Bell's Four Positions

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Bell offered four quite different positions which one might like to take as being compatible with his mathematical results:

1. Quantum mechanics is wrong.
2. Predetermination. (An observable attribute has a value whether it is observed or not?)
3. Nature is non-local.
4. Don't care (Bohr) .

In the opinion of Gill [1, Section 5.A] Bell missed a fifth position:

5. A decisive experiment cannot be done.

From [1, Section 6]:

That statistical independence holds when well separated physical systems are each used to generate randomness is not harder to understand.

These considerations mean that, for me, Bell's theorem has more
or less nothing to do with interpretations of probability.

Classical physical randomness and classical physical independence are what are at stake.

My conclusion (excluding the fifth position) is that quantum mechanics is definitely non-classical.

In order to establish that quantum mechanics is non classical we had to assume that physical independence between randomization devices at separate locations in space is possible.

Bell's conditional independence assumption[1] is a way to express the physical intuition, that even though this might introduce more statistical variation into the outcome, it cannot carry information from the other wing of the experiment, concerning the randomization outcome there.

I find it fascinating that in order to prove that quantum mechanics is intrinsically probabilistic (the outcomes cannot be traced back to variation in initial conditions) we must assume that we can ourselves generate randomness.

References

[1] R. D. Gill. Time, finite statistics and bell's fifth position. *arXiv:quant-ph/0301059v2*, January 2015.

[1] Bell (1964, 1987) used a statistical conditional independence assumption, together with an assumption that conditional probability distributions of outcomes in one wing of the experiment do not depend on settings in the other wing. [1, page 16]