The meaning of predicting yourself and the limits of objectivization

Juan Manuel Jones Volonte
juanmjv@gmail.com
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Abstract

The aim of this essay is to propose a different ontology based on creativity, we can call this not even an ontology but a *praxis*. The metaphysical desire for mechanical and deterministic explanations stops us to fully embrace the teachings of quantum mechanics, our best empirical theory. Even more, mathematics must be recognized for what it is, a creation of human intellect. We can create many different algorithms that explain certain aspects of the same part of nature, we can use them to create new and fascinating entities. What we cannot expect is to explain nature at a fundamental level as a classical computer.

Laplace's Demon and quantum self-reference

If we take the story about Laplace's Demon to its extreme it becomes meaningless: what does it mean to predict our own decisions? The experimental method presupposes the free agency of the experimentalist. Knowledge presupposes a knower and a know, subject and object are two terms related in the process of knowledge (1).

In quantum mechanics (QM) we can arbitrarily draw the line between subject-object in the following sense: a subject S measures the object O and assigns the state $|\varphi\rangle$ to it. Another subject can measure the composite object $S \otimes O$ and assign state $|\Phi\rangle$ to S.

Our Demon can *approximately* treat the universe as an object and make

probabilistic predictions about it. The result of the experiment, what becomes a fact about reality depends on the choice of experimental situation. We can describe quantum mechanically the Demon and the rest of the universe but we need another Demon, no God view is possible in QM.

Demon 1 can say "System S(φ) possesses the value A_i of A " (A is an observable with values A_i) . QM permits the meta-proposition "A_i (S, φ) is true", a second observer, Demon 2, can treat Demon 1 as a measurement apparatus and check if it's correlated with S.

This kind of self-referentiality was frequently used in analogies with Gödel's famous theorem, but we must be cautious. In a detailed comparison Peter Mittelstaedt states:

"The situation in the quantum theory of measurement has some similarity with the meta-mathematical problems studied by Gödel (...) universality of quantum mechanics implies that metatheoretical propositions can be reformulated in terms of object quantum mechanics making use of the theory of the measuring process (...) On account of the analogy with Gödel's work, one could guess that some of these meta-theoretical propositions are not provable within the object quantum theory, even if they can be seen to be true otherwise.(...)However, in spite of this interesting analogy there are important differences between Gödel's investigations and the situation in quantum theory. Since quantum mechanics is not given as a strictly formalised theory it is very hard to see whether the basic requirements of Gödel's system P are also fulfilled in quantum mechanics. Hence it is neither clear whether *all* metatheoretical propositions can be reformulated in terms of object theory, nor is it obvious that some true meta-propositions cannot be proved in the object theory."(2)

The incompleteness of the description of an internal observer, our Demon 1, is of a very different kind of that of Gödel. In QM the description can be completed by the aforementioned second Demon, but at a cosmological level we hit the limits of our approximation. Physics as we know it is only possible in an approximation in

which we separate reality in parts, objects. In QM an object C can be composed of two objects A and B, *in order to speak meaningfully of A and B as parts of C, we need to posit 'separated' states of C; i.e., states in which the interaction between A and B is negligible. On the other hand, in order to speak meaningfully of C as consisting of A and B, we need to posit 'connected' states of C, in which the interaction between A and B is not negligible* (3).

Empirical Mathematics

It's a common belief that logic and mathematics exist out there, in a platonic world. Also it's a common belief that Nature is a mathematical system. As Finkelstein I will call this the *mathetic fallacy* (4). What I propose is that mathematics must be understood as a creative act:

"Intuitionism is a philosophy of mathematics that was introduced by the Dutch mathematician L.E.J. Brouwer (1881–1966). Intuitionism is based on the idea that mathematics is a creation of the mind. The truth of a mathematical statement can only be conceived via a mental construction that proves it to be true, and the communication between mathematicians only serves as a means to create the same mental process in different minds."(5)

In the same way we must understand that logic arises out of an evolutionary process (6), a dynamic that is fundamentally lawless.

"...some Boolean concepts and laws do not work for quanta. (...) when the logician George Boole (1847) first formulated these, he already pointed out that they were in principle subject to revision. He could recognize this possibility because he expressed his concepts of classes and their relations in terms of patterns of human actions, simply to clarify their meanings."(7). In the words of Boole himself: "Now the several mental actions which in the above case we have supposed to be performed, are subject to peculiar laws. It is possible to assign relations among them, whether as respects the repetition of a given action or the succession of different ones, or some other particular, which are never violated. It is, for

example, true that the result of two successive acts is unaffected by the order in which they are performed; and there are at least two other laws which will be pointed out in the proper place. These will perhaps to some appear so obvious as to be ranked among necessary truths, and so little important as to be undeserving of special notice. Yet it may with confidence be asserted, that if they were other than they are, the entire mechanism of reasoning, nay the very laws and constitution of the human intellect, would be vitally changed. A Logic might indeed exist, but it would no longer be the Logic we possess." (8)

The non-commutativity introduced by Heisenberg changed classical logic. The old logic works in ideal situations, approximations, in the same way that newtonian mechanics works in some limits. The question about what is the “true” logic of the universe is an empirical one.

The quantum was created by Planck to solve the problem of the thermodynamics of a continuum. The problem of defining the continuum has a long history, starting with Aristotle.

“Mathematicians in the late 19th century (especially Cantor) tried to solve the problem by defining continuity not by human actions but as an infinite "class of points" , thus presupposing the mathematical existence of really existing objects. But what does "mathematical existence" mean here? Russell's paradox already showed during Cantor's lifetime that this naive concept of a class leads to logical paradoxes. The present axiomatic theory of classes avoids those paradoxes of which we have become aware. According to Gödel, the strict proof of its non-contradictory nature cannot be given by a calculus
in time.”(9)

But here it seems that we are mixing mathematics and physics, and that is what I propose. Weizsacker called it “empirical mathematics”. QM and the intuitionism started by Brouwer coincide in two fundamental notions that separate them from classical thinking: the meaning of the continuum and the rejection of the law of the excluded middle. The continuum can be divided infinitely, but step by step because

infinity is potential, not actual. This is expressed by the fact that a quantum system can be described completely at any time by a finite amount of information and that it is always possible to acquire new information about it. (10)

Law without law

“I still do not believe that the Lord God plays dice. If he had wanted to do this, then he would have done it thoroughly and not stopped with a plan for gambling [...]. Then we wouldn't have to search for laws at all.”(11)

This quote by Einstein is very famous, what is not always remarked is that he wasn't against a lack of mechanism but against a mechanism that gives weighted probabilities, some kind of probabilistic algorithm behind nature. But this in not the case in QM, what we have is what Wheeler called “*Law without law*”(12):

“In quantum mechanics the following facts are thus to be recognized. The measurement of a quantity that is undetermined in the preparation state of a system gives rise to a measurement result which is by no law determined. Now, by means of mere formal considerations from this follows that in a sufficiently large ensemble of equal measurements the relative frequencies of the measurement results are already determined by the preparation of the object systems and the measured
observable. Strangely enough, however, this is exactly what Einstein wanted.”(13)

This lack of mechanism is not new in physics. Newton's laws don't provide any mechanism but a description of relations that can be used to make predictions, it's what he states in his famous *hypotheses non fingo.* What changed is that now not all predictions are certain.

Creativity instead of objects

“In all philosophic theory there is an ultimate which is actual in virtue of its accidents. It is only then capable of characterization through its accidental

embodiments, and apart from these accidents is devoid of actuality. In the philosophy of organism this ultimate is termed creativity"[1](14)

What I propose as a better conceptual framework to deal with the situation of modern fundamental science is a philosophy that has actions and creativity as core concepts instead of objects, the pragmatism of Pierce and James and the work of Whitehead are good examples of this kind of thinking. Our physical approximations based on objects hit a limit, maybe if we consider these objects as emergent from more fundamental concepts a further approximation will be possible. For example objects can be viewed as relative to some frame of reference, a particular nexus in a web of relations.

"By praxism we will mean the belief that nature is composed of elementary actions, possibly with unpredictable consequences, rather than of elementary objects. This makes doing (praxis) more basic than being. Praxism leads us to analyze
nature into actions rather than beings. Praxic theories take actions as primary entities, and regard states of being as secondary, relative, derivative from actions, and approximations of limited validity."(15)

Modern science evolved from absolute concepts to relational ones. Programs for a quantum theory of gravity like the one of Finkelstein and Loop quantum gravity rest conceptually on relational ideas. What I've done here is to propose that radical new views in logic, mathematics and physics can be seen as aspects of the same way of thinking. The classical way of thinking that centuries ago tried to reduce nature to a clock now tries to reduce it to a computer, the difference is that today the empirical grounds for that kind of metaphysics is far less solid.

References

1- W. James, Essays in Radical Empiricism. University of Nebraska Press, Lincoln, NB, 1996.

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2- Peter Mittelstaedt ,Laws of Nature, 295-297
3- Carl Friedrich von Weizsäcker: Major Texts in Physics, Springer Briefs on Pioneers in Science and Practice 22, 2014, p.103
4 - David Ritz Finkelstein, MELENCOLIA I.1*, 2007, p. 35
5-Iemhoff, Rosalie, "Intuitionism in the Philosophy of Mathematics", The Stanford Encyclopedia of Philosophy (Winter 2019 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2019/entries/intuitionism/>
6-Carl Friedrich von Weizsäcker, Biological Preliminaries to Logic, found in C.F.v.W Major Texts in Philosophy, Springer Briefs on Pioneers in Science and Practice 23
7-8 David Ritz Finkelstein, Quantum Relativity A Synthesis of the Ideas of Einstein and Heisenberg, p. 3-4
9-Carl Friedrich von Weizsäcker, Time - Empirical Mathematics - Quantum Theory, published in Time, Temporality, Now
10-Carlo Rovelli, Relational Quantum Mechanics, 1997
11-Schilpp, Paul A.: Einstein, Philosopher-Scientist, The Library of Living Philosophers. Evanston: Open Court, 1949
12-Wheeler, J. A.: On Recognizing Law without Law. Am. J. Phys. 51 (1983), pp. 398-404 6
13-Peter Mittelstaedt: Einstein's Objections against Quantum Mechanics, Physics and Philosophy Issn: 1863-7388 2006 (a detailed formal explanation can be found in the paper)
14-Alfred North Whitehead, Process and Reality: An Essay in Cosmology, p. 7
15-David Ritz Finkelstein, Quantum Relativity A Synthesis of the Ideas of Einstein and Heisenberg, p. 26