Studia Humana
Volume 3:3 (2014), pp. 16—28
DOI: 10.2478/sh-2014-0011

Question of Consciousness: to Quantum Mechanics for the Answers

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Abstract:
The article presents the possible role of consciousness in quantum-mechanical description of physical reality. The widely spread interpretations of quantum phenomena are considered as indicating the apparent connection between conscious processes (such as observation) and the properties of the microcosm. The reasons for discrepancies between the results of observations of the microcosm and macrocosm and the potential association of consciousness with these reasons are closely investigated. The mentioned connection is meant to be interpreted in the sense that the probable requirement for a complete understanding of quantum theory is the adequate description of consciousness within it and that the correct theory of consciousness should include quantum-mechanical theoretical apparatus. In this context, the question about the methods of scientific cognition is discussed, in particular, the problem of the place and the importance of intellectual intuition in science and philosophy of science. The author draws the conclusions about the current state of the "measuring" problem in its relationship with consciousness.

Keywords: consciousness, measurement, philosophy of science, quantum mechanics, intuition

This work is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics (HSE).

1. Introduction

Since the times of ancient Greek philosophy lots of research was addressed to the problem of consciousness. The reflections on the phenomenon of consciousness and its origins are also to be found in the earlier mythological literature. However, its specific critical rationalist approach was formed in antiquity. Thereafter, the interest to the problem of consciousness grew stronger so many sometimes deep and noteworthy different points of view on this problem came out presently. Current research does not deal with details of consciousness interpretations of various kinds so the long subject formation history is to be left aside. Main point of interest for this article lies in analyzing the dimensions that link the phenomenon of consciousness and the natural science – quantum mechanics in particular (this science subdiscipline is to be further named according to conventional meanings by quantum theory and quantum physics). The consciousness is to a certain extent an important element of quantum mechanics but is not under the proper reflection of this theory (the theory include no mathematical description of consciousness). According the last point the following statement is (or possibly is not) meant to be proposed: the quantum theory is incomplete in the sense of its consciousness description absence (or the opposite way: the existing consciousness theories are incomplete because of their absence of any quantum-mechanical description). Quantum physics is also called non-classical and in particular for its mandatory requirement to give proper consideration or at least to presume the particular observer performing the measurements – due to Heisenberg indeterminacy principle. Sometimes this is stated as follows (which in fact is not entirely correct): the world varies depending on whether we observe it or not. The classical physics does not apparently based on such statements. The reality properties in classical physics do not depend on the fact or absence of its investigation. The same relations with the properties of reality occur in quantum physics until the very moment when this reality is being observed by the conscious viewers. Here the entire aspect is which is to be reflected in this article – rational consciousness. Such consciousness aspects as rational reality (and itself) awareness are primarily recognized. So the present research is to be deemed to the effect of abolition of different consciousness concepts and its possible associated ideas' meanings evaluation necessity.

The mathematician, Roger Penrose, [20, p. 145] named quantum mechanics "mystical" theory just as of the strange link between the reality performance and the fact or absence of our observation (realizing) of it at a particular time moment. There are various philosophical interpretations of this mysterious quantum-mechanical phenomenon which all grew from the lack of any explanation of this fact in quantum mechanics itself (through its terms, mathematical tools technique). The critical analysis of these interpretations becomes the subject of current research. The final conclusions concerning the role of consciousness in quantum mechanics are planned to be based on such analysis. The following statement on the research subject is also applicable: the role of quantum mechanics in consciousness identity and performance conceptualization.

In order to start the direct analysis of the connection between consciousness and quantum mechanics, it is necessary to give at least brief description of several key principles of the quantum mechanics itself which frame the range of concerned with this research issues.

2. Some Interpretation Problem

Herein the complicated interpretative problem arises. Basically the only way of adequate representation for modern physical theories is to be depicted in the mathematical form. This fact knocks the bottom out of attempts to speak about the quantum physics on natural language rather than on mathematical one. The natural language has the lack of completely equivalent concepts to express the necessary for an accurate description of physical, and thus the mathematical, phenomena mathematical abstractions. This applies especially to the physics of the 20-21 century. Much more serious problem is caused by the above: in what way the philosophy of modern physics (and all the natural sciences) is at least applicable to such cases? Whether is it quite possible at all? Is it granted that philosophy should be mathematical (i.e. operating the language of mathematics)? While attempting to reach philosophical understanding of the principles of modern science such a serious problem is being revealed. For example, A. Koyré (who generally admitted the existence of "translation" problem) boldly addresses to Newton and then Einstein as to outstanding philosopher-metaphysicians [15, p. 24] and in the same time states the philosophy being the forbear of science and serving as its basis. What should be stated as philosophy in this case? Is it possible to find at least one of Einstein's works matching the common criteria of philosophical research? Or the traditional principles of philosophy ought to be revised nowadays? The question of language choice remains then in the discussion: which language is the most suitable for philosophy of physics and mathematics. This research mainly managed to avoid the direct confrontation with the named problem and covers mostly established by now interpretations (however, all the above mentioned forces to assume none of such interpretations being entirely correct).

Galileo maintained rather radical position on the connection between nature, philosophy and mathematics (Galileo statement according this matter is possibly the same famous as his fabulous "It does move all the same" in popular culture):

> Philosophy is written down in that splendid Book (I mean the Universe) that is always open for our eyes, but possible for being read only by ones who learn the language at first and learn how to understand the inscribed signs of it. It is written in the mathematical language and its characters are the triangles, circles and other geometric figures which are the way to understand the each and every word of it and if failed to understand you have to only roam in the dark labyrinth [8, p. 41].

Penrose has similar and even more radical point of view. According to him mathematical objects (geometric, mathematical concepts and theories) do really exist and they in particular amount for the only true reality [20, pp. 96-97], [21, pp. 12-13]. He repeatedly names himself a Platonist and argues that the objects of mathematics do exist objectively (not all of them), timelessly and spacelessly, they exist initially – in the world of ideas, and they represent the true. To be more accurate, the mathematical (and geometric) objects do piece out the world of ideas. For this reason a scientist does not invent but discovers them. Some Plato dialogues (*The Republic*, *Timaeus*, *Epinomis*) clearly states mathematical entities to be parts of ideal world, meaning them to be intelligible, to be ideas. For example, Plato's *The Republic* contains the concept of the perfect "by itself" quadrangle: "... the idea is not addressed to the drawing but to those figures which are uniforming to it. They elicit from only the quadrangle itself and its diagonal but not for the very depicted diagonal" [23, 510d]. In Plato's *Epinomis* the numbers are under consideration: "We need to put the number in the base of everything" [22, 977d] and "It's the first time god grafted us the understanding of what we are shown; and then he has shown us [a number] and is still showing" [22, 978c]. He stated numbers to be ideal essences (the ideas) and so mathematics as their operator to be the supreme science. Here the famous Pythagorean "Everything is the number" is also applicable (curiously, according to Jonathan Barnes [1, p. 21], there is no convincing evidence that Pythagorus was actually interested in mathematics!)

However, one detail which was indicates by T. Gaidenko and could be unknown to R. Penrose still remains very important: if the numbers belong(and they definitely are)to the ideal world and do exist as the particular only intelligible and spaceless ideas, the geometric objects are by contrast in different situation [9, pp. 127-128]. Geometric figures surely depend on space and therefore should be placed between the sensible world and the ideal world. Here appear the difficulties with such objects as the Mandelbrot set: pure mathematical abstraction which could nevertheless be represented in graphics and is regarded as a geometric object? The same situation is with the Riemann sphere, the vectors sum according to the parallelogram rule, the geometrical representation of complex numbers (with the axes of the real and imaginary numbers), the Hilbertian space. Thus, many of intelligible mathematical entities could be spatially represented, that means them to have analogies in the sensible world! Moreover, Plato's world of ideas is not identical to the world of mathematical objects: for example, Penrose's attitude to the existence of bed idea in it is still not clear [23, 597a].

The role of mathematics review is important in this research considering the probable connection between concepts of computability (algorithm, resolvability) with the consciousness performance. Moreover, such mathematical concepts as complex numbers are also very significant for the quantum probabilities estimation – mostly because they are "absolutely fundamental to the structure of quantum physics" [20, p. 236]. Let us recall that a complex number maintain the form $a + ib$, where a and b are real numbers, and i (imaginary number) is the square root of –1. Real numbers specifics lies in the fact of their presentability as the non-terminating decimals and that the set of real numbers is greater than the set of rational numbers and is not countable (curiously, the real numbers were discovered by ancient mathematician and astronomer Eudoxus (5–4 centuries

BC)). The first recorded use of complex numbers dates from the 21 century (associated with the works of Gerolamo Cardano and Rafael Bombelli). Such advanced mathematics development seems to be of spectacular value. However, the theories of physics dominancy are also supported by the very convincing arguments [10, pp. 259–262].

3. Specific Features of Quantum Physics

Quantum mechanics in contrast to classical physics effectively conducts studies on the microcosm phenomena, characteristics and actions of such its components as atoms, electrons, protons, photons, etc. Specificity ("non-classicality") of it resides in its perception of microcosm as arranged in fundamentally different way than macrocosm, although the second seems to be "composed" of the elements of the first. In other words, the same what is observed at the level of the microcosm cannot be observed at regular for direct observation level. The reason for such peculiarity lies in what is known as wave-corpuscle duality: atomic components (photons, electrons, etc.) act both as particles and as waves. In other words, the correct (could be named objective apart from Niels Bohr and his followers statement of objective real world view absence in quantum mechanics) of insisted that in, objective picture of the real world does not exist) description of reality is possible only using the two opposite classical concepts. Such usage of mutually exclusive sets of concepts became the distinguishing characteristic of quantum mechanics and bears a name of Bohr complementarity principle. Given phenomenon was experimentally confirmed through the famous double-slit experiment where the particles (even single ones) create a wave (interferential wave) pattern being mostly interpreted as conducting the wave behavior of elementary particles. That is the process when one emitted particle passes through two slits at once thus being the wave. But the most amazing thing here is that in case if the tracing particles passage detector is installed near the one of the slits so the interferential pattern does not take place and the particle behaves itself as a particle. On the one hand, this experiment could lead us to the conclusion that the reason of conflict with our intuition lies in fact of that particles and fields concepts are not fundamental so there is the need to search for more fundamental components to explain the experiment properly. Another interpretation includes the thought that the microcosm is really regulated by such rules so the interference occurs when there is no exact *certitude* which slit the particle is going to pass through and vice versa.

There are also later versions of the double-slit experiment: an experiment with a laser beam splitter which splits the laser beam (emitting one photon at regular intervals) into two beams. The foundations stay the same: if the detectors are installed the photon behaves as a particle, if do not – s a wave. The distance between the two paths can reach many light years. Nevertheless, the interferential pattern depends on the presence or absence of the particles detector [11, p. 190].

Passage of a single particle (upon the detector presence) through one slit or the other is determined by the classical method of probabilities counting. Roughly said, there are two alternative ways which are half to half of the one possible variant (way A + way B = 1). However, upon the detector absence the interferential pattern should result from the two alternative ways sum (their superposition). But here the complex numbers are also additionally used as coefficients (extra factors) to the alternative ways sum ($A + iB$). In other words, quantum mechanics states the various alternatives for the same object actions are determined by the superposition of these alternative ways with complex factors. The only problem for such statement is the lack of the suchlike examples in macrocosm. For instance, it is difficult to imagine the situation when Socrates nationals see him in all the possible alternatives: when he has already taken the poison, when he has not yet, being in different places and performing all the different actions that he could perform at the same time. They see instead the only one situation. The real meaning of the complex coefficients in such situations and the way of their influence on visual macrocosm world view are not completely clear points. Despite of its obvious empirical confirmability why are quantum mechanics actions not noticeable in macrocosm?

Before proceeding with the current hypotheses on this let us briefly recall the quantum mechanics method of probabilities counting. Since the particle acts as a wave (when we do not track its actions) the probability of its location in a particular place could be determined by not the classical probabilities but the concept of amplitude. Mathematically, this probability amplitude is constituted by multiplied by a complex number alternative ways. A wavy line could be a better but not the exactly correct example – the higher is the crest of the wave, the larger is the amplitude. Accordingly, the highest probability of locating the particle is in the moment of the upper crest, the least – on the lower one. However, the particle could also be detected at lower crests despite of their low probability of particle to appear in "there". This implies that theoretically there are many possible locations of the particles. Next question seems to be appropriate here: is it possible to find out the location of the particle before its location observation? The answer is that you could not. Moreover, the standard quantum mechanics states it to be wherever it could be, so its location is described by superposition (all state vectors sum). In other words, before the exact observation the particle had no specific location. Such assertions are in crucial contradiction with our intuition and the observations of the everyday world. The act of observation (i.e. perception) turns out to be forcing the particle to locate in particular place while it has been everywhere it could before and has been described as acting exactly as the wave function. In fact, observation act here consists of switching the quantum level to the classical one, of the "increase" to the macroscopic level. In mathematics, this is the same with drawing the squared absolute value of quantum complex amplitude module – the simple procedure performed on the Argand subspace (defined by axes of the imaginary and real numbers) with the involvement of the Pythagorean theorem. The mentioned manipulation of drawing the squared absolute value of quantum complex amplitude in physics bears the name of the wave function collapse. According to the last wavy line example this resolves itself into the following: the very moment of the particle state recording, its localization, the one wave crest becomes the top and the others are down to zero. This appears as if it was our observation (consciousness) that makes the particle to select a specific location (and the quantum mechanics laws cease to describe its condition).

Let us keep in mind the fact that the classical physics is deterministic: if the location and impulse (or speed) of the object there is the theoretical possibility to predict its original and final location (although the actual situation is more difficult – the evolution of more than two particles interaction causes difficulties). But in quantum mechanics it is incorrect to claim the particle being located in a particular place at a particular time due to Heisenberg indeterminacy principle which states the location and impulse of the particle impossible for accurate measurement. The more precisely we state impulse of the particle, the less clear its location is for out observation, and vice versa (let us not to go into details of this known fact, but let us note that according to one of the most popular interpretations this is the way how the observer does unavoidably disturb the microcosm). For example, if a probability wave has the same grade amplitudes and wavelengths so the particle impulse has been defined correctly. This means the observation act (wave function collapse) to result in particle location detection in any place with equal probability because of equal squares modules at any wave area. So the particle location is completely undetermined. The situation when the so called "wave package" has been specified is appropriate in quantum mechanics: when location and impulse are limited to a specific range and, therefore, are approximately determined.

The Schrodinger equation describes the time evolution of a quantum system. Its form is not an important factor here, but its measurement act description absence in its structure is critical. The equation in this regard describes the world being deterministic: the evolution of the wave function as a superposition of probabilities is predictable, but indeterminacy arises with the start of observation and attempts to locate the particle (or define its impulse) so the switching the quantum level to the classical one happens. Indeterminacy arises due to the fact that the choice of the microcosm components being observed occurs intentionally by accident, in the unpredictable way. So the Schrodinger equation in not applicable here – cause of the wave function collapse. Erwin

Schrödinger himself was not pleased by this situation (the absence of correspondence between the quantum mechanics world modeling and what is observed in reality). Macrocosm has no superposition. His "Schrodinger's cat" imaginary experiment and many modifications are widely known. In the following there will be described the applicable to this research modification of this equation.

4. The Measurement Problem

Let us afford such freedom and imagine Socrates with a vase of poison instead of the cat. Then assume that no one is around him to observe his actions. The original Schrodinger's imaginary experiment is based on the role of subatomic unobservable effects described by a wave function directly influence the final cat condition as a superposition of alive and dead conditions. However, quantum mechanics does not include the statements on differences between macrocosm and microcosm patterns (moreover, all the objects of macrocosm, instruments and the observer him/herself are made up of elementary particles). Therefore, the microscopic conditions are to be overleapt (although, the Socrates poisoning quantum mechanism such as decay of a radioactive atom is easy to modify).So Socrates is holding a vase. If there is no observer (and no "measuring" process), then his condition is described as a superposition of possible alternatives – in other words, he has drunk the poison and died plus he hasn`t drunk and stayed alive. For the waiting outside Athens citizens (and also for the quantum mechanics) Socrates is simultaneously both alive and dead. And at the very moment of anyone entering the room, Socrates chooses a specific condition – either alive or dead, but no one has ever seen him both alive and dead. With the help of previously mentioned complex probability factors we could state the Socrates condition superposition being not just the sum of the two conditions – alive and dead – but the presumption of all possible complex combinations – and they are all different! For clarity (which is incorrect) this could be represented as follows: for example, the state vector of Socrates being 16% dead and 84% alive is possible (this is close to the dramatic A. Tolstoy fairy tale on the adventures of Pinocchio: Pinocchio "is more alive than dead", etc.). However, the entering the room observer will never see such a condition. As a result of wave function collapse which the observer provokes by the recognition of what is going on in the room Socrates appears to be either fully alive or completely dead. But this does not turn out to be the core problem. The problem is what Socrates feels about it himself. Obviously, he perceives nothing of the kind (no complex superposition of his conditions). He is self-aware when alive and, supposedly, is not when dead. This means that the reality is different depending on the observer. As Socrates measures his condition by himself, he surely knows that he does not fit into Schrödinger equation and that he is clearly alive. For those who are outside and cannot see him, Socrates is a complex superposition of dead and alive conditions and could be described by Schrödinger equation. There seems to be no contradiction in case Socrates is dead and has no recognition of what is happening anymore, but does not it? For outside observers he is still dead + alive, that is why *at all* it cannot be stated if Socrates has died, as when dead he would not be self-aware and he would not be observed by anyone.

As mentioned above, problems of this kind did not satisfy Schrödinger and he believed that his equation cannot be applied to macrocosm objects, such as, for instance, Socrates. However, this is only his private opinion and in quantum mechanics there are no valid grounds for not doing so. Contradictions to it may only come from our perception, intuition and the way we recognize reality, which cannot be considered to be a strong scientific argument.

Concerning this matter a question may appear: what are the legitimacy criteria for Schrodinger equation? Why should we accept it? For example, the equation includes quite questionable members, even combinations of members, the usage of which may be interpreted as a certain mathematical "trick" for the purpose of achieving the targeted results. Who decides that the equation is appropriate and applicable? It is natural to think that this decision is made by those rational beings who recognize the results of the equation's implementation, and because the equation corresponds to the results of experiments demonstrating the nature of microcosm. Another answer is that our conscience determines "legitimacy" following the fitting criteria of our perception and of what we consider "reasonable" based on our experience, observations, etc. Laws of energy conservation and second law of thermodynamics, for instance, are considered, to some degree, irrefutable postulates of physics. However, can we surely say that the evolution of the Universe will not turn backwards in some distant future because of the changes in entropy process, so that the entropy will be decreasing while the degree, on the contrary, will be increasing? This can't be surely stated, as well as the same thing can't be stated about the conservation laws (refer to Koyre's works on this issue [15, p. 24]). But accepting these laws is in full correspondence with our mental *intuition*. There are plenty of other examples from the science history. Einstein introduced the cosmological constant relying on the intuitive believe that the Universe can only be steady state, which he has later admitted to be the greatest mistake in his life. On the same grounds, the grounds of reason, Aristotle, Hipparchus and Ptolemy considered Earth to be the center of the Universe, and the Universe to be finite. Newton, however, did not even accept a possibility of gravity being a feature of objects themselves. In a certain sense has been developed the Descartes' statement that "we cannot doubt of our existence while we doubt, and that this is the first knowledge we acquire when we philosophize in order" [4, p. 316]. But nothing has prevented Zhuang Zhou to *doubt* contrary to Descartes (and even long before him) "whether Zhou is dreaming himself a butterfly or the butterfly is dreaming itself as Zhou" [28, p. 35]. It really seems to contradict reason, intuition, common sense (that is all). Nevertheless, in the history of philosophy, starting from the antiquity, there has been a question: why reason (or even experience, as we anyway understand it through our conscience) should be considered a sufficient basis for claiming any truth? Heraclitus' statement (way before the skepticism) is very representative: "I know nothing of anything" [17, p. 124]. Probably, such doubts had evolved in the course of time into Schopenhauer's belief that the world is nothing more than our perception of it, "everything exists only for the subject" [24, p. 20]. As shown by the examples from the field of physics, this problem troubles not only philosophers.

The history of misconceptions proves that reasonable grounds (as in the statements like, "this is false beyond reasonable doubt" and vice versa) rely on intuition, the character of which is determined by the knowledge that people have in a particular culture-historical period. For example, the proof of God's existence by Thomas Aquinas seemed right as it completely satisfied mental intuition of educated people of his time. However, with the development of knowledge and ideas, gaining the experience in with the appearance of new philosophic concepts, Thomas' proof started to lose its intuitive obviousness.

There is a counter-example: counterintuitive principles of quantum mechanics generally formulated above were such in the first half of the 20th century, but for the following generations of physicist these principles may already be grounds for intuition.

Cognitive problems which originate from quantum mechanics have various interpretations and alternate solutions. Let us consider particular (the most well-known) ones.

5. Interpretations of the Measurement Problem

1. According to Niels Bohr, the very problem of measuring operations as an attempt to explain why the rules of physics change during the transition from microlevel to macrolevel has never been a problem. There is no point in describing anything that is not provided for experimental observation. One should only work with something that exists, without raising senseless questions that have no answers. In other words, there is no reality rather than the one described by science.

2. A different point of view (derived from Heisenberg's ideas) which appeals to our consciousness is that wave function is not real. It only reflects human understanding of reality and cannot be considered an objective phenomenon. Consequently, wave function collapse means the change of understanding.

3. The next approach ascends to David Bohm [3, p. 369] who as well as Einstein [18, pp. 454–457] shared deterministic views on reality. According to him, particles in fact take certain positions and have certain speeds regardless of whether we can observe them or not. However, in accordance with the inderterminancy principle we cannot be aware of both simultaneously. Worth to mention that Bohm's theory challenges Bohr's complementarity principle, meaning that instead of wave-particle duality it postulates separate existence of particles and their waves. This approach is also known as the "hidden variable" theory. Therefore, our knowledge of reality has its limits, but the reality itself has objective features irrespective of our awareness (or whether we are observing it or not).

4. The fourth approach, probably the most unconventional one, belongs to a group of scientists (Girardi, Riminiand Weber) [2, p. 201]. They have obviously taken into account the possibility of bringing certain altercations into Schrodinger equation in such a manner that it would still "work" (technically, it is a kind of a mathematical "trick"). The idea of the innovation is that the wave function sooner or later collapses by itself with no interference of the observer who carries out conscious measurements. But this hardly ever happens, approximately once in a billion years for every particular particle. It is this "infrequency" that guarantees no evident contradictions with the conventional quantum-mechanical representation of the world. And it is an advantage, as the records of quantum-mechanics are extremely precise, otherwise the contradictions would appear. Thus, from time to time certain particles, so to say, measure themselves, but their whole development up to this accidental hardly probable event is described by a standard wave function. In this way the new theory explains the principal divergence between the behaviors of microcosm and macrocosm: as the macrocosm objects consist of multitude of elementary particles, the function collapse of separate particles constantly happens there. This process causes a peculiar chain reaction (determined by the "tangling" of all the wave functions) which makes the functions of other particles to collapse. As a result, a macrocosm object always takes a certain position, has a certain speed (though subjected to reservations even in macrocosm) and is not observed as a complex superposition of all possible conditions. Such an approach is rather attractive, because it ruins the mystical halo around quantum-mechanics (as well as Bohm's theory) eliminating the magical role of consciousness in interception of reality. However, it should be noted that all the mentioned approaches are only acceptable interpretations of the reality and there is no evident experimental proof of any of them).

5. The next theory is known as quantum decoherence [11, pp. 209–212]. It can be reduced to a statement that the visual environment and its influence on objects make these objects choose certain configurations, which are usual for observation. Schrödinger equation can be applied not only to microcosm but also to macrocosm considering that the objects of the real world are not isolated, but exposed to the outer influence (fields, elementary particles). And though from the macroscopic point of view this influence is insignificant, in reality it is sufficient to disturb the coherence of a macroobject. This influence on the wave function, which describes the development of microcosm in the course of time, suppresses interference. It means that the visual world "takes measurements" by itself and the human role with his conscious observation again loses its meaning. But there is a different point of view: Penrose makes an interesting observation concerning decoherence. His point is that decoherence brings us back to the matter of consciousness and implicitly suggests the acceptance of multiverse hypotheses [21, p. 1031].

6. Schrodinger equation can not be applied to conscious creatures (Jenő Wigner's concept [27, pp. 168–182]) meaning that it objectively describes reality only until it is not recognized by the observers in the relative proximity. According to Penrose, this leads to paradoxes [20, pp. 294–295]. Although these phenomena are considered to be paradoxes for the only reason that they are objectionable from the point of view of meeting the requirements of reasonableness. Assuming that in the universe there are other conscious observers the wave function collapse would represent a different portrait of the same region of space to different observers (as at the moment of observation various characteristics of reality are set randomly). Let us assume that the observers in the Milky

Way have recorded a supernova explosion in the Coma Berenices asterism, while the observers from the Andromeda Galaxy have not. Did it really happen or not, regardless space-time continuum, fixed by the special theory of relativity? This may be not an evident example but to a certain extent it reflects a more general problem. After all, there is no need to go that far and search for the inhabitants of Andromeda galaxy, the Earth would be more than enough, or even just a laboratory is required. Let us assume that a researcher takes measurements (for better evidence we shall consider that he is observing microcosm, axial direction of an electron spin, for example). After taking measurements he would inform another researcher who is not observing anything about the results in order to record them. But can such results be objective? It is highly *probable* (in the quantum-mechanical sense) that the second observer would get a completely different result under the same conditions (for the reason microcosm random nature at the moment of wave function collapse). Is it worth speaking about objective reality in this case if it is different depending not only on whether it is being observed or not but also on who is observing it?

7. John Wheeler [26, pp. 182–217] suggested an even more radical concept. As the reality chooses a particular condition (one of the possible alternatives) only as a result of conscious observation, the whole evolution of the universe up to the moment when consciousness was shaped becomes determined (i.e. obtains fixed specific values) only after the formation of consciousness. It is a very interesting theory especially because it leads to further questioning such as: what does it mean "to observe the past" in the quantum-mechanical sense, if we are speaking about the human history, of course, rather than space observation. In the latter case we literally see the past. But even if we understand it this way, there are known complexities. A photon traveling for many light years from a different galaxy (in an experimental case with a beam splitter) causes interferentional picture on Earth. It means, that for many years its condition has been described by a wave function and it was as if "smeared out" all over the universe where it could get, which a great variety of alternatives is! But with a detector installed, interference disappears, thus all through the history the photon had a particular trajectory. If the detector is absent – again the interference occurs. It may seem that the past changes depending on the act of observation, world's history is being rewritten. Here it should be noted that from the mathematical point of view this fact does not create any paradox. Paradoxality is rather a result of a certain philosophic interpretation.

8. John Wheeler's student Hugh Everett [7, pp. 315–324] proposed probably the most popular interpretation of the quantum theory in mass culture – the idea of parallel universes (often called multiversal interpretation). The core of Everett's concept is that wave function collapse does not happen at all and Schrodinger equation describes reality in a most correct way. The point is that all possible alternatives provided by the wave function find their realizations, but each of them does in its separate parallel universe. It means that a variety of additional universes constantly appears with all possible combinations of alternative events. This interpretation to a great extent simplifies the problem of measurement and seems to lessen the mystical role of consciousness in the evolution of the universe. However, it is not completely true. A logical question comes up: if there is such a variety of universes and their number keeps growing, why do we recognize ourselves only in one particular universe and are not aware of the others? As an objection, it is likely that we do recognize ourselves in all the universes, but in each independently. It ruins the intuitive concept of the unity of consciousness, the idea of self-identification: how can we be sure that it is "us" in the additional universes, if each of our doppelgangers has a different consciousness? This issue is collateral to the problem of teleportation, which we shall consider further.

Another problem is connected with the experimental evidence of the existence of parallel universes. Finding such evidence appears to be very problematic (and actually impossible) for obvious reasons. Still some physicists, for instance Alexander Guts [12, pp. 320–325] and David Deutsch, believe that such a test is possible with the help of the so-called "shadow particles". Describing interference of a photon, Deutsch comes to a conclusion, that interference is determined by the influence of "shadow photons", invisible particles that prove the existence of innumerable parallel universes (where these photons exist) [5, pp. 43–45].

9. Mikhail Mensky suggests an even more challenging approach. Accepting Everett's idea, he disagrees with the conclusion that the role of consciousness in objective shaping of reality reduces to zero. He, on the contrary, claims that consciousness is responsible for the choice of alternatives! Then he goes even further, stating that the choice of alternatives between parallel universes is consciousness [16, p. 108] (literally, consciousness is what separates the alternatives). Mensky is obviously so obsessed with this idea that he keeps expressing it again and again all through the book. In addition his interpretation preserves the idea of objective visual world (as he understands it), the world of all quantum superpositions, while he believes that it is the consciousness that carries out subjective separation of the alternatives. However, a human being is capable to perceive this objective world, the world of quantum superpositions, when he is unconscious: in a trance, while dreaming or meditating (in fact it is a modern understanding of the unconscious). Mensky believes that his concept can explain such wide-spread phenomena as clairvoyance, telepathy and other supernatural abilities. It is in the unconscious state (in the senses described above) that a person gets the ability (rather chances to have the ability) of "superintuition" (direct vision of truth). Perceiving all the universes in their superposition, an individual acknowledges all probabilities and their realizations. One of the last chapters in Mensky's book is titled "Why quantum concept of consciousness turned out to be successful". Here, not to confuse anyone, we must emphasize that it is not true. Mensky's quantum concept of consciousness is not at all successful (if under success we understand acceptance by the academic community). At least in this Universe! The reason is that Mensky's ideas are purely speculative and "facts" about all-possible wonders that he provides as examples have no scientific proof.

Mensky pays attention to the fact that Wolfgang Pauli, one of the founders of quantum physics, cooperated with Carl Jung on the issue of the role of consciousness (and the unconscious) in physics, but he mentions that the results of this cooperation have never been published. However, it is only partially true. Pauli and Jung published the work "The Interpretation of Nature and the Psyche" [19]. The aim of Pauli's research was to analyze how archetypes influenced Keppler's ideas, Jung's research at the same time, was devoted to the theory of synchronicity, which is used for the explanation of mystical superabilities that are attractive to Mensky.

There is an opinion, that Everett's theory violates the parsimony principal, which is a part of the "real" world. Still it is not a strong argument. This point comes directly from subjective perception of "how the things should be around" based on mental intuition. Some other criteria of a "proper" theory are popular among physicists and mathematicians. They are aesthetics [21, pp. 22–23] and simplicity. Moreover, quite often it is these criteria that determine the choice of approach or initial data. But certainly it is not about the objectivity of choice.

10. Another point of view on the measurement subject relates to nature of the observers. Is it necessary to obtain consciousness through the observation process for the collapsing of the wave function? Obviously, such a statement lacks enough confirmation. Thus, the following hypothesis is to be stated: the macrocosm bears the condition which is observed because of its constant being "measured" by different observers. For example, by animals (or bacteria).

6. Conclusions and Assumptions

Let us draw some conclusions about a possible connection between consciousness and quantum mechanics (for more details refer to works by Paul Dirac [6] and John Bell [2]). The question may be formulated in two ways: what is the role of quantum processes in the consciousness performance and, on the contrary, what is the role of consciousness in quantum processes? This article is mostly devoted to the latter question. To answer the first one requires an answer to a different question: how is consciousness structured and how is it functioning? Definitely, this question remains open. Although, there are a number of arguments that are of physiological character (in case that we adhere to the views that consciousness can be reduced to brain functions) – we shall skip them, as the description of brain structure would hardly be of any help. There is another important question:

how does consciousness work? Can we view brain as a certain computer that carries out calculations (which are reduced to what we call consciousness)? If so, then consciousness is actually a complex of programs that set the algorithms of calculations (algorithms in the sense of Alan Turing's machines). However, Kurt Gödel had proved that any considerably complicated mathematical theory is undecidable. In Turing machines case this means that there is no universal Turing machine that can resolve any mathematical problem, i.e. there are always such problems that cannot be solved algorithmically (the algorithm to solve them has not been discovered). If we devise an algorithm for such problems, anyway the new undecidable ones will appear. It should be noted that such problems can be solved in theory, but the existent algorithms are useless for the purpose. If we accept that consciousness is a kind of such program containing algorithms, we'll have to admit that there are numerous problems that cannot be solved by consciousness. Another problem described by John Searle [25] is that such a program will lack true understanding of calculations it is performing, so it is not analogous to consciousness. Thus, the man's mind and consciousness cannot be regarded as a classical computer (with appropriate software). Despite this, Deutsch [5, pp. 238, 337] claims that the brain is a typical computer operating on the basis of classical physics, i.e. it does not follow the rules of quantum mechanics. However, according to Deutsch, consciousness necessarily functions in reliance on the acceptance that our copies exist in the doubtlessly real parallel universes, "the fruitfulness of the multiverse theory in contributing to the solution of long-standing philosophical problems is so great that it would be worth adopting even if there were no physical evidence for it at all" [5, p. 339]. Regarding the multiversehuman brain turns into a cross-functional computer intricately avoiding the problem of undecidability (which seems not to be even considered a problem by Deutsch).

The following questions are appropriate here: does the intellectual intuition an algorithmic process? If not then may it be the quantum process? These issues are interesting for discussion but have still no at least approximate answer.

Penrose in his turn adheres to the point of view that consciousness is not a program and brain is not a computer particularly due to the fact of undecidability of certain problems. He insists that the very possibility to evaluate any algorithm legitimacy means that consciousness is not a complex of algorithms, because this evaluation is not algorithmic [20, pp. 411–413]. Indeed, how do we decide which mathematical operation should be used, that a certain result is legitimate, how do we select and formulate criteria of truth? Eventually, can there even be an algorithm for an algorithm? As Gödel has proved such an algorithm does not exist, but even if it would there would be another question: what criterion of truth can be applied to this algorithm? Would it be algorithmic? Is the process of wave function collapse algorithmic? If not, which is much likely to be so, it means that consciousness as an observer of reality can perform uncomputable processes and definitely cannot be interpreted as a classical computer program. It should be emphasized that such considerations remain correct if we do not take into account possible dualism of consciousness and body meaning that consciousness processes can be reduced to brain function. For example, the aforementioned Mensky holds a radical opinion that consciousness is not a brain tool, but just the other way round, brain is a tool of consciousness.

Penrose in his last fundamental work *The Road to Reality*, 2004, while bonding quantum mechanics to consciousness states that consciousness does not determine subjective observation and its results, but rather physically real wave function collapse is responsible for the work of consciousness [21, p. 1032] (Penrose prefers to speak of state vector reduction). Besides Penrose also does not consider brain to be a quantum computer (using Schrödinger equation to describe reality). He believes so for the simple reason that brain as a macroscopic object functions in a full accordance with the rules of classical physics. But he also believes that to understand the phenomenon of consciousness completely quantum mechanics should be modified in a way to connect it to the general relativity theory. As is well known, such connection is required to solve the problem of gravity, which is explained in general relativity theory, but is not applicable to quantum theory. It means that, according to Penrose, gravity plays an essential role in the problem of measurement. It is the gravity effect that provides objective reduction, with which the common macrocosm finds its realization and serves as a forthcoming of quantum reality. Then a conscious observer is unnecessary and consciousness does not determine the reality. It should be noted that such approach to the problem of observation becomes possible within quantum mechanics only if certain altercations are brought into standard quantum theory (like Bohm, Girardi, Rimini and Weber's approaches).

Concerning the quantum computer (still a hypothetical device nowadays, producing calculations based on quantum superpositions, containing operations with complex numbers) it is now worth speaking about its applicability only in terms of complexity theory, the increase of calculation effectiveness [20, p. 402]. There are no grounds to suppose that quantum calculations are closer to the actual work of consciousness than classical calculations, as there is no proof of superpositional probabilities in the work of consciousness.

The problem of consciousness was thrown into sharp relief in connection with arguments on the matter of such quantum phenomenon as teleportation which ceased to be hypothetical after an experiment carried out in 1997 [11, pp. 442–446]. According to the experiment teleportation should be considered a kind of replication, a creation of a copy with the perseverance of initial object (in fact, it is a process of duplicating structure and binding characteristics of elementary particles). Let us assume that a teleportation of a human being takes place (of course, currently it is impossible, and is unlikely to be ever possible due to principal complexity of the process, that is not the point). This poses a question: would the copy have the same consciousness? If yes, so would it be the same as the original one? Brian Green claims that it would, the same one, as he is conceived that there is no other reality as the reality of elementary particles (or their alternative description), which means that consciousness can be reduced to a certain arrangement of those particles.

The followers of the viewpoint that consciousness is able to change the reality in quantum processes (initiate a wave function collapse) sometimes provide anthropic principle as an argument. According to it, the Universe is such, because of the observers' presence. In other words, humans could not exist in a universe with different physical characteristics. It supposes the necessity of consciousness. This does not sound convincing. For instance, if we consider other basics of mental intuition, especially the fullness principle (refer to A. S. Karpenko [13, pp. 1508–1522] and [14, pp. 1660–1679]) and the law of sufficient reason, we can assume that all possible universes exist with their courses of nature, including ours. Then anthropic principle makes no sense and the presence of conscious observers only proves that all probabilities should be realized, including this one.

Generally the question of connection between quantum processes (interference, wave function) and consciousness remains open. Its complexity is principal and was formulated by V. P. Zubov in a different way, "…how can we bridge physics to physiological psychology, which is to do something completely opposite to what Descartes' theories as well as all the following did, which was separating physics from physiology?"[29, p. 60].

From Koyre's point of view "the objective structure of existence determines the role and meaning of our intellectual abilities" [15, p. 21], which means that quantum mechanics should somehow determine consciousness if we admit that it sufficiently describes reality.

Possibly, this issue to a certain extent depends on the progress in creation of quantum computers. Quantum artificial intelligence might give an answer not for the nature of consciousness, but at least on the connection between consciousness and quantum mechanics. It is also possible that because of the hidden unavoidable character of microcosm, according to the quantum mechanics, the answers will never be found at all. As Heraclitus once said, "nature likes to hide" [17, p. 193].

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