

Peer Review

# Review of: "Local Everettianism and Asymmetric Relative Statehood"

Howard Wiseman<sup>1</sup>

1. Griffith University, Australia

The author addresses an important issue – the locality (or not) of the Everett interpretation. He concentrates on the analysis of Timpson and Brown (TB for me, though the author for some reason prefixes EPR and refers to the paper as EPRTB).

To cut to the chase, I think the author will want to remove this paper because it makes a fundamental mistake in its analysis. The evolution in the middle pair of displayed equations on page 8 (I wish all authors would number all equations) is intended to be a fragment of evolution that is dynamically local (dynamically propinquitous, one might say, to borrow the author's word) and unitary. Unfortunately, such evolution does not lead from the first displayed equation on page 8 to the final displayed equation on that page. When observer  $A_1$  looks for particle  $O_2$  at position 4 (in order to measure its polarisation), the Universal Wavefunction will branch into two: one in which the particle is there, and one in which it is at the unlabelled (because default, presumably) position, in the propinquity of observer  $A_2$ . The change in the state of  $A_1$  because of this polarisation measurement will happen only in the former of these branches. By contrast, the author has this change happening regardless of the location of  $O_2$ . This is completely unphysical, and so it is not surprising that the author concludes that it gives rise to nonlocality in the Everett interpretation. It may well do so in any interpretation.

Naturally, I stopped reading at page 8. But I have some other comments on the paper prior to that.

1. The "representation" of the argument in TB on pages 3–4 does not make sense to me. I am not sure whether this is a flaw in the original or here. I strongly suspect the latter, given the author's apparent unfamiliarity with the quantum formalism. To begin, point 1 on page 3 contains a false dichotomy, as it hinges on whether "the distant subsystem" is "an eigenstate rather than a superposition". In general, the state of the distant subsystem is neither of these, but rather a mixture. This impinges on the second point on page 3. What does it mean to be "rendered

determinate-definite by virtue of" a measurement when the state in the no-measurement case is a mixture? It seems to me that any time the subsystem, initially entangled, becomes an eigenstate (relative to the outcome of the first observer), then it can only be by virtue of the measurement, meaning that the Everett interpretation would definitely be nonlocal by this criterion. I am not going to try to guess the relation of this "representation" to the original TB argument.

2. The equations are so badly typeset as to be almost unreadable. The sizes of brackets have no consistency, with similar terms having different sized brackets, and larger brackets enclosed by smaller ones. All brackets are round, whereas in physics we use a hierarchy of type  $\{[()]\}$  as well as size for easy reading. There are such large spaces between the spin-arrows and the vertical lines defining the kets that it is impossible to take in at a glance what objects are kets.
3. The diagram would be much more useful if it elucidated the complicated notation used, with subscripts themselves having both superscripts and subscripts.
4. The language is flowery. That's a choice, but at least don't mix metaphors. "Multifaceted" and "rhizomatic" do not describe the same sort of metaphorical object. It is also sometimes pointlessly circuitous – don't say "a somewhat decisive respect" when you mean "a decisive respect". On the other hand, don't use emotive words like "weaponised" for authors you disagree with (context: "weaponised by these authors as a means to elude ...")

## Declarations

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