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Original Paper

Toward a Unified Framework of Physics: Insights from Dialectics, Quantum Theory, and Relativity

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Abstract: One of the greatest unresolved problems in physics is understanding how to unify quantum mechanics with relativity. Unifying quantum mechanics and relativity is further complicated by the unresolved measurement problem in quantum mechanics. However, the application of dialectics to interpret and understand the relevance of natural and physical phenomena is rapidly increasing. The central thesis of dialectics is its demonstration of how opposing states or parts synthesize together to create a greater whole. A dialectical approach makes three basic assumptions including that all things are interconnected, change is constant and inevitable, and opposites can be integrated to form a closer approximation of the truth. As a methodology, dialectics can be employed to explain the concept of quantum entanglement, a phenomenon where a change in particles in one location changes the particles in another location, even when separated by a large distance. However, unifying quantum mechanics with relativity using dialectics has not been reported. The measurement problem in quantum mechanics remains unresolved. Contradictions between general relativity and quantum mechanics persist. The role of observer-dependent phenomena or emergent properties is not fully accounted for. Therefore, we present a review of the principles and latest research on dialectics, providing key new insights into how quantum mechanics can be linked and its relationship with relativity. Furthermore, we provide a comprehensive and critical comparison of the most relevant unification and quantum theories, highlighting the major research gaps in existing literature and providing a direct link on how to answer those specific research questions. This review will help lay the groundwork for developing a more comprehensive framework that can describe phenomena across all scales, from the subatomic to the cosmic. This unified understanding could lead to new insights into the nature of space, time, and matter, potentially unlocking advancements in fields such as quantum gravity, cosmology, and high-energy physics.

Keywords: Dialectics, opposites, thesis, quantum states, quantum system, synthesis

Introduction

Quantum physics provides a framework for understanding the fundamental nature of particles and energy, the building blocks of matter, and the forces governing their interactions [1]. Despite centuries of research and progress, science has not yet fully grasped our physical reality due to its complexity and the vast scales involved. Quantum mechanics and relativity address different aspects of this reality. This includes particle behavior and spacetime structure at macroscopic scales, respectively. Unifying these theories is challenging due to their distinct principles. Additionally, unresolved issues such as dark matter, dark energy, and quantum gravity persist [2]. Addressing these problems requires both understanding of theoretical advancements and new experimental methods, with the ongoing quest often uncovering more questions than answers. A critical review of findings from experiments, and theories, offers potential answers to some of the most challenging questions regarding the understanding of physical reality.

Young created the basic idea for what is now considered the famous double-slit experiment [3]. Basically, Young's experiment involved beaming a particle of light through two slits or openings cut into an otherwise solid barrier. One would expect to find two distinct patterns on the screen on the other side of the barrier where the light passes through the two slits. In contrast, an "interference" pattern was created. From the results, it was concluded that light acts not only as a particle but simultaneously also as a wave. This experiment was confounding in that when there was an observer present, the screen would show either a particle or wave pattern, but not both. According to Young's results, the act of observing or measuring a quantum system influences the system. In other words, reality only exists when it is observed, a concept known as the observer effect. However, how this effect happens constitutes the measurement problem of quantum mechanics. Young's contribution helped to establish the wave theory of light, which overcame the century-old view that light is a particle. However, his work did not explain how or why observing an object or system influences it.

A set of ideas about the meaning of quantum mechanics, based on the work of Niels Bohr, Werner Heisenberg, and Max Born, became known as the Copenhagen interpretation [4]. The most held interpretation of quantum mechanics, the Copenhagen interprets a quantum system to exist in a state of superposition [1]. That is, a system exists in all possible states simultaneously until it interacts with or is observed by the external world, at which point the superposition collapses into a single definite state, a concept known as the wave function collapse. In other words, the act of measurement affects the system, causing the set of probabilities to reduce to only one of the possible values immediately after the measurement. The Copenhagen interpretation advanced our understanding of reality by explaining the effects of observation on quantum systems. However, the problem with the Copenhagen interpretation is that, because physical systems do not have definite properties before being measured, quantum mechanics can only predict the probability distribution of possible measurement outcomes.

Erwin Schrödinger formulated a thought experiment to demonstrate the issues he identified in the Copenhagen interpretation of quantum mechanics [5]. Schrödinger challenged the notion that a quantum system is physically distributed across the different components of a superposition. In his thought experiment, Schrödinger proposed placing a cat in a sealed box, along with a vial of poison, such that the cat's state remained hidden from observers [6]. In Schrödinger's thought experiment, a vial of poison is set to break and kill the cat if a specific quantum event, such as the decay of a radioactive atom detected by a Geiger counter, occurs [7]. Since radioactive decay is probabilistic and cannot be predicted for individual cases, the experiment lacks a means to determine whether the decay—and consequently, the vial's breaking—has happened, leaving the cat's fate indeterminate [7]. Schrödinger's thought experiment challenged the notion that a quantum state exists in superposition when not observed, arguing that the cat in the box could not simultaneously exist in multiple states despite being unseen. Schrödinger's experiment addressed the question of what constitutes "measurement" in quantum mechanics, emphasizing that wave function collapse relies on observation [1]. While Schrödinger did not propose an alternative explanation for quantum mechanics, his cat thought experiment remains a crucial reference point for contemporary interpretations of the theory.

Another concept is the quantum decoherence credited to Bohm. David Bohm introduced the concept of quantum decoherence, describing it as the “destruction of interference in the process of measurement” [8]. Quantum decoherence occurs when a quantum state interacts with its environment, causing the system to become entangled with that environment [8]. This interaction leads to the quantum state evolving into a mixture of states that align with what is observed. Despite its development into a comprehensive framework, there remains debate about whether decoherence fully resolves the measurement problem.

The Ghirardi–Rimini–Weber (GRW) theory was the first spontaneous collapse model, leading to the development of several similar models in the following years [9]. The core idea behind collapse theories is that particles undergo spontaneous wave-function collapses, occurring randomly in both time and space. This approach avoids the ambiguous “observer” and “measurement” issues present in earlier interpretations, as the wave function collapses independently of observation. GRW theories also contribute to the understanding of the relationship between quantum mechanics and relativity, particularly regarding time and space. However, they do not explain why, when, or how a wave function collapses, only that it happens randomly [9]. Succinctly speaking, all these theories have contributed toward understanding the physical universe. However, none of them provides a specific actual way to measure a physical system.

Dialectics, on the other hand, offers a philosophical framework for understanding the dynamic and contradictory nature of reality. In this section, we will introduce the concept of dialectics, explore its historical development, and examine how it has been applied to resolve various issues in philosophy and science. We will then connect these ideas to quantum physics, discussing how dialectical reasoning can provide insights into the complexities and paradoxes inherent in quantum mechanics.

Dialectics has a strong foundation in the history of philosophy, mathematics, and science [10, 11, 12]. Wells documented a shift toward dialectical approaches in nearly every natural science, and a dialectical perspective is also evident in various theories of scientific development [10, 11]. The evolution and understanding of dialectics present a singular, all-encompassing, coherent theoretical framework of physics that potentially explains and links together all aspects of the universe. It offers a perfectly symmetrical representation of the universe, making it a more predictive and less arbitrary method for seeking and understanding truth [13, 14]. Dialectics refers to a method of philosophical argument that involves a contradictory process between opposing sides, derived from the highest form of thought [13, 14, 15]. Existing discussions on opposing sides which produce a linear progression or evolution in philosophical views, understanding and thoughts have been documented [16, 17]. In the classic form of dialectics, Plato presented his philosophical arguments through a back-and-forth dialogue or debate [18]. A widely known dialectic is the Socratic dialectic method, which is a hypothesis elimination, mostly determined by steadily identifying, and eliminating those that lead to contradictions [19, 20, 21]. According to Aristotle, knowledge could be developed through discussion of where the first person would present a thesis, the second its opposite (an antithesis), and through rational debate the claims of each would be tested [22, 23]. The above scenario removed falsity, giving rise to a more perfected and robust synthesis.

In another development, Georg Friedrich Hegel described the dialectical method as the only valid approach for scholarly and scientific exposition in his Science of Logic [24]. The Hegelian dialectic is an interpretative method where a thesis is necessarily opposed by an equally contradictory antithesis, and the contradiction between the opposing states is reconciled on a higher level of truth through a synthesis [24]. Hegel identified three stages of development in the dialectical relationship as follows:

There is a thesis which gives rise to its reaction. The development of an antithesis, while sharing common traits, contradicts and opposes the thesis. The development in the dialectical relationship is that as two opposing states 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 the two opposing states (a thesis and its antithesis), by reconciling their common truths, thus forming a new thesis that causes the process to begin again.

The study of dialectics was further developed by Friedrich Engels [24] who was the first to apply dialectics to nature. Engels postulated three laws of dialectics from his reading of Hegel's Science of Logic and presented them in his work, Dialectics of Nature [24]. Dialectical laws include the law of the unity and conflict of opposites, which asserts that opposing aspects of an entity can be both contradictory and interdependent. The law of the transition of quality into quantity and vice versa explains how changes in quantity can lead to changes in quality, and vice versa. The law of the negation involves a process where an initial state is negated, and then the negation is negated itself, resulting in a new state that incorporates elements of the original.

In the late 1970's, Marsha Linehan, a pioneer in mental health treatment, was the first to bring the philosophy of dialectics into the mainstream when she created dialectical behavior therapy, an evidence- based cognitive behavioral treatment which helps patients to change their thoughts, emotions, and behaviors by integrating opposite states in thinking, feeling, and behaving [25, 26, 27]. Linehan describes three basic principles of dialectics in the following way.

(i) Everything opposes each other and simultaneously synthesizes together. Everything comprises contradictions or opposing states. According to the principles of polarity, two opposing forces can both be true. Reality is not static but comprises two opposing states, a thesis and antithesis, in constant motion.

(ii) Everything is separate and simultaneously connected. According to the principles of inter-relatedness and wholeness, each part of a system is of limited value unless the analysis of that system relates the part to the whole. Therefore, the identity of each part of a system exists and evolves relative to its interaction with each other and relative to the system as a whole [28].

(iii) Everything is incompatible with everything else and simultaneously shares a continuous transactional relationship. Change is transactional with opposing states influencing and affecting each other reciprocally. It is the conflict, tension,

> and friction created between the thesis and antithesis forces within each system that produces change. The new state following change (the synthesis) also comprises polar forces, and thus change is continuous [29].

Dialectics can consistently be applied to all aspects of science. For instance, in reproduction, two opposing male and female counterparts synthesize together to create an embryo. In other words, life is literally created through the synthesis of common, interlocking truths between dialectically opposing male and female counterparts. In genetics, two opposing strands share a transactional relationship and synthesize together to create deoxyribonucleic acid (DNA). In neuroscience, two sympathetic and parasympathetic parts exist at opposing ends of one whole continuum and synthesize together to create the central nervous system; and two right and left hemispheres exist at opposing ends of one whole continuum and synthesize together to create the brain. In chemistry, opposing protons and electrons synthesize together to create an atom, opposing atoms synthesize together to create a molecule, and opposing molecules synthesize together to create a chemical compound. In cell biology, two opposing chromosomes synthesize together to create a cell. The whole reality, that is, the observable universe could be made to represent unity in its diversity. However, the essence has not been well detected. Dialectical logic provides an explanation for quantum entanglement, a phenomenon in which subatomic particles, energy or waves are always entangled with each other [31, 32]. In quantum entanglement, the result of a measurement carried out on a component of a particular system leads to a correlated result on another component. Dialectical logic illustrates the exact mechanism of how the physical universe may work at macro and micro levels [33].

Since dialectics has been applied to interpret various processes, including science, art, and recent technological developments, this review has explored the concept of quantum mechanics, the origins of relativity and quantum physics, and the evolution of dialectics over the years. Despite these insights, there remains a lack of sufficient understanding regarding how dialectics can be used to interpret the unification of quantum mechanics and general relativity. Therefore, this review will discuss not only how dialectics are used to understand natural occurrences and physical systems but also demonstrate that dialectical methods can help address many unanswered questions arising from philosophy of quantum mechanics concepts as discussed in the introduction. The remainder of the article is organized as follows: In Section 2, we will discuss a dialectical interpretation of quantum mechanics. In Section 3, the dialectical approach focusing on the interpretation of quantum mechanics is presented. Section 4 presents the unification of quantum physics and relativity from a dialectical perspective. Section 5 presents the unification problem between quantum mechanics and relativity. In Section 6, the algebraic description of the dialectics of quantum systems and relativity is presented. In Section 7, we presented the comparison between dialectics with other unification theories. While Section 8 describes experiments of dialectical thought, Section 9 lists recommendations and future research scope. Finally, the conclusion is presented in Section 10.

1. A Dialectical Interpretation

1.1. *Quantum States and Dialectics*

In this section, we apply dialectical concepts to quantum physics, noting that each quantum state is defined by specific values or attributes and characterized by energy or measurements. Figure 1 displays images of the different quantum states A, B, C, and D. In Figure 1, each circle represents a different quantum state which exists as separate from each other with its own specific, individual values and attributes. Therefore, quantum states are mutually exclusive to each other. However, at the same time, quantum states do not exist alone because quantum states string or synthesize together to create a superposition of states (AB, BC, CD, ABC, BCD, and ABCD) [34]. In this way, each quantum state is entangled, creating a completely different set of attributes that characterize a different energy and measurement. Here, the quantum states are non-mutually exclusive. Hence, quantum states overlap and coexist, connecting to each other rather than being entirely distinct or separate. This implies that the probability of the quantum states occurring at the same time is non-zero. For example, if you have two quantum states $|\psi_1\rangle$ and $|\psi_2\rangle$, they are non-mutually exclusive if there is a nonzero probability of finding the system in a state that is a combination of both $|\psi_1\rangle$ and $|\psi_2\rangle$. In contrast, a system can only be in one of two states at a time in classical states, where two distinct states cannot coexist [35]. Dialectically, opposing states exist at the same time as shown in Figure 1, where quantum states exist as separate, individual, mutually exclusive, opposing, or contradictory states. Four parts A, B, C, and D represent all the states that are non-mutually exclusive. As the different quantum states synthesize or string together, they create one continuum of change or superposition of states.

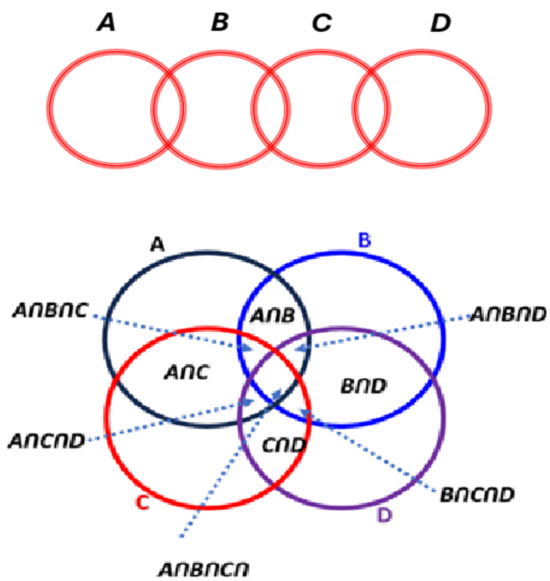


Figure 1: Representation of different quantum states, A, B, C, and D and their intersections.

Depending on the reference frame, the states could be mutually exclusive and non-mutually exclusive. This is consistent with a dialectical perspective where opposing states, i.e., mutually exclusive and non-mutually exclusive states, exist at the same time. The conflict, tension and friction that is created between the parts (A, B, C and D) and the whole (ABCD) produces change in each system through a common synthesis. This synthesis is described as the interlocking truths between a quantum state and a superposition of states. In other words, a quantum state and a superposition of states exist at the same time. A quantum state is simply a part of one whole continuum or superposition of states.

1.2. *Newton's Third law of motion dialectically interpreted*

Figure 2 shows the synthesis of opposing states of thesis-antithesis, represented by rings, and synthesis of opposing forces of action-reaction, represented by Newton's third law. Dialectical processes are supported by the work of Isaac Newton's third law of motion in several ways. First, Newton states that when two objects interact with each other, the force exerted by the first object on the second is referred to as an action. Dialectically, this is referred to as a thesis. Next, Newton states that this action is then followed by a reaction (dialectically referred to as giving rise to its reaction) as the two states apply forces to each other of equal magnitude and opposite direction given as

$$\frac{dp_1}{dt} = F_{12} + F_{11} \text{ , and } \frac{dp_2}{dt} = F_{21} + F_{22} \text{ ,} \qquad (1)$$

where p_1=$m_i u_i$ and p_2=$m_2 u_2$. The internal and external F_{11} and F_{22} forces acting on the particles due to sources outside the system are represented as F_{12} and F_{21}. and F_{11} and F_{22}, respectively. Mutual interaction between two particles occurs only when the internal forces comply with Newton's third law which states that

$$F_{12} = -F_{21} \qquad (2)$$

Dialectically, this is referred to as the development of an antithesis which contradicts and opposes the thesis. Next, Newton's third law states that for every action, there is an equal and opposite reaction [36]. Dialectically terminology is referred to as a thesis-antithesis. Furthermore, Newton's third law states that the two forces are part of a single interaction forming a quantity, and neither force exists without the other. Dialectically, this is referred to as a synthesis between the two opposing states which creates one greater whole continuum.

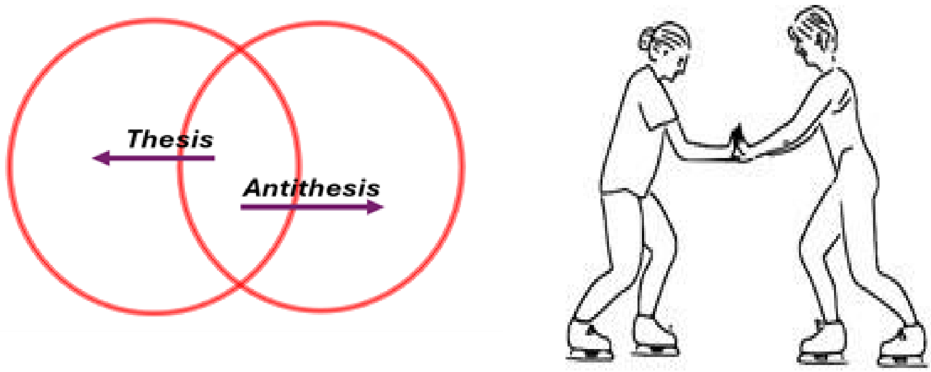


Figure 2: Opposing states, represented by rings (left) create a distinct third group which resolves the conflict between two opposing forces through a synthesis. Newton's law example (right): A thesis and antithesis oppose each other and synthesize together. They are separate and connected/part of a greater whole; they share a continuous transactional relationship which produces motion or change.

Dialectics also build upon Newton's third law in several ways. First, dialectics extends the term, "objects" to refer to any two forces, interactions, or quantum states. Next, Newton's third law states that motion and change result from an interaction between the two opposing objects. Dialectically, motion and change result from the transactional relationship between two opposing objects. Interaction refers to a two-way process where two objects take turns sending and receiving messages and feedback. In a transactional relationship, both objects or forces are considered to each be both a sender and a receiver at the same time. Next, the basic idea Newton taught us is that motion is caused by forces. Dialectics explain the mechanisms of how these forces produce motion and change as: It is the conflict, tension, and friction created between the thesis and antithesis forces within each system that produces change. Dialectically, the synthesis between the two opposing states, referred to as a synthesis of common, interlocking truths, creates one continuum which enables the two states or objects to apply forces of equal magnitude and opposite direction. One example can be seen through the work of Albert Einstein where mass (an object's resistance to motion) would be considered a thesis, the speed of light squared (a state of motion) its antithesis, and the synthesis of common, interlocking truths between these two opposing states is energy. Energy is the distinct third group that is created through a thesis and an antithesis and which resolves the conflict, tension, and friction between the two opposing states through a synthesis. According to Hegel, a synthesis refers to the higher state of truth that merges a thesis with an antithesis. Newton's third law states that for every action in nature there is an equal and opposite reaction. A synthesis of common interlocking truths simply refers to the change that occurs because of this action-reaction or thesis-antithesis. Another example of how dialectics build upon Newton's work relates to the law of the unity of opposites which is a central concept in dialectics that describes a situation where the existence of something depends on the coexistence of two opposing conditions that are also dependent on each other. Newton's third law of motion, which states that for every action, there is an equal and opposite reaction, is an example of the law of the unity of opposites.

1.3. Electromagnetic waves and dialectics

Figure 3 presents a chain analysis of vulnerability-prompting events, linking behavior and consequences to illustrate the relationship between quantum states and dialectics. It also demonstrates how oscillation, wave propagation, and the period of electromagnetic waves (both magnetic and electric fields) explain changes over time. Dialectically, any behavior or state can be understood as a series of linked components (represented by interlocking circles). These links are chained together because they follow in succession one after the other. In dialectics, Linehan uses a chain analysis to identify how behavior is caused and how it creates change. The purpose of a chain analysis is to understand what the problem behavior is, what prompted it, what is its function, why is it interfering with the resolution of the problem, what maintains it, and finally to identify solutions to the problem. In this way, the dialectical process shows how change occurs over time [37].

In Figure 3, we can physically observe how the electromagnetic wave parallels the dialectical process. The wave comprises: (i) Two opposing states, crest and trough (thesis-antithesis), which simultaneously oppose each other and synthesize together into a unified whole. (ii) Each peak and trough exist separately while forming part of one whole continuous, interconnected system. (iii) Although the crest and trough are incompatible with each other, they share a continuous, transactional relationship. This is the essence of entanglement, where each part influences the whole and the whole affects each part. The conflict, tension, and friction created between crest and trough

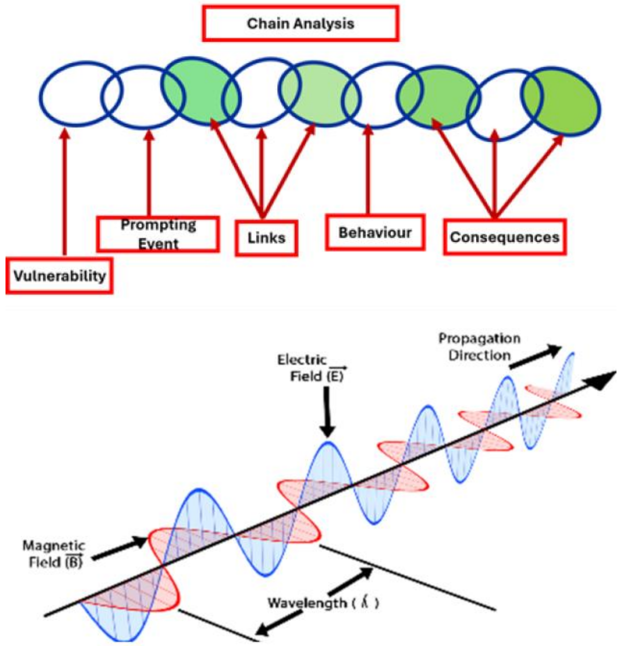


Figure 3: The chain analysis (top) of vulnerability-prompting events links behavior and consequences, illustrating the relationship between quantum states and dialectics. On the bottom, the oscillation, wave propagation, and period of electromagnetic waves (both magnetic and electric fields) are used to demonstrate how change occurs over time.

drive motion or change in the wave. The resulting new state, the synthesis, also consists of opposing forces (new crest and trough), making change a continuous process.

The illustration of the wave with opposing troughs and crests shows how separate, opposing forces are entangled through a continuous, transactional relationship [38]. Dialectics show us how opposing states exist simultaneously. For instance, when we focus on one point in the wave, we are observing a quantum state. When viewed as one whole continuum, what we really observing is a superposition of states. If one goes back and forth between looking at a part and the whole, what is physically observed is how a quantum state and superposition of states exist simultaneously. The only thing that changes is the perspective.

Quantum states exhibit superposition due to quantum mechanics, which allows particles to exist in multiple states simultaneously until measured [30]. This means a quantum system can be in a combination of all possible states, as described by a probability wave function. For instance, an electron can be in a superposition of two locations at once, collapsing to a single state upon observation. The idea that quantum systems operate independently of relativity is not well established and may be misleading. This is because quantum mechanics and relativity describe different aspects of physics. For instance, quantum mechanics addresses small-scale phenomena, while relativity explains space, time, and gravity at large scales and high speeds. Though quantum mechanics and special relativity have been unified in quantum field theory, general relativity, which encompasses gravity, has not yet been fully integrated with quantum theory, presenting a significant challenge in modern physics. From a dialectical perspective, quantum states exist in a state of superposition because a quantum system exists independently of relativity, that is, independently of any specific point in time and space which is what separates the various quantum states. It is only when relativity is introduced into the system, for instance, the wave's state at a specific point in time and space, that one can observe one of the many possible definite and measurable states. This interpretation of quantum mechanics was introduced by Klein (2020) [39].When a quantum system is observed or measured, it simultaneously undergoes a change in its state. Then relativity, which refers to the specific point in time and space from which the observation or measurement is made, is incorporated into the quantum system.

1.4. Biological interpretation of the dialectic

Extending dialectics from the micro to the real world, we start with a biological perspective. For instance, throughout time and space, the life span of a butterfly exists as both a caterpillar and a butterfly [40]. However, at any specific point in time and space, the butterfly exists only as either a butterfly or a caterpillar. A collapse does not occur because it is seen or measured. Figure 4 displays how the butterfly exists across time and space while simultaneously being located at a specific point in time and space, creating a single quantum state or component. In Figure 4, we can observe how opposing quantum states exist at different points in time and space. At the same time, the butterfly exists in superposition of states.

Figure 4: The butterfly exists throughout time and space (as a superposition or as a whole continuum) and simultaneously exists at a specific point in time and space creating a single quantum state or part.

This same process can be extended to biological evolution. In evolution, opposing forces interact and influence each other to produce a unified outcome [41]. For instance, natural selection and genetic variation, which are conflicting factors, combine to shape species development [41]. This synthesis results in a continuous evolutionary process, reflecting a cohesive continuum of traits and adaptations. This concept parallels the idea of superposition in quantum mechanics, where multiple states merge to form a unified state, illustrating how opposing forces can create a dynamic and comprehensive continuum. Again, a dialectical perspective allows us to simultaneously observe the separate quantum states (the parts) and a superposition of states (the whole) as shown in Figure 5, [42, 43].

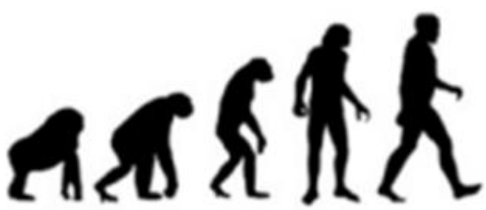


Figure 5: Opposing states in evolution synthesize together to create one whole continuum or superposition of states.

In Figure 5, quantum states share a dialectical relationship with each other as: (i) Opposing forces both conflict and synthesize together to form a unified whole. (ii) They are distinct states that, together, create one greater continuum or superposition of states. (iii) Although incompatible with each other, these forces maintain a continuous, transactional relationship. The conflict, tension, and friction that is created between two opposing quantum states lead to changes in both systems through the synthesis of common, interlocking truths. The resulting new state also includes opposing forces, making change an ongoing process [29].

2. Dialectical approach: The Interpretation of quantum mechanics

Now that a foundational understanding of dialectics has been established, we examine how a dialectical approach builds upon previously described interpretations of quantum mechanics.

2.1. Double slit experiment

The double-slit experiment suggests that particles exhibit both particle-like and wave-like characteristics, and that observing or measuring a quantum system affects the system [3]. How this influence occurs is known as the measurement problem in quantum mechanics. As Richard Feynman often said, all quantum mechanics can be understood by carefully examining the implications of this single experiment [44]. Klein's dialectical interpretation offers a novel approach to achieving this understanding (Klein, 2020). A dialectical interpretation of the double slit experiment suggests that particles and waves exist simultaneously in a state of superposition because a quantum system exists independently of relativity, that is independently of any specific point in time and space which is what separates the different quantum states [45]. It is only when relativity is introduced into the quantum system—referring to the particle or wave's state of existence at a specific point in time and space (such as during a measurement or observation)—that the system collapses into a single observable state. This interpretation is supported by the work of Shahriar S. Afshar who devised an experiment to determine the path taken by an electron in a double slit experiment[46, 47]. The results suggest that light can be measured as a wave and a particle simultaneously. Furthermore, the development of quantum computers is based on matters being held in more than one state at the same time [46, 47]. Shoichi Sakata describes the above scenario as a fundamental character of the dialectics of nature [48].

2.2. **Schrödinger'*s cat***

Klein (2020) [39] examined Schrodinger's cat experiment from a dialectical perspective. Existence comprises two opposing states of life and death. They exist at opposing ends of a single continuum, which we can refer to as the cat's lifespan. Life and death, along with all states in between, exist in a state of superposition. This is because a quantum system's state is not tied to any specific point in time and space, meaning the different quantum states between life and death are not separated by relativity. Once relativity is introduced into the system, that is, the cat's state of existence at any specific point in time and space (such as when an observation or measurement occurs), then one can observe a single quantum state. Bernard F. Schutz [49], well-known for his research in Einstein's theory of general relativity, sums up the idea of observers used in almost all treatments of standard special relativity, describing an inertial observer as, "a coordinate system for space- time, which makes an observation simply by recording the location (*x, y, z*) and time (*t*) of any event [49]." Therefore, if the event is an observation or measurement, its collapse will occur at the specific point in time and space where the observation or measurement takes place. Dialectically, this can be conceptualized as:

$$|\psi\rangle = \Sigma C_i\, |\phi_i\rangle \qquad (3)$$

where $|\psi\rangle$ is the quantum state, i is the sum over all possible states, C_i are the coefficients corresponding to each state, and $|\phi_i\rangle$ are the basis states that form the superposition. The spatial coordinates (*x, y, z*) and time t are implicitly included in the basis states ϕ_i and their coefficients c_i which describe the state of the system at a given point in space and time. Equation (3) can be equally expressed as:

$$(\textit{quantum-state}) = (\textit{superposition-of-states})_{(x,\, y,\, z)(}t) \qquad (4)$$

A dialectical interpretation of quantum mechanics suggests that the state of Schrodinger's cat is created through the synthesis between two opposing states. On one side we have the cat's quantum state (thesis). On the other side we have a specific point in time and space from which an observation, measurement, or some other event occurs (antithesis). Whether the cat is alive or dead, or somewhere in between, is determined by the specific point in time and space from which an observation, measurement, or some other event occurs. In this case, that event is the release of gas which determines how much poison is exposed to the cat. Like a set of meshing gears transmitting rotational motion, the conflict, tension, and friction that is created between the two opposing states 0 produces change in both systems through a synthesis of common, interlocking truths. The new state following change, the synthesis, also comprises opposing states, and thus change is continuous. The dialectical resolution is that the cat exists in a single quantum state at any specific point in time and space (such as when an observation, measurement, or some other event occurs) and the cat simultaneously exists in a superposition of all possible states at once across any span of time and space. The gear model has been used throughout modern physics. James Maxwell used a gear wheel in his model of electromagnetism to explain the electric current as a rotation of particles in opposite directions to that of the rotating field lines [50]. Quantum physics uses gears as a model for several different systems, such as artificially constructed nanomechanical devices or a group of ring molecules.

Here, we focused on a more in-depth mathematical understanding of dialectics. Theorems and proofs which demonstrate that a complete dialectical process is a non-empty set of dialectical triads have been demonstrated. Dialectical triads are explained as a set of theses, a set of corresponding antitheses, and the set of resulting syntheses [15]. Such processes provide the formal basis of modern dialectics. In addition, a complete dialectical process was demonstrated as a function, showing that every real function is a complete dialectical process [15]. As an example, a complete dialectical process can be expressed as a functional decomposition [51]. Take for instance, for any real function $f : \mathbb{R} \to \mathbb{R}$, the s positive and negative parts are defined as

$$f_+(x) = \max\{f(x), 0\}, \qquad f_-(x) = \min\{f(x), 0\} \tag{5}$$

Equation 5 can be decomposition as,

$$f(x) = f_+(x) + f_-(x) \tag{6}$$

where f_+ represents the thesis, f_- represents the antithesis, and their sum f is the synthesis. This shows that every real function f can be regarded as a complete dialectical process. Equation 5 mathematically states that every real function is the sum of two opposing components (positive and negative parts). This is a direct, literal mathematics statement of the dialectical triad.

Kohut uses dialectical logic to develop the unity principle which illustrates the exact mechanism of how the physical universe may work at its macro and micro level [52, 53, 54]. Kreidik has described the basis of dialectical physics and the mathematics of dialectics, including mathematical expressions of dialectical philosophy and logic as well as elementary dialectical kinematics and dynamics of exchange [55, 56.]. The dialectical triad can be modeled as a functional operator:

$$S(x) = F\big(T(x), A(x)\big) \qquad (7)$$

$$S(x) = T(x) + A(x). \qquad (8)$$

where T (x) is the thesis, A(x) the antithesis, and S(x) the synthesis. Furthermore, the dialectical change can be cast as a dynamical system [57,58] given as

$$\frac{d\phi}{dt} = \phi - \phi^2 \qquad (9)$$

where ϕ is a concept or structure. Here the growth term (ϕ) is the thesis, the limiting contradiction ($-\phi^2$) is the antithesis, and the equilibrium point is the synthesis.

2.3. Observer effects and reality

Klein (2020) applied a dialectical approach to further examine observer effects and reality. The observer effects can be related to Newton's third law of motion. An observation is an action on "an object". When an observer is present, there is a transaction and synthesis between a quantum state and that observer. The conflict, tension, and friction that is created between the quantum state (thesis) and observer (antithesis) creates change in both systems through a synthesis of common, interlocking truths. An observation does affect a system, and the observer effect, therefore, does exist. However, just because an observer interacts with and affects a system, one cannot conclude that material objects do not have definite properties prior to being observed. Dialectics have shown us how opposing systems exist at the same time. In fact, there are four separate states of reality that exist simultaneously including objective state, subjective state, a synthesis between the two, and a superposition of states [59]. These different states of reality account for observer effects.

Subjective reality is relative to our individual life experiences and perceptions and separates us from each other. In this way, subjective reality represents an individual or part. Objective reality exists independently of individual life experiences and connects us to each other. In this way, objective reality represents a greater whole. Objective and subjective reality share a dialectical relationship. Reality is created through a synthesis of common, interlocking truths between dialectically opposing objective and subjective states of reality. For instance, if a tree falls in a forest and no one is around to hear the sound of falling, then the synthesis of common interlocking truths between opposing objective and subjective states of reality is, "A tree falls in a forest, and no one is around to hear the sound." In this way, opposing states of reality synthesize together and are reconciled on a higher level of understanding and truth, thus creating a greater whole reality.

Objective and subjective reality share a dialectical relationship as they: (i) Oppose each oppose each other and synthesize together, (ii) Are each separate states and parts of one greater, whole continuum, (iii) Are incompatible with each other and share a continuous, transactional relationship. The conflict, tension, and friction that is created between objective and subjective states of reality creates change in both systems through a synthesis of common, interlocking truths.

Recall that a dialectical synthesis contains elements of both the thesis and antithesis so that neither of the original positions can be regarded as true. The synthesis always suggests a new thesis and thus change is continuous. In this way, dialectics reveal a physical reality in constant motion, evolving to newer and higher forms. As there are multiple states of reality and infinite levels of reality in constant synthesis and change, there is no absolute truth; rather, truth evolves and develops over time. Opposites can, however, be integrated to form a closer approximation of the truth [60, 61].

2.4. Validation of dialectical interpretation of quantum mechanics

A dialectical interpretation is largely compatible with and may be viewed as a natural extension of previous interpretations of quantum mechanics and the physical realization (correspondence between theory and experiment) of quantum mechanics with some key differences. We will argue this point from three viewpoints.

First, dialectic quantum mechanics is most compatible with quantum decoherence. Here, quantum decoherence argues that quantum states are never in perfect isolation, rather they interact with the rest of the universe, which breaks any initial eigenstate or superposition of eigenstates. For instance, Quantum decoherence can be understood mathematically using the density matrix formalism. Decoherence occurs when a quantum system interacts with its environment, causing the system's quantum coherence to decay and classical properties to emerge. For instance, the state of the system is described by a pure state $|\psi\rangle$, and the corresponding density (ρ) matrix is:

$$\rho = |\psi\rangle\langle\psi| \qquad (10)$$

If the system interacts with its environment, the overall state of the system plus the environment can be described by the combined density matrix ρ_{SE}. Due to the interaction, the system (S) no longer evolves independently. To describe the system alone, we trace out the environment's (E) degrees of freedom, leaving a reduced density matrix:

$$\rho S = T_{rE}(\rho_{SE}) \qquad (11)$$

where $T_{rE}(\rho_{SE})$, is the partial trace over the environment. Over time, this reduced density matrix can be described by the combined density matrix ρS will evolve into a mixed state due to decoherence, which can be expressed as:

$$\rho S = \Sigma \rho_i \mid \psi_i \rangle\langle \psi_i \mid \qquad (12)$$

In this mixed state, off-diagonal elements of the density matrix, which represent quantum coherence between states, will approach zero due to environmental interactions. This leads to classical probabilities rather than quantum superpositions. This process mathematically explains how quantum states lose coherence and appear to behave classically as they interact with their surroundings. The whole idea of quantum decoherence results in eigenstate mixing which is analogous to weak and strong wave turbulence theory and drives a wave description of a particle to a statistical description of a particle over a long timescale. A dialectical interpretation of quantum mechanics argues that such pure eigenstates are never pure and will mix over their evolution in spacetime. Measurements are regions of enhanced interaction that break these pure energy measurement eigenstates.

2.5. *The interpretation of quantum mechanics to collapse theories; The case of GRW theory*

In quantum mechanics, the measurement problem—more precisely, the problem of wavefunction collapse—is addressed by the Ghirardi–Rimini–Weber (GRW) theory [62]. The generalized relativistic wave function theory (GRW) presents an objective, spontaneous collapse mechanism that happens independently of observation, in contrast to the conventional interpretation of quantum mechanics, which holds that wavefunctions only collapse upon measurement [62]. Recall that in quantum mechanics, the evolution of the wave- function (t) is described by the Schrödinger equation:

$$\frac{i\hbar\psi_i}{t} = \widehat{H}(t)_i \tag{13}$$

where $\widehat{H}(t)_i$ is the Hamiltonian operator. This equation predicts a smooth, unitary evolution of the wavefunction over time. In the GRW Theory, the collapse occurs according to a Poisson process with a certain rate per particle, leading to a modified wavefunction. For instance, for a system of N particles, each particle undergoes a collapse with a probability rate $\wedge$ (typically chosen as $\wedge \approx 10^{-16}s^{-1}$ for each particle). Therefore, when there is a collapse of a particle at position x_0, the wavefunction is multiplied by a localization function that is $g(x - x_0$, which is a Gaussian:

$$g(x - x_0) = 1/(\pi r^2)^{\frac{3}{4}} exp - (\frac{(x - x_0)^2}{2r^2}) \tag{14}$$

where r_C is the localization length scale (typically chosen around $r_C \approx 10^{-7}m$. The new wavefunction due to collapse is represented as:

$$\psi^{'}(x_1, x_2, ..., x_N) = \frac{g(x - x_0)\psi^{'}(x_1, x_2, ..., x_N)}{(\int |g(x - x_0)\psi'(x_1, x_2, ..., x_N)|^2 dx)^{\frac{1}{2}}}. \tag{15}$$

where x_1 is the coordinate of the particle undergoing collapse, and the denominator normalizes the wavefunction. Here we compare our interpretation of quantum mechanics to collapse theories such as the GRW theory [39]. As opposed to the Copenhagen interpretation, which maintains that a quantum system exists in a superposition of states until it is observed, at which point the wave function collapses into a definite state, the General Relativity theory suggests that the wave function collapses randomly and spontaneously, taking place independently of observation. Therefore, the GRW allows microscopic particles to exist in multiple states at once (superposition) and spontaneously collapse into a single quantum state [30]). Here, we find some correspondence as GRW theory posits that collapse of quantum states is only possible when an interaction between a pure state takes place with a large number of other pure states. Again, dialectical quantum mechanics is compatible with this theory as it is only relevant for pure quantum states when an interaction with other states is weak. Unlike GRW theory, where the collapse of the wavefunction is explicitly modeled as a spontaneous and random event, our approach does not specify the exact mathematical mechanism for this collapse. Instead, we posit that a significant deviation in the system's evolution operator (Hamiltonian) occurs due to interactions with the environment or the rest of the universe at the point of measurement. While the GRW theory provides a specific framework for collapse, we assume that these interactions lead to a measurable outcome without detailing how the collapse process unfolds. As the collapse is produced by a perturbed Hamiltonian, all measurements are unitarity preserving (for the entire state, not the pure state). Another interesting aspect is the de Broglie relation expressed as

$$\lambda = \frac{h}{p} \tag{16}$$

Where λ is the de Broglie wavelength and p is the momentum. In Equation 16 de Broglie relation does not eliminate one pole (wave or particle) and does not keep them strictly separate (as in classical physics). However, it unites them in a new conceptual framework, such as the quantum domain, where the apparent opposites are complementary. The de Broglie relation is a dialectical synthesis, because it transforms contradiction (wave vs. particle) into a higher-order unity (quantum object). In other words, the Planck constant *h* is the "mediator" that resolves the contradiction and makes the synthesis possible. We could even cast de Broglie relations in this form as a symbolic dialectical equation

$$\underbrace{\text{(Thesis: Particle)}}_{p} \oplus \underbrace{\text{(Antithesis: Wave)}}_{\lambda} \quad \text{Synthesis (mediator: } h\text{)} \quad \lambda = \frac{h}{p} \tag{17}$$

Finally, we discuss the relation between dialectical quantum mechanics and the classical Copenhagen interpretation [49, 63]. The major issue with the classical interpretation is that it gives special weight to the nature of measurement operators. It is unclear how such operators are produced, how unitarity is guaranteed in their formulation, and how these measurement operators operate on particles. Our interpretation, while compatible with the idea of measurement induced wavefunction collapse, prescribes the precise way this collapse would take place. Collapse to a measurement eigenstate will take place due to interaction with the rest of the universe at a particularly strong space-time point during a measurement. Our interpretation guarantees unitarity and removes the arbitrary nature of the measurement operator in the Copenhagen interpretation in favor of strong nonlinear interactions (governed by a perturbing Hamiltonian) at a particular space-time point.

2.6. *Importance of a dialectical approach*

There are several advantages to a dialectical approach over other interpretations. First, a dialectical interpretation of quantum mechanics explains the measurement problem inherent in earlier theories. Specifically, the wave function collapse differs from a dialectical interpretation in the following way. In our current interpretation, the wave function—initially in a superposition of several states—reduces to a single state due to interaction with the external world (e.g. an observation). This supposedly occurs without any understanding as to why or how or when. A dialectical interpretation suggests that the wave function exists in a superposition of several states and simultaneously exists as a single state. There is no “initial superposition” or “reduction” of states (the “collapse”). Rather, the wave function collapse more simply and elegantly refers to a single quantum state (a part) which simultaneously exists within one greater continuum or superposition of states (the whole).

Secondly, a dialectical approach provides an explanation for quantum entanglement by showing how separate states are simultaneously connected to each other. Third, dialectics explain the relationship between a quantum state and spacetime, demonstrating how they are interdependent upon each other rather than being a random occurrence as in GRW theories. Finally, a dialectical approach provides a new understanding of what a superposition of states is. That is, a quantum state is a part, and a superposition of states is a series of quantum states which occur across any span of time and space (creating a greater whole or higher truth).

There are two main criticisms for a dialectical approach to quantum physics. First, a dialectical theory would be a novel approach and methodology and as such, requires additional research to support it. Second, science must exist within an accepted paradigm that establishes the norms of what good research is, and dialectics fall outside our current scientific paradigm. A paradigm establishes the foundation for legitimate work and is necessary for normal science to proceed uncritically. If all scientists were constantly critical of a theory and spent their time trying to falsify it, detailed and focused research would suffer. At the same time, i.e., dialectically, science must push beyond the boundaries of that same paradigm if we want to fully advance our understanding of the universe[64]. According to Thomas Kuhn, the evolution of scientific theory does not emerge from the straightforward accumulation of facts but rather from a set of changing intellectual circumstances and possibilities, known as a paradigm shift [65]. Kuhn describes how the scientific paradigms preceding and succeeding a paradigm shift are so different that their theories are incommensurable–the new paradigm cannot be proven or disproved by the rules of the old paradigm, and vice versa. Examples of pushing the boundaries of science include Ptolemy's astronomy giving way to Copernican astronomy, Aristotle's physics giving way to the physics of Galileo and Newton, Newtonian physics giving way to Einsteinian physics, and the shift from the belief in a flat earth to the understanding of a round earth. These shifts demonstrate how scientific progress relies on embracing new paradigms. While research must be focused, Kuhn explains a dialectic where it can become so detailed that it uncovers anomalous experimental and theoretical results. The inability to fully understand the fundamental interactions of the universe could be considered an example of such an anomaly. When existing assumptions about reality break down, they are usually addressed by revising the understanding of reality to a new one that remains self-consistent in the presence of new evidence [66]. Perhaps Einstein best encapsulates this idea when he said, "We cannot solve our problems with the same thinking we used when we created them" [67].

3. Dialectical Unification of Quantum Physics and Relativity

Over the past few centuries, two theoretical frameworks have been developed that best describe how our universe works at its micro and macro levels. These two theories are quantum mechanics and general relativity [68]. Many scientists believe that unifying these two theories would provide a comprehensive "theory of everything" which would fully explain and link together all aspects of the universe in a single framework [68]. The problem is that science has been unable to understand the relationship between these two theories, and finding a theory of everything remains one of the major unsolved problems in physics.

The first theory, quantum mechanics, as discussed earlier in this paper is the study of matter and its interactions with energy on the scale of atomic and subatomic particles, thus describing our universe at the micro level. Quantum mechanics encompasses three fundamental forces which are mediated by fields and make up what is known as the Standard Model of Particle Physics [69]. These three fundamental interactions include: (i) Electromagnetism which acts on electrically charged particles, (ii) The strong interaction which is responsible for holding together particles to form atomic nuclei, and (iii) The short-range interaction which is responsible for some forms of radioactivity. The second theory, general relativity, encompasses the fourth known fundamental force in modern physics, gravity [70]. Gravity is directly related to time and space and describes our universe at the macro level.

3.1. History of some of the major contributions to unifying the fundamental forces of the universe

4.1.1. Isaac Newton

In 1687, Isaac Newton developed what was widely regarded as the first great unification theory in physics [71] . His universal law of gravitation states that every particle in the universe attracts every other particle [71]. Newton developed a mathematical framework for understanding motion, from an apple falling from a tree to the motion of planets and their moons. His groundbreaking discoveries on gravity and the laws of motion started a scientific revolution which led to all the discoveries which followed and formed the fundamental foundation for modern physics.

4.1.2. James Maxwell

In 1865, James Maxwell developed the classical theory of electromagnetic radiation, which was the first theory to describe electricity, magnetism and light as different manifestations of the same phenomenon [72]. Maxwell demonstrated that electric and magnetic fields travel through space as waves moving at the speed of light, and his equations for electromagnetism have been called the second great unification in physics.

4.1.3. Albert Einstein

In 1915, Albert Einstein expanded on the work of Newton and developed the theory of gravity, also known as the general theory of relativity, which remains the current description of gravitation in modern physics [73]. Albert Einstein is best known for his equation $E = mc^2$, which states that energy and mass (matter) are the same thing, just in different forms.

4.1.4. String Theory

Beginning in the 1960s, several decades of research conducted by thousands of physicists put forth a theoretical framework called String theory which describes how the point-like particles are replaced by one-dimensional objects called strings that move through space and interact with each other [74]. In string theory, one of the vibrational states of the string corresponds to the graviton, a quantum mechanical particle that carries the gravitational force, and has thus contributed toward developing a quantum theory of gravity [75]. String theory has contributed toward advances in mathematics, our understanding of black holes, early universe cosmology, nuclear physics, and condensed matter physics [75, 76.]. Some of the problems with string theory, however, are that it does not provide an adequate definition of all things; it describes a complicated landscape of possible universes instead of providing a description of the real world; and it is widely considered to be beyond empirical testing, meaning that it cannot be proven [79].

4.1.5. Standard Model

In the mid-1970s, the Standard Model was the result of research conducted by thousands of physicists across the globe since the 1930s. The Standard Model of particle physics describes the fundamental structure of matter and demonstrates that everything in the universe is made from fundamental particles [78]. It has become established as a well-tested physics theory, accurately describing three of the four known fundamental forces (electromagnetic, weak and strong interactions) in the universe and classifying all known elementary particles. The Standard Model has become one of the greatest contributions to science and is widely considered the closest thing we have to a theory of everything. Its main drawback is that it is simply incompatible with gravity or relativity [79]. Since then, there have been several proposals for a theory of everything although none is currently universally accepted. A major problem for experimental tests of such theories is the energy scale involved, which is well beyond the reach of current accelerators. Trying to combine graviton with strong and electroweak interactions leads to fundamental difficulties, and the incompatibility of the two theories remains an outstanding problem in the field of physics.

3.2. Dialectical Interpretation of Matter, Energy, Time, and Space

Dialectical materialism, a philosophical approach commonly connected with Marxist thought, is the basis for dialectical views on matter, energy, time, and space. This viewpoint highlights how reality is dynamic and related, arguing that these ideas are crucial parts of a constantly changing and interconnected system instead of being fixed or distinct. In the context of physics, we will discuss the dialectical interpretation of matter, energy, time, and space. Everything in the universe consists of matter, energy, time and/or space. These are the fundamental components of the universe upon which the four fundamental interactions act. A dialectical interpretation of matter, energy, time, and space, the four fundamental aspects of nature provide a new perspective of quantum entanglement [79] , showing how each separate part of nature affects all of nature (the whole) and how the whole of nature affects each part. A dialectical interpretation of our universe shows how entanglement occurs because everything exists relative to everything else. It shows how nature consists of contradictions which are reconciled on a higher level of truth through a synthesis of common, interlocking truths, creating a continuum of interconnectedness in a state of constant motion and change.

Klein (2020)[80] applied dialectical principles to matter, energy, time, and space. Mass (an object's resistance to motion) and the speed of light (a state of motion) exist at opposing ends of one continuum and synthesize together to create energy. Position and direction exist on opposing ends of one continuum and synthesize together to create space. Particles and antiparticles exist at opposing ends of one continuum and synthesize together to create matter. The past and the future exist at opposing ends of one continuum and synthesize together to create the present time. Matter and energy exist at opposing ends of one continuum and synthesize together to create quantum physics. Time and space exist at opposing ends of one continuum and synthesize together to create gravity or relativity. From a dialectical perspective, quantum physics and relativity exist on opposing ends of one continuum and synthesize together to create the universe [80] (Figure 6). These relationships form a distinct, all-encompassing pattern in our laws of nature that demonstrate how everything in the universe is connected to creating our reality.

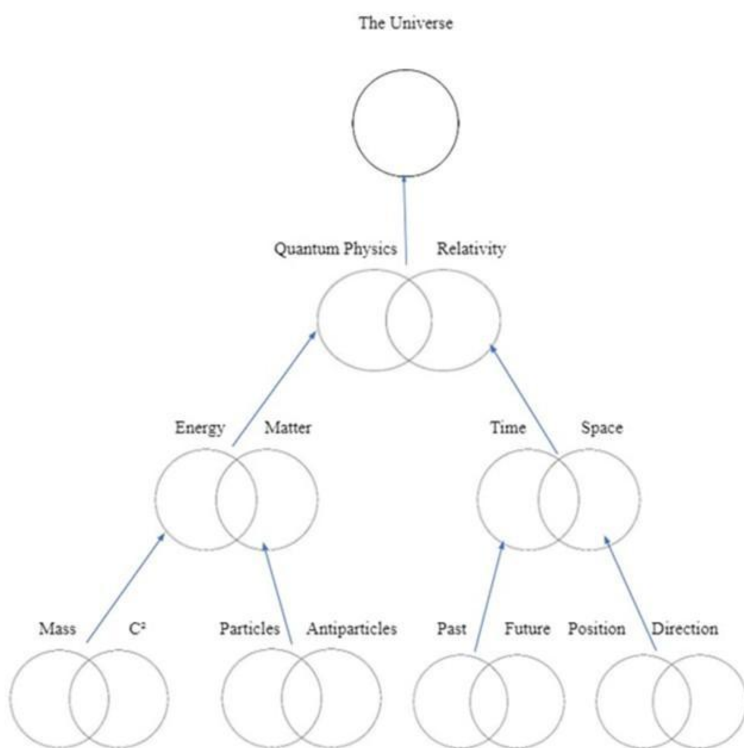


Figure 6: A Dialectical Interpretation of Matter, Energy, Time and Space.

There is interchangeability and connectivity between matter and energy. This relationship is demonstrated by Einstein's theory of relativity [81] as:

$$E = mc^2 \qquad (18)$$

where E, m and c are the energy in Joules, mass in Kg and the speed of light in m/s^2, respectively. Equation 18 states that matter and energy are two variations of the same underlying reality. This suggests a dialectical relationship where one form of reality may transition into another, and that matter can change into energy and vice versa. For instance, this relationship is directly demonstrated in particle annihilation in particle physics. A particle and its antiparticle annihilate one another when they meet one another, changing the particle's mass into photons of energy [81].

A dialectical interpretation of matter, energy, time, and space builds upon the work of Maxwell who demonstrated that electric and magnetic fields are two manifestations of the same phenomenon [79]. It builds upon the work of Einstein who demonstrated that energy and mass (matter) are interchangeable and different forms of the same (See Equation 11). Dialectics are built upon Newton's universal law of gravitation which states that every particle in the universe attracts every other particle [82]. Finally, dialectics build upon Newton's third law of motions which states that forces always occur in pairs, and one body cannot exert a force on another without experiencing a force itself as discussed earlier in Equation 2.

3.3. *Dialectical interpretation of spacetime as a unified continuum*

Spacetime is a unified continuum that is thought to include both time and space as intertwined elements. Time and space are interdependent, constantly changing, as shown by the dynamic nature of this continuum that is molded by the presence of matter and energy. This is a living example of the dialectical concept of transformation and interconnection. A prime example of this dialectical character is the spacetime fabric, which is experienced as gravity, is distorted by massive objects like planets and stars. Time dilation effects near massive objects or at high velocities show that this distortion also affects the passage of time. According to the dialectical interpretation, matter, energy, time, and space are not distinct entities but rather are in a constant state of interaction and evolution. Physical systems develop and evolve because of interactions between changes in one aspect and other aspects. For example, this interaction is best illustrated in cosmology by the universe's expansion. The energy of the universe, including dark energy, influences the speed of space expansion. The distribution of matter and the passage of time throughout the universe are impacted by this expansion. The dialectical interpretation emphasizes how these core ideas are interrelated and always changing and evolving, reflecting a dynamic and changing reality as opposed to a static one. Extremely high densities of compressed matter produce black holes, which cause a noticeable curvature in spacetime. Time dilation and space distortion around the black hole are caused by this strong gravitational field [83]. Extreme conditions cause significant changes in these basic concepts, as demonstrated by the dynamic transactions between matter, space, and time in black holes. An example is the Particles (matter) and their interactions, which arise from underlying fields, as explained by quantum field theory. Changes in these fields, which can be thought of as energy exchanges, are expressed in the production and destruction of particles. With particles and fields constantly undergoing change, this theory illustrates the dialectical interaction between matter and energy. Another example is the cosmic wave. So many years ago, the universe was much different from what we see today. This is what the cosmic microwave background radiation represents. Variations in space and time, as well as changes in matter and energy, are reflected in the properties and distribution of this radiation. A study of this radiation can reveal how the universe has changed over time in terms of both expansion (a change in space) and cooling (a change in energy).

4. Unification problem between quantum mechanics and relativity

Klein (2020) examined the unification problem between quantum mechanics and relativity more closely from a dialectical perspective [80]. Everything in the universe comprises all or some of energy, matter, space, and time. As these four states come together, they create 13 possible states of as shown in Figure 7: (1) all possible states at once (2) space, matter, and time (3) matter, time, and energy (4) space, time, and energy (5) matter, energy, and space (6) space and matter (7) matter and time (8) time and energy (9) space and energy (10) space (11) matter (12) time (13) energy (14) superposition of states.

Set theory has already been identified as a suitable mathematical treatment of quantum systems considering the indistinguishability of quantum mechanical particles as well as an ontological extension to classical particles/elements required for macroscopic realness. This concept of using set theory to evaluate the relationships between quantum sets has led to the recent development of quasi-set theory. Such advancements in the use of set theory are, however,

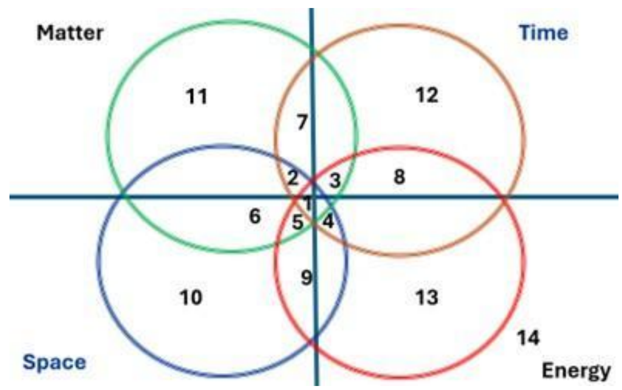


Figure 7: All Possible States involving matter, energy, time, and space.

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 the philosophy of dialectics and the synthesis of states.

Figure 7 illustrates all possible logical relationships between a finite collection of sets, namely energy, matter, time, and space. Four states come together to create 13 possible states. We can see that the nine new states were created through a synthesis of common, interlocking truths between opposing states. Dialectically, 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 (a thesis and their antithesis) by reconciling their common truths. Speed is the one common trait or denominator that links quantum physics and relativity. Quantum physics comprises energy which contains speed. Relativity comprises time which contains speed. There are 10 possible states of reality that contain either energy or time and therefore contain speed. Speed connects quantum physics and relativity in another way. Relativity and quantum physics are both crucial to the foundations of how electromagnetic fields operate. Relativity is at work behind the scenes of many electromagnetic phenomena and quantum physics is crucial for understanding lasers (the basis of fiber optics). In fact, a common connection between the two theories is that they both developed from questions concerning electromagnetic radiation. Relativity developed from questions about the speed of light, and quantum physics was developed from questions about thermal radiation which is generated by the thermal motion of particles at high speed. This supports the authors' postulation, and the dialectical theory, that speed is the common trait that links quantum physics and relativity.

5. Algebraic description of the dialectics of quantum system and relativity

In mathematics, the intersection of two sets, namely a quantum system and relativity, is the set that contains all the elements of quantum physics that also belong to relativity (or equivalently, all elements of relativity that also belong to quantum physics). In set theory, the union (∪) of a collection of sets is the set of all elements in the collection. As matter (M), energy (E), time (T) and space (S) intercept, quantum physics (M∪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∪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). Reconciling the states that contain the common interlocking 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 (See Figure 8).

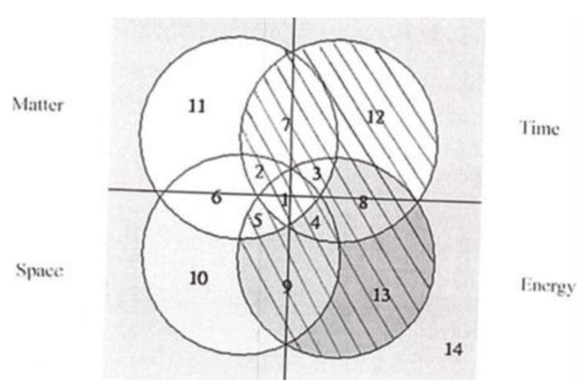


Figure 8: Creation of reality through a synthesis of states that contain the common interlocking trait of speed.

As the literature shows, the problem with combining quantum physics and relativity is that relativity gives nonsensical answers when scaled down to quantum size, eventually leading to infinities in its description of gravity. Likewise, quantum physics encounters problems when blown up to cosmic dimensions, piling so much energy in the quantum field that it creates a black hole that causes the universe to fold in on itself. The dialectical relationship, which excludes states 6, 10, and 11 from the synthesis, subtracts tiny particles of matter and huge gravitational fields of space, thereby bridging the gap between quantum physics and relativity [84]. At its essence, as a unification theory, dialectics is a simple application of Newton's third law where it is the interaction between two opposing states, namely a quantum system and relativity, which produces motion or change. Quantum physics and relativity share a dialectical relationship as they: (i) Oppose each other and synthesize together, (ii) Are each separate states and part of one greater, whole continuum, (iii) Are incompatible with each other and share a continuous, transactional relationship. Like a set of meshing gears transmitting rotational motion, the relationship between quantum physics and relativity is not combined but transactional, and it is the conflict, tension and friction that is created between them that produces change. The new state following change (the synthesis) also comprises polar forces, and thus change is continuous. Dialectically, the universe is simultaneously finite at any specific point or span of time and space and infinite in its quantum state of superposition [30].

5.1. *A dialectical interpretation of the fundamental forces*

Following this approach, the authors apply a dialectical method to the four fundamental interactions of nature. For instance, opposing electromagnetic (thesis) and weak interactions (antithesis) are two parts which simultaneously synthesize together to create the electroweak interaction (whole). Opposing states of time (thesis) and space (antithesis) are two parts which simultaneously synthesize together to create gravity (whole). Opposing electric (thesis) and magnetic charges (antithesis) are two parts which simultaneously synthesize together to create electromagnetism (whole). (Klein, 2020). Strong interactions (which bind) and weak interactions (which decay) are two opposing parts which simultaneously synthesize together to create a nuclear interaction (whole). Fermions (a type of particle) and anti-fermions are two opposing parts which simultaneously synthesize together to create weak interaction. Quarks (particles which have mass) and gluons (massless particles) are two opposing parts which simultaneously synthesize together to create strong interaction. Gravity (which attracts) and electromagnetism (which repels) are two opposing parts which simultaneously synthesize together to create a greater whole.

As the four fundamental forces come together, one can observe a synthesis of states which contain the common, interlocking traits of attracting and binding. Dialectically, as the four fundamental forces 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, a thesis which attracts/binds and an antithesis which repels/decays, by reconciling their common, interlocking traits thus forming a new thesis that causes the process to begin again (See Figure 9).

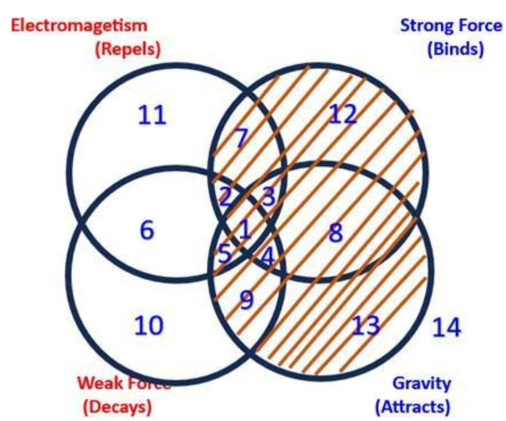


Figure 9: Synthesis of all possible states which contain the common, interlocking trait of holding atoms together

7. Comparison between dialectics and other unification theories

As a unification theory, dialectics compare, contrast, and build upon previous established unification attempts [87, 86]. Isaac Newton's universal law of gravitation states that every particle in the universe attracts every other particle (see Equation 13), and he developed a framework for understanding motion [89].

$$F = G\frac{m_1 m_2}{r^2} \quad , \qquad (19)$$

where F is the gravitational force, m_1, m_2 are the masses of the two particles, r is the distance between them, and G is the universal gravitational constant.

In the same way that dialectics build upon Newton's theories in understanding quantum mechanics, gravitational states and motion. Newton describes a process of interaction between two objects in terms of an action-reaction (See Equation 1). Dialectics describe a very similar process with some key differences. First, dialectics refers to the process between two objects as a thesis-antithesis. Second, Newton's law refers to the interactional relationship between two opposing objects while dialectics describe this process as transactional. Interaction refers to a two-way process A and B where two objects take turns sending and receiving messages and feedback [89, 90]. Mathematically, this can be expressed as

$$A \underset{F}{\overset{M}{\longleftrightarrow}} B \qquad (20)$$

where M denotes a message and F denotes feedback.

In a transactional relationship, both objects or forces are considered a sender and a receiver at the same time as demonstrated in Equation 14 . Third, while Newton refers to the interaction between two opposing ***objects,*** dialectics expands this concept to describe the transaction between ***any two states***, an object and an observer, matter and energy, time and space, opposing states of reality, a quantum system and gravity. Fourth, Newton's third law which states that the two forces are part of a single interaction forming a quantity, and neither force exists without the other is exactly consistent with dialectics. Newton describes how two objects apply forces of equal magnitude and opposite direction. Dialectically, this is where the synthesis occurs, thus creating a continuum. The ***"equal magnitude"*** is the ***synthesis of common, interlocking truths*** between two opposing states. Newton's force of "opposite direction" is what creates a single continuum of opposing forces. Fifth, Newton's third law of motion, which states that for every action, there is an equal and opposite reaction, is consistent with the dialectical Law of the Unity of Opposites. A simple mathematical description is thus explained. Let X be a phenomenon consisting of two contradictory but unified aspects, denoted by A and B. Then:

$$X = A \oplus B, \tag{21}$$

where $\oplus$ represents a dialectical unity in the form of a dynamic relation of contradiction and interdependence**[91, 92**]. Then the opposites satisfy

$$A \neq B, \quad A \cap B \neq \varnothing. \tag{22}$$

The dynamic interaction can be expressed as the struggle between A and B, which leads to transformation as

$$\frac{dX}{dt} = f(A, B) \tag{23}$$

where f (A, B) represents the dynamic influence of A and B upon one another. Then the unity through contradiction will only have s a limiting case, which can be expressed as [93,94]:

$$\lim_{A \to B} X \quad \to \quad \text{Self-Negation or Transformation} \tag{24}$$

Sixth, Newton discovered that every particle attracts every other particle. This phenomenon is explained by Hegels law of unity of opposites which refers to the principle that opposites are not merely contradictory but are interconnected and mutually dependent. This law emphasizes the interdependence of all elements in the universe, illustrating that unity is essential for understanding the nature of reality. Finally, dialectics build upon Newton's framework for understanding motion by describing the exact mechanism that produces that motion. *It is the synthesis between conflict, tension, and friction between opposing states which creates motion or change.*

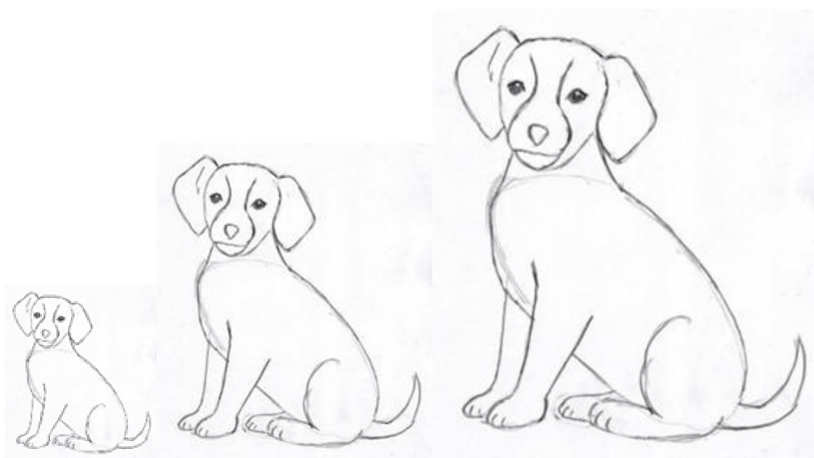
James Maxwell developed the classical theory of electromagnetic radiation, which was the first theory to describe electricity, magnetism and light as different manifestations of the same phenomenon [71]. Albert Einstein discovered that energy and mass (matter) are the same thing, just in different forms. These are two examples of Hegel's Law of the Transformation of Quantity into Quality. This law states that gradual quantitative changes can lead to a sudden qualitative change. For example, heating water gradually increases its temperature (a qualitative change), but once it reaches 100 degrees Celsius, it transforms into steam (a qualitative change). This principle illustrates how small, incremental changes can culminate in a significant transformation. Dialectics explain the phenomenon of how opposing states are actually one and the same and further expands this concept to other states of nature.

String Theory describes a complicated landscape of possible universes instead of providing a description of the real world. Dialectics provide a clear and consistent description of the real world. Finally, the Standard Model is widely considered the closest thing we have to a theory of everything, uniting all the fundamental particles of the universe. Dialectics build upon the Standard Model by demonstrating how dialectical concepts and processes can theoretically connect the Standard Model with gravity.

Finally, the unification of black holes and gravity through Stephen Hawking's work has been a significant milestone in the field of astrophysics. Stephen Hawking observed that black holes simultaneously create and destroy energy, emitting particles and energy in the form of radiation in an area of space-time surrounding a black hole where the gravitational pull is so strong that nothing should be able to escape. From a dialectical perspective, a black hole and gravity exist on a continuum. As a black hole and gravity come together, they create a distinct third group which resolves the tension between them by means of a synthesis. This synthesis solves the conflict between two opposing forces, namely a thesis and antithesis, by reconciling their common truths and forming a new thesis. The new state following change (the synthesis) also comprises polar forces, and thus change is continuous. A black hole and gravity share a dialectical relationship as they: (i) Oppose each other and synthesize together, (ii) Are each separate states (the parts) and part of one greater continuum (a greater whole), (iii) Are incompatible with each other and share a continuous, transactional relationship. This explains how information is reciprocally exchanged between a black hole and gravity.

8. Thought experiment

In Figure 10, one can observe the representation of a dog existing in a superposition of states. From a dialectical perspective the dog exists along one single continuum that we can call the lifespan of a dog (the whole). If the dog is newborn, one can predict that he will have the characteristics of a puppy in terms of physical structure and developmental stage (Figure 10 a) [95.]. As time progresses (30 months later), one can predict that he will have the characteristics of an adult dog in terms of physical structure and developmental stage (Figure b). At the late age of the dog (60 months or older), one can predict that the dog will have the characteristics of an older dog (Figure c) [96,97.]. In this way, each quantum state of the dog (the parts) shares a transactional relationship with time while simultaneously being part of one greater, whole continuum



(a) (b) (c)

Figure 10: Dialectical thought experiment. Analysis of dog evolution.

Another example is the quantum state of a dog which includes where the dog exists in space. For instance, if the dog exists in an extremely cold environment, one can predict that the dog will have hypothermia and frostbite [98]. If the dog exists in an extremely hot environment, one can predict that the dog will have heat exhaustion and heatstroke [99]. If the dog lives in an environment where there is no food, one can predict that the dog will starve. If the dog lives in a home where all needs are met, one can predict that the dog will live a full and happy life. If the quantum state of the happy do is illness, one can predict that the dog will live a shorter time span than a healthy dog. If the dog exists in the exact point of spact-time during which a car is passing, one can predict that the dog will result in injury or death. This thought experiment illustrates the transactional relationship between a quantum state and space-time through a dialectical perspective.

9. Recommendations for future research

This article presents a new interpretation of a superposition of states. Recommendations for further studies include:

I. To ensure that the theory is mathematically consistent, not merely philosophical. Future study should provide a foundation for predicting measurable phenomena and linking the interpretation to existing quantum formalism. Specifically, the mathematical formulation of the quantum state should be understood and solved as it relates to the superposition of states through a dialectical interpretation.

II. To translate visual and conceptual insights into algebraic equations, enabling other researchers to test, simulate, or expand this work, it is important to bridge abstract ideas with real-world physics. Therefore, it is recommended to develop a mathematical formulation to support Figure 8, linking it to an algebraic description of matter, energy, time, and space.

III. To develop a mathematical formulation for Figure 9, an algebraic description of the fundamental forces or interactions of nature. This provides a unified framework connecting dialectical reasoning with physical interactions, offering a potential path toward conceptual unification in physics.

10. Conclusion

Dialectics, with a history dating back over 3,000 years, have long served as a method for seeking and understanding truth. Over time, the evolution of dialectical thought has developed into a unified and coherent theoretical framework, offering the potential to explain and link together all aspects of the universe. This approach provides a symmetrical and predictive representation of the universe, minimizing arbitrariness. In this paper, a dialectical interpretation of the universe is presented, extending Newton's laws of physics to fundamental natural elements. It posits that the transaction between opposing forces or states (such as quantum and gravity) drives motion and change, leading to a more comprehensive understanding of the universe. By unifying fundamental natural interactions, this approach consistently yields accurate predictions across various scientific fields, positioning dialectics as a superior framework for interpreting the universe. Unified field theory is an evolving concept in physics, still under research, with challenges largely stemming from the absence of a solid mathematical framework. Developing this framework requires deeper collaboration to create tools for standardizing and visualizing theory. A dialectical approach could serve as a bridge between quantum mechanics and relativity, offering a foundation for new mathematical formulas that could guide future experimental testing and studies.

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Data Availability

The data that supports the findings of this study will be made available upon request

Authors Declarations

Conflict of Interest

The Authors have no conflicts of interest to disclose.

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