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UNCERTAINTY IN THE HEISENBERG UNCERTAINTY PRINCIPLE

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Annotation

The "uncertainty principle", one of the main principles of quantum physics, was proposed by the German physicist Werner Heisenberg in 1927. The uncertainty principle states that some properties of a subatomic particle, such as an electron, cannot be measured simultaneously with infinite precision. One pair that has an uncertainty relationship between them is momentum-position. First, the more uncertain the location of a subatomic particle, the more uncertain its momentum. The reverse of this relationship is also true. The order in which the measurement is performed changes the result. According to this result, revealed by the mathematical formulation of the Heisenberg Uncertainty Principle, there is a limit to what we can know about the universe. Accepting the idea that the main cause of uncertainties is the wave-particle duality, Heisenberg emphasized that this situation arose as a feature of the physical structure of the universe and did not arise only due to measurement. Such a result, of course, had philosophical consequences. Today, the picture of the universe revealed by the uncertainty principle is still a matter of debate among physicists and philosophers. This study aims to evaluate these philosophical considerations both ontologically and epistemologically.

Keywords

Heisenberg uncertainty principle, philosophy of quantum physics, philosophy of physics, history of physics, philosophy of science.

During the period when modern physics was born, developments in physical science revealed the limits of classical physics theories in terms of explaining and understanding the universe. These developments have called into question the validity of many long-accepted principles of scientific research. The innovations under discussion appeared as less specialized but blurred problems. One of the biggest reasons why problems are described as indeterminate is, of course, the Heisenberg Uncertainty Principle. Werner Heisenberg, the scientist who put forward this principle, as the name of the principle suggests. Heisenberg developed the first and consistent mechanics of quantum processes in 1925, which was highly controversial at the time. During his time at the Bohr Institute in Copenhagen between 1924 and 1927, Heisenberg did some of his most creative work in quantum mechanics, including his interpretation of matrix mechanics and the uncertainty principle. Heisenberg, who gave a new identity to atomic physics with these studies, received the Nobel Prize in Physics in 1932 for his contribution to quantum physics.

Among the interpretations of quantum mechanics, Einstein's realism, Bohr and Heisenberg's Copenhagen interpretations, and von Neumann's hypothesis about the collapse of wave functions are prominent, but they represent two different interpretations of quantum physics, Von Schömansr. Uncertainty principle related to the Copenhagen interpretation Heisenberg development of quantum mechanics era in quantum physics. In other words, it has just found its place in physics and made another revolution under another atomic revolution. The reason Heisenberg's enormous contribution is considered "revolutionary" is due to the many creations of his principle. It is necessary to distinguish three of these productions from the point of view of their philosophical considerations. One of the features is a mathematical structure based on this principle. This mathematical structure is now called "matrix algebra". Heisenberg first introduced matrix algebra to physics through the uncertainty principle.

Heisenberg saw that the mathematical mechanism of quantum theory included the inevitable uncertainty in predictions and the externality of the object in the process of observation. Related to the result of the second theory. That is, there is a limit to what we can know about the universe in which we live. The governing of what we can know at this limit is due to the fact that, in principle, it is governed by laws that can be viewed from the general perspective of quantum mechanics. Therefore, its control may require multi-valued logic systems rather than classical logic. These emphasized features of the principle are undoubtedly evidence that a new era has entered the philosophy of science, both from the point of view of epistemological and ontological reflections. To use the triangle, the first part describes the Heiberg Uncertainty Principle. The second section develops an additional new mathematical framework in the Uncertainty Principle for evaluating the claim that there is a limit to what we can know, and then interprets the principle from a philosophical perspective. In conclusion, the discussion of philosophical interpretations according to the highlighted legal documents, where "uncertainty" in the uncertainty principle has arisen.

What is the Heisenberg Uncertainty Principle?

In 1927, Heisenberg asserted that, according to the predictions of quantum mechanics, some pairs of variables such as "position and momentum" and "energy and time" cannot be determined "simultaneously" at a high and arbitrary level. kidded. members of the group of particles represented by the wave function ps. He put forward a mathematical thesis. The principle that explains this situation at the subatomic scale is called the Heisenberg Uncertainty Principle. The physical explanation of this mathematical thesis put forward by Heisenberg is as follows: The position and speed of an atomic particle cannot be specified together, at any time, and precisely. The position can be accurately measured, but then the interference of the tracking devices interferes with the velocity measurement to some extent. If velocity is measured first, then position cannot be learned at all. Planck's constant provides a lower bound for the result of these two uncertainties.10 In other words, if the position of a moving electron is to be precisely determined, it must be exposed to light of a certain wavelength. However, light rays falling on an electron cause the electron to move due to its mass. Therefore, the speed of the electron changes uncontrollably. In this regard, if the position of the electron can be determined more precisely, light beams of shorter wavelengths should be used.

The energy of the short-wavelength light is very high, and this light beam causes the particle to have a speed greater than the actual speed of the electron. Thus, the electronic check at that time is lost. For this, this case "reveals the uncertainty that the state and control of an electron cannot be controlled once in itself." These worlds, according to Heisenberg, see that the problems associated with Newtonian mechanics no longer take us far, because in order to process a mechanical process, we need both the position of the particle at a given moment and the process. But quantum theory has determined that such a thing will happen. Under these conditions, the future of subatomic particles cannot be accurately predicted or determined. According to Planck, the Heisenberg uncertainty principle does not apply to medium-sized physical objects. The "uncertainty" in the uncertainty principle turns out to be that finding the location and then the evolution of the electron gives a different result than if we first determined the evolution of the electron and then determined its location. The word "uncertainty" in the principle does not mean "uncertainty about the truth of the theory." This shows the ambiguity that is convenient when using classical Newtonian properties such as "particles" to describe a physical system. This situation is considered mathematically under the heading of structure. For Heisenberg's Uncertainty Principle, includes uncertainty. reveals the energy and time couple.

In other words, the more precise our knowledge of time is, the more imprecise our knowledge of energy is. In this, according to the uncertainty principle, as our knowledge of time increases, so does our knowledge of energy. According to Hutten, the uncertainty "must be considered qualitatively of the electron, not as evidence of the creation of a charge." This remarkable result actually comes from the mathematical formulation of the Heisenberg Uncertainty Principle. The mathematical principle for this is discussed below.

General structure of the Heisenberg Uncertainty Principle. Mathematical structure

Heisenberg used a new type of mathematics to implement motion on a subatomic scale, which was considered strange by his contemporaries. He created the mathematics of quantum mechanics using the foundations of this mathematical system called "matrix algebra", which is discussed below. Heisenberg shows how to load tables of rows and columns containing amplitude and frequency information about specific transitions at subatomic-scale locations. Heisenberg, who called these quantities "quantum theoretical quantities", connected them using a method he introduced called "quantum-chanic relations". From these tables and these mechanical methods to formulas, he succeeded the formulas in the classics. This method of mathematics has a high degree of control over quantum effects and predictions. This mathematical method is different from classical mathematics. In classical mathematics, there is a "change" in appearance.

For example, 3x4=12 and 4x3=12. So 3x4 = 4x3. In other words, it doesn't matter if the numbers are multiplied. They give the same result regardless of the order of multiplication. to do, this rule is invalid in Heisenberg's method. When it comes to atoms, Heisenberg found that the variables he multiplied gave different things depending on their arrangement. In other words, AxB and BxA gave different sites. In other words, the electron is processed at a certain time and changes the order of production, such as moving quickly when multiplied. In other words, this lookup operation is not commutative. These Heisenberg tables are mathematical objects that mathematicians call "matrices," and the new method that he produced is the method that mathematicians use to multiply matrices. O' Law does not apply to matrices. Thus, Heisenberg, along with his mentor Max Born, advanced the theory known today as Matrix Mechanics.

Heisenberg's new mechanics was not quickly accepted as a mathematical thing that most physicists at the time had not studied. If so, it was the creation of a great theoretical mathematician who succeeded in describing how atoms behave. "The continuous discrete mathematics of Heisenberg's theory was well suited to express the continuous, continuous, i.e. uncaused, structure of nature on which the Copenhagen school was based." The mathematical method by which the Heisenberg Uncertainty Principle is defined is described: Every quantity in classical mechanics corresponds to an operator in quantum mechanics. In the subatomic world, the quantum mechanical operators (matrices) corresponding to different types are not necessarily commutative. That is, the order in which the states are implemented can lead to differences from the actual observed values. For two noncommutative observable operators A and B, there is a general restriction in quantum mechanics that the production of ΔA and ΔB can be small. a floor itself has the presence or limitation of these variables in a number of dimensions.

Interpretation of the Heisenberg Uncertainty Principle

The Uncertainty Principle has been the production of many phenomena, the cause of randomness in quantum theory. There is no uncertainty in the wave of consciousness itself over time. The reason for this wave is the uncertainty about the position and momentum in the wave packet itself. For this, the propagation action occurs with impulses and velocities. if the wave packet itself is still fully defined, they will continue to propagate in time without any uncertainty. What we consider to be randomness comes not because of the wave itself, but because the particle completes the cause. In other words, the uncertainty produces the product. According to Popper, this means mutual causality. The uncertainty principle does not apply to all properties of the microcosm. For example, mass and electric charge have exact values, which would be impossible without their uncertainty. Uncertainty applies only to certain pairs of variables (eg, position-momentum, energy-time), as mentioned above. These pairs are considered conjugate variables.

This damage only helps to get a certain result when increased from one power. It also puts a necessary limit on what we can know and predict about the physical parts of quanta. According to Planck, our direct law of motion is gradually weakening through our measurements of atomic phenomena. Planck said that the main reason for this is that the test is the answer to the questions that need to be answered, and our measurement test of anything made up of atoms cannot provide this sensitivity. An example of the situation is: "An object cannot be drilled if the drill is larger than the object itself." This example is one of the examples where uncertainty visualizes the situation. Heisenberg pointed out that observation itself

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plays an important role in the phenomenon, and reality itself differs depending on whether we observe it or not.

Heisenberg continues to calculate: "The term ``exactness''" means that there has always been an additional set of contents and systems of laws that make up a whole and mathematical formulas. They are valid for some fields of experience. They are for these fields. have a universal truth; they do not contribute to the changes and the laws for which they represent new fields of experience. We can call the laws of quantum theory concrete only in this sense, see Heisenberg's words 'supported, and quantum mechanics cannot give the position of the electron at a certain moment, it can only give the exact position of the electron. can be found at a certain time in the planned electron mass, he noted.

Philosophical structure

Werner Heisenberg did not consider physical physics separately from philosophy. His unusual ideas in physics, which are quite familiar, have encouraged the development of philosophy and question-and-answer from physics. Heisenberg first encountered Plato's Timaeus during his high school years. Greek philosophy had a profound influence on Heisenberg. Heisenberg's words:

"While reading the Timaeus, I had the first opportunity to study Greek atomic philosophy from its original source. I thought I understood at least a little of why the Greek philosophers thought of infinitesimal and indivisible particles of matter. The view that atoms are real bodies, defended by Plato in the Timaeus, was not so clear to me. but the belief that it is impossible to deal with modern atomic physics without knowing the Greek natural philosophy was firmly established in my mind even in those days.".

According to Holton, Heisenberg's combination of these views of the atom with mathematical structure is a thematic choice in the Platonic tradition. certainty-based theory. on intuition and empirical grounds." Although Heisenberg was influenced by Ernst Max in his youth, in his philosophical works on quantum mechanics he strongly opposed the Logical Positivism produced by philosophers of science associated with the Vienna Circle. I believe that Heisenberg. not classical physics, but These can be seen as reasons why he came up with deeper and bolder ideas about atoms. The heated philosophical debates about the Heisenberg Uncertainty Principle related to the properties and behavior of atoms have had their force on how much we can know about the subatomic world. derives from having a general limit, because that basic limit is epistemic, ontological, or both.

For the solution under consideration, the properties of "events" - "observer" - "measurement" and the document are related to each other. The subject of the

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Heisenberg Uncertainty Principle is "electron". The quantities to be measured are the "position" and "momentum" of the electron in motion. According to the uncertainty principle, to measure the motion of an electron in motion, the position and momentum of the electron are not yet known before the measurement. According to Heisenberg, measurement at the quantum level is now a phenomenon in itself. This is a phenomenon in the sense of interfering or malfunctioning as a result of nature's own activity.

According to Bridgman, one can decide whether an electron has a position and a size by measuring its position and velocity. The physical properties of the electron are not things that exist in its natural material in the absolute sense, but they are the behavior of the observer itself. That is, the measurement and the observer are inseparable, and this is related to the ontological structure of the electron. 'changes. . electron. According to Rovelli, Heisenberg thought that electrons did not always exist. Electrons only exist when someone is looking at them, or more precisely, when they interact with something else. There is a complaint that when electrons hit something, a file can appear and be described somewhere. In quantum mechanics, no object has a definite position unless it collides with another object. The description of the transition of an electron through an interaction is not in real space, but in an abstract formula that does not lie in an abstract mathematical space, but an implementation.

- These jumps, which allow individual electrons to jump out of a single interaction, become possible rather than predictable. Thus, the occurrence of an electron cannot be predicted. It is possible to determine the location of the electron only. Therefore, this moment in the Heleisenberg Uncertainty Principle and the reason for the uncertainty is that the measurement is not a security sense. The dimension in question will never be sensitive, because they themselves consist of electrons. In this case, the "uncertainty" in question can be interpreted epistemologically.

- to do, the "uncertainty" in the uncertainty principle arises as an epistemological question about what we know about natural nature. This situation can be interpreted as an ontological problem directly related to nature itself. The problem is not "knowing", but "not knowing". From these comments, it can be understood that Heisenberg's Uncertainty Principle casts doubt on the unquestionable fundamental assumptions of matter. Heisenberg's comment on the matter:

- "Electrons and atoms do not have a physical reality like the things in our everyday experience. "The search for an optimal physical reality for electrons and atoms is precisely what quantum mechanics is all about."

These views of Heisenberg can be interpreted as a sign that we need a new epistemology. The "uncertainty" in the Uncertainty Principle is neither insecurity in the theory nor in the measurements. It is a fact of nature how it behaves on a subatomic scale. In response to criticism, Planck noted: “The biggest accusations against theoretical physics are that it descends into abstract mathematical formalism and reality slips through its cracks. This criticism is as unfair as it is sterilizing. Because the value of an idea is not measured by its concreteness, but by the work achieved."

With these views, Planck seems closer to instrumentalism than to scientific realism. Scientific realism asserts that objects in the world have a reality separate from human thought and perception and human rights, and that scientific research can only be considered true if it follows this view. , what grades this world helps. for Einstein is a scientific realist. On the other hand, one of the founders of quantum mechanics, Bohr, Heisenberg and some other scientists stated that the purpose of physical theories is only to provide a way to predict actions. Therefore, they are instrumentalists.

The great debate between Bohr and Einstein continued for years at the Fifth Solvay Congress in 1927 and until Einstein's death in 1955. Soon after these discussions, it became clear that quantum mechanics could be produced, and its predictions became more favorable. . seen but even today it is difficult to say that any interpretation of quantum mechanics is fully agreed upon.

Conclusion

In terms of its structure, organization, and operation, quantum mechanics has remarkable properties compared to previous theories of physics. The interpretation of quantum mechanics is a philosophical issue and highly controversial. Of these interpretations of quantum mechanics, the one associated with Heisenberg's Uncertainty Principle is one of the most difficult and profound to accept. In the principles advanced by Heisenberg and his contemporaries such as Pauli and Dirac, empirical-operational approaches are distinguished as a tendency to avoid unobservable entities. Philosophically brilliant intellectual trends toward the theories of second-generation quantum physicists, especially Heisenberg, led to crises in ontology, epistemology, and especially causality.

In his Uncertainty Principle, Heisenberg tried to explain, along with causation, why causation is impossible at the subatomic scale, in terms of the limits of our observations, as in classical physics. Causality is impossible because it affects the observed object. Seen in this light, "uncertainty" appears as a reality inherent in the immediate objects themselves. For example, the existence of an electron can appear as either a particle or a wave, but not both at the same time. This is a serious ontological problem for philosophy. It seems that it is impossible to talk about the movement of particles independently of the observation process. In quantum theory, the mathematically formulated laws of nature seem to depend not on the fundamental particles themselves, but on our knowledge of them. This situation is a serious epistemological problem for philosophy.

This problem is related to the Heisenberg Uncertainty Principle of finding the certainty of motion, or the absolute limit to which we can know. This result is not a flaw in the uncertainty principle. It is impossible to obtain it by directly producing the technique placed in the observation. In the case of quantum mechanics, the boundary between epistemology and ontology seems to disappear. There is an epistemological and ontological reloading of quantum mechanics. At the subatomic scale, which shapes the modern world and otherwise holds reality, our mesoscale senses cannot be used. The Heisenberg Uncertainty Principle shows that some of Newton's assumptions about physical nature are not true. For this formula, what devices regarding Newtonian mechanics take us far away to see, because the mechanical process needs to know the position and development of a particle at a moment, and quantum theory has determined such things. cannot happen. Although the calculations in quantum mechanics seem complicated, the answers are still specific and understandable.

Newton's theory is not for such complex systems. For this reason. Based on nearly a century, the correctness of quantum mechanics has been proven by various experiments and there is no doubt about its validity.

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