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Peer Review

Review of: "Questioning the Reasonableness of the Quantum Nonlocality Debate"

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Review of the Commentary „On the Unreasonableness of the Quantum Nonlocality Debate“

C. Gallus, 6. Feb. 2026

The work discusses an interesting topic in the foundations of quantum theory: Although the debate about realism and locality in possible interpretations of quantum theory is old, it can still be very exciting.

The title is a bit provocative and possibly a play on Wigner's well-known work *"The Unreasonable Effectiveness of Mathematics in the Natural Sciences"*. However, it may be taken the wrong way as it is not the debate itself that is unreasonable – in my view, the debate is still warranted – but some things that were said or written in this debate.

The debate requires clear terms, stating all assumptions clearly, arguing rigorously, and paying attention to detail. You rightly criticize that there is sometimes a lot of confusion and a lack of rigor in parts of the debate. You correctly point out some fallacies that can sometimes be heard. Some fallacies and "unacceptable antinomies", as you call them, may be the result of a lack of rigor in the presentation and of disagreement over (implicit) assumptions.

To advance the present debate, confusion needs to be reduced, and in its current stage, the presented manuscript unfortunately does not achieve that. The comments posted by Howard Wiseman and Marco Genovese already point to many critical issues with the manuscript, so I will not focus on those points. I will rather try to guess possible intentions of your work and make some additional suggestions that are hopefully useful to you. I apologize in advance if I have guessed intentions incorrectly.

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A. Assumed intention “Apply rigor to the debate”: This requires clear definitions as a starting point, e.g., around locality (LOC). As pointed out by H. Wiseman, different notions exist. The locality in the Bell argument is of a very specific form and is sometimes even called Bell locality. It is defined using a certain factorization of the observed probability distribution under the assumption of a hidden variable, see for example [1]. Whether the assumption of hidden variables is allowed is a delicate issue related to realism (see B). An important distinction to make is between observables and hidden variables. Various things may happen with hidden variables, but those are not accessible directly. An important concept is non-signaling, i.e., the inability of Alice to send a message to Bob by making specific choices of measurements on her side which Bob may be able to infer from the statistics he sees at his location only. While non-signaling follows from Bell locality, it is a violation of non-signaling that would be very concerning, while nonlocal influences on hidden variables are of a different category.

B. Assumed intention “remove metaphysical baggage (extravaganzas)”: As H. Wiseman rightly pointed out, determinism is not the same as “predicting with certainty”, but the issue of determinism may not be needed in the debate, so it might be easiest not to use this term. Discussing the issue of realism (R) is indeed ultimately a philosophical point, but it will probably be unavoidable. Possibly it can be narrowed down to Counterfactual Definiteness (CFD). As pointed out, unperformed experiments have no results, see [2]. Can realism and CFD be context-dependent, and what role does free choice play? Pointing to initial conditions (p.6) when discussing CFD is insufficient. Discussing Stapp vs. Bell-CHSH may be instructive and could take more room in your manuscript. Here Dickson’s critique, see [3], should be considered. As you rightly point out in Section 4.1, the four expectation values in the definition of S can be computed from experiments that were performed; there is no CFD needed here. However, a key question is how CFD is used in the derivation of |S| \leq 2. Here a hidden variable model (\lambda) and possibly Reichenbach’s principle play a role. The use of \lambda and a joint probability space that includes \lambda assumes some form of CFD. One direction to elaborate on could be whether causality is a key ingredient of the debate. If so, can it be causality in its classical form, or is a revised form of quantum causality needed?

C. Assumed intention “Apply logical inference to the debate”: The manuscript tries to state logical implications between LOC and R. I don’t think that can work simply because one may think of examples where LOC and R are seen as independent concepts. Depending on proper definitions, for all of the four combinations, LOC and R, non-LOC and R, LOC and non-R, non-LOC and non-R, one might think of models where the combination is realised. In that sense, you could have an

explanatory note to rigorously disprove some fallacies. Personally, I rather think of the debate in the sense of statements that “R and LOC and FREE Choice and Order or time and ...” imply |S| \leq 2. On this basis, we know that the experimental results logically force us to give up at least one of the assumptions. Sometimes people jump to giving up locality. Also, it is sometimes stated that it becomes a matter of preferences what should be given up. Depending on the measure used, the assumptions can indeed be seen as equally costly under a classical causal model, see our work [4, 5]. However, maybe it is not just a matter of preferences, and other measures allow a distinction between the concepts. To the extent that you put a proper mathematical formalism in place, logical inference could be applied to prove theorems advancing the debate around nonlocality.

[1] Scarani, V. (2019). Bell Nonlocality. *Oxford University Press.*

[2] Peres, A. (1978): Unperformed experiments have no results.” *Am. J. Phys. 46, 745-747.*

[3] Dickson, M. (1993): Stapp’s Theorem Without Counterfactual Commitments: Why It Fails Nonetheless. *Studies in History and Philosophy of Science Part A 24(5), 791–814.*

[4] Blasiak, P. et. al. (2021). Violations of locality and free choice are equivalent resources in Bell experiments. *Proc. Natl. Acad. Sci. USA 118.*

[5] Blasiak, P., Gallus, C. (2024). Comparing the cost of violating causal assumptions in Bell experiments: locality, free choice and arrow-of-time. *Phil. Trans. R. Soc. A.*

Declarations

Potential competing interests: No potential competing interests to declare.