Review of: "On the Bell Experiment and Quantum Foundation"

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Potential competing interests: No potential competing interests to declare.

In this paper, the author adopts ψ-epistemic approach to quantum theory and defines the system state as an observer-dependent perspectival concept. As far as I can understant, the author does not deny the existence of an external physical reality, but sees quantum theory as a theory of our own knowledge rather than the external world. The author's approach can be evaluated within the framework of an interpretation known as Convivial Solipsism in the literature. Although my approach to quantum theory is realistic, I accept that physics has an observer-dependent perspectival component. For this reason, I found the paper interesting. The paper can contribute to the discussion on the foundations of quantum theory by bringing a new perspective. I support the publication of the paper. However, I think there are some vague points in the paper that should be clarified before publication.

The points I find vague are the following:

(1) At several places in the text (see for example corollary 1) the author states the observer's inability to keep enough variables in his/her mind. I think this requires a better definition. The issue is that the mind of the observer is not defined clearly enough in the text. For example, the following question comes to mind: According to Corollary 1 Charlie is not able to keep all four variables A, A’, B and B’ in his mind at the same time t during the modelling process. However, EPR-type experiments with entangled spin 1/2 pairs are not performed for a single particle pair. But, the experiments are performed many times on an ensemble of identically prepared systems and statistical analysis is performed. Therefore, knowing the values of the variables A,A',B,B' does not mean knowing for the same experiment. The observer can have in his mind all the values of these variables as a result of the measurement statistic he performs. Does the author mean in corollary 1 that the observer cannot keep all the variables in mind for a single experiment performed?

(2) The author stated in chapter 7 that he abandoned the assumption of realism as a result of Bell's theorem. Abandoned realism in the context of Bell's theorem means that the measurement result is not an element of reality before the measurement. The fact that the observer or experimenter cannot access the knowledge of this reality (hidden variables) does not affect the validity of Bell's theorem. On the other hand, inaccessible variables defined in the paper seem to play the role of hidden variables. If the paper had adopted a purely solipsistic approach and rejected external reality completely, Bell's inequalities would not impose a constraint on the proposed model. But as far as I can understant, the author does not deny the existence of the external physical reality. In this case, I don't see how his proposed model differs from the hidden variable theory. I think the author should make it clear how inaccessible variables differ from hidden variables.

Comment: I think it's an interesting idea, as the paper argues, to treat Quantum theory as a theory of our own mind and knowledge. For my opinion, the Lucas-Penrose argument is important in this context. In 1961 Lucas and in 1990s Penrose examined the problem of the equivalence of the human mind to a Turing machine. According to Gödel's incompleteness theorem or its another version about halting problem (Turing's theorem), the set of all mathematical true formulas that a human mathematician can cognize, can neither be fully formalized in an axiomatic system nor described by an algorithm. Thus, the exact formalization of the human mind cannot be made. If we approach quantum theory as a formal theory of human knowledge and mind, undecidable formulas must exist in quantum theory. Let us speculate as follows: Could the variables that the human mind cannot keep together be related to some undecidable formulas? For example, if the value of a variable A is undecidable when taken together with some other variables, it is not provable that neither A=+1 nor A=-1. Perhaps in this case there is both A=+1 and A=-1, i.e. a superposition. Or the values A=+1 and A=-1 arise randomly. I don't know if this speculation is true. But I believe the notion of probability in quantum theory has to do with undecidability in formal systems. Indeed, studies of mathematicians such as Martin-Löf, Chaitin, Kolmogorov have shown that there is a deep relationship between undecidability and probabilities. I presented my thoughts on how the notion of probability could emerge for a realistic approach to quantum mechanics in a paper titled Comments on indeterminism and undecidability(*Preprints.org **2021**, 2021060056 and* arXiv:2106.08132).