Discovery of the Solution to the "EPR Paradox"

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In 1935, Albert Einstein, Boris Podolsky and Nathan Rosen (EPR) published a thought experiment [**1**] that is entirely correct, has been demonstrated in real experiments, and is now the most famous in quantum physics. Their pioneering work described, for the first time, quantum correlations and can be regarded as a very early glimpse into today's 'deep' quantum technologies, by which I mean those that enhance functionality by making use of quantum correlations. However, their work also contains a paradox that Erwin Schrödinger had already recognised as such in the same year [**2**] and which has since been cemented by the Bell experiments. Here, I am now able to pinpoint the origin of the paradox within the chain of reasoning, which ultimately resolves the paradox.

The starting point – In their paper [**1**], EPR investigated the question whether quantum theory (QT) can be considered a complete theory. They proposed a thought experiment involving measurements on a position-momentum-entangled system of two free particles. The measured values and their correlations within the uncertainty intervals should indicate whether the measured values had a 'reality' prior to the measurement or whether the measurement results arise by chance, i.e., without any form of causality. EPR derived an implication from a seemingly logical line of argument which, when applied to the thought experiment, shows that quantum mechanics does not describe the whole of reality and is therefore incomplete.

This work – Here, I will show that the full line of argument put forward by EPR in their paper can be summarised by the following implication.

> 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 — but this value has no counterpart in the physical theory — then the theory is incomplete. This is because a *predictable value* cannot be the result of a *truly random process*. And it is really only the truly random process that may lie outside the scope of a complete theory. [I]

I will present an example that contradicts implication [I]. My example highlights where the reasoning in the EPR paper is flawed. I finally draw the following conclusion [**3**]:

> *The predictability of a measured value does not rule out the possibility that the value is the result of a truly random process.*

My finding is fully consistent with my recent discovery of how the original position-momentum-entangled system of two free particles in the EPR though experiment [**1**] can actually be created [**4**].

References

[1] A. Einstein, B. Podolsky, and N. Rosen, Physical Review 47, 777 (1935).

[2] E. Schrödinger, Mathematical Proceedings of the Cambridge Philosophical Society 31, 555 (1935).

[3] R. Schnabel, *Discovery of the Solution to the "Einstein-Podolsky-Rosen Paradox"*, arXiv:2604.09826.

[4] R. Schnabel, npj Quantum Information 11, 76 (2025).