Re-reading Wilczek's remark on "*Lost in Math*": The perils of postempirical science and their resolution

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Abstract

Sabine Hossenfelder's recent book "Lost in Math" has attracted numerous responses, including by notable physicists such as Frank Wilczek. In this article we focus on Wilczek's remark on that book, in particular on the perils of postempirical science. We also discuss shortly multiverse hypothesis from philosophical perspective. In last section, we offer a resolution from the perspective of Neutrosophic Logic on this problem of classical tension between mathematics and experience approach to physics, which seems to cause the stagnation of modern physics.

Keywords: evidence-based physics, Neutrosophic Logic, multiverse, realism interpretation, postempirical science.

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Introduction

Sabine Hossenfelder's recent book "*Lost in Math*" has attracted numerous responses, including by notable physicists such as Frank Wilczek.[2] In this article we focus on Wilczek's remark on that book, in particular on the perils of postempirical science.[3]

A few words on Sabine Hossenfelder and her book. She is a professional theoretical physicist, who is also an active writer. In this new book, which in theme is quite similar to Penrose's[1], mixed interviews with eminent physicists with her own narratives on the present crisis and stagnation in modern physics, in particular during the past 30-40 years or so.

While Frank Wilczek can understand the source of frustration of researchers like Sabine Hossenfelder, he pointed out that her book's diagnosis of the present crisis and stagnation of modern physics in the past 30-40 years is not correct. Wilczek is right that in *Lost in Math*, Sabine does not only question beauty and internal consistency as criteria of a good theory, but she questions the tendency towards post-empirical science in some of the most advanced theories, such as multiverse, naturalness, and superstring.

Wilczek wrote:

> "Hossenfelder's real target, when you strip away some unfortunate terminology, is not beauty but self-satisfaction, which encourages disengagement from reality. That attitude reaches its theoretical apex in the doctrine of "*postempirical science*," which argues that social consensus, not experimental evidence, determines scientific validity. Here she quotes physicist George Ellis, rebuking physicists and philosophers who adopt that attitude: "There are physicists now saying we don't have to test their ideas because they are such good ideas. They're saying—implicitly or explicitly—that they want to weaken the requirement that theories have to be tested. To my mind that's a step backward by a thousand years."[3]

Instead of arguing the perils of postempirical science, Wilczek went on writing that the present stagnation of physics science is caused by rapid success in the period before the stagnation. In other words, for him it becomes difficult to keep the pace of new discoveries of the past era.

But it seems to us, he downplays what Sabine Hossenfelder (and also Roger Penrose) found out: that the current stage of modern physics seems to overemphasize on too much abstraction and oversophisticated mathematics, and less and less care about actual physics (evidences). This is to add to the problem of postempirical science.

In the following section, we will discuss an example of such postempirical tendency, i.e. the case of multiverse hypothesis (MWI).

The case of Multiverse Hypothesis (Many Worlds Interpretation)

In its simplest form the quantum theory of measurement considers a world composed of just two dynamical entities, a system and an apparatus. According to the Copenhagen interpretation of QM, at the point of time when an observer operates the apparatus to observe the system, the system's wave function collapse. But the exact mechanism of wave function collapse is unknown. Furthermore, it is difficult to model the correlation between a *macroscopic* observer and apparatus (governed by classical physics) with the *microscopic* system in question, which is supposed to be governed the Schrödinger's wave function. This is known as quantum measurement problem, which baffled many physicists since the early years of QM development.

To quote De Witt's paper in *Physics Today* [7]:

> "At this point Bohr entered the picture and deflected Heisenberg somewhat from his original program. Bohr convinced Heisenberg and most other physicists that quantum mechanics has no meaning in the absence of a classical realm capable of unambiguously recording the results of observations. The *mixture of metaphysics with physics*, which this notion entailed, led to the almost universal belief that the chief issues of interpretation are epistemological rather than ontological: The quantum realm must be viewed as a kind of ghostly world whose symbols, such as the wave function, represent potentiality rather than reality."

Apparently, Everett also realized that Copenhagen interpretation is largely incomplete. In his 1955 dissertation, Everett essentially proposed a resolution from measurement problem by assuming a multitude of possibilities, which is why his hypothesis is called Many Worlds Interpretation. In De Witt's words:[7]

> "… it forces us to believe in the reality of all the simultaneous worlds represented in the superposition described by equation 5, in each of which the measurement has yielded a different outcome. Nevertheless, this is precisely what EWG would have us believe. According to them the real universe is faithfully represented by a state vector similar to that in equation 5 but of vastly greater complexity. This universe is constantly splitting into a stupendous number of branches, all resulting from the measurement like interactions between its myriads of components. Moreover, every quantum transition taking place on every star, in every galaxy, in every remote comer of the universe is splitting our local world on earth into myriads of copies of itself."

In other words, Everett's hypothesis called for a different picture of reality, and obviously this requires a careful consideration of the distinction and boundary between physics theories and metaphysics.

Since publication of his dissertation, Everett's MWI has caused debates especially on philosophical problems related to his proposal. Such a proposition leads some physicists to argue that MWI actually moves the measurement problem into wild metaphysical speculation of branching universes. Barrett has reviewed earlier discussions on this topics.[6]

Despite acceptance of MWI by some theoretical physicists, and even Barrau [9] argued in favor of possible experimental vindication of MWI, there are also those who raise serious criticisms on such a wild hypothesis.

One critics came from Adrian Kent from Princeton University, from the same department where Everett obtained his PhD. In essence, Kent's objection on MWI is because:

> "The relevance of frequency operators to MWI is examined; it is argued that frequency operator theorems of Hartle and Farhi-Goldstone-Gutmann do not in themselves provide a probability interpretation for quantum mechanics, and thus neither support existing MWI nor would be useful in constructing new MWI."[5]

Furthermore, he argues:

> "Firstly, the very failure of MWI proponents to axiomatize their proposals seems to have left the actual complexity of realistic MWI widely unappreciated. It may thus possibly be tempting for MWI advocates to assume that there is no real problem; that Everett's detractors either have not understood the motivation for, or merely have rather weak aesthetic objections to, his program. (Hence perhaps the otherwise inexplicable claim by one commentator that "Avoiding this [prediction of multiple co-existing consciousnesses for a single observer] is their [Everett's opponents'] motivation for opposing Everett in the first place.")
>
> Secondly, MWI seem to offer the attractive prospect of using quantum theory to make cosmological predictions. The trouble here is that *if MWI is ultimately incoherent and ill-founded, it is not clear why one should pay attention to any quantum cosmological* calculations based on it." [5, p. 27]

In answering frequent question of what are the alternatives to MWI hypothesis, Kent outlined a number of ideas, including subquantum physics.

Another critics came from Steven Weinberg. For example, in 2005 interview with Dan Falk, Steven Weinberg still has objection on multiverse hypothesis. Meanwhile, he agrees that positivism or constructivism may be no longer valid in physics sciences, but he also admits that he still tries to figure out an alternative interpretation of QM:

"SW: And sometimes, as with the example of positivism, the work of professional philosophers actually stands in the way of progress. That's also the case with the approach known as constructivism — the idea that every society's scientific theories are a social construct, like its political institutions, and have to be understood as coming out of a particular cultural milieu. I don't know whether you'd call it a philosophical theory or a historical theory, but at any rate, I think that view is wrong, and I also think it could impede the work of science, because it takes away one of science's great motivations, which is to discover something that, in an absolute sense, divorced from any cultural milieu, is actually true.

Dan Falk: You're 81. Many people would be thinking about retirement, but you're very active. What are you working on now?

SW: There's something I've been working on for more than a year — maybe it's just an old man's obsession, but I'm trying to find an approach to quantum mechanics that makes more sense than existing approaches. I've just finished editing the second edition of my book, *Lectures on Quantum Mechanics*, in which I think I strengthen the argument that none of the existing interpretations of quantum mechanics are entirely satisfactory."

Weinberg himself has proposed his own theoretical physical interpretation of QM, albeit his theory is non-ontological in nature. He wrote:[14]

"ψ is theoretically physical and describes the probabilistic possibilities, as the Copenhagen interpretation implies. It has physical units (see Eq. (3)). ψ is also, naively, a function of a real spacetime coordinate argument solving a partial differential equation, such as the time-dependent Schrödinger equation, for example, with spacetime partial derivatives. All this argues for theoretically physical formalism (*not ontology*), applicable predictably prior to 'Copenhagen observation."

Philosophical viewpoint

In our opinion, the essence of problem with MWI is captured in De Witt's remark as quoted above: "The *mixture of metaphysics with physics*." Formally speaking, Everett's many worlds interpretation of QM can be viewed as large scale implication if one accepts Feynman's *sum over history* interpretation of QM. But, it is known that Feynman famously declared that nobody understood completely Quantum Mechanics. Therefore, one should be very careful before generalize his sum over history interpretation of QM toward Universe.

Nonetheless, Everett's Multiverse found numerous followers, especially science fiction fans all over the world. And some people also relates his Multiverse as a realization of one of Borges's story: "*Garden of the forking paths*."

While we shall admit that such a Multiverse hypothesis is a nice material for science fiction novels or movies, now is the right time to ask: *Is it science?* See article by Baggott, [19]

Such a philosophical implication of cosmology development has been emphasized by Bernard Carr:

> "By emphasizing the scientific legitimacy of anthropic and multiverse reasoning, I do not intend to deny the relevance of these issues to the science– religion debate [32]. The existence of a multiverse would have obvious religious implications [33], so contributions from theologians are important. More generally, cosmology addresses fundamental questions about the origin of matter and mind, which are clearly relevant to religion, so theologians need to be aware of the answers it provides."

Rodney identifies several problems related to multiverse hypothesis:[17]

> "Among the problems identified with the hypothesis are
>
> (1) the existence of infinitely many universes depends critically on parameter choice;
>
> (2) the probability that any universe in an ensemble is fine-tuned for life is zero;
>
> (3) the physical realization of any ensemble will exclude an infinity of possibilities;
>
> (4) the hypothesis is untestable and unscientific; and
>
> (5) the hypothesis is not consistent with the amount of order found in this universe, nor with the persistence of order.
>
> If these factors are taken into consideration the conclusion of the last chapter will be much stronger, because the prior probability of many universes will be further reduced and because the 'likelihood' entering Bayes's theorem will also be reduced."

It seems worth noting here to quote George Ellis's remark in his Emmanuel College lecture:[19]

> "The very nature of the scientific enterprise is at stake in the multiverse debate: the multiverse proponents are proposing weakening the nature of scientific proof in order to claim that multiverses provide a scientific explanation. This is a dangerous tactic.

> …
>
> The often claimed existence of physically existing infinities (of universes, and of spatial sections in each universe) in the multiverse context (e.g.Vilenkin: Many Worlds in One: The Search for Other Universes) is dubious.
>
> …
>
> Here one must distinguish between explanation and prediction. Successful scientific theories make predictions, which can then be tested. The multiverse theory can't make any predictions because it can explain anything at all."

Finally, Ellis warned his fellow cosmologists:[18]

> "I suggest that cosmologists should be very careful not make methodological proposals that erode the essential nature of science in their enthusiasm to support specific theories as being scientific, for if they do so, there will very likely be unintended consequences in other areas where the boundaries of science are in dispute. It is dangerous to weaken the grounds of scientific proof in order to include multiverses under the mantle of 'tested science' for there are many other theories standing in the wings that would also like to claim that mantle.
>
> *It is a retrograde step towards the claim that we can establish the nature of the universe by pure thought*, and don't then have to confirm our theories by observational or experimental tests: it abandons the key principle that has led to the extraordinary success of science.
>
> In fact we can't establish definitively either the existence or the nature of expanding universe domains that are out of sight and indeed out of causal contact with us."

Neutrosophic resolution of the present stagnation of modern physics

In our re-reading of those recent debates on the present crisis and stagnation of modern physics, it seems the real problem is not only about *beauty and internal consistency* criteria, which are still necessary, although not sufficient. The other sufficiency criterion is *falsifiability* a la Popper. Now with regards to the methods, it seems that overreliance on too much abstraction and oversophisticated mathematics only make majority of physicists getting out of touch from reality, even if they admit that physics is not just about fancy mathematics but also an evidence-based science. Therefore we should strive for *evidence-based physics.*

Moreover, there are old tensions between experimenters who emphasize the role of actual evidences, and theoreticians who focus on formal theoretical basis of some fields, using mathematics.

As we argued in a recent paper [21], this deep problem in philosophy of science can be viewed as another case that calls for implementation of Neutrosophic Logic: whenever there are two opposite sides, there is always a choice to find a neutral side, in order to reconcile those two opposite sides. We can also think of them starting from the *principle of contradiction*, proposed by Kolmogorov. To summarize, he argues that there is fundamental problem in developing complex arguments, they always lead to contradiction. This was proven later by Gödel.

What can we conclude from Kolmogorov's principle of contradiction? It is quite simple, i.e. developing a complicated theory from a number of postulates will very likely lead to messy contradictions, which are often called "paradoxes, " just like the twin paradox in general relativity, or cat paradox in quantum wave function; see also [20].

To put this problem succinctly, we can paraphrase Arthur C. Clarke's famous saying: "Any sufficiently advanced technology is indistinguishable from magic," (Arthur C. Clarke**,** "Profiles of The Future", 1961 (Clarke's third law). url: http://www.quotationspage.com/quote/776.html) to become "*Any sufficiently complicated theory will result in a number of contradictions and paradoxes.*"

Such a logical analysis derived from Kolmogorov's principle of contradiction eventually remind us of the following:

(a) To keep humble mind before Nature (God's creation), and perhaps we should not rely too much on our logic system and mathematical prowess;

(b) In developing a theory one should keep complications and abstractions to a minimum;

(c) To build theory in the nearest correspondence to the facts; it is the best if each parameter can be mapped to a measurable quantity.

We hope the above three criteria can be a useful set of practical guidelines for building mathematical models in theoretical physics.

To emphasize the aforementioned argument, from Neutrosophic Logic perspective, the old tensions between mathematicians (opposite 1) and experimenters (opposite 2), can be reconciled if we can consider a third approach. Those the available approaches would be somewhere in the following spectrum:

Mathematics (opposite 1) – evidence-based mathematics -- experiments (opposite 2)

Therefore, the middle way that we submit as a plausible resolution to the present stagnation of modern physics, is to return to *evidence-based mathematics.*

Concluding remarks

In this paper, we review QM measurement problem which paved a way to Many-Worlds Interpretation of QM (multiverse). Nonetheless, it is clear that Everett's hypothesis called for a different picture of reality, and obviously this requires a very careful consideration of the distinction between physics theories and metaphysics.

We also discuss how the present stagnation of modern physics can actually be viewed from classic tensions between mathematics and experiments.

To emphasize the aforementioned argument, from Neutrosophic Logic perspective, the old tensions between mathematicians (opposite 1) and (experimenters opposite 2), can be reconciled if we can consider a third approach. Those the available approaches would be somewhere in the following spectrum:

Mathematics (opposite 1) – evidence-based mathematics -- experiments (opposite 2)

The middle way that we submit as a plausible resolution to the present stagnation of modern physics, is to return to *evidence-based physics* and *evidence-based mathematics*. That is how Neutrosophic Logic perspective can offer a new insight to this problem.

We hope the present article can be found useful to resolve present stagnation of modern physics.

References:

[1] R Penrose. *Fashion, Faith and Fantasy in the new Physics of the Universe*. Princeton: Princeton University Press, 2017.https://press.princeton.edu/books/hardcover/9780691119793/fashion-faith-and-fantasy-in-the-new-physics-of-the-universe

[2] S Hossenfelder. *Lost in Math: How beauty leads physics astray.* Basic Books, 2018. url: https://www.amazon.com/Lost-Math-Beauty-Physics-Astray/dp/0465094252

[3] F Wilczek. Has elegance betrayed physics? *Physics Today* 71, 9, 57 (Sept. 2018); doi: 10.1063/PT.3.402

[4] J. Butterfield. Lost in Math? Review for *Physics in Perspective*. February 2019.

[5] Adrian Kent. Against Many Worlds Interpretation. *Int. J. Mod. Phys*. A 5 1745-1762 (1990). See also arXiv:gr-qc/9703089

[6] Jeffrey A. Barrett. Everett's pure wave mechanics and the notion of the worlds. *Eur. Jnl. Phil. Sci.* (2011), 1:277-302

[7] Bryce De Witt. Quantum Mechanics and Reality. *Physics Today,* Vol. 23 no. 9 (1970)

[8] Hugh Everett III. The Many-Worlds Interpretation of Quantum Theory. Princeton PhD dissertation, 1955. Also published later in 1973 by *Princeton University Press.*

[9] Aureliu Barrau. Testing the Everett Interpretation of Quantum Mechanics with Cosmology. arXiv: 1415:7352 (2014)

[10] Natalie Wolchover. At Multiverse Impasse, a New Theory of Scale. *Quanta Magazine.* August 18, 2014

[11] William A Bardeen. On Naturalness in Standard Model. Fermilab-Conf-95-391-T. 1995

[12] Katsuya Hashino et al. Discriminative phenomenological features of scale invariant models for electroweak symmetry breaking. *Phys. Lett.* B 752 (2016)

[13] Dan Falk. Science's path from Myth to Multiverse, Interview with Steven Weinberg. *Nature,* March 17, 2005. www.nature.com

[14] Steven Weinberg. ARTSCIENCE (AS) IN CLASSICAL AND QUANTUM PHYSICS. Arxiv: physics/0509095 (2005)

[15] Steven Weinberg. EXPERIMENTS IN PRINCIPLE FOR THE ARTSCIENCE (AS) INTERPRETATION. arXiv: physics/0509223 (2005)

[16] Bernard Carr. *Universe or Multiverse?* Cambridge: Cambridge University Press, 2007.

[17] Rodney D. Holder. *God, The Multiverse, and Everything.* New York: Routledge, 2004

[18] George Ellis. The Multiverse, ultimate causation, and God. *Talk at Emmanuel College,* 6th Nov. 2007. url: https://www.faraday.st-edmunds.cam.ac.uk/resources/George%20Ellis%20Lecture/Ellis-Faraday.pdf

[19] Jim Baggott. Post-empirical science is oxymoron. *Aeon*. url: https://aeon.co/essays/post-empirical-science-is-an-oxymoron-and-it-is-dangerous

[20] Charpentier, E.; Nikolski, A.L.N. *Nikolski. Kolmogorov heritage in mathematics*; Springer: Berlin/Heidelberg, Germany, 2007, p. 25

[21] V Christianto & F Smarandache. A Review of Seven Applications of Neutrosophic Logic: In Cultural Psychology, Economics Theorizing, Conflict Resolution, Philosophy of Science, etc. *J*, March 2019. www.mdpi.com

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