Article

Schrödinger's equation and Kant's noumenon

Can quantum physics describe things-in-themselves as they really are?

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Abstract*:* Modern physics is on the fine line between scientific inquiry and attempting to answer metaphysical questions. Modern scientists such as Henry Stapp and Roger Penrose are trying to create an ontological interpretation of the Schrödinger's equation in the superposition state and its reduction or collapse to the classical state. In this short essay I will try to explore if Immanuel Kant's metaphysics and the concept of the noumenon can be integrated with quantum physics and the Schrödinger's equation.

Keywords*: Schrödinger's equation; Immanuel Kant; Noumena; Metaphysics; Quantum physics*

1. Locke and Newton

The laws of classical physics are created through the observation of perceived reality and the subsequent application of induction. Observations are described as form, mass, force, motion in space and time, causality etc. In the words of John Locke:

> "I doubt not but if we could discover the Figure, Size, Texture, and Motion of the minute Constituent parts of any two Bodies, we should know without Trial several of the Operations one upon another, as we do now the Properties of a Square, or a Triangle".(Locke 1740)

According to Aristotle, science studies the "efficient cause" of objects and events; "the primary source of the change or rest".(Gotthelf 1976) All of Newton's or Maxwell's physics can be properly described in this manner. These theories of classical physics agree well with man's everyday intuitive experience.

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By the end of the 19th century there was a sense that everything that should be discovered had already been discovered. Albert Michelson famously stated in 1899:

> ”The more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote”.(“When Physics Was ‘Made in the USA’” 2012)

Modern physics emerged at the beginning of the 20th century as a result of an attempt to explain certain experimental results that did not fit into the existing classical theory of physics. Famous experiments and discoveries, such as the fact that the speed of light in the vacuum is constant, the double slit experiment, entanglement and tunneling of particles, the Heisenberg uncertainty principle, the Schrödinger equation and Born rule, the photoelectric phenomenon and the equivalence of gravity and acceleration; all these lead the pioneers of modern physics to create the now well-known theories of relativity and quantum mechanics. All this is well explained and detailed in many texts and there is no need to dwell on it here.

2. Kant

Since Kant published the first Critique in 1781, the Prolegomena in 1783 and the second edition of the first Critique in 1787, countless secondary literature has been written, “it is perhaps the Refutation of Idealism that has attracted the most sustained and still-unsettled critical commentary”.(ROBINSON 2010) Since it is impossible to cover all of this literature in this short article, I will refer to it briefly. Jonathan Vogel argues that “if the self can be directly known to persist through change, the Refutation fails”.(ROBINSON 2010) Robinson in accordance with Kant states that:

> “the self certainly cannot have direct knowledge of its persistence through change, for it cannot have direct knowledge of any substance...”

and concludes that Kant's Refutation of Idealism holds ground.(ROBINSON 2010) As I understand it, Immanuel Kant was neither a dualist[1] nor an idealist.[2] He viewed reality as a unified whole, but also as a reality that cannot be perceived by humans directly. This “noumenal” reality is not necessarily obeying the rules of human perception and understanding and therefore the laws of physics and thermodynamics do not necessarily apply to it. In this reality there is no obligatory space and time no humanely perceived material objects and no known physical forces acting upon it, no past and future and certainly no causality or necessity and free will is possible as “the faculty of starting an event spontaneously” without prior causality. On the other hand, perceived "phenomenal" reality is subject to a priori rules of perception and understanding such as space and time etc. “The understanding doesn’t draw its laws from nature, but prescribes them to nature”.(Kant 1783) Although the human mind or “transcendental ego” is noumenal, it perceives reality indirectly.(Kant 1783) The natural sciences can study only perceived phenomenal reality, we cannot experience or study reality as it is. Already Aristotle concluded that “we never can

[1] “I now want to use the word ‘nature’ in a broader sense, its material sense, in which it refers to ·every aspect of· •the totality of all objects of ·possible· experience, i.e. the whole perceivable world.”(Kant 1783)

[2] “What would I have to say to stop people from accusing me of idealism?”(Kant 1783)

coherently go beyond our experience; the only project we can really undertake and meaningfully pursue is the investigating, the mapping of the sphere of our experience".(Magee 2000)

3. Schrödinger

Currently physics creates a dual view that somewhat resembles Kant's metaphysics, in the sense that classical physics describes the phenomenal world of objects in space and time that obey the rules of human sensual perception and a priori concepts of understanding, while modern physics tries to describe the ontology of the "real" world, assuming that we cannot directly perceive things as quantum fields and strings[3] etc. that constitute matter and energy.

Schrödinger's famous equation calculates the probability distribution of finding a particle, such as an electron, at a certain location before a measurement is made (superposition state).(Schrödinger 1926) After measurement the wave function collapses (or reduces) and the location of the particle can be found in the physical world. The specific classical properties of an individual particle cannot be calculated in advance. The orthodox Copenhagen interpretation of the wave function, created by Niels Bohr and Werner Heisenberg, denies that the superposition state represents a material object; rather it is a mathematical representation of the properties of the object being measured. Some authors such as Werner Heisenberg in his later years,(Stapp 2009) Henry Stapp(Stapp 2009) and Roger Penrose(Penrose 2014) have postulated that the wave function represents existing objects in reality.[4] Penrose assumes that the wave function is physically real and that the particle exists in more than one instance before the reduction of the function. After reduction only one instance of the particle remains in the physical world, and the other instances "die".(Penrose 2014) Stapp offered a different ontological explanation, adopting Heisenberg's model[5] that "the probability distribution that occurs in quantum theory exists in nature herself" and that it has sudden uncontrolled quantum jumps.(Stapp 2009) Both authors also have different ideas regarding the cause of reduction.

4. Bohr

Just as Newton's gravitation equation does not give an ontological explanation of the phenomenon of gravitation but is a formalization of an observable law, Schrödinger's equation should be considered only as formalization of quantum laws. Looking for ontological meanings in this equation, in my opinion, is unnecessary and impossible.

> "The pure concepts of the understanding have absolutely no meaning if they are pulled away from objects of experience and applied to things in themselves (noumena)… Hence pure

[3] Regarding string theory.
[4] "The understanding begins its misbehaviour very innocently and soberly. First it brings to light the elementary items of knowledge that it contains in advance of all experience, though they must never be applied outside experience. It gradually discards these limits, and what's to prevent it from doing so when it has quite freely drawn its principles from itself? ·Then, having dropped the restriction to experience·, it proceeds first to newly thought-up powers in nature, and soon after that to beings outside nature. In short, it proceeds to a ·non-natural· world; and there can be no shortage of materials for constructing such a world, because fertile fiction-making provides them in abundance—and though it isn't confirmed by experience it is never refuted by it either".(Kant 1783)
[5] Actually based on David Bohm's theory.

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> mathematics as well as pure natural science can never bear on anything except appearances.".(Kant 1783)

Physics can only study the efficient cause of objects and events of our perception. Quantum mechanics, being derived from the experience of the phenomenal world, cannot say anything about the noumenal reality. These equations are abstract mathematical descriptions or formalizations derived from the analysis of results of the above-mentioned experiments which do not fit the rules of classical physics. I argue that they have no meaning other than formalizing the observed rules and predicting other observations. My understanding of this issue is similar to that of Niels Bohr, who was deeply influenced by Kant.[6](Bitbol and Osnaghi 2016) Bohr, although he never quoted Kant directly, referred to quantum formulas that:

> "merely offer rules of calculation for the deduction of expectations about observations obtained under well-defined experimental conditions specified by classical physical concepts".(Bohr 1963)

Later researchers moved away from these concepts and began attributing ontological meanings to Schrödinger's equation. Nowadays there is a multitude of interpretations of Schrödinger's equation and even many opinions about the meaning of the orthodox interpretation.

Kant argued that we can make guesses about the properties of the things-in-themselves through careful analysis of perceived reality, but we can never perceive them directly and cannot know if our guesses are correct. So, can quantum physics describe things-in-themselves as they really are? The answer is no.

[6] "The Kantian element in Bohr's thought was subsequently recognized by a number of historians and philosophers of physics, while being minimized or denied by others."(Bitbol and Osnaghi 2016)

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