Abstract:

Quantum mechanics does not deal with individual events and all its predictions are of a statistical nature. For example, if we have radioactive nuclei or molecules in excited states we can, in principle, predict the average rate of decay but not when exactly this given nucleus or molecule passes to its ground state. This situation leads to long-time and very hot debates on “completeness” of quantum mechanics, its applicability or inapplicability for macroscopic objects, existence or nonexistence of underlying classical reality (“hidden parameters”), role of measurement devices and observes, and so on, and so forth.

Recently, we proposed [1-5] a purely phenomenological way to build the quantum theory as the most robust description of reproducible experiments and have shown that this may be done independently on any assumptions on underlying ontology, based purely on logical inference approach and a minimal amount of additional physical postulates, such as applicability of classical physics at the average. Basic experiments of quantum physics, such as Stern - Gerlach or Einstein - Podolsky - Rosen - Bohm experiments can be analyzed within this framework, without any presumptions on wave function and Born rule. In a sense, our approach is a formalization of a well-known quasi-philosophical motto, ‘quantum theory describes our knowledge of atomic world rather than the atomic world itself’ which can be now analysed by conventional powerful tools of mathematical physics. Basic equations of quantum mechanics can be derived in this way.

The other important epistemological principle clarifying the mathematical structure of quantum mechanics is the “separation of data” condition which assumes a separability of the data on initial state of the system under investigation and of the measuring device. I will discuss physical consequences of this similarly innocent requirement [4,6].

I will also discuss a very recent prediction of emergent quantumness in neural networks [7] which provides an interesting example of mimicing quantum behavior in the systems which are not quantum *per se*. This can be potentially useful for development new efficient algorithms.

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