Going to the Root of Quantum Measurement Problem

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Abstract

We can not think of measurement devices as if they would be a part of nature. Why? Because it violates the definition of nature, becoming the tautology: nature is what (measures) nature.

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I. ABOUT MEASUREMENT PROBLEM

This note presents an instrumental interpretation of Quantum Mechanics (QM). This new interpretation is needed because all known interpretations only suggest how Quantum Mechanics works so that one can be able to apply the equations, but do not answer the question: "why does nature need Quantum Mechanics at all?" Good papers are: [1–3]

Quote from Ian Miller: www.academia.edu/s/20977fc657

`As I understand it, the measurement problem is simply a consequence of the fact that the measurement itself collapses the probability disrribution to a single probability, thus making a very big change, but the act of doing so lies outside the formalism. This suggests to me that either the formalism is wrong, or it is restricted, and i think most would agree it is restricted, which brings one back to Einstein who argued the formal quantum mechanics is incomplete.`

Quote from Rick DeLano: www.academia.edu/s/20977fc657

`Quantum mechanics describes physical systems that are:`

`1. Linear, 2. Time-symmetric.`

`Which, immediately, rules out any thermodynamic system.`

`George Ellis' recent paper on the measurement problem beautifully shows how any measuring apparatus is, necessariily, a thermodynamic system (it is non-linear and time-asymmetric). https://arxiv.org/abs/1807.08171`

II. MY IDEA IN SHORT

1. Reality is like a story, the story which is built upon definitions. That is demanded by Aristotle's logic laws, which are not a human construct, but objective laws of life. Life closely follows the correct definitions, hereby word for word: it is like PC follows a program.

2. Nature is what the instruments are measuring, and instruments are what measures nature: it is the circle-like definition. As Einstein has said: "Time is what the clock shows", it is intuitively true.

3. Clock shows the time with measurement uncertainty, thus, the time itself is discrete: there is minimum possible time: Planck's Time interval.

4. Same applies to any kind of measurement, e.g. the spin of the particles.

A. Do I have new interpretation, or explanation?

Why is another interpretation needed? Because all known interpretations only describe how Quantum Mechanics works, so that one can be able to apply equations, but do not answer the question: "why did nature need Quantum Mechanics at all?" In other words: "can there be a universe in the Multiverse that does not have Quantum Mechanics?".

Nature is what instruments measure. For example, Albert Einstein answered the question "what is time?" by something that is measured by clocks. A clock is showing the time with a fundamental measurement error (or uncertainty range). For example, you cannot say strictly scientifically that it is 2 PM now, but you can say "2 PM plus or minus 5 minutes". The error is unavoidable because the devices (like clocks) themselves change nature in an uncontrolled way while measuring it. For example, when measuring blood pressure, the cuff presses on the arm, agitating the patient. Therefore, it follows from this definition that nature itself (and not only our measurement methods) is characterized by Heisenberg's uncertainty principle, leading to a measurement error.

Note that I mention only the devices (instruments), but did not say a word about who is using them – the Observer. There is no need to mention the Observer. We don't have to go everywhere with a ruler and a thermometer to measure nature. Nature can be measured in principle.

The entire point is found in the definition. One agrees that the device affects nature, but one does not include the device into the definition of nature. I included it in the definition of nature. Reality is built on definitions, as there are three laws of Aristotle's logic (according to the first law, everything must have a definition). I propose to define nature as what the device measures. Our brain also subconsciously measures but produces inaccurate, rough measurements that do not have a scientific form. Otherwise, we would not be able to move among the obstacles.

And there is no other explanation why nature needs Quantum Mechanics. Therefore, you need to have a goal: to find it possible to accept my article and not to reject it.

III. CONCLUSION

We can not think of measurement devices as if they would be a part of nature. Why? Because it violates the definition of nature, becoming the tautology: nature is what nature. measures.

IV. APPENDIX: DAVID BOHM'S THEORY

David Bohm's theory was intended to show that all quantum effects occur not because nature is quantum, but because we cannot accurately measure it. David Bohm's theory is untenable because:

1. Although he considers particles to be classical, he introduces an additional field, a new fundamental interaction, which we have not identified in experiments.

2. The theory contradicts experiments on the verification of Bell's inequalities and does not describe photons.

V. APPENDIX: THERE IS NO NON-LOCALITY

Because nature reveals itself at the measurement, there is no quantum superposition in nature. Thus, quantum entanglement does not apply to nature. Scientific research in a closed small laboratory can not determine the position of that laboratory in spacetime, and all such laboratories can be isolated from outside influence and show the same physical laws. It is the strong equivalence principle.

Because there is no non-locality in nature, faster than light communication is not possible.

VI. DISCUSSION

Suppose, that the wave-function of an electron is spread over some volume. Then there was the detection of the electron in someplace inside the volume. That we can tell? The measurement has told us, that electron is at this point of the volume. I mean, we do not measure the wave-function of the volume, but we determine the nature inside of this volume.

Nature appears at the very moment of measurement because nature is what we measure. No measurement - no nature.

Dear Doug, thank you for your very important comment. I now see, how my simple idea is seen by a physicist. You have written: "Thus, you are saying that the act of measuring affects the outcome of the measurement. Is that right, or do you mean something more by the term "nature"?"

If the detector has detected an electron with spin +1 at New York, then in New York there is the electron with spin directed as +1 (relative to the detector axis). These are facts of nature. The wave-function, [which was there before measurement] is the part of mathematical law, which nature obeys. Nature reveals itself at the measurement. It is Mathematics/Physics co-play. "Physics" is the Greek word for Nature.

Doug: "It does sound like you mean more when you get to the conclusion: "Nature is what nature measures.""

This is a tautology, thus, it is wrong to say that. But it comes if we treat measurement apparatus as part of nature. It is the Measurement Problem, which is absurd: "nature measures nature". To avoid that I suggest thinking of measurement apparatus as non-natural [have you been in the forest? Have you seen clocks and thermometers growing there? No, it is non-natural to find them in the wilderness]. This is the definition of measurement apparatus: "non-natural thing, which measures the nature."

A. Comment from Doug Marman and my reply

As Ian pointed out, the measurement problem arises because physicists start with the wave function. This is what is so well understood mathematically. But there is nothing in quantum theory that explains how the wave collapse occurs. What actually occurs at the quantum level when the wave collapses?

It sounds like you are suggesting that it might make more sense to look at this from the standpoint of the measured results. This is an interesting idea. It would be even more interesting if the measured results are the drivers somehow. But most of quantum mechanics is built on the idea that the wave function is the driver. This is why I thought

you meant the wave function when you were talking about nature.

We can see that the wave function influences the outcome. This is why the probabilities are so accurate, statistically. But the wave function does not determine the individual results. Something happens during measurement that makes the process unpredictable and non-linear. Does this mean nature is doing something during the wave collapse? Does your paradox help us understand this better?

I reply to Doug:

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[1] Massimiliano Proietti, Alexander Pickston, Francesco Graffitti, Peter Barrow, Dmytro Kundys, Cyril Branciard, Martin Ringbauer, Alessandro Fedrizzi, "Experimental rejection of observer-independence in the quantum world," arXiv:1902.05080 (2019)

[2] M. Ringbauer, B. Duffus, C. Branciard, E. G. Cavalcanti, A.G. White, A. Fedrizzi, "Measurements on the reality of the wavefunction," Nature Physics **11**, 249–254 (2015).

[3] Alain Aspect, Jean Dalibard, Gérard Roger, "Experimental Test of Bell's Inequalities Using Time-Varying Analyzers," Phys. Rev. Lett. **49**, 1804–1807 (1982).