A SACRAMENTAL QUESTION ADDRESSED TO QUANTUM THEORY

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Abstract

The author of this small in size, but extremely important in terms of physical significance, article shares with readers his knowledge of quantum mechanics, experience in writing scientific books and articles, and logical thinking skills in relation to the problem of creating a quantum theory (in this situation, a response to A. Einstein's objection to one from the main relations of quantum mechanics - uncertainty relations).

Keywords: uncertainty relation, gamma quanta, particles and antiparticles, theory of relativity, quantum theory, wave field reduction, corpuscular formations, waves of information, nonlocality of particles.

When I perceive, it is not I who thinks about the world. And he organizes himself around me.
Maurice Merleau Ponty

One of A. Einstein's strongest objections to one of the main relations of quantum mechanics - the uncertainty relation - is based on the following thought experiment.

When two gamma quanta collide, having the same and sufficiently high energy (exceeding the rest energy of the electron), the reaction of the formation of an electron-positron pair, particles that differ only in the sign of the electric charge, is possible. This reaction is symbolically written like this:

$$\gamma + \gamma \to \mathrm{e}^- + \mathrm{e}^+$$

A particle (electron) and an antiparticle (positron) diverge from the place where the pair is formed in different directions and at the same speed. The position of the target on which pairs are produced is determined by the experimenter. According to quantum theory, the variables velocity and position of a particle (or antiparticle) are complementary in the sense that the possible accurate measurement of velocity excludes the simultaneous measurement of the coordinate; at least the uncertainty of the latter is so great (and this uncertainty is irremovable) that it does not allow one to judge the position of the particle within the experimentally used device or physical instrument. On the contrary, in the case when the device is designed to accurately measure the coordinate, it is practically impossible to judge the magnitude and direction of the particle velocity. The same can be said regarding the simultaneous measurement of the speed and position of the antiparticle.

Further A. Einstein reasoned as follows. If the coordinate of an electron is experimentally measured, and after a sufficiently long time t , such that the distance from the target to the counter recording the position of the particle exceeds ct , where c is the speed of light, then the mutual influence of the electron and positron at the moment of measurement is excluded (causal interdependence at This becomes, according to the theory of relativity, impossible). The speed of the particle, as already mentioned, is not determined. However, if the time t is known , then from its value it is not difficult to determine the speed of the antiparticle, since its position is given by a point symmetrically located relative to the target. It turns out that the positron has (at the moment of measuring the position of the electron) both a certain coordinate value and a certain velocity value, which directly contradicts the uncertainty relation. In this case, any impact of the device on the state of the positron is excluded due to the accepted assumption that there is no causal connection between the act of measurement and the state of the positron.

A rather acute dilemma arises. Either the electron and the positron really are particles, i.e. they are localized regardless of whether any measurements are made on them or not. But in this case the uncertainty relation does not hold, and therefore, quantum theory, based on these positions, must be declared invalid. Or the quantum theory is correct, but the particles are not localized in space, but are somehow "smeared" throughout space. At the same time, the thesis of nonlocal interaction allows us to assume a causal relationship between an electron and a positron even at distances exceeding the light interaction (i.e., through the exchange of "signals") between them. But then it is difficult to explain the so-called reduction of the wave packet, precisely why the electron (and positron) give an almost point-like flash on the recording screen, i.e. the package shrinks to a point rather than creating a wide spot.

However, there is another possibility. This is an assumption that corpuscular formations do not exist at all as objects independent of our consciousness. But in physical theory, explicitly or implicitly, some physical processes are assumed to occur in objects, and not in the observer's brain. Our consciousness only states this occurrence. If this position is incorrect, then the question arises: how can our consciousness determine the course of physical processes? Measurement acts, it would seem, provide only information about these processes. Accepting the thesis about the nonlocality of particles as such, we will certainly encounter difficulties associated with the reduction of the wave field. Perhaps what we call a wave disturbance associated with an electron is in reality also just a wave of information. This eliminates many questions, with the exception of one - why these fields of information are exactly what quantum mechanics prescribes them to be, and not others. The answer to this sacramental question still awaits its time.