The Schrodinger's cat though experiment

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CHAPTER I

Schrödinger's cat

Schrödinger's cat is a thought experiment imagined in 1935 by physicist Erwin Schrödinger to highlight supposed gaps in the Copenhagen interpretation of quantum mechanics, and specifically to emphasize the problem of measurement.

Quantum mechanics is relatively difficult to conceive because its description of the world is based on probability amplitudes (wave functions). These wave functions can be in a linear combination, resulting in "superposed states." However, during a so-called "measurement" operation, the quantum object will be found in a determined state; the wave function gives the probabilities of finding the object in a certain state.

According to the Copenhagen interpretation, it is the measurement that disturbs the system and causes it to bifurcate from a superposed quantum state (an atom both intact and decayed, for example... but with a probability of decay within a given time interval that is perfectly determined) to a measured state. This state does not exist prior to measurement: it is the measurement that brings it about.

However, the notion of measurement or bifurcation does not appear explicitly or even indirectly in the quantum formalism, and attempts to bring this notion out encounter extreme difficulties. As a result, some physicists do not attribute any physical reality to the concept of measurement or observation. For them, superposed states do not collapse or "bifurcate," and the measured state does not actually exist.

Schrödinger's cat thought experiment was a response to Einstein's objection to the Copenhagen interpretation of quantum mechanics. Einstein argued that the idea of a superposition of states was absurd, and that quantum mechanics was incomplete because it did not provide a complete physical description of reality. Schrödinger's cat was intended to illustrate the absurdity of the Copenhagen interpretation by demonstrating how it leads to paradoxical situations. The cat is meant to represent a macroscopic object, which according to the Copenhagen interpretation, can exist in a superposition of states until it is observed. This leads to the paradoxical situation where the cat is both alive and dead until it is observed, which seems to violate our common-sense understanding of the world. The thought experiment highlights the strange and counterintuitive nature of quantum mechanics and continues to be an important part of discussions surrounding the interpretation of quantum theory.

In this experiment, a cat is placed in a closed box which also contains a source of radiation, such as a short half-life radioactive atom, a radiation detector, a hammer, and a flask of poison. If the atom decays, the radiation detector triggers the hammer, which breaks the flask of poison and kills the cat. If the atom does not decay, the cat survives.

The idea behind this experiment is that at the quantum level, the atom is in a state of quantum superposition where it is both decaying and not decaying. As long as the box is closed and no one observes it, the cat is also in a state of quantum superposition where it is both dead and alive.

Quantum superposition is an idea from quantum mechanics that suggests subatomic particles can be in multiple states simultaneously. Superposition does not apply to macroscopic objects like cats because their size and complexity prevent the quantum state from spreading to their scale. However, the cat is used in this experiment to help understand the implications of quantum superposition.

According to quantum theory, the closed box creates a situation where the atom and the cat are in states of quantum superposition, which means they can exist simultaneously in two different states until the box is opened. Once the box is opened and the cat is observed, the quantum state of the particle is supposed to "collapse" or "reduce" to a particular state.

This thought experiment is used to explore the implications of quantum mechanics and the difficulties associated with measuring quantum systems. The cat is used as a metaphor for a more complex quantum system, and this thought experiment helps to highlight the strange nature of quantum mechanics.

CHAPTER II

Schrodinger's cat interpretation

Schrödinger's cat was invented by physicist Erwin Schrödinger to demonstrate how easy it is to arrive at a nonsensical prediction by misinterpreting or misunderstanding quantum mechanics. It is important to note that Schrödinger did not propose the cat experiment as a way to test quantum mechanics or explore the role of the observer in the measurement process.The true purpose of the cat experiment was to illustrate how misunderstandings or misinterpretations of quantum mechanics could lead to absurd predictions. This experiment has been widely discussed and debated, but it was not intended to propose an actual experiment or to suggest that a cat could exist in a superposition of quantum states.

Einstein wrote to Schrödinger: "You are the only contemporary physicist, besides Laue, who sees that one cannot get around the assumption of reality, if only one is honest. Most of them simply do not see what sort of risky game they are playing with reality—reality as something independent of what is experimentally established. Their interpretation is, however, refuted most elegantly by your system of radioactive atom + amplifier + charge of gunpowder + cat in a box, in which the psi-function of the system contains both the cat alive and blown to bits. Nobody really doubts that the presence or absence of the cat is something independent of the act of observation."

Einstein wrote to Schrödinger about his ideas on the concept of reality in quantum mechanics. He thought that most physicists were playing a risky game by assuming that reality depended on experimental results. He praised Schrödinger for recognizing that reality was an independent concept and that honesty demanded that one accept this assumption. Einstein believed that Schrödinger's thought experiment with the cat in the box disproved the idea that reality was "fuzzy" and dependent on observation. He claimed that the psi-function of the system contained both the living and the broken cat, and that the presence or absence of the cat was independent of the act of observation. Einstein believed that the universe had already determined what happened before anyone observed it, and that there was a fixed reality independent of our observations, as opposed to the fuzzy, observer-dependent reality that some physicists believed in. from which the sentence: "God does not play dice."

Quantum systems are described by a probabilistically weighted superposition of all possible, allowable states, but an observation or measurement will always reveal one definitive state. This means that any interaction between two quantum particles can determine the quantum state and collapse the quantum wavefunction.

The Schrödinger's cat experiment is based on the idea that a quantum system can exist in a superposition of states until it is observed or measured, at which point it collapses into one definitive state. In the experiment, a cat is placed in a sealed box with a radioactive atom, a Geiger counter, a hammer, and a vial of poison. If the atom decays, the Geiger counter will detect it, triggering the hammer to break the vial and release the poison, killing the cat. Until the box is opened and the cat is observed, it can be considered to be in a superposition of states, both alive and dead at the same time. However, in reality, the possible decay of the atom triggers the door mechanism, which is where the transition from bizarre quantum behavior to familiar classical behavior occurs. The cat is either alive or dead, but the observer doesn't know which until the box is opened. This experiment has sparked significant discussion about the nature of quantum mechanics and the role of the observer in the measurement process.

There are several interpretations of quantum mechanics, including the Copenhagen interpretation, which suggests that a system remains in a superposition until it is observed, at which point the superposition collapses and the system is found to be in a particular state. However, this interpretation raises questions about what happens during the measurement process and how it affects the quantum state of the system. at which point the superposition collapses and the system is found to be in a particular state.

Popular interpretations of quantum mechanics include the many-worlds interpretation, which proposes that each quantum event creates multiple parallel universes where all possible outcomes occur, and the objective reduction interpretation, which suggests that the measurement process reduces the quantum state of a system due to the interaction between the system and the measuring device. But none of these theories can be scientifically proven nowadays.

Recently, a new perspective on the Schrödinger's cat paradox has been proposed, which suggests that the cat is a non-paradoxical macroscopic correlation where one of the correlated systems is a detector. This idea suggests that the entangled state is not a paradoxical macroscopic superposition of states, but a phase-dependent superposition of correlations between the subsystem states. While this perspective resolves the problem of definitive results, it doesn't fully address the measurement problem, as the entangled state remains reversible. Further research is needed to fully understand this perspective and its implications.

It is essential to note that the cat is a valid observer, and any non-reversible interaction that occurs within that system, even if it's completely sealed off from the outside world in that box, will reveal one and only one definitive state: either the atom has decayed, or it has not. Schrödinger knew that the cat must be either dead or alive, and the cat itself will never be in a superposition of quantum states but will either be definitively dead or alive at any moment in time. While the Schrödinger's cat experiment is widely known as a thought experiment, it remains a valuable tool for exploring the implications of quantum mechanics.

In the field of quantum computing, maintaining quantum behavior for a substantial amount of time is a significant challenge, even for just a few qubits.

In conclusion, the key takeaway from Schrödinger's cat thought experiment is that quantum systems are probabilistically weighted, and an observation or measurement will reveal one and only one definitive state. This is true regardless of which interpretation of quantum mechanics one chooses. In the case of Schrödinger's Cat, the story was not meant to be taken literally, but rather as a critique of the idea of quantum blurriness and the Copenhagen interpretation of quantum mechanics. Understanding the original argument allows us to engage in meaningful debates and discussions about the topic, rather than perpetuating misunderstandings.The Schrödinger's cat paradox remains a valuable tool for exploring the implications of quantum mechanics and continues to inspire discussion and debate among scientists and philosophers alike.