PHILOSOPHICAL IMPLICATIONS OF THE QUANTUM THEORY

JAROSLAV CEPKO
Matej Bel University

Recently, a volume by Dr. Miroslav Karaba entitled «Philosophical Implication of the Quantum Theory in the Philosophy of Nature» has been published in Slovakia [*Philosophical Implications of the Quantum Theory in the Philosophy of Nature*. Bratislava: Dobrá kniha, 2009. 256 p. ISBN 978-80-7141-573-2]. The book is a slightly modified version of author's doctoral thesis successfully defended in 2005. Presently, Dr. Karaba works at the University of Trnava where he lectures the philosophy of science and epistemology. Besides his lecturing activities, he publishes in the field of mutual relations among natural sciences, philosophy and theology.

The starting point of Karaba's position is a version of critical realism which has already been clearly visible in his earlier studies concerning philosophy of science [1]. The reviewed publication can be considered to be an attempt to join the scientific knowledge with the philosophical and, in part, the theological one. The modern science transformed the originally moral approach of some streams of ancient Greek natural philosophy, which depicted the nature of the world as a continuous change in the configuration of the atoms, into a commonly accepted truth. Reducing the essence of the nature into atoms and vacuum, such truth developed a general feeling that could be, with Jacques Monod, called «a cosmic alienation» or, put in Robert Lenoble's words, «an inquietude of modern people».

As for the internal structure, the book is divided into two main parts. The first half (chapters 1-3) offers a review of natural philosophical thought from seeking for the basic unity of the original principle, as we find it in the Ancient Greek philosophy, to the fundamentals of natural philosophy set forth by the progress of classical physics in the Modern Era. Sure enough, the natural-philosophical thinking born on the European continent is firmly embedded in the Greek cultural background. Accordingly, Karaba focuses, for instance, on the basic concepts of natural philosophy as found in Pre-Socratic thinkers, in Plato and, mostly, in the Aristotelian and Thomistic system. The manner this system treated the issues of origin, extension, duration and structure of the universe, the question of relation between the substantial change and the knowledge of true nature of material things, as well as the theory of space and time, became a departure point for modern natural-philosophical conceptions. And those represent the object of the third chapter of the book, which attempts to illustrate the course and consequences of the shift in the reference point of natural philosophers from so called *causae primae* to *causae secundae* of natural and social processes. Gradually, natural-philosophical systems of Francis Bacon, Galileo Galilei, René Descartes and Isaac Newton lead to a thoroughly elaborated view on the universe. In the European thought of that period, a deeper value started to be ascribed to empirical experience, which, subsequently, slowly changed the whole way of understanding the reality. The human attitude towards the nature changed into a pragmatic one. Thus man ceased to be interested in what the nature is like, but focused to question what could be done with the nature and how to exploit it. The nature was transformed into technology and every progress in the knowledge was connected with the question of practical usage of new pieces of information. Eventually, in the nineteenth century a solid framework was settled for natural science that determined not only further character of science, but the opinions of mass audience as well. This framework was marked by fundamental terms of classical physics – space and time, matter and causality. The notion of reality started to apply to things or events perceptible by senses or observable using certain devices available by means of technology. The matter became the primary reality and the scientific progress started to appear as a

[1] Cf. Karaba, M., «Realistic Interpretations of Scientific Knowledge in Theistic Context», in *Humanity, the World and God: Understandings and Actions,* Lund, 2007; Karaba, M., «Scientific Progress and Its Sources in the Kuhn's Approach», in *Studia Aloisiana*, Bratislava, 2008; Karaba, M., «Theories of Scientific Progress: Evolution or Revolution?», in *RAN*, Bratislava, 2008.

conquest of the realm of matter. Notions introduced in physics by the end of the nineteenth century represented, so to speak, a firmly closed system applicable to a wide scale of experiments and, together with older terms, it formed a vocabulary that could be used not only by scientists in their work, but also by technicians and engineers. «Usefulness» simply became a slogan of those times. The inventory of underlying ideas in this scientific language contained such suppositions as: the sequence of events in time is totally independent on their spatial configuration; the Euclidean geometry is applicable on the real space; the spatiotemporal events occur independently on the fact whether they are observed or not. Of course, it was not denied that every observation affects the observed event, but, generally, it was admitted that, in principle, it would be possible decrease and eliminate this influence by means of more attentive execution of experiments. That was considered to be a keystone of accomplishing the ideal of objectivity, which is the very fundament of natural science. On the other hand, this framework still appeared to be too rigid and narrow, because it was quite impossible to find an appropriate place for several notions within it, that have always formed a part of our vocabulary (e.g. spirit, human soul, life, etc). Especially, it was difficult to find in this framework a place for such dimensions of reality that constituted the object of traditional religion. Within this framework they necessarily appeared to be just an illusion. Trust in the scientific method and the rational thinking were supposed to replace all the other certainties of human spirit.

The second part of the book (chapters 4-7) illustrates, first, the process of shift from the «classical» Newtonian physics to the 20^{th} century natural science. It was a qualitative change whose origin is to be found in formulation of radically new notions in the field of physics. However, it gradually made its way in other scientific branches, too, especially in cosmology, chemistry, biological sciences, etc. The natural science of the eighteenth and nineteenth century was successful in understanding the processes occurring not only in the nature but also in laboratories. Classical physics was fully functional, while it remained limited to the realm of mechanic phenomena. Yet very soon after its appearance, classical physics had to cope with the issues of molecular physics. Other complications occurred in the nineteenth century in connection with impressive progress of physics in the field of thermodynamics, optics and electrodynamics and with appearance of respective relatively independent disciplines. Nonetheless, the situation in physics seemed convenient and rather simple, because most new phenomena were still reducible to mechanical processes. The physics in the last decades of the nineteenth century was feeling stronger than ever. It gave the impression that the final comprehension of natural processes was at hand.

A distinctive feature of the first decades of the twentieth century was the fact that too many complications arose in connection with the notions of matter, space, time and energy. Consequently, the confidence in the older, orthodox and commonly accepted suppositions was severely shattered. Based on results of observations and experiments in natural sciences that were too far beyond the common human experience, a revision of former science had to be done. Hence the special and general theory of relativity as well as the quantum theory came on stage. The fourth chapter of the book offers a review of the progress in physics beginning with the so called «older quantum theory», through the elaboration of two equivalent quantum mechanic theories – the wave mechanics (Schrödinger) and matrix mechanics (Heisenberg, Born, Jordan), to the relativistic quantum theories. The next chapter is dedicated to several issues connected with the quantum theory, such as the EPR-paradox, the measurement problem or the hidden variables problem. An analysis of the quantum theory interpretations follows, starting with the Copenhagen quantum theory interpretation (Bohr, Heisenberg, Born), through the Bohmian interpretation (de Brogie, Bohm) and the Kochen-Dieks-Healey interpretation, to the Many-worlds interpretation. The reader of Karaba's text surely notices that the author stands firmly on the ground of the orthodox (Copenhagen) interpretation, which he considers to be the most coherent one and this position also permeates his analyses of ontological and epistemological issues of quantum theory. Among the main features of the quantum theory he mentions and, later, from the philosophical point of view analyses complementarity, quantum properties, quantum non-locality, indeterminancy and chance. The book reaches its apex in the chapters presenting a holistic ontological view and a description of a new world picture according to the twentieth-century physics and the quantum theory in particular.

In consequence, the classical mechanics is a causal and deterministic theory. Its causal character is manifest in the thesis that from an exact and complete information about a state of the system at time t_0 (i.e. from exactly defined coordinates and momenta of all the particles of the system at time t_0), the state of the system at time $t \neq t_0$ can be positively predicted by means of equations of motion. Its deterministic character is shown by the fact that in a given state of a system we can positively determine the value of a random quantity (we can measure in the system) and this value is, at least in principle, measurable with arbitrary precision and without changing the state of the system. The quantum theory, on the other hand, is causal and indeterministic. Its causal character is obvious from the fact that from a complete information about the state of a system at time t_0, depicted by the quantum state vector $|\psi(t_0)\rangle$, the state of the system at time $t > t_0$ can be predicted by the Schrödinger (time-dependent) equation. The information about the state of the system can be obtained by simultaneous ascertaining of proper values of a complete set of commuting operators assigned to certain physical quantities. In a given state of the system $|\psi(t_0)\rangle$, the quantum mechanics does not provide unequivocal predictions of precise measurements of all physical quantities. Instead of that, it ascertains what values of given quantity can by found in the process of precise measurement and what probabilities there are for setting single values. Hence the indeterminism of quantum mechanics.

In addition, there are considerable divergences between the classical physics and quantum mechanics regarding the measurement process. In principle, in the classical physics it is possible to measure arbitrary physical quantity precisely without essentially affecting the state of the system. In the quantum physics, however, generally a change is caused in the state of the system during the measurement and this change cannot be made arbitrarily small. Moreover, while in the classical physics the interaction between the examined system and the measuring device can be described by means of the classical physics itself, in the quantum physics the change of state of the system is not described by the Schrödinger equation. The indeterminism of the quantum theory and its description of the measurement process are connected directly with the issues of possibilities and tasks of the physical description of the nature. In that way, it becomes an epistemological and ontological issue.

The results of the reviewed publication can be summarized in following statements:

1. The obtained results and pieces of knowledge can lead us to a conviction about «explicability» of the world. Such belief represents a kind of epistemological realism. It is, therefore, possible to know that there is a form of order in the universe and we are able to recognize the fundamental features of its structure.
2. Up to the beginning of the twentieth century a commonly accepted view of the universe prevailed, which was founded on principles formulated by ancient Greek philosophy and further elaborated within the European civilization. This view also contained a world picture created by classical physics, based on the concept of matter consisting of firm and indestructible atoms, existing in infinite Euclidean space and in absolute time as well as succumbing the laws of classical mechanics.
3. Every kind of understanding (either scientific or non-scientific) depends on language, because our thoughts can be expressed only by means of language. The classical science managed to reach its goal with slightly modified common words of every-day experience. However, the notions of classical physics cannot be applied in the quantum system, in the period between two subsequent observations, because such notions are applicable just in the process of observation. Nonetheless, if we tried to give up this conceptual framework, we would lose the ability to communicate unequivocally. In consequence, the progress of the very science would be impossible.
4. It appears that the higher levels of quantum theory interpretations (basic interpretation of the theory, level of internal consistence and coherence, complementarity with other theories) delimit, in quite a significant way, the deeper interpretation levels (philosophical interpretation proper), but they do not totally determine them at all.
5. The ascertained quantum-mechanical properties (e.g. complementarity, quantization, non-locality, indeterminacy, chance, correspondence, indeterminism, etc.) imply new «world pictures» that can essentially differ from the «pictures» formed upon the pieces of knowledge acquired by classical sciences and, sometimes, can even contradict them.
6. New natural-scientific conceptions have definitely discredited the old-fashioned mechanistic materialism of the nineteenth century. New understanding of the matter, space, time, etc.

> has rejected the former naturalism, but has not contributed to a positive confirmation of theistic conceptions. Nevertheless, it has brought new inspirations and opportunities for Christian scientists and theologians who engage in the field of relations between science and religion.

To sum up, Karaba argues the discrepancy, that in a sense appeared between man and nature, is imputable to the influence of modern science. The notion of a nature inexorably governed by deterministic laws has lead to human sentiments of estrangement and loneliness in this world. Man can search the order of the nature and that could be enough for him, but also, he can go further and recognize something beyond him and his horizon. He can be aware of the signs nature offers us to be able to proceed and discover its Creator. Although this kind of issues does not enter among the aims of the reviewed work, yet the reader can feel their echo throughout its chapters. And indeed, the research in quantum properties of the systems points to the fact that mind could play an important (if not even decisive) role in the universe. Nowadays, a responsible seeking for answers concerning the essence and meaning of everything that surrounds us as well as of our own selves, involves a cooperation of various disciplines within natural sciences, humanities and social sciences, which is the case of the reviewed publication as well. The pieces of knowledge collected by modern science seem to point to a great mystery of existence, which our own being is inscribed in.

JAROSLAV CEPKO, PhD.

[Texto básico publicado en Tendencias21.net,
por la Cátedra CTR, Escuela Técnica Superior de Ingeniería,
Universidad Comillas, Madrid]