

# A Dialectical Interpretation of Schrodinger Cat Paradox in Terms of Hidden "Variable Realities"

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**Abstract** Schrodinger's cat paradox is largely viewed as a defining cornerstone of the weirdness of Quantum mechanics. It examines the situation when a quantum object is coupled or entangled to a macroscopic object. At a point before any observation of the composite system has been made, the quantum object, atom particle etc., and thus additionally the cat, are in a superposition of states, i.e. the cat is dead and alive. This paradox highlights some questionable assumptions of the Copenhagen interpretation of Quantum Mechanics. In this article we address this question and develop a new assumption about Schrodinger cat experiment using mathematical interpretation of set theory. Through examining the paradox in light of dialectic reasoning and set theory, it is found that the state of the cat is largely dependent on the initial condition of the system. According to the initial conditions of system there is maximum probability that cat would be alive inside the box, represents by the overlapping or superposition of all common states or reality states of system.

**Keywords** Schrodinger Cat, Set theory, Venn diagram, Quantum mechanics, Copenhagen

## 1. Introduction

One of the most famous paradoxes of quantum physics is that of Schrodinger's cat in a box. this paradox is generally studied or correlated with so called "observer effect", where an observation, typically through measurement, causes the collapse the wave function describing the quantum system. This interpretation raises some fundamental question regarding how we define an observer, as well as the relationship between the observer and the gross matter [1,2,3]. How do we resolve Schrodinger's cat paradox? Is it a mere artifact of mathematics or is the cat truly in a superposition of states inside the box, and if so what is the probability to find it? In this paper we will show that Schrodinger's cat paradox is a "self-emergent" phenomenon in any quantum system having two subsystems (cat +Maxwell's demon) and (measuring device+ observer) in entangled state, hence the information transfer is by entanglement [4,5,6].

The set-up of the thought experiment known as Schrodinger's Cat. In his 1935 paper, Schrodinger postulated a seemingly conceptual problem in quantum mechanics; he discusses and rejects the interpretation that a quantum system is physically somehow spread on different parts of a superposition... It described a cat apparently held in a

superposition of alive and dead states, specifically, superposition of two coherent states with same amplitudes but opposite phases [7,8]. In the thought experiment a cat is confined to a steel chamber, alongside the accompanying gadget (which must be guarded against direct obstruction by the cat) comprising of a radioactive substance, that decays according to probabilistic quantum mechanical theory [9]. Here the decay of the radioactive substance, if it occurs, is responsible for the death of the cat by activating a counter cylinder which causes a hammer to break a little flask of poison [10]. The paradox is focused on the state of the cat after one has left this whole framework to itself for a period of time; do we really consider that the cat is in a superposition of states, or would one state that the cat despite everything lives in the interim?

This thought experiment has raised many controversial arguments, [10,11]. Upon a closer investigation the Schrodinger dilemma can be seen to consist of different parts, often mixed carelessly:

- What is the state of the cat in the box, is it really in a superposition?
- Can quantum mechanics provide a full description of the entangled macroscopic system?
- When does the state of the cat change? The so-called wave function collapse.
- Can we have macroscopic system being in superposition of states? At what level does macroscopic realness exist?

Each of the questions above should be regarded separately as they refer to different aspects of the problem, not

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necessarily on equal footing. We know (at least most of us believe) that the cat in the box is either dead, alive and not in a smeared-out state between those alternatives, so is something missing in order to have a valid quantum mechanical description of the system [12] [13]. Does quantum mechanics have the capacity to describe the macroscopic world as good as the microscopic world [14,15].

Quantum mechanics is a hypothesis that gives an exact portrayal of frameworks containing the constituents of matter and thus must be applicable to any physical real framework [15]. As we know from our daily experience, classical mechanics works only for macroscopic and recognizable objects. We in this manner expect that when quantum mechanics is applied to such systems, it still correctly yields observed classical outcomes [16,17]. This is that we refer to as the classical limit. Quantum mechanics, as indicated by its Schrodinger picture, is a non-relativistic hypothesis about the wave-like nature of matter and its dynamics [18]. There are two principle issues in the reasonable establishments of quantum mechanics. The first one concerns the physical importance of the wave function in the hypothesis. It has been generally contended that the likelihood translation isn't completely acceptable due to depending on the ambiguous idea of probability and uncertainty [19]. Then again, the importance of the wave function is likewise in question in the alternative interpretations of quantum mechanics, for example, the de Broglie-Bohm hypothesis and the many-universes translation [20]. The subsequent issue concerns the advancement of the wave function. It incorporates two sections. One section concerns the direct Schrodinger advancement. For what reason does the non-relativistic development of the wave function fulfill the Schrodinger condition? It appears that a palatable deduction of the condition is yet missing [21]. The other part concerns the breakdown of the wave function during a measurement or observation. The breakdown hypothesizes or wave collapse model is still actively researched and doesn't disclose how a definite wave function collapses [22]. Although the alternative interpretations of quantum mechanics as of now give their separate answers for this issue, it has been a hot subject of discussion which interpretation is correct. In the final investigation, the wavefunction breakdown is still not known to be genuine or not. Regardless of whether the wave function falls under certain conditions, it stays muddled, why and how the wave function breakdown would occur [23]. The estimation issue has been universally recognized as one of the hardest and most significant issues in the establishments of quantum mechanics [24].

In this postulation, we will attempt to tackle these issues from an alternative focus, the dialectic nature of Quantum mechanics and how it is manifest in the Cat in the box paradox. The key is to understand that the deciphering the wave function collapse might be resolved when care is taken of the observation issue. Although the significance

of the wave function ought to be positioned as the first interpretative issue of quantum mechanics, it has been treated as a negligible issue, particularly contrasted and the measurement issue [25].

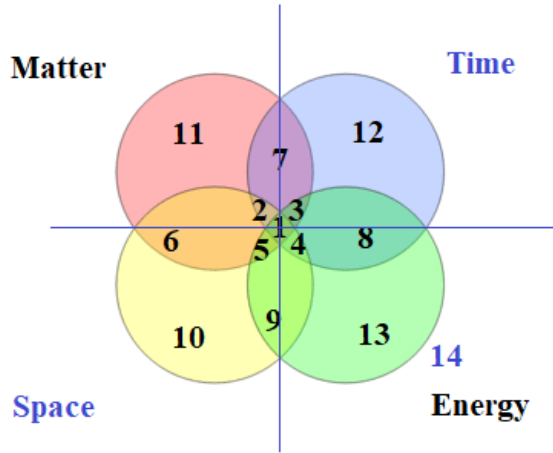
In order to deeper investigate the finer details of the paradox and present the dialectic nature of Quantum mechanics we rely in the mathematical backing of Set theory. Set theory, branch of mathematics that deals with the properties of well-defined collections of objects, such as numbers or functions. The theory is less valuable in direct application to ordinary experience than as a basis for precise and adaptable terminology for the definition of complex and sophisticated mathematical concepts [26].

In fact Set theory has already been identified as a suitable mathematical treatment of quantum systems [27], taking into account the indistinguishability of Quantum mechanical particles as well as an ontological extension to classical particles/elements required for macroscopic realness [28]. This concept of using set theory to evaluate the relationships between quantum sets has led to the recent development of quasi-set theory [29]. Such advancements in the use of Set theory are however not surprising from a dialectic point of view considering the essential elements of union, separation and intersection used to develop the axioms are all related to dialectic philosophy of synthesis of states.

Having the logical framework all set, we can now develop axiomatic set theory as a specific first order theory. It might come as a surprise that requiring a single binary predicate symbol, usually written infix, suffices [30,31]. The other set-theoretic symbols such as  $\subseteq$  can all be defined within the theory, for instance  $x \subseteq y$  is an abbreviation for  $\forall z. z \in x \rightarrow z \in y$ . Venn diagrams can be used to express the mathematical logical relationships between various sets, elements. Basically, Venn diagram depict us how different items or elements are relating with each other against an overall environment of system [32]. In this article, we will use Venn diagrams to illustrate various operations (union, intersection, difference) of various hierarchical aspects of quantum physics as well as relativity. This is done to evaluate how a dialectic interpretation [33] can lead to a better understanding of the Schrodinger cat paradox.

## 2. Methodology

As matter, energy, time and space intercept, quantum physics ( $M \cup E$ ) becomes a set that contains 11 elements (nine states that contain speed, one state that contains space and matter, and one state of matter). Relativity ( $T \cup S$ ) becomes a set that contains 11 elements (nine states that contain speed, one state that contains space and matter, and one state of space) shown in figure 1. Reconciling the states that contain the common trait of speed results in 10 possible states of reality coming together to form states 1, 2, 3, 4, 5, 7, 8, 9, 12 and 13. According to dialectical principles, reality is created through a union or synthesis of states that contain the common, interlocking trait of speed.



**Figure 1.** The different components of Quantum Mechanics can be represented as dialectic components that overlap to form the real world we experience. In this way we can represent the various components in the language of set theory and visually as Venn diagrams

In the Copenhagen interpretation, a quantum system remains in a state of superposition until it interacts with or is observed by the external world, at which time the superposition collapses into one or another of the possible definite states. In other words, reality is subjective. A dialectical interpretation is consistent with the Copenhagen interpretation. It goes further by explaining why a quantum system collapses when it is observed or measured; because an observation or measurement is an event which occurs at a specific point in time and space. The state of the cat is the synthesis of common, interlocking truths between the quantum system and any specific point in time and space. Let's try a different thought experiment, another extension of Schrodinger's cat in a box. It begins with two dialectical relationships: The relationship between life and death, and the relationship between objectivity and subjectivity (i.e., the box is closed with no observer vs. the box is open and seen by an observer). They create 4 separate, possible states of reality; the cat is objectively alive; the cat is objectively dead; the cat is subjectively alive; the cat is subjectively dead. As these opposing forces come together, they create 13 possible states of reality. (13) Dead, (12) Objective (the cat's state in a closed box), (11) Alive, (10) Subjective (the cat's state as observed from outside the box), (9) Subjectively dead, (8) Objectively dead, (7) Objectively alive, (6) Subjectively alive, (5) Subjectively alive and dead, (4) Objectively and subjectively dead, (3) Objectively alive and dead, (2) Objectively and subjectively alive, and (1) All possible states at once. Let's elucidate possible four states through inclusion-exclusion formula for sets. Here we Consider four events  $A, B, C$  and  $D$  for convince to formulate the set theory. We can derive the corresponding inclusion-exclusion formula using the results for two events  $A, B$  and three events  $A, B, C$ . Starting from benchmark formula of inclusion-exclusion we have;

$$P(A \cup B) = P(A) + P(B) - P(A \cap B) \quad (1)$$

Since the probability of any event is smaller than or equal to one, we have that  $P(A \cup B) \leq 1$  and so, Here the union of two or more sets is the set that contains all the elements of each of the sets; an element is in the union if it belongs to at least one of the sets. The symbol for union is  $\cup$ , and is associated with the word "or", because  $A \cup B$  is the set of all elements that are in  $A$  or  $B$  (or both). Similarly, the intersection of two or more sets is the set of elements that are common to each of the sets. An element is in the intersection if it belongs to all of the sets. The symbol for intersection is  $\cap$ , and is associated with the word "and", because  $A \cap B$  is the set of elements that are in  $A$  and  $B$  simultaneously

$$P(A) + P(B) - P(A \cap B) \leq 1 \quad (2)$$

After rearranging this gives the desired result

$$P(A \cap B) \geq P(A) + P(B) - 1 \quad (3)$$

Firstly, using Proposition for three events, where  $P$  denotes the probability of real states.

$$P(A \cup B \cup C \cup D) = P((A \cup B \cup C) \cup D) = P(A \cup B \cup C) + P(D) - P((A \cup B \cup C) \cap D) \quad (4)$$

Using Proposition of three sets, the first term on the right-hand side of (4) can be written as

$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(A \cap C) + P(A \cap B \cap C) \quad (5)$$

The last term on the right-hand side of (4) is trickier but can be treated as follows:

$$P((A \cup B \cup C) \cap D) = P((A \cap D) \cup (B \cap D) \cup (C \cap D)) = P(A \cap D) + P(B \cap D) + P(C \cap D) - P(A \cap B \cap D) - P(A \cap C \cap D) - P(B \cap C \cap D) + P(A \cap B \cap C \cap D) \quad (6)$$

where in the second equality we have used again Proposition of three sets.

Finally, substituting (2) and (3) into (1) and grouping similar terms, we get

$$P(A \cup B \cup C \cup D) = P(A) + P(B) + P(C) + P(D) - P(A \cap B) - P(A \cap C) - P(B \cap C) - P(A \cap D) - P(B \cap D) - P(C \cap D) + P(A \cap B \cap C) + P(A \cap B \cap D) + P(A \cap C \cap D) + P(B \cap C \cap D) - P(A \cap B \cap C \cap D) \quad (7)$$

Further we will consider Venn diagrams to illustrate the above stated mathematical states for possible states of reality for Schrodinger's cat; shown in next section. In all sorts of situations, we classify objects into sets of similar objects and count them.

### 3. Results and Discussion

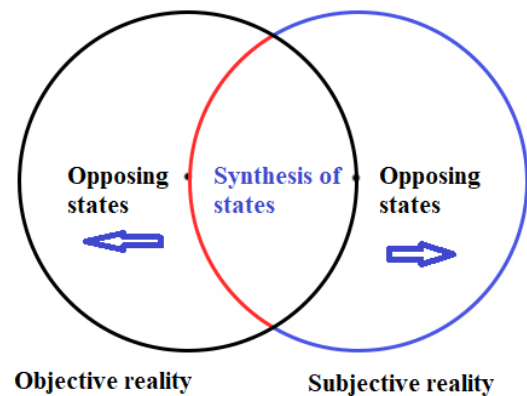
In dialectical relationships, opposing states resolve the tension between them by means of a synthesis. This synthesis solves the conflict between two opposing forces by reconciling their common truths. Let's assume the cat is alive in a closed box. There are seven (7) states where the cat can be alive: 1, 2, 3, 5, 6, 7 and 11. This includes: all possible states at once, objectively and subjectively alive, objectively alive and dead, subjectively alive and dead, subjectively

alive, objectively alive, and alive. There are seven (7) states where the cat can be in a closed box: 1, 2, 3, 4, 7, 8 and 12. This includes: all possible states at once, objectively and subjectively alive, objectively alive and dead, objectively and subjectively dead, objectively alive, objectively dead, objectively. Common truths between the state of being alive and objectively being in the box are states 1, 2, 3 and 7: all possible states at once, objectively, and subjectively alive, objectively alive and dead, objectively alive. If we were to reconcile the common truths between these four states, the result would be that cat is objectively alive in the closed box.

Let's assume the cat is both subjectively and objectively alive. There are seven (7) states where the cat can be alive: 1, 2, 3, 5, 6, 7 and 11. This includes: all possible states at once, objectively and subjectively alive, objectively alive and dead, subjectively alive and dead, subjectively alive, objectively alive, and alive. There are seven (7) states where the cat may be observed subjectively from outside the box: 1, 2, 4, 5, 6, 9 and 10. This includes: all possible states at once, objectively and subjectively alive, objectively and subjectively dead, subjectively alive, subjectively alive and dead, and subjectively. There are (7) seven states where the cat can be in a closed box: 1, 2, 3, 4, 7, 8 and 12. This includes: all possible states at once, objectively and subjectively alive, objectively alive and dead, objectively and subjectively dead, objectively alive, objectively dead, objective. Common truths between the cat being alive, being observed subjectively from outside the box, and its objective state in the closed box include 1 and 2: all possible states at once, and objectively and subjectively alive. If we were to reconcile the common truths between these two states, the result would be that the cat is objectively and subjectively alive. This dialectical formula will hold true for any of the four possible states of reality for Schrodinger's cat in a box. Actually, there are 3 separate, co-existing states of reality: objective, subjective, and the synthesis between the two; shown in figure 2. Reality is created through a union or synthesis of common, interlocking truths between dialectically opposing objective and subjective states of reality. For instance, if a tree falls in a forest (objective reality) and no one is around to hear it (subjective reality) then the synthesis of common, interlocking truths between objective and subjective states of reality is, "A tree falls in a forest, and no one is around to hear it." As a quantum system and relativity come together, they create a distinct, third group that resolves the tension between them by means of a synthesis. This synthesis solves the conflict between two opposing states by reconciling their common truths. Speed is the one common trait or denominator that links quantum physics and relativity. In this way a dialectic hierarchical interpretation of the states of reality can be developed [30].

The fact that the dialectical formula will work for any and all of the possible states suggests that reality is created through the synthesis of common truths between two opposing forces. Hypothetically, dialectical formula using common truths strategy proves Schrodinger cat possibility. In discrete probability, we assume a well-defined experiment,

such as flipping a coin or rolling a die. Each individual result which could occur is called an outcome. The set of all outcomes is called the sample space, and any subset of the sample space is called an event. For example, consider the experiment of flipping a coin two times. There are four individual outcomes, namely  $HH, HT, TH, TT$ .



**Figure 2.** Three distinct states of reality in space time with respect to subjective, objective realities in the presence of opposing forces

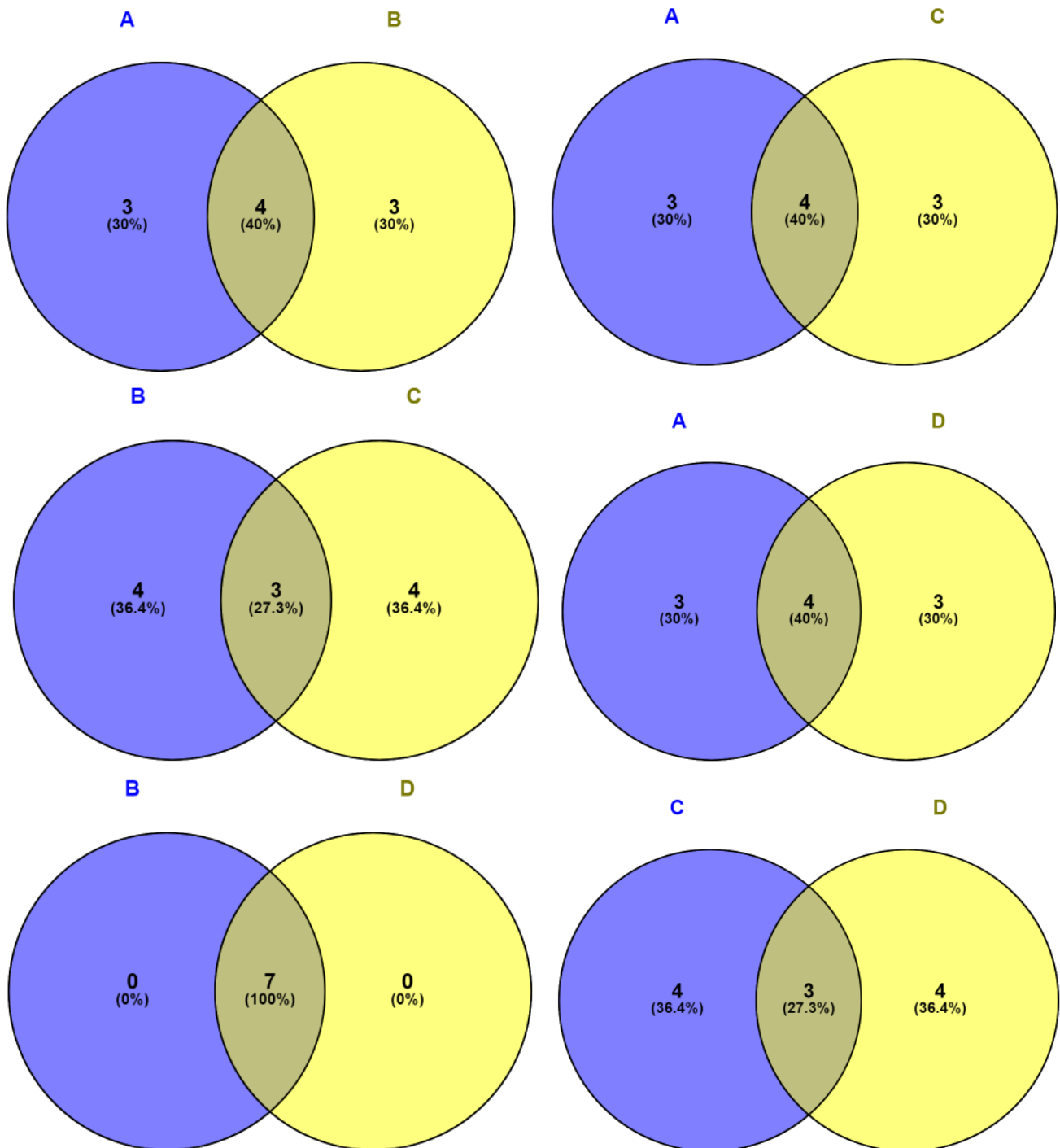
The sample space is thus  $\{HH, HT, TH, TT\}$ . The event "at least one heads occurs" would be the set  $\{HH, HT, TH\}$ . If the coin were a normal coin, we would assign the probability of  $1/4$  to each outcome. Similarly, starting from equation 7, we find out the common interest among four sets labeled as;

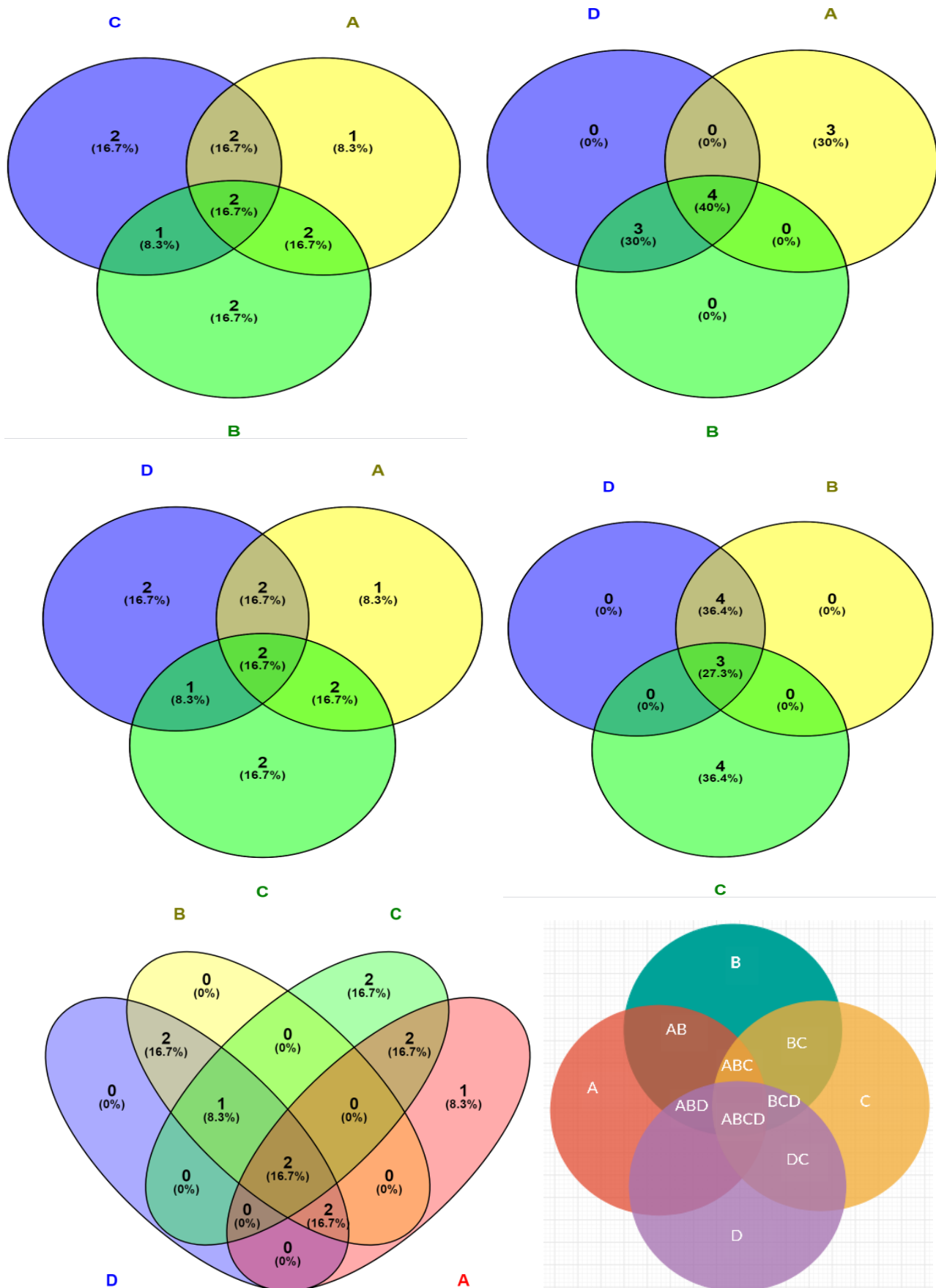
$$A = \{1,2,3,5,6,7,11\}, B = \{1,2,3,4,7,8,12\}, C = \{1,2,4,5,6,9,10\} \text{ and } D = \{1,2,3,4,7,8,12\}$$

Left side of equation elucidate the probability of four sets, which one having more probability to appear depend on the elements of corresponding sets. First four term on right side of equation are  $P(A), P(B), P(C)$  and  $P(D)$  represents the probability of corresponding sets. In probability two events are mutually exclusive if they cannot occur at the same time. Another word that means mutually exclusive is disjoint. If two events are disjoint, then the probability of them both occurring at the same time is zero. While other terms in Eq.07 are represented by using Venn diagram for individual term, involving elements of  $A, B, C$  and  $D$  sets. Venn diagrams depict that  $(B \cap D)$  having maximum 100% probability to find the Schrodinger cat in Box, while  $(A \cap B)$ ,  $(A \cap C)$ , and  $(A \cap D)$  40% probability for having cat in Box. In three sets, probability of  $(B \cap C \cap D)$  is maximum as compared to  $(A \cap B \cap C)$ ,  $(A \cap B \cap D)$  and  $(A \cap C \cap D)$ . Although, probability of Schrodinger cat within box in  $(A \cap B \cap C \cap D)$  sets revealed by multi-dimensional Venn diagram. From the figure 3 we observed that every circle occupies maximum probability of alive cat within box. According to Heinsberg uncertainty principle, if we find out the position of cat then there exists certainty in the time span, we can find out alive cat within box. But there is a point when all of four sets Venn diagram are merged there is maximum probability of cat alive in Box. At the intersection of four sets there, four common states

intersect from each set, and give a maximum point where all of states having maximum probability. We can assume, all of four sets are eventually subset of each other, because of one common state of reality. This point revealed whether subjectively or objectively there exist a point where all of common states give maximum probability to find out Schrodinger cat within box. Moreover, hypothetically there is possibility of cat until we will open the box to find the real state of system. Mathematical results are consistent with above stated dialectical formula. Because there exists one common state which prove the cat is alive within box.

There is a direct relationship between a quantum state and spacetime. An objects quantum state is determined by its interaction (intersection) with spacetime. Whether the cat is alive or dead or somewhere in between is determined by the specific time the gas is released and the specific (amount of) space in the box. The cats state of reality can be determined by the interaction and synthesis between the cat (the cat's continuously evolving state of superposition, including his age, physical condition, medical problems, ...) and the specific point in time and space from which the gas is released (which determines how much poison interacts with the cat).





**Figure 3.** Schematic illustration of probability of finding alive Schrodinger cat inside the box with the superposition of common reality set elements



Pause for a moment and think about the popular example used to illustrate the theory of superposition. There's an electron described by a wave function that extends across locations A and B. Until we measure its location, this electron is in both location A and location B, at the same time. A physicist would say that the wave function is a superposition of the electron being at location A and being at location B. In mathematical language, if we observed double slit experiment for the position of photon, which particle pass through the double slits is not a physical particle, in fact called a wave function which represent the state of photon (position of particle). Similarly, according to Heisenberg uncertainty principle, mathematical interruption says that reality does not exist until observed. "The idea of an objective real world whose smallest parts exist objectively in the same sense as stones or trees exist, independently of whether or not we observe them-is impossible." No elementary quantum phenomenon is a phenomenon until it is a registered ('observed,' 'indelibly recorded') phenomenon. But in quantum mechanics it is confusing to define "measurement". Means that we need a classical measuring device without knowing the boundary between the ties where classical state ends and quantum states started in system. Theoretically this idea is not limited to the superposition of photons going through the slits at once, but it puts the photon in slits in superposition of being two positions at a same time. The principle of quantum superposition essentially says that a system comprising quantum particles exists as a combination of all possible configurations of the system, at the same time. Conceptually, wave function resembles to the element of reality which object existed instead of observer is measuring or not. In another view, wave function does not relate with reality instead represent the objective state of observer knowledge about underlying reality. In Copenhagen interpretation, wave function is mere mathematical probability, which is associated with only one value when any observer measures, otherwise collapse it. Schrödinger did not come out nearly as forcefully against the Copenhagen interpretation as Einstein did. However, he did find the new consensus view to be problematic from a philosophical and conceptual standpoint.

In our mathematical interpretation, when two sets are involved in any system and observed by observer, the probability of finding any common truth or reality about Schrodinger cat; whether alive or not depends on observer who it calculates. When more than two common states observe, correspond to the superposition of two common truths and give highest possibility of aliveness of cat. Probably, this type of superposition phenomenon is observed elsewhere system of two different set observed by observer objectively or subjectively. When maximum common truth/reality states are involved in superposition according to Venn diagram leads to maximum possibility of aliveness of Schrodinger cat. Let's understand by a simple mathematical analysis of probability in the context of classical and quantum mechanics. Consider  $(A \cap B)$ , in which there is probability forecasting about Schrodinger cat whether dead

or alive in box is 30% and 40%, respectively. First of all we consider a classical mechanics because it will help us to calculate more accurately depending upon initial conditions. The fact is that these predictions are solely reflects the lack of knowledge of observer. Substantively, this prediction is deal with the subjective knowledge of observer instead of considering this prediction as a reality element. Moving towards quantum mechanics we may consider the prediction as a wave function subjectively (analogues to prediction knowing the knowledge of observer) or whether this predicted wave function as the reality element. According to second assumption, consider the reality, if we put any alive cat inside the box which mean it would possible to live inside the box (reality). The concept of whether the cat is alive or dead subjectively or objectively deals with predictions related to sets using mathematical set theory or position of wave function at specific time. Moreover, according to rational quantum mechanics, the probability of future aspects of any specific system depends on the past values or initial conditions of same system instead of past values of another system. According to this theory, in our case the initial condition of system is that we placed an alive cat inside the box, so there is maximum possibilities/probability that cat would be alive inside the box.

## 4. Conclusions

Schrödinger described a hypothetical apparatus, designed to illustrate, and even exaggerate some of the stranger consequences of the Copenhagen view of quantum theory. However, according to the Copenhagen interpretation, this is not merely a matter of our ignorance related to the prediction whether Schrodinger cat is alive or dead inside the box. We have applied set theory based on real/common truths/states of four different sets. According to mathematical theory there are appeared some common states using two different sets A and B. after the superposition of common truth or reality states from different sets give the maximum probability of finding the cat alive inside the box objectively or subjectively based on the knowledge of observer or initial conditions of system. When all of the possible states of the system are overlap or superimposed like withing specific time and space/position. Throughout time and space, the butterfly can exist as both a caterpillar and a butterfly. However, at any specific point in time and space, it can exist either as caterpillar or a butterfly, but not both. A collapse does not occur because a measurement takes place in analogy to a butterfly which exists throughout time and space and yet simultaneously exists at a specific point in time and space.

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