# Copenhagen Interpretation of Quantum Mechanics

## What does physicists do from their experiments on atomic objects?

> *summarized_paragraph* : The aim of Bohr's effort is to give an empirical interpretation of the quantum formalism. He does not seek to reduce terms concerning theoretical entities to terms about sense-data or purely perceptual phenomena. **He insists only that the empirical evidence physicists collect from their experiments on atomic objects has to be described in terms of the same concepts which were developed in classical mechanics in order for them to understand what the quantum theory is all about.** There are both similarities and overlaps between some of the proposed explanations concerning the indispensability of classical concepts.

> *avg_grammar_rating* : 4.7
> *avg_answerability_rating* : 4.0
> *sum_yes_meaningful* : 2
> *sum_no_meaning* : 1
> *sum_maybe_meaning* : 0

## What theory states that it is impossible to make an unambiguous separation between time and space without reference to the observer?

> *summarized_paragraph* : In general, Bohr considered the demands of complementarity in quantum mechanics to be logically on a par with the requirements of relativity in the theory of relativity. He believed that both theories were a result of novel aspects of the observation problem, namely the fact that observation in physics is context-dependent. This again is due to the existence of a maximum velocity of propagation of all actions in the domain of relativity and a minimum of any action in theDomain of quantum mechanics. **And it is because of these universal limits that it is impossible in the Theory of relativity to make an unambiguous separation between time and space without reference to the observer.**

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 5.0
> *sum_yes_meaningful* : 4
> *sum_no_meaning* : 0
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> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## What should be able to predict the numerical values of Planck's constant?

> *summarized_paragraph* : The guiding principle behind Bohr’s and later Heisenberg's work in the development of a consistent theory of atoms was the correspondence rule. The full rule states that a transition between stationary states is allowed if, and only if, there is a corresponding harmonic component in the classical motion. **The correspondence rule was a heuristic principle meant to make sure that in areas where the influence of Planck's constant could be neglected the numerical values predicted by such a theory should be the same as if they were predicted by classical radiation theory.**

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 3.8
> *sum_yes_meaningful* : 4
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## What concepts of the classical theories will never become superfluous for the description of physical experience?

> *summarized_paragraph* : **"No more is it likely that the fundamental concepts of the classical theories will ever become superfluous for the description of physical experience," he says.** "It continues to be the application of these concepts alone that makes it possible to relate the symbolism of the quantum theory to the data of experience" "It is possible to connect the symbolism of the quantum theories to thedata of experience . . . and to make it possible for us to understand the nature of the universe," he adds. "This is the key to our understanding of the world."

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 4.8
> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 1
> *sum_maybe_meaning* : 0

## According to Popper , the fundamental concepts of classical theories will never become superfluous for the description of what kind of experience?

> *summarized_paragraph* : **"No more is it likely that the fundamental concepts of the classical theories will ever become superfluous for the description of physical experience," he says.** "It continues to be the application of these concepts alone that makes it possible to relate the symbolism of the quantum theory to the data of experience" "It is possible to connect the symbolism of the quantum theories to thedata of experience . . . and to make it possible for us to understand the nature of the universe," he adds. "This is the key to our understanding of the world."

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> *sum_yes_meaningful* : 2
> *sum_no_meaning* : 1
> *sum_maybe_meaning* : 0

## What kind of physics must be used in a functional description of a system?

> *summarized_paragraph* : If a measuring instrument is to serve its purpose of furnishing us with knowledge of an object – that is to say, if it is to be described functionally – it must be described classically. Of course, it is always possible to represent the experimental apparatus from a purely structural point of view as a quantum-mechanical system without any reference to its function. **But any functional description in which it is treated as a means to an end, and not merely as a dynamical system, must use the concepts of classical physics.**

> *avg_grammar_rating* : 4.8
> *avg_answerability_rating* : 5.0
> *sum_yes_meaningful* : 4
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## What type of description is used to describe our environment?

> *summarized_paragraph* : Bohr thought that properties like momentum, position, and duration could be attributed only to an atom object in relation to a specific experimental arrangement. As Dieks mentions while denying any deeper philosophical motivation on Bohr's part: the use of classical concepts is part of the laboratory life. **"This classical description is basically just the description in terms of everyday language, generalized by the addition of physics terminology, and it is the one we de facto use to describe our environment"**

> *avg_grammar_rating* : 4.5
> *avg_answerability_rating* : 4.5
> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 1
> *sum_maybe_meaning* : 0

## What type of concepts did not change?

> *summarized_paragraph* : Bohr believed not just retrospectively that quantum mechanics was a natural generalization of classical physics, but he and Heisenberg followed in practice the requirements of the correspondence rule. **In the mind of Bohr, the meaning of the classical concepts did not change but their application was restricted.** This was the lesson of complementarity. Bohr's practical methodology stands therefore in direct opposition to Thomas Kuhn and Paul Feyerabend's historical view that succeeding theories, like classical mechanics and quantum mechanics, are incommensurable.

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 2.7
> *sum_yes_meaningful* : 0
> *sum_no_meaning* : 3
> *sum_maybe_meaning* : 0

## What was restricted to the concept of classical concepts?

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> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 3.3
> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## What did quantum theory need to be found?

> *summarized_paragraph* : spin is a quantum property of the electrons which cannot be understood as a classical angular momentum. Needless to say, Bohr fully understood that. **But he didn't think that this discovery ruled out the use of the correspondence rule as guidance to finding a satisfactory quantum theory.** A lengthy quotation from Bohr's paper "The Causality Problem in Atomic Physics" gives evidence for this. It says that Bohr "understood that the theory of spin is not a theory of angular momentum".

> *avg_grammar_rating* : 3.7
> *avg_answerability_rating* : 2.7
> *sum_yes_meaningful* : 1
> *sum_no_meaning* : 2
> *sum_maybe_meaning* : 0

## What concepts were essential for physicists to understand the nature of the universe?

> *summarized_paragraph* : Bohr saw the classical concepts as necessary for procuring unambiguous communication about what happens in the laboratory. Classical concepts are indispensable, because they enable physicists to describe observations in a clear common language, and because they are the ones by which the physicists connect the mathematical formalism with observational content. **Bohr wrote in his book, The Theory of Relativity, that classical concepts are essential for physicists to understand the nature of the universe and to make sense of it.** The book is published by Hodder & Stoughton at £16.99.

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 4.3
> *sum_yes_meaningful* : 4
> *sum_no_meaning* : 0
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## What did bohr do in his book , the theory of relativity?

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> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## Who believed that the wave function formalism is a mere tool for prediction?

> *summarized_paragraph* : Dennis Dieks argues that Bohr's lecture was meant to promulgate an instrumentalist interpretation of quantum theory. **Dieks goes against the more general interpretation of Bohr according to which Bohr only believed that the wave function formalism is a mere tool for prediction.** Just because Bohr writes off quantum formalism as a pictoral representation, it still gives us some insight into physical reality, Dieks says. The argument concerns the fact that theWave function in quantum mechanics cannot represent a three-dimensional entity.

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> *avg_answerability_rating* : 3.7
> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## What happens to position or momentum talk over to a quantum object?

> *summarized_paragraph* : Bohr believed that quantum mechanics is universal in the sense that Heisenberg's indeterminacy relation applies to both micro- and macroscopic systems due to the quantum of action. Bohr believed for epistemic reasons that we had to use classical language because this language is a refinement of our everyday language, which is adapted to describe our sensory experience. **Dieks concludes that the interaction between the measuring device and the quantum object determines, in the classical textbook examples, whether position or momentum talk can be carried over to quantum object.**

> *avg_grammar_rating* : 3.0
> *avg_answerability_rating* : 2.8
> *sum_yes_meaningful* : 1
> *sum_no_meaning* : 3
> *sum_maybe_meaning* : 0

## What is the symbolism of quantum theories able to relate to?

> *summarized_paragraph* : "No more is it likely that the fundamental concepts of the classical theories will ever become superfluous for the description of physical experience," he says. **"It continues to be the application of these concepts alone that makes it possible to relate the symbolism of the quantum theory to the data of experience" "It is possible to connect the symbolism of the quantum theories to thedata of experience . . .** and to make it possible for us to understand the nature of the universe," he adds. "This is the key to our understanding of the world."

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> *avg_answerability_rating* : 5.0
> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## What did he believe a phenomenon to be a measurement of?

> *summarized_paragraph* : After EPR paper Bohr spoke about Heisenberg's "indeterminacy relation' as indicating the ontological consequences of his claim that kinematic and dynamic variables are ill-defined unless they refer to an experimental outcome. Bohr no longer mentioned descriptions as being complementary, but rather phenomena or information. He introduced the definition of a "phenomenon" as requiring a complete description of the entire experimental arrangement. **He took a phenomenon to be a measurement of the values of either kinematics or dynamic properties.**

> *avg_grammar_rating* : 4.3
> *avg_answerability_rating* : 4.0
> *sum_yes_meaningful* : 2
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 1

## bohr did not think of what kind of measurement?

> *summarized_paragraph* : Howard: Bohr's interpretation of complementarity and the textbook Copenhagen interpretation (i.e. wave-particle duality and wave packet collapse) are incompatible. **Henderson: On one side of the spectrum there is Bohr who did not think of quantum measurement in terms of a collapse of the wave function.** In the middle we find Heisenberg talking about the collapse as an objective physical process but thinking that this couldn't be analyzed any further because of its indeterministic nature.

> *avg_grammar_rating* : 4.0
> *avg_answerability_rating* : 3.3
> *sum_yes_meaningful* : 2
> *sum_no_meaning* : 2
> *sum_maybe_meaning* : 0

## According to Von Neumann , what does it make to compare the numerical values of the theory of atoms with classical physics?

> *summarized_paragraph* : The correspondence rule was based on the idea that classical concepts were indispensable for our understanding of physical reality. It is only when classical phenomena and quantum phenomena are described in terms of the same classical concepts that we can compare different physical experiences. Bohr directly mentioned the relationship between the use of classical concepts and the correspondence principle in 1934 when he wrote in the Introduction to Atomic Theory and the Description of Nature. **He wrote: "It is obvious that it makes no sense to compare the numerical values of the theory of atoms with those of classical physics"**

> *avg_grammar_rating* : 3.0
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> *sum_yes_meaningful* : 0
> *sum_no_meaning* : 2
> *sum_maybe_meaning* : 1

## bohr's view was that truth conditions of sentences ascribing a certain kinematic or dynamic value to an atomic object are dependent on what apparatus?

> *summarized_paragraph* : Complementarity is first and foremost a semantic and epistemological reading of quantum mechanics that carries certain ontological implications. **Bohr’s view was, to phrase it in a modern philosophical jargon, that the truth conditions of sentences ascribing a certain kinematic or dynamic value to an atomic object are dependent on the apparatus involved.** These truth conditions have to include reference to the experimental setup as well as the actual outcome of the experiment. This claim is called Bohr's indefinability thesis.

> *avg_grammar_rating* : 3.3
> *avg_answerability_rating* : 2.3
> *sum_yes_meaningful* : 0
> *sum_no_meaning* : 3
> *sum_maybe_meaning* : 0

## Who was aware of the idea of decoherence?

> *summarized_paragraph* : Quantum fundamentalists must be ready to explain why the macroscopic world appears classical. An alternative to von Neumann's projection postulate is the claim that the formalism should be read literally and that measurements do not describe the world as it really is. **If Bohr had known the idea of decoherence, he would probably have had no objection to it, as several authors have pointed to it as a natural dynamical extension of his view that measurements is an irreversible amplification process.**

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 2.3
> *sum_yes_meaningful* : 3
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0

## According to Popper , what type of experience does he believe there is a physical correlate to?

> *summarized_paragraph* : In 1932 [1996], von Neumann suggested that the entangled state of the object and the instrument collapses to a determinate state whenever a measurement takes place. This measurement process (a type 1-process as he called it) could not be described by quantum mechanics. He argues that during a measurement the actual observer gets a subjective perception of what is going on that has a non-physical nature. **However, he holds on to psycho-physical parallelism as a scientific principle, which he interprets such that there exists a physical correlate to any extra-physical process of the subjective experience.**

> *avg_grammar_rating* : 4.3
> *avg_answerability_rating* : 5.0
> *sum_yes_meaningful* : 3
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## What does he do with psycho - physical parallelism?

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> *avg_answerability_rating* : 4.3
> *sum_yes_meaningful* : 1
> *sum_no_meaning* : 1
> *sum_maybe_meaning* : 1

## What kind of outcomes are represented by the wave function symbolically?

> *summarized_paragraph* : The term “pictorial representation” stands for a representation that helps us to visualize what it represents. A pictorial representation is a formalism that has an isomorphic relation to the objects it represents such that the visualized structure of the representation corresponds to a similar structure in nature. Conversely, a symbolic representation does not stand for anything visualizable. It is an abstract tool whose function it is to calculate a result whenever this representation is applied to an experimental situation. **With respect to the formalism of quantum mechanics it is particularly one’s interpretation of the wave function that determines whether one thinks of it symbolically as a tool for calculation of statistical outcomes.**

> *avg_grammar_rating* : 5.0
> *avg_answerability_rating* : 3.8
> *sum_yes_meaningful* : 4
> *sum_no_meaning* : 0
> *sum_maybe_meaning* : 0