preservation of the properties of consciousness on a new medium is possible only in exceptional special cases.

First of all, this is a case of quantum mechanical experiments. But at the same time, it is not the consciousness as a whole which is preserved, but only that small part of it, which is

responsible for conducting specific observations and has unlimited capabilities of the "Demon" within the framework of this experiment. Such "Demons" are absolutely free to choose the way of observation of the quantum system. They differ from each other only in the information obtained as a result of the experiment. Therefore, to preserve the properties of the "dead Demon", it is sufficient to copy all the information he had obtained about the quantum-mechanical state of the observed system onto a new "matrix".

The second special case of accurate preservation is possible in the case when external "Demons" - psychologists put a set of sensors on the subject and force him to act as a "quantum mechanical system". At the same time, they will monitor and control the course of the subject's subconscious reactions, thereby depriving him of the opportunity to show at least some of his own “freedom of choice”. Of course, such experiments are possible only in relation to very simple functions of consciousness.

These manifestations of the quantum properties of consciousness have nothing to do with the physical quantum state of neurons or atoms of the visual nerve. But with the joint information description of these functions of consciousness, the same logical contradictions as in quantum mechanics arise. Therefore, it is quite natural to apply the same mathematical apparatus (wave functions and quantum alternatives) to describe them.

Weak (Gödelian) preservation of consciousness is entirely more realistic. However, it is not currently possible using the modern technologies. We have described above the possibilities of artificially preserving certain properties of consciousness within the framework of quantum computing technology. At present, we cannot speak of complete fulfillment of the conditions for the maximally accurate "resurrection" of human consciousness. We no longer need the capabilities of the "Demon", since such "resurrection" provides not the exact correspondence to the previous consciousness, but only the consistency of its properties with the results of all weak measurements.

However, the number of all results of weak measurements is still extremely large. It includes both those results that were preserved in the memory of the person himself before death, and those that were preserved in the memory of other people about him. At the same time, for the maximally complete preservation, all those results that were realized, but later forgotten, are also required. Therefore, we can observe and artificially reproduce the preservation of only separate properties of consciousness - those relatively simple information structures of consciousness that can be considered almost isolated from the rest.

But, as we have shown in the first section, biological evolution can be considered as only one of the varieties of information evolution. Therefore, within the framework of the latter, the information structures of the brain already have ***natural mechanisms of preservation*** after a person's death.

Could it be that in the process of information evolution, nature has already created mechanisms for the preservation after death of those properties of consciousness for which artificial methods of preservation are not yet available? To answer this question, let us analyze in more detail the most common methods of natural "reproduction" and preservation of information structures after a person's death.

- *The biological method* (reproduction of individuals) allows preserving only the genetic code, which contains all the individual characteristics of the organism, including the properties of its brain. But such mechanism turns out to be absolutely computational. It can be simulated by a simple algorithm on a conventional (non-quantum) computer. Within the framework of a physical analogy, we can say that this preservation mechanism corresponds to the "classical" approximation in physics. It allows preserving most of the physical properties of the brain, but it cannot have anything to do with the preservation of its non-computational and uncomputable functions which principally distinguish consciousness from other structures.

• The next mechanism for the preservation of individual properties of consciousness in terms of importance and historical sequence is the *upbringing of offspring*. The very mechanism of training and education is a sequence of macroscopic actions performed by the teacher. From this point of view, the process of education is certainly computational. However, its impact on the information structure of consciousness can also create quantum phenomena, like, for example, the analogue of the quantum Zeno effect described above at a certain sequence of questions. Or the “quantum entanglement” of the states of two players (“Alice” and “Bob”) in quantum games [47, 48]. Even computational learning algorithms for neural networks can, in principle, lead to their uncomputable state, if their information structure allows it.

Based on these examples, we can assume that in the process of education and upbringing, not only computational properties of consciousness (behavior algorithms), but also non-computational properties (regularities of free choice) can be preserved. In other words, as a result of education and training, the "student" can not only learn the properties of the surrounding world known to the "teacher", but can also learn to make a choice, similarly to the teacher, in completely new situations.

• The third type of mechanisms for preserving the properties of consciousness can be conditionally called "*social*". These mechanisms act on a person's consciousness, changing the conditions of his free choice; limiting or freeing some of the possibilities. Social psychology specifically solves the problem of formation of certain information structures in the consciousness of people as a result of changes in social rules and conditions of their existence.

This suggests an analogy with the "Bomb Paradox" discussed above. In this experiment, by changing the macroscopic properties of the device, we could change the properties of all emitted photons. In this case, the phase of the wave function of the photon (or electromagnetic wave) remained undefined (individual for each emitted photon).

In the same way, under the effect of social mechanisms of influence, the consciousness of people, of course, changes, but these changes do not help preserving the individual characteristics of each of them. Apparently, these mechanisms should also be classified as "classical" (in physical sense) and computational.

• And, finally, let us consider separately the so-called "*esoteric" phenomena* of consciousness. These include "telepathy", "spiritualism", "transmigration of souls", "afterworld", etc. Within the framework of the materialistic worldview, their physical reality is usually not even discussed. First of all, because rigorous physical experiments do not confirm their possibility.

But they cannot confirm it in principle. The fact is that all rigorously arranged physical experiments assume the possibility of freedom of choice for only one ideal observer. And all these phenomena require simultaneous freedom of choice of at least two participants of the process. Therefore, we cannot exclude that with an accurate arrangement of experiments (with account of the simultaneous possible influence on the results of the choice of both non-ideal subjects of observation), we will obtain "entangled states of consciousness", "collapses of consciousness", "superposition of alternative states of consciousness", and other analogs of physical quantum effects.

At the same time, for their acceptance and understanding, no "mystical" forces or undiscovered phenomena are required. For example, in the paradox of the "Schrödinger's Cat" discussed above, the freedom of choice of "Wigner" and his "Friend" turns out to be "entangled" simply because a semi-transparent mirror cannot be fixed and released at the same time. Therefore, the new "generalized physics" allows for the existence of "esoteric phenomena." But, firstly, their research should be carried out strictly scientifically (experimentally confirming the stated assumptions and theoretical conclusions). And secondly, so far researchers have been “looking for” them in the surrounding physical world, and not at all where they are (in the information space of the non-computational properties of consciousness of two or more observers).

Finishing this short (and far from complete) review of possible natural mechanisms for the preservation of the properties of consciousness after human death, we would like to express the hope that the development of the scientific information-physical theory of consciousness will serve as a new stage of evolution of information structures. We can expect that at this stage new mechanisms for the preservation of consciousness will emerge, the possibility of which we could only discuss hypothetically so far. At the present, many social structures use some properties of consciousness as their building elements ("bricks"). They developed unique mechanisms for the preservation of these properties after the death of a person himself. But such mechanisms have nothing to do with the preservation of consciousness of this person.

3.5. Conclusions for the section and for the work as a whole

In this essay, we have given an answer to the question about the informational essence of the phenomenon of consciousness, as an essential part of the description of our ideas about the "universe". As complete an answer as the current state of science allows.

And also the answer to a particular question about the possibility of preserving human consciousness on a new material medium. In this regard, the following can be considered proven:

- Preservation of consciousness as a whole is possible in principle. In the sense that after such preservation, neither this consciousness itself, nor the scientists studying it, will be able to prove the opposite in any of the experiments.
- Human consciousness is a very complex information structure. Currently, there are no either natural (evolutionary) or artificial (created by man himself) mechanisms for its preservation as a whole.
- Nevertheless, a number of mechanisms for preserving its individual properties and information substructures exist and successfully “work” within the framework of the information evolution.
- These properties and substructures are divided into computational and non-computational. The former cannot possess the phenomenon of "awareness" and "freedom of choice." Therefore, they can be preserved using conventional mechanisms - natural (genetics) or artificial (prosthetics).
- The latter require the use of material carriers "capable" of non-computational (conscious and active) behavior. This is the brain of another person, or (possibly) artificially created deep learning neural networks.
- Preservation of the non-computational properties of consciousness on these carriers is possible both using natural mechanisms (education, training) and artificial methods (quantum informatics).
- Currently, the fate of humanity is greatly influenced by the evolution of social information structures. For such structures, the totality of human consciousnesses represents a carrier. But so far these social structures as a whole do not possess mechanisms of non-computational "conscious" behavior.

4. On the way from "To be or not to be?" to "Why to be?" (Instead of an afterword)

The answer to the question about the relationship between consciousness and matter in the process of perceiving the surrounding reality is undoubtedly very important for each of the people. But it seems to us only as the "tip of the iceberg" that the "Titanic" of human civilization is about to run into.

As the history of mankind shows, the main problems of recent decades are not associated with the development of technologies, and not with the limitation of resources, but with their surplus and, as a result, thoughtless (and even insane) use. This is not so much about natural resources as about the resources of human mind.

Indeed, advances in the field of robotization and artificial intellect are already allowing to put on "algorithmic rails" almost all areas of human activity that are responsible for the survival and reproduction of the human species on the entire planet. By giving up "bad habits", each person can now significantly extend their life span and increase the chances of survival of their descendants. But neither individuals nor their communities, as a rule, "bother" with such "trifles". Most of human intelligence, vitality, time and natural resources are spent on absolutely unnecessary for survival, but "pleasant" things.

The main reason for this is that the information structure, for the sake of which evolution created for hundreds of millions of years, first the brain, and then the consciousness - the human genotype, has obtained new, much more reliable tools of survival! These tools are modern technologies.

The irony of evolution is that such tools were created by the very consciousness of people. And they made this consciousness, if not superfluous, then at least excessive. For many millennia, the human consciousness was puzzled by a great number of questions “HOW?” :

- How to hide from predatory animals?
- How to recover from diseases?
- How to feed the increasing population?
- How to defeat competitors in the struggle for food, for territory, for the possibility of reproduction?

And that is all that was required by the evolution from the awakening human consciousness.

But it turned out that in the modern era, reliable technological answers have been obtained to most of these questions. And if someone on our planet dies from "hunger and cold", or from "meaninglessness of existence", if wars and genocide are started, it is not at all because the Earth cannot feed 7-8 billion human individuals. And not because modern science cannot provide artificial conception (or at least the preservation of genetic material) to almost every person.

It is all because most of these 7-8 billion people do obvious (from the standpoint of common sense) and completely unnecessary (from the standpoint of the theory of biological evolution) " nonsense". Modern man no longer wants to simply survive. For most people on the planet, the tasks “not to die of hunger”, “not to be eaten” and “to have sex” are not relevant, since they are solved by simple and accessible methods. All of this is no longer enough for the consciousness of such a person. He needs, at least, to see in all this some kind of additional meaning. He needs to know the answer to the main question for him: "WHAT IS THE PURPOSE OF ALL OF THIS?"

It is regrettable to realize it, but neither science nor philosophy proved to be ready to give an unambiguous and clear answer to the question "WHY TO BE?", which becomes the main question in the era of redundancy of the resources of human consciousness. Neither in physics, nor in mathematics, nor in any other exact science, such question is not posed at all!

In search of "correct" answers to this question, and inventing their own naive answers instead, people commit most of the "obvious nonsense", unlike representatives of other species of the animal world. In the first part of the essay, we proposed a simplified hierarchy of the "meanings of existence" that obviously arise in the "liberated" consciousness of people. Within the framework of this hierarchy, there are also obvious "bloopers" of evolution.

- What is the purpose of care for survival in the consciousness of a drug-addicted person?
- What is the reason of struggle for survival in the consciousness of a billionaire who spends profit on the purchase of a palace that he does not need?
- What was trying to preserve in this world the consciousness of Socrates drinking a bowl of hemlock?
- What was “thinking about” the consciousness of a hermit who went into the “desert” and broke off all contacts with the outside world? ...

So many of these questions can be answered with simple but sad answers. Not because people themselves like these answers, or they are not smart enough to realize their inferiority. But because they have no other ("correct") answers yet.

And, as it seems to us, the point is not at all that there are no tools in science for studying human consciousness as one of the phenomena of the existence of the Universe. Most of the computational functions of human consciousness have long and accurately been studied by neurophysiologists and biophysicists. And most of the uncomputable properties are precisely described by psychologists, sociologists, economists and ... psychiatrists.

But, along with this, most people (including the smartest ones) are not yet ready to perceive their consciousness as an object of study and control (first of all, self-study and self-control). Some kind of analog of "pride" does not allow them to recognize their consciousness as "a bunch of atoms and elementary particles" moving in the humid environment of the brain according to the laws of classical physics and quantum mechanics.

And, as we have showed above, they are absolutely right! An accurately observable human brain in a completely banal physical sense loses its cognitive functions and becomes a "trembling creature" before the greatness of physical laws. For such a brain, the question "Why to be?" loses any meaning.

At the same time, the essence of an accurately unobservable human consciousness contains non-computational functions, and therefore is not cognizable within the framework of computational theories (modern physics). But this does not mean that it is not cognizable at all!

- Even now the need to introduce additional (non-computational) properties of a non-ideal observer (awareness, freedom of choice) into the description of closed systems follows from the results of physical quantum measurements.
- It is already becoming clear what kind of mathematical apparatus is necessary to include these new properties and their corresponding parameters in the structure of equations of modern physics.
- Even now, modern technologies allow performing accurate and reproducible experiments to preserve the non-computational properties of the observer (so far very simple) after the destruction of the carrier.

The program of further activities for the development of the information-physical theory of consciousness is not much different from what has been successfully done long time ago by people in other areas of knowledge. For example, the following research strategy is possible:

- Derive new laws of dynamics for systems that include uncomputable parameters of behavior of "observers", along with description of objects with computable dynamics.

- Using the methods of statistical physics, generalize the models of elementary information-physical events into complex systems, which will represent various groups and communities of people.
- Regulate the hierarchy of information structures that have already arisen in the process of evolution, determine their properties, mechanisms of reproduction and "purpose of existence".
- Determine the conditional "area" in which each of the structures wages its own struggle for survival with competitors. Build models of relationship of these structures both from one and from different levels of the hierarchy. Introduce concepts similar to "parasitism", "symbiosis", etc.
- Build algorithms for forecasting and controlling the information evolution. Develop containment mechanisms for those structures that can lead to their destruction.
- Develop a methodology for experimental testing of hypotheses and theoretical conclusions.

The "program of action" outlined by us above is only one of the possible. We do not claim it to be either exclusive or optimal. Another thing is important – the fact that in modern science there are already all the grounds (including both theoretical models and reliable experimental results) that allow starting its implementation. In this essay, we have tried to organize and present, as completely as possible, these models and results.

The problem of their comprehension and acceptance by the scientific community, as it seems to us, is as follows. The subjective perception of the human consciousness of the surrounding world was formed long before the results of scientific research forced to doubt the "obvious" truths. And now, even with these results, we need a qualitative and a decisive rejection of "algorithmic" notions (in the last century they were called mechanistic) not only about the structure of consciousness, but also about the properties of inanimate matter associated with the procedure for its observation. Although more and more publications have recently appeared in which authors explicitly call for this (including Nobel laureates), they are still considered by the scientific community as "games of the mind" and nothing more.

The development of a new theory of consciousness, based on a generalized physical picture of the world, of course, will not be able to stop or change the laws according to which both the humanity as a whole and the consciousness of its individual representatives develop.

But within the framework of these laws, humanity will obtain a powerful tool that will allow optimizing the evolution of not genotypes, but “meanings of life” (both for individuals and for the humanity as a whole). The mechanism that will allow foreseeing and avoiding at least some of the obvious "foolishnesses" on this path – “To avoid the iceberg that our common “Titanic” is about to run into”.

SO LET'S DO IT TOGETHER!

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