

## Peer Review

# Review of: "On the Unreasonableness of the Quantum Nonlocality Debate"

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I apologise that this is not a complete review, as I have not read all of the paper. But I have read enough to have some major criticisms.

First, the author makes the mistake of thinking that something like this

*"Definition 1. A theory is nonlocal if it predicts that what happens in a region of space has an immediate and instantaneous influence on another separate region without allowing a time delay for the propagation of the effect."*

is an adequate definition. It is not. How can one tell, in a theory, whether a "happening" has an "influence"? Much work was done in the 1970s and 80s on refining vague ideas like this to yield *different* notions of locality. For example, there is Bell's 1976 *local causality*, which is clearly different from the not very well formulated notion of *locality* which he used in 1964. Jarrett (Nous, 1984) formalised these a bit more carefully and called them *strong locality* and *locality*, respectively, while Shimony's 1984 term "parameter independence" has also become well known as a synonym for *locality*. For a discussion, see Wiseman (J. Phys. A, 2014) and also Wiseman and Rieffel (Int. J. Quantum Found., 2015). In a paper about quantum nonlocality, failing to properly define nonlocality, and failing to recognise the existence of different notions of nonlocality, is a fatal flaw.

Second, in a paper claiming to address "a perplexing lack of logical rigor pervading the debate on quantum nonlocality" the next section displays a shocking lack of elementary logic. The author says

*"Note that EPR realism is just an intricate form of requiring determinism since, by its very definition, If, without in any way disturbing a system, we can predict with certainty (i.e., with probability equal to unity) the value of a physical quantity, then there exists an element of physical reality corresponding to this physical quantity."*

Note the relevant point is about “predicting with certainty” (determinism), and the rest is metaphysical speculation about what purportedly exists without actually being observed.”

Note these basic errors:

1. determinism is *not* the same as “predicting with certainty”. See, for example, Wiseman and Cavalcanti (Found. Phys., 2012).
2. the quote from EPR is a *criterion* saying (to simplify): **if**, without disturbance, prediction of X is possible, **then** X is predetermined. In no way does this “require” prediction (or determinism) in general.
3. this is not mere “metaphysical speculation”. It is a metaphysical criterion that is essential for the EPR argument.

It seems the author needs to see a presentation of EPR’s argument using the formal language of logic. This can be found in Wiseman (Ann. Phys., 2013).

Third, I agree with the author that Bohr did not merely argue that in quantum mechanics, there is no realism as EPR wanted (though he did emphasise it). However, the author seems to think it is impossible to understand how Bohr argues against EPR. In fact, it is not so difficult, especially if one reads the two papers Bohr wrote in reply to EPR (one a notice). Wiseman (Ann. Phys., 2013) also presents Bohr’s response in the language of formal logic, showing that it is just as logical as EPR’s argument.

I stopped reading the paper at this point because I could not imagine how the author could build a worthwhile argument on such flawed foundations. In addition to the references above, I would recommend to the author Wiseman and Cavalcanti, “Causarum Investigatio and the Two Bell’s Theorems of John Bell” (published in Quantum [Un]speakables II, 2017; I give the title so the author can search for a copy on the arxiv), which analyses notions of locality, inter alia, in causal terms, which has become the norm in modern quantum foundations. It is not a perfect presentation, and there is certainly important relevant work that has been done since then. I’m also aware that I’ve referred a lot to my own work in this review in general (partly because I am most aware of what is in my own work and so can point to the relevant papers easily). So I still recommend this 2017 paper.

## Declarations

**Potential competing interests:** No potential competing interests to declare.