Question of Consciousness: to Quantum Mechanics for the Answers[1]

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Abstract: *The article looks at the possible role of measurement in a quantum-mechanical description of physical reality. The widely spread interpretations of quantum phenomena are considered as indicating an apparent connection between conscious processes (such as observation) and the properties of the microcosm.*

Key words: *measurement, quantum mechanics, consciousness*

1. Introduction

This article investigates the current ideas about the possible impact of conscious observation on reality in the context of quantum mechanics, a subdiscipline which is yet to be named according to the conventional meanings of quantum theory and quantum physics. The best hypotheses about the relationship (or lack of it) between observation and reality are discussed in the article. The conclusion summarizes the current state of the issue. The current analysis also identifies the difficulties in this issue in the context of epistemology

2. Interpretations of the measurement problem

Cognitive problems which originate from quantum mechanics have various interpretations and solutions. Let us consider some particular examples.

1. According to Bohr, the very problem of measuring operations as an attempt to explain why the rules of physics change during the transition from the micro to the macro level has never been a problem. There is no point in describing anything that is not possible 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 the wave function is not real. It only reflects human understanding of reality and cannot be considered an objective phenomenon. Consequently, the wave function collapse means a change of understanding.

3. David Bohm[2] like Einstein[3] has deterministic views on reality. According to him, particles in fact take certain positions and have certain velocities regardless of whether we can

[1] The results of the project " Rule Following: Reasoning, Reason, Rationality ", carried out within the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE) in 2014, are presented in this work.

[2] *Bohm D.* A suggested interpretation of the quantum theory in terms of 'hidden' variables, I and II // Quantum theory and measurement / ed. John Archibald Wheeler and Wojciech Hubert Zurek. Princeton, 1983, P. 369.

[3] *Pais A.* Subtle Is the Lord: The Science and the Life of Albert Einstein. New York, 2005, P. 454-457.

observe them or not. However, in accordance with the indeterminacy principle we cannot be aware of both simultaneously. 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 reality itself has objective features irrespective of our awareness (or whether or not we are observing it).

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

However, it should be noted that all these approaches are only interpretations of reality and there is no experimental proof for any of them.

5. The next theory is known as quantum decoherence[5]. Simply, the visual environment and its influence on objects makes these objects choose certain configurations, which are observed. The Schrödinger equation can be applied not only to the microcosm but also to the macrocosm considering that objects in the real world are not isolated, but exposed to an outer influence from for example fields or 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 macro object. This influence on the wave function, which describes the development of the microcosm over the course of time, suppresses interference. It means that the visual world "takes measurements" by itself and the human with conscious observation is unnecessary. However 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 the multiverse hypotheses[6].

6. The Schrödinger equation cannot be applied to conscious creatures (Jenő Wigner's concept[7] meaning that it describes reality objectively only while it is not perceived by the

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[4] *Bell J.S.* Speakable and Unspeakable in Quantum Mechanics. Cambridge, 1987, P. 201.

[5] *Greene B.* The Fabric of The Cosmos. Space, Time, and The Texture of Reality. New York, 2004, P. 209-212.

[6] *Penrose R.* The Road to Reality. A Complete Guide to the Laws of the Universe. London, 2004, P. 1031.

[7] *Wigner E. P.* Remarks on the Mind-body Question // Quantum theory and measurement / ed. John Archibald Wheeler and Wojciech Hubert Zurek. Princeton, 1983, P. 168-182.

observers in the relative proximity. According to Penrose, this leads to paradoxes[8]. Although these phenomena are considered to be paradoxes only because they are objectionable from the point of view 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 a researcher takes measurements of a microcosmic phenomenon, for example, the axial direction of an electron spin. After taking measurements he informs another researcher who is not observing anything of the results in order for the second to record them. But can such results be objective? It is highly probable (in the quantum-mechanical sense) that a second observer would get a completely different result under the same conditions because of the random nature of the microcosm at the moment of the collapse of the wave function. 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[9] suggested an even more radical concept. As reality chooses a particular alternative only as a result of conscious observation, the whole evolution of the universe up to the moment when consciousness formed obtains fixed specific values only after the formation of consciousness. This is a very interesting theory especially because it leads to further questions on such issues as: what it does mean "to observe the past" in the quantum-mechanical sense if we are speaking about the human history, of course, rather than the observation of the extra-terrestrial universe. In the latter case we literally see the past. But even if we understand it this way, complexities arise. A photon traveling for many light years from a different galaxy (in an experimental case with a beam splitter) causes an interference pattern on Earth. This means, that for many years its condition has been described by a wave function and it was "smeared out" all over the universe , which is a great many alternatives. But with a detector installed the interference disappears, thus all throughout history the photon had a particular trajectory. If the detector is absent – the interference remains. It seems that the past is changing in relation to the act of observation, history is being rewritten. From a mathematical point of view this fact does not create any paradox. The paradox is a result of a philosophical interpretation.

8. John Wheeler's student Hugh Everett[10] proposed probably the most popular interpretation of the quantum theory in mass culture - the idea of parallel universes (often called the multiverse interpretation). The core of Everett's concept is that is no collapse of wave function and the Schrödinger equation describes reality in a most complete way. All possible alternatives of the wave function have their realizations, but each of them does so in a separate parallel universe. It means that a variety of additional universes constantly appears with all possible combinations of alternative events. This interpretation simplifies the problem of measurement and seems to lessen the mystical role of consciousness in the evolution of the universe. However, 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. This ruins the intuitive concept of the unity of consciousness, the idea of self-identification: how can we be sure that these are "us" in the parallel universes, if each of

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[8] *Penrose R.* The Emperor's New Mind: Concerning Computers, Minds, and The Laws of Physics. New York, 1991, P. 294-295.

[9] *Wheeler J. A.* Law Without Law // Quantum theory and measurement / ed. John Archibald Wheeler and Wojciech Hubert Zurek. Princeton, 1983, P. 182-217.

[10] *Everett H.* Relative State Formulation of Quantum Mechanics // Quantum theory and measurement / ed. John Archibald Wheeler and Wojciech Hubert Zurek. Princeton, 1983, P. 315-324.

our doppelgangers has a different consciousness?

Another problem is experimental evidence for the existence of parallel universes. Finding such evidence is very problematic for obvious reasons. Still some physicists, for instance Alexander Guts[11] and David Deutsch, believe that such a test is possible with the help of so-called "shadow particles". Describing the interference of a photon, Deutsch suggests that interference is determined by the influence of "shadow photons" - invisible particles that prove the existence of innumerable parallel universes where these photons do exist[12].

9. Mikhail Mensky suggests an even more challenging approach. Accepting Everett's idea he disagrees with the conclusion that the role of consciousness in the objective shaping of reality reduces to zero. He claims, on the contrary, 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 - consciousness is what separates the alternatives[13]. In addition his interpretation preserves the idea of an objective visual world - the world of all quantum superpositions - while he believes that it is the consciousness that carries out the subjective separation of the alternatives. However, a human being is capable of perceiving this objective world, the world of quantum superpositions, when he is unconscious: in a trance, while dreaming or meditating. Mensky believes that his concept can explain such wide-ranging phenomena as clairvoyance, telepathy and other supernatural abilities. In an unconscious state a person has the ability (or rather, chances to have the ability) of "superintuition" which is a direct vision of truth. Perceiving all the universes in their superposition an individual acknowledges all probabilities and their realizations. One of the last chapters of Mensky's book is titled "Why a quantum concept of consciousness turned out to be successful". In order to avoid misunderstanding we should emphasize that this is not true. Mensky's quantum concept of consciousness is not at all successful if we understand "success" to be accepted by the academic community. At least, it is so in this Universe. Mensky's ideas are purely speculative and "facts" about all-possible wonders provided by him as examples are unfalsifiable.

Mensky pays special attention to the fact that 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 states 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"[14]. The aim of Pauli's research was to analyze the influence of archetypes on 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 super-abilities that are so attractive to Mensky.

There is an opinion that Everett's theory violates the parsimony principle which is a part of the "real" world. Still this is not a strong argument. This point comes directly from subjective perception of "how things should be" based on mental intuition. Another criteria of a "proper" theory popular among physicists and mathematicians is aesthetics[15]. Moreover, it is quite often these criteria that determine the choice of approach or initial data, but the objectivity of choice is not under consideration.

10. Another point of view on measurement relates to the nature of observers. Is it

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[11] *Guts A.K.* Elementy Teorii Vremeni (Time Theory Elements). Omsk, 2004, P. 320-325.

[12] *Deutsch D.* Fabric of Reality. New York, 1987, P. 43-45.

[13] *Mensky M.B.* Soznanie I kvantovaya mekhanica. Zhizn v parallelnykh mirakh (Consciousness and Quantum Mechanics. Life in Parallel Words). (The miracles of consciousness – from quantum reality). Fryazino, 2011, P. 108.

[14] *Pauli W., Jung C.J.* The Interpretation of Nature and the Psyche. New York, 1991.

[15] *Penrose R.* The Road to Reality. A Complete Guide to the Laws of the Universe. London, 2004, P. 22-23.

necessary to have consciousness through the observation process for the collapse of the wave function? Obviously, such a question lacks confirmation. Thus, the following hypothesis is stated: the macrocosm is as observed because it is constantly being "measured" by different observers, for example, by animals (or bacteria).

3. Conclusion

Penrose, in "The Road to Reality" 2004, while bonding quantum mechanics and consciousness, states that consciousness does not determine subjective observation and its results, but rather the physically real wave function collapse is responsible for the work of consciousness. This corresponds with the Koyré statement that "the objective structure of existence defines the role and importance of our cognitive abilities"[16]. Nor does Penrose consider the brain to be a quantum computer. He believes so for the simple reason that brain as a macroscopic object functions in full accordance with the rules of classical physics. But he also believes that in order to understand the phenomenon of consciousness completely quantum mechanics needs to be modified to connect to the general theory of relativity. Physicists having been trying for a long time but not in relation to the observation of the nature of consciousness[17]. It means that, according to Penrose, gravity plays an essential role in the problem of measurement. It is gravity that provides the objective reduction (the equivalent of wave function collapse) with which the macrocosm finds its realization and serves as the realization of quantum reality. A conscious observer is therefore unnecessary and consciousness does not determine reality. This approach to the problem of observation becomes possible within quantum mechanics only if certain alterations are brought into standard quantum theory (such as the approaches of Bohm, and Girardi, Rimini and Weber).
The quantum computer's applicability is worth speaking about only in terms of its increasing of calculation effectiveness[18]. There are no grounds to suppose that the summing up of quantum probabilities is closer to the actual work of consciousness than classical calculations.

The followers of the viewpoint that an act of conscious observation itself is able to change the reality in quantum processes (that is, initiate a wave function collapse), sometimes provide the anthropic principle as an argument. According to this, the Universe is such, because of the presence of an observer. 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 the fullness principle (see Karpenko [19,20]) and the law of sufficient reason, we can assume that all possible universes exist with their courses of nature, including our own, then the anthropic principle makes no sense and the presence of conscious observers only proves that all probabilities should be realized.

Generally, the question of the possible impact of conscious observation on the physical characteristics of reality, thus drawing the differences between the microcosm and macrocosm, still remains open. As has been shown, this to a greater extent depends on the interpretation which is sometimes not strictly scientific enough because of an absence of

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[16] *Koyré A.* Ocherki Istorii Filosofskoy Mysli (Essays on Philosophical Thoughts History). Moscow, 1985, P. 21.

[17] It is commonly known that such a connection is required because quantum theory does not include a description of gravity.

[18] *Penrose R.* The Emperor's New Mind: Concerning Computers, Minds, and The Laws of Physics. New York, 1991, P. 402.
Journal of Symbolic Logic. 1999. Vol. 64, № 2. P. 881–903.

[19] *Karpenko A.S.* Filosofskiy Printzup Polnoty. (Philosophical Completeness Approach). Part I // Filosofia i kultura (Philosophy and culture). 2013. Vol. 11, P. 1508-1522.

[20] *Karpenko A.S.* Filosofskiy Printzup Polnoty. (Philosophical Completeness Approach). Part II // Filosofia i kultura (Philosophy and culture). 2013. Vol. 12, P. 1660-1679.

mathematical description of conscious observation in quantum theory.

From section 5 it can be concluded that solutions are usually purely intuitive without any empirical evidence. This situation brings us back to the speculative method. It may even be stated that the solution for the characteristics of reality, and knowledge, and the connection between the two has not come far since the pre-Socratic philosophy.

Nevertheless, this issue is very important and such a solution could possibly show the way to a proper understanding of quantum mechanics (and even the nature of consciousness). But it is also possible that the answers will never be found at all, as the fundamental laws of nature may impose restrictions on the ability of cognition. This results from the concepts of the existence of hidden variables that cannot be calculated in accordance with the principle of Heisenberg. In this case, it would be fair to say that the possibilities of conscious observation of nature are limited by nature. And, therefore, consciousness is unable to know whether it affects the properties of the reality or not.