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A New Argument on Schrödinger's Cat

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Abstract.-This article adds new details to the Schrödinger's cat argument that allow the development of a new argument from which 24 violations of the Second Law of logic are deduced. Schrödinger's cat argument is also examined from the perspective of the old *problem of change*, which has remained unsolved for 26 centuries, and which physics (the science of change in a changing physical world) has completely forgotten.

1 Introduction

In my opinion, the argument of Schrödinger's cat [24] is one of the most brilliant challenges that have been proposed throughout the history of modern physics. So brilliant that 89 years after its publication no satisfactory answer has been given. The argument links the fate of a macroscopic system (the contents of the famous *steel room*) with that of a quantum micro-system (atom of the radioactive mini-sample), thus challenging certain interpretations of quantum mechanics, such as that of Copenhagen, which link the collapse of the wave function describing the superposed states of such quantum systems with concrete facts of observation.

I have dealt with the issue of Schrödinger's cat from the perspective of logic and biology of the famous cat in a mini-series of three mini-articles [15] (I write this way because, being a dissident author, I believe that the probability of reading a short article is higher than that of a long article). Here I develop a new argument that leads to conclusions similar to those in that mini-series, which are also similar to those that Schrödinger himself posited. The argument involves the Principle of Directional Evolution of the universe, which is introduced in the next section, and the Second Law of Logic.

Finally, the collapse of superimposed quantum states is examined from the point of view of change itself, i.e. from the point of view of the classical problem of change, which is still the old problem raised by Parmenides and illustrated by Zeno with his famous paradoxes. It is worth remembering that this problem has not been solved (not even approximately) for more than 2500 years and that physics, the science of change (as J. C. Maxwell would surely say [17, p.98]), has completely forgotten. The collapse of Schrödinger atom is an example of a canonical change that remains unresolved as such.

2 The Principle of Directional Evolution of the universe

As will be noted, the inductive principle introduced in this section is a generalization of the Second Law of thermodynamics that makes explicit the independence of the directional evolution of the universe from its possible observers:

Principle 1 (of Directional Evolution) *The observable universe evolves independently of its observers and always in the same direction of increasing its global entropy.*

Where entropy could be replaced with isotropy because the former can be defined in terms of the latter, and the latter is less confusing than the former [12]. The independence of the evolution of the universe with respect to its possible observers is included because for most of the history of the universe there were no observers of its evolution, of whose directionality there is enormous empirical evidence, including that which has been recorded in the rocks of our planet since long before terrestrial observers appeared. In any case, the empirical evidence for this principle is sufficiently extensive to be accepted without much discussion. In a (very) informal way one could say that if when uncorking a bottle of champagne the gas spontaneously released from the champagne in the bottle will not spontaneously return to the champagne in the bottle no matter how many millions of years one waits for it to do so, then the universe evolves according to the Principle of Directional Evolution.

The statement of the following theorem is usually accepted as an inductive principle that needs no proof. Here it will be proved in basic formal terms from the Principle of Directional Evolution of the universe. Assuming that a physical law is consistent if a contradiction cannot be deduced from it, and taking into account that the violation of any of the two fundamental laws of logic (the Principle of Identity and the Principle of Non-Contradiction) allows to prove any proposition, it is immediate to prove the following:

Theorem 1 (of the Consistent Universe) *The universe evolves under the control of a unique set of invariant and consistent physical laws.*

Proof.-If any of the laws governing the evolution of the universe were inconsistent, then anything could be demonstrated. For example, that the universe is evolving in different directions at the same time, which violates the Principle of Directional Evolution. On the other hand, if the set of consistent laws governing the evolution of the universe were not a unique set of invariant laws, then the evolution of the universe could change over time; and different regions of the universe could evolve in different directions, which is also against the Principle of Directional Evolution of the universe. Therefore, the universe evolves under the control of a unique set of invariant and consistent physical laws. □

The Principle of Directional Evolution and the Consistent Universe Theorem do not seem to be compatible with physical laws that change with time, as some authors have defended (P. Dirac [6], L. Smolin [26]). That principle and that theorem, together with the Second Law of logic, are the fundamental pillars on which the new argument about Schrödinger's cat introduced in this article has been built.

3 Adding details to Schrödinger's cat

Let us recall Schrödinger's original argument about his dead and alive cat (text in straight brackets, italic and underline are mine) [24, §5]:

> Imagine a cat locked up in a room of steel together with the following hellish machine (which has to be secured from direct attack by the cat): A tiny amount of radioactive material is placed inside a Geiger counter, so tiny that during one hour perhaps one of its atoms decays, but equally likely none. If it does decay then the counter is triggered and activates, via a relais, a little hammer which breaks a container of prussic acid [hydrogen cyanide]. After this system has been left alone for one hour, one can say that the cat is still alive provided no atom has decayed in the mean time. The first decay of an atom would have poisoned the cat. *In terms of the Ψ-function of the entire system this is expressed as a mixture of a living and a dead cat.*

According to this Schrödinger text, in the argument developed in the next section, the following physical objects (Schrödinger's objects from now on) with their corresponding superposed states are considered:

1.- Radioactive atom: decayed and not decayed.

2.- Container: broken and not broken.

3.- Cat: poisoned and not poisoned; dying and not dying; dead and not dead.

In what follows I will assume that the causes of the superimposed states of the container and the cat are only those derived from Schrödinger's text: the container is broken only by the mechanism indicated in the text; the cat is poisoned exclusively by the poison in the container; the cat enters the process of its death exclusively by that poisoning; and it dies by that same process. Any other object, fact or cause not directly included in Schrödinger's text will be ignored. The following section discusses the chronological and causal relationships between the superposed states of these Schrödinger's objects.

4 Superposition or consistency

Naturally there is a chronological and a causal relationship between the states of Schrödinger's objects. In the chronological order, the first to reach a superposition of states is the radioactive atom, which occurs as soon as the steel room is closed. After a time t_1 (the time it takes for the mechanism to hit the container), it is followed by the container with the poison. After t_2 (the time it takes for the cat to start breathing the poison), the poisoned cat follows. After a time t_3 (the time it takes for the poison to reach the lethal concentration for the cat) the dying cat follows. And finally after a time t_4 (the time it takes for the biological process of the death of the cat) the dead cat follows. Consequently, after a time $t_{sc} = t_1 + t_2 + t_3 + t_4$ all Schrodinger objects, and in the chronological order indicated, will be in a superposition of states.

The reason why it is necessary to consider the simultaneous superposition of states of all macroscopic Schrödinger objects is the following: the superposition of states (decayed and non-decayed) of the radioactive atom implies the coexistence of a decayed atom, and of a non-decayed atom. The existence of a decayed atom implies the existence of a broken container; and the existence of a non-decayed atom implies the existence of a non-broken container. In turn, the existence of a broken container implies the existence of a poisoned cat; and the existence of an non-broken container implies the existence of an non-poisoned cat. And the same argument holds for the poisoned and non-poisoned cat; and for the dying and non-dying cat.

As for the causal relations between the states of the different Schrödinger objects, it will be initially accepted that an atom can be decayed and non-decayed at the same time (although that seems to be a violation of the Second Law of logic). And the reason for accepting that possibility is that individual atoms are not part of our perceptual world, therefore we have no inductive knowledge of their behavior. But we do, and overwhelmingly so, of the rest of Schrödinger's objects. Of these objects it cannot be accepted that they violate the Second Law of logic: we have never observed that a macroscopic object, as is the case of the macroscopic Schrödinger's objects, violates that law. A violation that, on the other hand, would destroy the logical argumentation: any proposition could be proved if the Second Law of logic is violated. A violation incompatible with the Consistent Universe Theorem and therefore with the Principle of Directional Evolution. We list below the superposed states of each of Schrödinger's objects in the chronological order in which they appear:

1.- A decayed atom and a non-decayed atom.

2.- A broken container and a non-broken container.

3.- A poisoned cat and a non-poisoned cat.

4.- A dying cat and a non-dying cat.

5.- A dead cat and a non-dead cat.

For the reasons given, the last four (macroscopic) cases would represent four violations of the Second Law of logic. But there are 20 other violations of that law because each state of each of the Schrödinger objects is compatible with one of the states of one of the other objects, and incompatible with the other state of that object. For example, the poisoned cat is compatible with the broken container, and incompatible with the non-broken container. Each of the superpositions of incompatible states of Schrödinger objects is actually a violation of the Second Law of logic, because it implies the existence of two different objects in such a way that the state of each of them is logically impossible to exist at the same time as the state of the other object. Therefore, from the instant t_{sc}, we would have 24 violations of the Second Law of Logic; for example: decayed atom and non-broken container; decayed atom and non-poisoned cat; non-decayed atom and broken container; dying cat and dead cat; non-dying cat and dead cat: etc.

It could be argued that only one state of each of the objects coexists with only one state of each of the other objects, but that would mean that the corresponding collapses have occurred before observing the interior of the steel room. Therefore, to accept that an atom can be at the same time in an S-state and in a non-S-state, implies at least 24 violations of the Second Law of logic, and therefore the violation of the Consistent Universe Theorem and of the Principle of Directional Evolution of the universe. Or put in informal terms, if Schrödinger's radioactive atom can be simultaneously decayed and non-decayed, then after a finite time the gas released from a bottle of champagne spontaneously returns to the same champagne in the same bottle.

5 Schrödinger atom and the problem of change

The collapse of Schrödinger atom is an example of change, in this case a canonical change, the most simple of changes: a change between two states between which there are no intermediate states: either the atom is collapsed and exists in only one state, or it is not collapsed and the atom exists in two superposed states (decayed and non-decayed). This section briefly discusses the collapse of the Schrödinger atom wave function from the point of view of a canonical change as such a canonical change, i. e. how one can go from one state to a different state without intermediate states.

Posed by Parmenides and illustrated by his disciple Zeno with his famous paradoxes, the problem of change has been unsolved for 26 centuries, and almost 25 centuries forgotten by physics, to the point that a good number of contemporary physicists ignore its existence. It is one of the embarrassments of modern physics because it will not be possible to explain the physical world, which is in continuous change, if the problem of change is not previously solved. And the problem of change will not be solved as long as it continues to be ignored by physics, the science of change, the science of the regular succession of events, in the words of J. C. Maxwell [16, p. 1].

For their part, some philosophers such as G. W. F. Hegel [9, 10, 19, 20, 23, 27] argued that change is an inconsistent notion; while others, such as J. M. E. McTaggart, came to the same conclusion as Parmenides [21] on the impossibility of change [18]. We now know that the problem of change is complicated by our perception of natural phenomena as continuous phenomena, when in fact that continuous perception is a delusion of our brain, which takes 13 milli-seconds to process any image that comes to it from the external world [22, 7]. We see natural phenomena as continuous for the same reason that we see as continuous the action projected on a screen from the discontinuous sequence of the frames of the projected film.

In fact it can be formally proved that the problem of change has no solution in the spacetime continuum [11, 14, 13]. And it does not, as we shall soon see, because the set of real numbers is densely ordered: between every two of them there always exist other different real numbers: exactly $2^{\aleph_0}$ different numbers, which gives rise to the so called Dimension Problem proved by G. Cantor [1, 5, 25, 28, 8, 4, 2, 3], and which I often provocatively illustrate with the same inevitable infinitist conclusion: light traverses in one thousandth of a second the same number of points in space as in 14800 million years (exactly $2^{\aleph_0}$ points). Or that light takes the same number of time instants to travel through one thousandth of a millimeter as it takes to travel through 9.9 billion light years (exactly $2^{\aleph_0}$ instants).[1] On the other hand, it can also be proved that the problem of change could be solved if space and time were both discrete [11, 14, 13].

The canonical change **C** that supposes for Schrödinger atom to collapse its two superposed states into a single state has to last a non-zero time, otherwise it would be an instantaneous change, a change of zero duration, and there would exist an instant in which that atom would be collapsed and non-collapsed, which is impossible even in quantum mechanics. Therefore **C** cannot be instantaneous. Let then t be any real number greater than 0 and suppose that the change **C** lasts for a time t. Consider the real interval $(0, t)$, and any element τ in $(0, t)$. If at the instant τ Schrödinger atom is still in a superposition of states, then the change **C** has not yet begun and its duration will be less than t. If at the instant τ Schrödinger atom is already collapsed into a single state, then the duration of the change **C** will also be less than t. But the Schrödinger atom can only be in these two states: collapsed and non-collapsed. Therefore the change **C** has to last for a time less than t. And being t any real number greater than zero, we must conclude that the change **C** has to last for a time less than any real number greater than zero. But the only real number less than any real number greater than zero is precisely zero.

[1] The editor of a well-known physics journal required me to prove these claims, ignoring the fact that they have been proven for more than 120 years.

Thus the duration of **C** must be zero. The whole argument then leads us to the final conclusion that the change **C** cannot be instantaneous, but it must be instantaneous. Consequently, and as it could not be otherwise, the change **C** is also impossible in the spacetime continuum. It could be that our models and explanations of what happens in the physical world were not the most appropriate.

6 Conclusion

All interpretations of quantum mechanics involving superposition of states and collapses produced by the observation of the corresponding quantum systems, will also have to interpret the 24 violations of the Second Law of logic deduced in the above argument about Schrödinger's cat, which is an immediate extension of Schrödinger's original argument. Although many contemporary physicists encourage disregarding these logical "irregularities", I remind all of them that a simple violation of the Second Law of logic allows one to prove any proposition one wishes to prove, which would make the construction of science impossible. And for those who defend that each of the options of a superposition of states collapses into a new universe, they will have to extend the ability to create universes from acts of observation.

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