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Paradoxes of quantum mechanics

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Abstract
A hypothesis consisting in a different view of the electron is presented. This makes it possible to explain some paradoxes of quantum mechanics.

Keywords: Paradoxes of quantum mechanics

Introduction

Quantum mechanics explains physical phenomena very well, but also some phenomena in biology or chemistry. The mathematical apparatus is relatively complex, but it leads to results that coincide with observations. Attempts to look at some of these phenomena from the point of view of classical physics sometimes lead to paradoxes [1]. For example, we can read and hear: an electron can be in more than one place at the same time, an electron can interfere with itself, an electron can pass through a potential barrier even if it does not have enough energy to do so (tunneling) and particles can in certain cases affect themselves at intergalactic distances (quantum entanglement). One option is to accept this situation and not look for any explanation. However, it is better to try to explain it while respecting the results of quantum mechanics calculations. A hypothesis is presented in this work, explaining the above paradoxes, and I admit that it may not be correct. If this provokes discussion, then this work will fulfill its purpose.

Model suggested.

In layman's terms, the electron is viewed as a "hard", spatially unchanging particle. However, one of the basic experiments, the diffraction of electrons at a double slit, shows the presence of waves. The same can be said about the diffraction of electrons on crystals. I believe that some paradoxes can be explained by a change in view of the electron itself. The electron in my conception is therefore not a "hard" immutable particle, but it is a variable, but spatially limited undulating environment having matter and electric charge. At this article it will be called electron field EF. It is the form of existence of the electron. (According to quantum field theory, an electron is an excitation of a more general electron field.) In different situations, the EF occupies different spaces, but its total mass and electric charge are independent on the occupied space . Its energy is quantized according to the laws of quantum mechanics. The important thing is that the EF of one electron is indivisible. Whether this field is part of an atom or located in free space, its density distribution is approximately proportional to the square of the wave function | Y|, where its size is substantial. (As is known, the square of the wave function represents the probability density of the particles and is zero to infinity. Here, however, unlike quantum field theory, the EF is considered to be limited in terms of space.) The EF energy is determined by the Schrödinger equation for the electron. When this field is part of an atom, it is in its most concentrated form.

Now, let us suppose that electrons have been emitted, and they are partially collimated and are directed towards the detector. For each electron, the EF in the cathode is delocalized during the emission, and it propagates towards the detector in the form of a rippling "cloud". And here let us digress slightly into nature. During a thunderstorm, a cloud charged with electricity spreads over the landscape. If a suitable object, tree or metal spike is found, the cloud is discharged in the form of lightning. Thus, the charge from the whole cloud, or a large part of it, is "sucked" into one place on earth. Let us call it the lightning effect.

So when the rippling "cloud" of EF arrives at the detector, I assume that the lightning effect occurs, i.e. the EF is completely (it is indivisible) "sucked" into one place of the detector, it becomes, for example, part of an atom and a photon is emitted or a point appears on the film and so on. At that point, the wave function of the electron manifested itself as the wave function of the electron in an atom. Each emitted electron generally ends up at a different point in the detector. The distribution of these places on the detector then corresponds to the intensity (density) of EF just before the detector and thus to the square of the wave function at the detector location. The highest density of the impact sites will be where the EF density is highest, probably in the beam axis. So we get the same final picture as the usual quantum-mechanical calculation gives. The meaning of the square of the wave function appears here more as the probability of capturing (detecting) an electron rather than its occurrence near detector.

The electrons in the cathode are more like particles. Between the cathode and the detector they have more of a wave character, and in the detector they again have the character of a particle. This is how the statement that electrons have both particle and wave character should be understood. They have it, but not at the same time.

From the above, diffraction on the double slit is understandable. An experiment is described in which the distance between the slits was 500 nm [2], i.e. about 10 orders of magnitude larger than the calculated classical radius of the electron. Similarl situation is in [3]. One EF creates a wave when emitted, and after diffraction on the double slit creates diffraction maxima and minima at a certain distance. The whole EF with its maxima and minima is now absorbed at one point of the detector. A large number of electrons then create a number of points on the detector, the density of which copies the diffraction image of EF. There is no reason to say that the electron is in two places at the same time. It is EF (delocalized electron) which diffracts.

Another paradox is tunneling. The quantum solution of the movement of an electron towards a potential barrier that is higher than the energy of the electron shows that the wave function is non-zero even beyond the potential barrier. This means that an electron can be located behind the barrier. The question is whether this interpretation is correct. The wave function is generally zero up to infinity, although real objects are spatially limited. This means that quantum physics gives a very good description of reality, but not a perfect description. Nevertheless, tunneling was observed in the fifties of the last century by Ivar Giaevere, and in 1973 Leo Esaki and Ivar Giaevere were awarded the Nobel Prize for the application of tunneling. Among the applications, we can name a tunnel diode, see for example [4, 5]. This phenomenon can also be understood (at least at temperature T>0) by the introduction of the EF. In front of the barrier, an electron oscillates in the form of an EF. Although its total energy is not high enough to overcome the barrier, a certain part of EF may overcome it for a moment due to local fluctuations, but it is still connected with the main part in the front of barrier. Now two cases may arise. Either this sprayed part is pulled back, or it is traped in a suitable place outside the barrier where it begins to be absorbed, pulling down the remaining part of the EF located in the front of the potential barrier. This is interpreted as if the electron overcame the potential barrier. (This can be thought of as a boiling liquid on the stove in a pot. At a certain temperature, the liquid starts to bubble and splashes a certain amount out of the pot. However, here this part is separated from the liquid in the pot, whereas in the case of EF, the "splashed" part is connected to the rest in the potential barrier.)

The last paradox is quantum entanglement. For experiments with quantum-entangled photons, Alain Aspect, John F. Clauser and Anton Zeilinger were awarded the Nobel Prize in 2022. Quantum entanglement is related to the principle of superposition, which states that if the solution of one Schrödinger equation is two wave functions, then their linear combination is also a solution. The paradox lies in the fact that the result of the measurement of one of the entangled particles affects the result of the measurement of the other of the entangled particles, even at a long distance [6]. Here, too, the introduction of EF offers an explanation for this phenomenon. Quantum entanglement can be explained by the fact that the EF of the two particles mixes with each other, but the individual fields remain interconnected (they cannot be split). The simplest example might be two electrons with opposite spin. We denote them (+) and (-). When entangled, two particles are formed, each representing a "mixture" of parts EF (+) and EF(-), with parts of EF(+) in both particles remaining interconnected, and similarly with EP(-). In this way, the two particles can move away from each other to a certain (not long) distance. Suppose the left particle hits the detector and manifested itself as an electron with spin (+). (How it manifests itself also depends on the structure of the detector.) This means that EP(+) has been "sucked" into the left detector from both sides and the detector on the right can only detect an electron (-). If the detector on the left detects an electron (-), the detector on the right can only detect an electron (+). In this way, the measurement on the one side affects the measurement result on the other side. Obviously, this can only be true if the particle distance is not too large. If so, then the forces that keep individual EFs whole will prevail over the entanglement and the entanglement will be abolished. EF(+) will be directed to one side and so is the EF(-). So, instead of two entangled particles traveling from each other to opposite sides, it travels further an electron (+) to one side and an electron (-) to the other, or both electrons travel to one side. (The observer has no chance of registering this change). Even if they travel to very long distance in this way, it will be true: if an electron of one sign is measured on one side, then on opposite side may be measured only an electron of the other sign (or nothing may be measured there).

It follows from this article that paradoxes, or rather mysteries, have moved into explaining the nature and properties of EF. Deciding whether EF's concept is correct, or studying the properties of EF, requires discussion and possibly further research.

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