Determinism and Free Will

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In this article I would like to discuss some of the issues that Emanuele Severino raises in *Law and Chance*, which have a direct connection with Physics, and in particular with the foundations of Quantum Mechanics.
Some years ago (in 2017), I organized a workshop where the two main keynote speakers were Emanuele Severino and Gerard ‘t Hooft (theoretical physicist, Nobel laureate in 1999). The conceptual reasons that led us to organize this encounter can be found in the research line of ‘t Hooft, who aims to provide quantum mechanics with a deterministic foundation. His program seeks to bring this theory back under the umbrella of the most stringent determinism, a goal pursued by Einstein during the last decades of his life. On the other hand, Severino has built up an ontological vision that radically denies any reality to the becoming, a point of view which is often associated with the strict deterministic conception of reality supported by Einstein and Spinoza. Thus, Severino and ‘t Hooft appeared to be somehow the natural (philosophical) interlocutors for each other.

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1. Becoming

In Severino's vision, "becoming" (understood as the coming out of and the return to nothing of things) does not exist, namely, is not an element of reality. Becoming, far from being the most obvious, trivial, and undeniable evidence of the world, is indeed a theory, that is, just one 'interpretation' of events, among the many possible interpretations. Indeed, Severino thinks that the interpretation of becoming, manifested since the Greek origins of Western thought, as an oscillation of things between being and nothing, is just a «very stubborn illusion», a misinterpretation of events. These words sound surprisingly similar to those used by Einstein to describe "time" in a letter to the sister of his beloved friend Michele Besso. With his philosophical research, Severino aimed to provide a foundation for the eternity of beings, the eternity of each single entity, of each single event. This vision is undeniably similar to the vision proposed by General Relativity (GR), in which all events, past, present, and future, have since always coexisted (and will do so forever), as eternally remaining points on the space-time manifold.

In the realm of Physics, the threat for this vision usually comes from the very heart of the other great theoretical construction of 20th century, namely from Quantum Mechanics (QM). Here, in fact, the General Relativistic point of view clashes against Heisenberg's uncertainty principle, according to which the future is not strictly determined by the present, and the present is not strictly determined by the past, because there is a non-eliminable role played by chance in generating even the elementary events.

Physics, at least from the days of Maxwell and Boltzmann, has been accustomed to using probabilistic laws to describe complex events, when only certain macroscopic observables are relevant, and when it is more than reasonable to average over certain (microscopic) degrees of freedom. Then probability and chance are naturally expected to play an important role.

The novelty in the standard formulation of Quantum Mechanics was that even the elementary single event, the absolutely simple event (think for example of the emission of a photon by an electron in an atom, or the decay of a neutron) happens "by pure chance", not controlled by any microscopic variable/law (hidden variables), or, told in other words, the event happens without *a cause*. On the contrary, in the deterministic interpretation that 't Hooft proposes, Quantum Mechanics is brought back to the most complete, strict, Einsteinian determinism. 't Hooft's vision is thus somehow close to Severino's idea of the eternity of every single event, of the non-existence of becoming (where "becoming" is understood, since the Greeks to today, as the random emergence of events from nothing).

2. Cellular Automaton

An important motivation of the 't Hooft program, is precisely the fact that, once a greater conceptual homogeneity between QM and GR has been obtained (particularly as regard the ideas of causality and time), then the much coveted goal of a unified theory of all physical phenomena would certainly become closer.

The possibility, as shown by 't Hooft, of describing a cellular automaton, which is a perfectly classical and deterministic system, by using the mathematical language of Quantum Mechanics, inevitably suggests that, perhaps, even the much more complicated system we observe, namely the physical world, so well described by that sophisticated quantum field theory called the Standard Model, may in fact be nothing but a very complicated but deterministic cellular automaton.

3. Influential Metaphysics

Severino's ontology could perhaps be considered as a kind of «influential metaphysics" of General Relativity, just to use a Popper's expression. Severino could even seem to be in some respects stricter than Einstein when he establishes the eternity of every being, even if he usually emphasizes the different conceptual origins of the two logical structures. However, the common features and the intrinsic coherence make it tempting to overlook the different origins of the two pictures, and instead to point at the similarities. It is also true that the scope and the terms of the two frameworks differ so much, that the existence of some common language between the two structures appears to be almost miraculous.

4. Single event in QM

It is well known that at least two of the founding fathers of QM, Einstein and Schroedinger, put forward critical insights into various aspects of the quantum theory. Although these insights have generated research for about now 90 years, many aspects of those problems remain without a shared consensus in the scientific community. Let us here recall just a few of these points:

a) For Einstein, QM is not a theory of the single event. The fact that the theory has such a radically statistical structure, prevents predictions about individual events (except for certain special cases). To quote Einstein: «The wave function does not describe, in any way, the condition of 'a' single system» (A. Einstein, Physics and Reality, 1936).
b) In the famous EPR article (1935), Einstein claims to have demonstrated the «incompleteness» of Quantum Mechanics: there are elements of the physical reality that are not described, or captured, by the Quantum wave function.
c) Along the same lines, in the same year, Schroedinger launches another important idea in the form of his famous "cat paradox". If we follow the standard interpretation of QM, in fact, we are forced to say that before a direct observation ('measure') has been performed, the cat closed in a box should be considered both alive and dead at the same time! Just as the radioactive atom (which controls the life of the feline through a clever mechanism) would result in a linear superposition of the decayed and non-decayed states, before observation.
d) For both Einstein and Schroedinger, the statistical character of QM, although it captures a description of reality to which each future model should be compared, is not a good foundation upon which to build a theory able to describe single events (rather than just statistical sets of events). Exactly as, according to Einstein, «the Newtonian laws of point particle mechanics could not be inferred from thermodynamics» (Physics and Reality, 1936).

Einstein and Schroedinger's attitude towards the successful Quantum Theory resembles what the young Einstein, influenced by Mach, expressed with regard to the fundamental concepts of absolute space and time elaborated by Newton: «The prodigious success of his doctrine [Newtonian mechanics] obscured [for two centuries] the critical investigation of its foundations» (Herbert Spencer Lecture, Oxford 1933).

5. Free Will (Theorem)

An important topic in the foundations of quantum mechanics directly involves the concept of free will, a concept which might seem to be linked, at a first sight, to very concrete legal or social problems, rather than to the foundations of a quite abstract physical theory.

In fact, one of the most debated (and paradoxical) results of quantum research in recent years is the so-called Free Will Theorem. This proceeds roughly as follows. The authors, Conway and Kochen, give a formal definition of free will, which makes it possible to «quantify» the degree of «free will» possessed by a particular entity. Then, they analyze a Bell-type experiment (involving electron spin or photon spin/helicity), and demonstrate that, on the basis of commonly accepted quantum mechanical principles, the observed electron (photon) must have the same degree of «free will» as the observer who performs the experiment.

The paradoxical and astonishing aspect of this conclusion is evident. How could an elementary particle (elementary, therefore without structure) have the same degree of free will as the human being who observes it? The real purpose of the theorem thus appears to be to highlight the paradoxical aspects of Quantum Theory, quite like the "Schroedinger cat" experiment.

For some, the content of the Free Will Theorem is even tautological. Indeed, if the world is completely deterministic, then neither the electron nor the observer have any free will, because everything is completely predetermined. On the other hand, if we admit that the observer has free will, then the world is not completely deterministic, and we pay the price of seeing the electron exhibiting a kind of indeterminacy, a «freedom» of choice, almost qualifiable as «its own free will».

6. Bell's Inequality

Bell's inequality is the most frequently invoked argument against the possibility of building deterministic and local models of quantum phenomena. The vast majority of physicists believes that the lengthy debate triggered by Einstein's criticism in the 1930s has been definitively closed in favor of a non-deterministic interpretation of QM, since the appearance of Bell's theorem in 1964. The supporters of a return to determinism are often viewed as people far away from the mainstream of scientific research. Nevertheless, some of the most original thinkers of our days, including 't Hooft, Penrose, Ghirardi, and others, have questioned various aspects of the standard Copenhagen interpretation of QM. And Bell's inequality plays a key role in favor of the standard interpretation.

Bell's inequalities are obeyed by any theory (with hidden variables) that is deterministic and local, and are violated by quantum mechanics, and by the observed quantum correlations. This is the standard argument that excludes a priori all local deterministic models of quantum phenomena involving hidden variables, since, as said, they obey Bell's inequalities, while QM and experimental results violate them. As a consequence, most people renounce to the deterministic local models in favor of quantum indeterminacy.

However, the importance of the hypothesis of «measurement independence» in demonstrating the theorem was already very clear to John Bell himself, and subsequently to other scientists like Shimony, Clauser, Horn, and others. This hypothesis can be linked to the «free will» of the observer who performs, or supervise, the measure; that is to say, linked to the freedom of the observer who arbitrarily chooses the orientation of the polarizing filters used in the measurement. The crucial role played by this apparently innocent and obvious hypothesis was pointed out by John Bell in an explicit sentence: «If free will does not exist, then the deduction of the Bell inequalities is not valid.»

In other words, the hypothesis of free will, or the "obvious" assumption of observer's freedom of choice, is essential to prove the Bell's inequalities.

The use of the free will postulate (or equivalent assertions) to prove Bell's inequalities is confirmed also by the most recent formulations of such ideas (see, for example, Brukner, Costa, Pikovski, Zych, «Bell Theorem for Temporal Order», arxiv:1708.00248). So, Bell's theorem and its (indirect) support for QM may appear as a kind of projection of the «obvious» hypothesis of attributing «free will» to human beings. Although it is not the only working model, Quantum Mechanics appears instead under the weird light of being the model that fulfills our (natural) desire to attribute free will to humans! One could almost say, in this subtle and specific sense, that QM is a «projection» of the human mind, caused by the dogma, which sounds typically Ptolemaic, of maintaining to humans the property of free will. These ideas are in line also with the Free Will Theorem, whose authors suggest (given a mathematical definition of free will) that if Quantum Mechanics is true, then the electron and its (human) observer should have exactly the same degree of "freedom of choice": a clearly absurd situation.

7. Measurement independence

Summarizing, the «hidden», and apparently trivial, hypothesis behind Bell's inequality, the so called «measurement independence», is closely related to the possibility of attributing "freedom of choice" to the observer who performs, or supervises, the measure. Somehow, since humans want to have free will, they must therefore also attribute it to elementary particles. A fully deterministic description of the (micro) world would automatically imply a negation of human free will. From this prospective, Quantum Mechanics looks almost like a "choice". Humans want to have free will, so they naturally have to choose QM (which somehow guarantees it) over other models. Different models are discarded essentially because they are deterministic (and non-local), although they could in principle work (such as Bohmian mechanics, for example, at least in the non-relativistic regime).

Quite recently (2010-2019), Michael Hall (Canberra) has clearly shown that, provided the «measurement independence» hypothesis is relaxed "a bit" (for the definition of "a bit", see the Hall's papers), then it is possible to build local and deterministic models able to perfectly mimic the experimentally observed quantum correlations.

8. Conclusion

The considerations exposed in Law and Chance certainly help to illuminate the (so I would call them) "Severinian" aspects of this situation: humans “want”, “believe”, and “choose” to have “free will”. So, somehow humans «choose» the world to be indeterminate in order to preserve their supposed “freedom of choice”; they «choose» a world that is «becoming» (indeterminism) in order to better manipulate it. In this above-mentioned sense, the usual non-deterministic interpretation of QM looks rather like a «projection» of our mind. In Severino’s words, “the will-to-power ‘wants’ the ‘becoming’ to exist, wants things to come out of nothing without a cause (randomly), in order to maximize the possibility of manipulating them”. In some way, it wants standard interpretation of Quantum Mechanics to be the only proper representation of the physical world.

Finally, I should also add that, the prevalence of a non-deterministic vision in the standard interpretation of quantum mechanics is described in «Law and Chance» as one of the many results of the more general course of Western philosophical thinking, over the last two centuries. The progressive destruction of immutable, operated by the “faith in the reality of becoming”, which secretly moves, according to Severino, the entire history of Western thought.

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