# Review of: "Bell’s Theorem and Counter factual Definiteness CH"

Eugen Muchowski

Potential competing interests: No potential competing interests to declare.

The author deals with arguments against Bell's theorem, especially against the assertion that Bell made counterfactual definiteness as a tacit assumption. Counterfactual definiteness is trivial for every deterministic model and is not an argument against the derivation of Bell's theorem. The derivation of Bell's inequality in his 1964 paper is mathematically correct.

If you want to refute Bell's theorem, you have to work out exactly where the flaw in Bell's argument is. In his 1964 paper, Bell claimed that the measured values of polarization/spin measurements can be described by A(a,l)=+/-1, B(b, l)=+/-1, where a,b are the instrument/polarizer settings and l is supposed to be a hidden parameter.

That means that he assumed that the properties of entangled states must be derived from the behavior of distinguishable particles. From this he derives Bell's inequality, which is violated by QM. However, it is well known that the singlet state, like all Bell states, is not separable. This means that without further intervention the state of each of the two photons is not only not known, but that a separate state of each of the two photons does not even exist. The reason for this is the indistinguishability of the photons that form the entangled state.

If there is no defined state of a single photon from the entangled state, then there is also no definable measurement result A(a, l) or B(b, l) before measurement. If there were measurement results A(a, l) / B(b, l) defined before measurement, then these could only result from the states of the individual photons, which, however, do not exist because of the non-separability. Thus we have the case that non-existent states produce defined measurement results, which is a contradiction. The conclusion is that Bell’s assumption that measurement results have to be of the form A(a, l) / B(b, l) in order to reproduce the QM correlations is wrong. Because of this wrong assumption Bell's inequality fails to correctly describe the relationships between expectation values with polarization entangled photons.

A detailed argumentation on this topic can be found in “What connects entangled photons?”https://ijqf.org/archives/6946

Nevertheless, it is commendable that the author deals with arguments against Bell's theorem. After all, it is not helpful if there are various theories in the room that purport to refute Bell's theorem but do not stand up to critical scrutiny.