WHO KILLED THE CAT?

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ABSTRACT

This essay will discuss the purpose and comprehensive understanding of the Schrödinger's thought experiment, well known as Schrödinger's cat.
As we know, ever since it was first heard of, Schrödinger's cat was thought by many to be a paradox that challenges the principles of logic.
Over time, due to its controversial nature, numerous misconceptions and myths regarding Schrödinger's experiment have emerged, leading to a distorted understanding of this intriguing concept.
This essay aims to debunk common myths surrounding Schrödinger's cat and provide a more accurate portrayal of its significance.
Schrödinger's experiment has been a useful tool in the field of Quantum Mechanics and has contributed a lot to the understanding of the microscopic world and to raising it to public awareness.
But does it even effect our everyday life? Do we even understand its full meaning?
In this article we will lay out quantum mechanics' main properties and discuss 2 main myths regarding Schrödinger's thought experiment:

1. Schrödinger's cat is both dead and alive simultaneously, and once found dead – the observer has killed it.
2. Schrödinger's cat demonstrates the collapse of the wavefunction.

In addition, we will address a few examples of how Schrödinger's cat applies to our daily lives, illustrate some of the paradoxes inherent in it, and demonstrate the magic of the microscopic world.
We will come to see that this experiment serves as a theoretical illustration to highlight the peculiar and counterintuitive nature of superposition, which is a fundamental concept in quantum theory.
This article concludes that the apparent paradox arises from the combination of quantum superposition and classical macroscopic observation, and the cat was just a tool meant to illustrate the bizarre implications of quantum mechanics.

INTRODUCTION

> *"Since its beginnings in 1900, the quantum theory has led to the most spectacularly well confirmed predictions ever made in science (some experimental results agree with the theoretical predictions up to one part in a billion), and it underpins all modern electronics and telecommunications. It explains the stability of atoms and of stars, and lies at the foundation of the whole of particle physics, but also solid state physics, chemistry, and thus, in principle, biology. It is truly our most fundamental theory of the world. Yet, to quote the famous American physicist Richard Feynman,2 "nobody understands quantum mechanics"*
> -- Jean Bricmont, 2016, *Making Sense of Quantum Mechanics*

There are many ways in which quantum mechanics has been described throughout history, and as controversial as it is, we all agree it has revolutionized our understanding of the physical world and has challenged many classical theories.
Such an unconventional approach to our reality, must have undergone many changes throughout those years, some of which are not necessarily correct.
In fact, the myths surrounding this branch of physics are so various, that the distinction between what it true and what is false is one of the most important steps towards understanding it.
Bricmont (Bricmont, 2016) names two main mysteries of quantum mechanics: superposition and entanglement.

The first, is the vaguest and probably the one most referred to when it comes to Schrödinger's cat. Quantum mechanics introduces principles that differ from classical mechanics. One of said principles is wave-particle duality, which suggests that particles can exhibit both wave-like and particle-like behavior, and that every quantum system can be described by a wave function. Meaning, each state is assigned a probability, and the result is governed by the collapse of the wave function into one definite state.
This introduces inherent uncertainty, as expressed by Heisenberg's uncertainty principle.
superposition describes a quantum system that can exist in multiple states simultaneously.
In contrast to classical physics, where objects are typically considered to be in a single state at any point in time, in the quantum realm, particles can be in a combination of several different states at once.
Mathematically, we will denote linear superposition of a quantum system, which can be, for example, in a superposition of both states $|A\rangle$ and $|B\rangle$, as follows:

$$|\psi\rangle = \alpha|A\rangle + \beta|B\rangle$$

where $|\psi\rangle$ represents the state of superposition the system is in, and $\alpha, \beta \in \mathbb{C}$ are called probability amplitudes, which determine the probabilities of the system being observed in each state.

The second, referred to as *spukhafte Fernwirkungen* – "spooky action at a distance" by Albert Einstein in a letter to Max Born on 3 March 1947, describes the strong correlation between particles that are physically separated. Entangled particles that cannot each be described independently of the other, and even when there is a vast distance between them, changes made to one particle can instantaneously affect the other.
Entanglement is, in fact, a direct implication of superposition. When particles become entangled, their states become dependent, and the whole system is described by a single combined wave function.

Much more will be discussed about the collapse of the wave function, the act of measurement which causes it, and the state of superposition, but to start our journey towards a further understanding of dead-and-alive cats, we would like to step back and discuss the importance of quantum mechanics. quantum mechanics is irreplaceable in modern physics, as it explains microscopic phenomena which classical physics fails to adequately explain, exposes the fundamental nature of our reality by challenging our classical intuitions, and much more.
It has left its marks in many fields of technology as well: quantum Information and computing, the development of semiconductor devices, lasers, and atomic clocks, which have transformative applications in areas such as electronics, telecommunications, and precision measurements.
As for present days, quantum technologies are being explored for cryptography and improved imaging techniques. All of these and many more, were made possible using quantum mechanics.
Indeed, despite the difficulty comprehending the quantum world, it is truly remarkable how people - scientists and engineers, use it in their calculations without appreciating the care and thought that went into it.
We have gotten used to hearing about quantum calculator, "super computers", as our brains have been trained well to allow us not to feel discomfort with the word quantum, expressing ideas that are far beyond our intuition's reach. Therefore, to begin to understand the quantum world and its size, we would like to construct a bridge between our intuition and the quantum realm:

Imagin the following experiment: a beam of particles, electrons for example, is directed toward a barrier with two slits. Behind the barrier there is a particles detector. One would think the particles would behave as individual, each passing through one of the two possible slits, creating two distinct dots on the screen.
However, that is not the case. When the particles are not observed, they exhibit an interference pattern on the screen, which resembles the pattern created by overlapping light passing through two slits, indicating that the particles have simultaneously taken multiple paths.
This experiment is called The Double-slit experiment [1], and it demonstrates the type of thinking we should embrace in order to understand quantum mechanics, everything can be described as a wave.

Our goal in this essay is to shake off the quantum myths we have grown so accustomed to by visiting the paradoxes Schrödinger's experiment brings with it, we wish to challenge the sense of calm we have when using this experiment as a reference to something, and its efficient tools to describe our world.

In section 1 we will take a historical tour, motivating our current understanding of Schrödinger’s experiment through the lens of different counter-intuitive ideas.
In section 2 we will discuss the measurement problem, as it is a key point of the cat paradox.
In the third section we will address the myths stating the cat is in a state of life and death until the moment the box is opened, when the cat is somehow forced into ‘aliveness’ or ‘deadness’ through the action of looking inside the box, as well as that Schrödinger's cat is aimed to demonstrate the collapse of the wavefunction.
It is hopeless to cover all the myths and all the relevant ideas in just one essay, but we will try and tell the main storyline through the core concepts.
In the fourth section we will give our conclusions and additional remarks.

SECTION 1

SCHRODINGER'S THOUGHT EXPIREMENT

The story of Schrödinger's cat starts in 1935, as part of some correspondence [2] between Albert Einstein and the now very famous, Erwing Schrödinger - the namesake of the thought experiment. This correspondence was intended to be a discussion on the EPR article [3] (named after its three authors Einstein, Podolsky and Rosen).

Let us set the ground first, explaining The EPR article and the common approaches and interpretations of quantum mechanics at that time.
The EPR article proposes a thought experiment aimed to argue that Quantum Mechanics is an incomplete model of reality. It points out issues with the Copenhagen interpretation of quantum mechanics [4], which states that particles are in a state of superposition until they get in contact with an observer, at which time a state is chosen according to the probability distribution.
Given two entangled particles, the EPR article states that if the position of the first particle is measured then the position of the second one can be predicted deterministically, the implication being that information is transferred between the particles instantaneously, and therefore contradicting the principles of special relativity.

During his correspondence with Einstein, Schrödinger further highlights issues with the Copenhagen interpretation by proposing a scenario involving a cat, a steel chamber, some radioactive substance, and flask of acid.
Schrödinger describes this scenario in his article, "The present situation in quantum mechanics":

> *"One can even set up quite ridiculous cases. A cat is locked up in a steel chamber, along with the following device (which must be secured against direct interference by the cat): in a Geiger counter, there is a tiny bit of radioactive substance, so small, that perhaps in the course of an hour only one of the atoms decays, but also, with equal probability, perhaps none; if it happens, the counter tube discharges and through a relay releases a hammer that shatters a small flask of hydrocyanic acid. If one has left this entire system to itself for an hour, one would say that the cat still lives if meanwhile no atom has decayed. The psi-function of the entire system would express this by having in it the living and dead cat (pardon the expression) mixed or smeared out in equal parts.*
> *It is typical of these cases that an indeterminacy originally restricted to the atomic domain becomes transformed into macroscopic indeterminacy, which can then be resolved by direct observation. That prevents us from so naively accepting as valid a "blurred model" for representing reality. In itself, it would not embody anything unclear or contradictory. There is a difference between a shaky or out-of-focus photo and a snapshot of clouds and fog banks".*

Which, in simple terms, suggests that the claim that if one places a cat and some poison in a box and seal it, until the box is opened, the cat is both dead and alive, is absurd.
Schrödinger felt that such a naive application of quantum mechanics would lead to contradictory and counterintuitive results when dealing with everyday objects.
The experiment aimed to challenge the existing interpretation of quantum mechanics and suggest that the quantum formalism is incomplete.

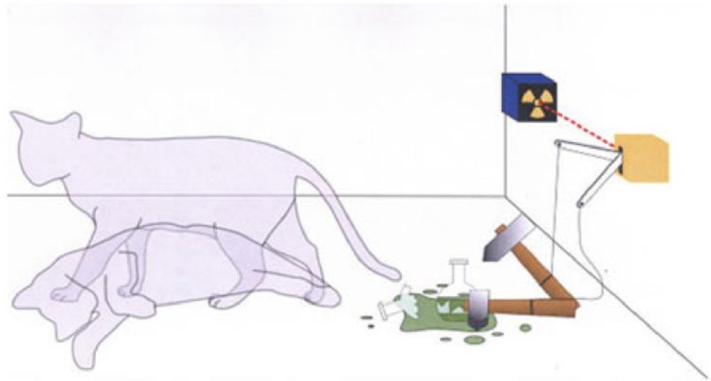

Fig 1: The cat which is both alive and dead. By Dhatfield

In the following years, the Schrödinger's scenario became a very famous experiment and has gained popularity among the physics community, with multiple interpretations of the experiment.
Some attempting to state that it is not in contradiction with the Copenhagen interpretation and others showing it as consistent with different visions of the quantum mechanics. Interpretations were provided by many including John von Neumann and Niels Bohr [5].
Additionally, modifications of the thought experiment have been provided to help minimize the differentiation between the understanding of various theories. Examples include the quantum suicide machine [6],which helps in the differentiation between the Copenhagen interpretation and the many worlds interpretation.
In the many decades following the proposal of the thought experiment, it has slowly creeped into popular culture. Examples include the Schrödinger's Cat Trilogy by Robert Anton Wilson and dialogue in the famous tv show the Big Bang theory.

We will now briefly and simply summarize the physics behind the experiment.
The superposition of states in the experiment comes from the radioactive decay of some atom - for instance, alpha decay. Alpha decay is the emission of alpha particles by an atom [7]. This event is random, but it is governed by the wave function of the alpha particle. The alpha particle is trapped inside what is known as the potential barrier in the atom by the so-called strong force. Classically, it does not have enough energy to leave the potential barrier but according to quantum mechanics it has a certain probability of leaving it. Once it does it will escape the atom. This is known as radioactive decay.
As before, we can consider two quantum states: $|alive\rangle$ and $|dead\rangle$.
They are the alpha particle reaching the potential barrier and the alpha particle not reaching it, respectively. Those two quantum states are equivalent to the cat being dead or alive.
Note we have simply replaced our coin flipping from previous discussions with a cat.
Assume our measuring device is placed over the box, and will point out "dead" or "alive" according to the result of its measurement, the measurement will result in:

$$c_1\varphi_1|alive\rangle + c_2\varphi_2|dead\rangle$$

when φ_1, φ_2 represent the wave functions of the alive and dead states respectively.

As we can see, Schrödinger's Cat experiment represents the key counter-intuitive points of superposition and beautifully demonstrates the measurement problem.

The key aspect of the experiment lies in the quantum superposition principle. According to this principle, until the box is opened and observed, the cat's fate is undetermined or in a superposition of being both alive and dead.
This seemingly absurd idea arises from the fact that the radioactive decay itself is governed by quantum mechanics, where particles can exist in multiple states until measured or observed. It is only upon observation of the cat's state that the superposition collapses, and the cat is found to be either alive or dead.

The purpose of this thought experiment was to create a paradox that challenges our intuitive understanding of reality and highlights the peculiar and counterintuitive nature of quantum mechanics. The notion that an object as macroscopic as a cat can exist in a superposition of states until observed seems absurd in the context of our everyday experiences.
It forces us to confront the idea that quantum principles may not be complete, as any principle that apply to microscopic particles should also apply to macroscopic objects in some sense, since there is no sharp distinction between “microscopic” and “macroscopic”.

SECTION 2

THE MEASUREMTN PROBLEM

John Stewart Bell states in his book [8]:

> *"The problem of measurement and the observer is the problem of where the measurement begins and ends, and where the observer begins and ends. Consider my spectacles, for example: if I take them off now, how far away must I put them before they are part of the object rather than part of the observer? There are problems like this all the way from the retina through the optic nerve to the brain and so on. I think, that—when you analyze this language that the physicists have fallen into, that physics is about the results of observations—you find that on analysis it evaporates, and nothing very clear is being said".*
> – *Jhon. S. Bell,* The Foundations of Quantum Mechanics

Such a simple example, and still no immediate answer comes to mind, for we do not live our lives thinking what part of our environment is considered to be an observer, even though the answer to this question withholds great quantum implications.

So why does it matter at all?
As discussed earlier, each quantum system can be described using a wave function.
In classical physics and the world as we know it, the observer is considered separate from the system being observed, and the act of observation does not typically affect the observed object.
However, in quantum mechanics, the act of observation has a profound impact on the quantum system being observed, leading to the collapse of the wave function and the determination of a specific outcome.
Throughout this essay, we will be referring to 'the observer' as some entity or a system that performs a measurement or interacts with a quantum system, thereby influencing the behavior and properties of that system.

Let us try and illustrate the measurement problem with another everyday scenario: Imagine Alice and Bob, two physicists, observing a quantum system with 2 possible outcomes, which describes a scenario of flipping a coin. The result could either be heads or tails. A quantum coin toss is performed, and the result is tails, as seen by Alice. If the coin was a simple coin, the kind we are familiar with and see every day, the outcome of the toss would be a nonnegotiable fact, both Alice and Bob agree upon seeing tails. But when it comes to a quantum coin toss, things would not be as simple. There are theoretically plausible scenarios, in which Alice found the result to be tails, while Bob found it to be heads!
That's because, as we have established, in the quantum realm, the behavior of particles is described by wave functions that represent a superposition of multiple states simultaneously. In our case, the coin can exist in a superposition of both heads and tails until a measurement is made, that is, until Alice and Bob interact with the system.
This bizarre situation is where the measurement problem lies.

Now that we have gathered a basic understanding, let us complicate things a bit more: assume our physical system also contains a measuring device with 3 possible states, which adjusts its needle to a specific state according to the flipping result.
If the coin has not been flipped yet, the needle is pointing to "ready", if the coin has been flipped and the result is heads, our measuring device will point to "α", and if it's tails it will point to "β".
This interaction with the device, which causes it to lock in a specific state is what we call a measurement. Hence, the measurement process involves the interaction between the system being measured and the measuring device, so when considering our system, we should consider the wave function of both the measured system and the device.

Denote the wave functions that describe heads and tails results by φ_α and φ_β, and the states of the pointer pointing to "α" and "β" by ψ_α, ψ_β.
Our device also have a "ready" state, which we will denote by ψ_0.
By that terminology, the Schrödinger equation will result in [9]

$$\begin{cases} \varphi_\alpha\psi_0 \to \varphi_\alpha\psi_\alpha \\ \varphi_\beta\psi_0 \to \varphi_\beta\psi_\beta \end{cases}$$

As we know, our system can be in a state of superposition, where the needle's state is yet to be determine.
Let α, β are complex probability amplitudes, such that $|\alpha|^2, |\beta|^2$ represent the probabilities of observing heads and tales respectively.
The coin exists in a probabilistic combination of both states:

$$|Coin\rangle = \alpha|Heads\rangle + \beta|Tails\rangle$$

and upon preforming a measurement on our quantum coin, its wave function collapses into one of the possible outcomes, that is, if we measure heads, the wave function collapses to $|Heads\rangle$, and if we measure tails it collapses to $|Tails\rangle$.
As the Schrödinger equation is linear, applying it on a system wave function which describes the superposition of heads and tails mentioned above:

$$\varphi = \alpha\varphi_\alpha + \beta\varphi_\beta$$

will result in:

$$\varphi\psi_0 \to \alpha\varphi_\alpha\psi_\alpha + \beta\varphi_\beta\psi_\beta \qquad (*)$$

But how can the system and device be entangled such that the needle points to both "α" and "β" simultaneously, when we have determined our measurement result can be either "α" or "β"?
Seems we have encountered a contradiction. This apparent paradox is the core of the measurement problem, which arises once we question the nature of the collapse itself.
what constitutes a measurement? In what way and why does the act of measurement lead to the collapse of the wave function into a definite state?

Our contradiction can be explained in 3 different ways:

1. "α" or "β" are not the only possible results, but also both at the same time.
2. "α" or "β" are the only possible results, and the Schrödinger equation is not correct.
3. "α" or "β" are the only possible results, the Schrödinger equation is correct, but it's inputs, the wave functions, are not an adequate and comprehensive enough description of the system. Meaning, we are missing some hidden variables that cause the needle to point to a distinct state.

But it does not end there. Assume the wave function does provide a complete description of our system. How can the statement that $|\alpha|^2, |\beta|^2$ represent the probabilities of observing 2 different results coexist with the claim that Schrödinger equation is deterministic?
if the wave function describes our system fully, it cannot describe one state at one measurement, and the other in another, as it is the same system.
And thus we have encountered yet another contradiction: the wave function cannot both provide a complete description of a physical system and also only provide the system's probabilities to collapse into a specific definite state, because if we only have probabilities, the description of the system is evidently not complete – we are missing that exact information that will tilt the scales, literally, into a single state.

Hence, as Tim Maudlin describes in his article – *'Three Measurement Problems'* [10], the measurement problem can be understood as the inconsistency of three following assumptions:

1. A measurement should result in a distinctive single state of the system.
2. Schrödinger' linear equation leads us to the wave function, as it is described in $\circledast$.
3. The wave function provides a complete description of a physical system (no other hidden parameters exist).

Let us go back to our coin flipping and measuring device scenario. If the wave-function does contain all the information needed to specify all the physical properties of our system, then it should fully describe the system and everything related to it, including the measuring device. Now, when we consider measuring the result of the flip, and let's say the measuring device indicates "heads," according to our assumption, we must account for this result in the complete wave-function. However, if we consider symmetry, the wave-function cannot distinguish between the states "heads" and "tails" of the measuring device, as both are treated symmetrically!
The measuring device has two possible states: one that indicates which the wave-function treats symmetrically, and thus cannot specify or determine which of the two indicator states the device is in after the measurement.
As a result, if the wave-function is complete and evolves linearly, it cannot account for the definite outcomes in measurements.

There have been numerous interpretations of quantum mechanics proposed to solve the measurement problem, including [11] the Copenhagen interpretation, the many-worlds interpretation, and the consistent histories interpretation. Each interpretation offers different perspectives on how to understand the measurement process and the implications for the nature of reality.

SECTION 3

DEBUNKING THE MYTHS

> *"A first reading of these lines [referring to Schrödinger's description of his experiment] my leave the reader somewhat confused. What Schrödinger says is exactly right and exactly what has to be said, but he has not been too considerate with the reader. He doesn't really help us get the point, especially if we are used to skimming over written text to extract information quickly. But Schrödinger was famous and he could afford to say things as they are and wait to be understood. Unfortunately, though, things went wrong in this case. The cat story has become folklore, but absurd discussions have distorted the content and also the genesis of the problem beyond recognition."*

As stated by Detlef Dürr and Dustin Lazarovici in their book "Understanding Quantum Mechanic- The World According to Modern Quantum Foundations", and they are very right.
Due to the controversial nature of superposition, many myths arose around Schrödinger's experiment, leading to many misconceptions regarding the purpose and true nature of the experiment.
We will focus on 2 myths concerning the purpose of the experiment and the nature of quantum mechanics and its fundamental principles, superposition, and the wave function.

Myth 1 – Superposition

The first and most common misconception is that the Schrödinger experiment aims to demonstrate the principle of superposition in a more accessible manner, using terms we all know and objects from our everyday lives, implying that Schrödinger did believe that the cat in the experiment is both dead and alive simultaneously, and once found dead – the observer has killed it, since it was not dead before it was observed, he was somewhat alive and dead.

David J. Griffiths and Darrell F. Schroeter say in their book [12]:

> *"The cat is neither alive nor dead, but rather a linear combination of the two, until a measurement occurs— until, say, you peek in the window to check. At that moment your observation forces the cat to "take a stand": dead or alive. And if you find him to be dead, then it's really you who killed him, by looking in the window."*
> *-- Introduction to Quantum Mechanics, by David J. Griffiths and Darrell F. Schroeter, 2018 (Page 585).*

This quote is indeed what the experiment describes, but it is most certainly not what it comes to demonstrate and not how Schrödinger believed our world works.
We have already established, and it has been experimentally confirmed, that in quantum mechanics, until a measurement is made, a particle can exist in multiple states simultaneously.
A cat is most certainly not a quantum particle, and this principle does not apply, at least not as naively and straightforward as the experiment describes, to it, or to any object we are familiar with from our everyday life.
This principle does exist all around us, and is an integral part of our lives, at the microscopic level.

Schrödinger came up with the idea for the experiment to illustrate the problematic nature of the Copenhagen interpretation in moving from subatomic systems to macroscopic systems, and managed to raise those doubts in other scientists, such as Einstein, who in one of his letters to Schrödinger, referred to Bohr as the "Talmudic philosopher" for whom "reality is a frightening creature of the naive mind". Einstein also referred to Bohr as "the mystic, who forbids, as being unscientific, an enquiry about something that exists independently of whether or not it is observed, i.e., the question as to whether the cat is alive at a particular instant before an observation is made (Bohr)."
Schrödinger was equally critical:

> *"Bohr's […] approach to atomic problems […] is really remarkable. He is completely convinced that any understanding in the usual sense of the word is impossible. Therefore the conversation is almost immediately driven into philosophical questions, and soon you no longer know whether you really take the position he is attacking, or whether you really must attack the position he is defending. Erwin Schrödinger" (Bricmont, 2016, P. 21).*

Schrödinger applied superposition to a hypothetical scenario, arguing that if a principle applies at the microscopic level, it should also apply to macroscopic objects like cats.
The purpose of this argument is to demonstrate the counter-intuitive nature of quantum mechanics and the mathematics needed to describe quantum states, in order to show that the existing interpretation of quantum mechanics is incomplete.
The idea of a particle being in a quantum superposition of two possible states is, of course, a concept that arises many question marks when applied to large-scale (macroscopic) systems, such as a cats.
According to the Copenhagen interpretation, not only do physical quantities exist and are well-defined only after they have been measured by a well-defined measurement system, but the observer's decision has a decisive meaning in determining the result of the experiment: the observer can decide, for example, for an electron, whether it is a wave or a particle. Before the measurement, the particle does not have a defined state but a wave function describing the possible results of the measurement together with the probability of receiving them.
This interpretation is seemingly only valid for the microscopic world, which shows us there is something missing in the formalism of quantum systems.
Schrödinger opposed the interpretation and argued that the laws of nature cannot change to that scale when the number of atoms increases beyond a certain threshold, which leads to the understanding that there are missing variables the current interpretation fails to consider.

The misunderstanding of what is the condition of the cat while the box is closed is just not the point, Schrödinger initiated the experiment to refute the Copenhagen interpretation, by bringing the result of the interpretation to the point of absurdity, because according to basic intuition, a macroscopic body like a cat cannot be both alive and dead.
His experiment was meant to raise to awareness regarding the question – does the wave function really provide a comprehensive description of a physical system, or maybe there are hidden variables that effect the system's final state, which are yet to be discovered. How can we claim that superposition exists in microscopic systems, a phenomenon which has already been experimentally observed, but does not exist in the macroscopic world?

Myth 2 – The wave function

The second misconception we will be addressing states that Schrödinger's experiment aims to demonstrates the collapse of the wave function, and describe how the collapse postulate also applies to our macroscopic lives.

Quantum mechanics presents us with the Wave-particle duality principle, which states particles can exhibit both wave-like and particle-like behavior.
This means that the state and properties of a quantum particle, a photon for example, can be described mathematically using a wave functions.
In principle, wave functions can be used to describe any quantum system, including complex systems like molecules or collections of particles.

The misunderstanding of the purpose of the experiment in regards to the collapse postulate, arises from the Copenhagen interpretation, which suggests that when a measurement is made on a quantum system, the wave function collapses into a definite state corresponding to the measurement outcome. It is only upon observation of the cat's state that the superposition collapses, and the cat is found to be alive or dead.
That is, of course, an absurd notation when applied to a cat, as it is a macroscopic object that is either alive or dead, regardless of our knowledge of the system or our observation.

Physicist Richard Feynman explains In his book "Quantum Mechanics and Path Integrals" [13] that the cat is, in fact, not in a superposition of alive and dead states, but it is either one of the two, the observer just lacks knowledge of the cat's state, as he is situated outside of the box, and does not know what had happened inside it, until the box is opened.
Meaning, the cat's state is pre-determined, whether the box is opened or closed, we just not know what it is until we observed it. It was never both alive and dead – if it is dead, it was dead once he interacted with the poison, and not when we opened the box.

This leads us to the conclusion that standard quantum mechanics is incomplete, in particular, that the wave function does not provide a complete description of the physical state.
Let us explain this conclusion:
if we operate under the assumption that our cat is either alive or dead, but not both, we in point of fact assume, that a measurement have unique outcomes.
Also, we assume that the wave function fully describes the properties of our system and is following Schrodinger's linear equation. Assuming these 3 statements coexist leads us back to the measurement problem we have discussed in section 2.
We have a linear equation and the collapse of the wave function, but, as Ghirardi, Rimni and Weber suggest in their GRW theory, the collapse postulate cannot be based on observations and measurements alone, it must be mathematically and rigorously described and proven. According to The GRW theory, the second assumption is incorrect, and Schrodinger's equation should be replaced by a non-linear one.

It is essential to understand that Schrödinger does mention the collapse of the wave function into a definite state once an observer opens the box, not to demonstrate or explain this principle,
but to show how bizarre this principle is when applied to our classical world.

CONCLUSION

In this essay we have visited two main myths and explained why they are, to say the least, inaccurate. We have explored the principles of the quantum realm, and came to the realization something is missing in current quantum mechanics formalism.
Schrodinger's experiment and some scenarios from our everyday lives, such as flipping a coin, helped us further understand the measurement problem and why we claim there is more to a physical then whet the wave function describes.
We have discussed the three inconsistences lies within the assumptions that the wave function's description is complete and follows from Schrodinger's equation, and that a measurement results in a single quantum state.
It is of course not our goal to arrive at a verdict on the subject, but to act as the aperitif to the mind, for the problems and internal paradoxes are far removed from the black boxes young physicists are given for their use and study.

We hope that the reader will obtain a renewed curiosity of the brave decisions made throughout the century regarding all aspects of quantum mechanics, and other possible alternatives that remain to be discovered, as well as help minimize the spreading of misconceptions about this already very controversial experiment.

> *"In the world of the very small, where particle and wave aspects of reality are equally significant, things do not behave in any way that we can understand from our experience of the everyday world...all pictures are false, and there is no physical analogy we can make to understand what goes on inside atoms. Atoms behave like atoms, nothing else."*
> *-- John Gribbin*, *In Search of Schrödinger's Cat: Quantum Physics and Reality*

The subjects of superposition and the wave postulate and their presence in our everyday life are still being investigated and studied in the fields of physics and mathematics, and even though their existence is an all-out rebellion against what we can believe to be true, we must not limit reality with the boundaries of what the human mind can grasp, while also keep doubting and investigating the nature of our world.

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