

The Evolution of Modern Temporal and Spatial Concepts: From Newton and Leibniz to Kant

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Abstract. The spatiotemporal problem remains one of the fundamental issues throughout Western philosophy. Philosophers from different eras and schools have developed distinct worldviews and cosmological perspectives on this subject, which in turn guided the advancement of natural sciences. This paper systematically examines and compares the views of three influential modern philosophers regarding spatiotemporal concepts to clarify the developmental trajectory of Kant's transcendental spatiotemporal theory. Newton advocated an absolute spatiotemporal view, asserting that space and time constitute independent "entities." Leibniz critiqued Newton's absolute spatiotemporal framework, proposing instead that space and time represent continuous relationships between moving objects. Kant's spatiotemporal theory transcended both predecessors by rejecting... Space-time is regarded as a completely independent entity rather than a sequential relationship. Building upon synthesizing perspectives from both sides, a transcendental view of space-time was proposed, asserting that it constitutes the subject's innate sensory intuition. Cognitive objects are first received by the subject in spatial-temporal forms, embodying both empirical reality and transcendental conceptual characteristics. Modern conceptions of space-time evolved from initial interpretations as "entities" and "relations" to being ultimately recognized as essential cognitive conditions inherent to human cognition. This developmental trajectory is inseparable from Kant's epistemological turn, exerting profound influence on modern philosophies such as phenomenology and philosophy of science.

Keywords: absolute space-time, relative space-time, a priori space-time, empirical reality, a priori conceptuality

1. Introduction

Time and space, as the basic problems in the history of philosophy, have a profound influence on the construction of philosophers' views of the universe and the world, and promote the development of natural science as background knowledge. Therefore, it is of great significance to construct a view of time and space from a philosophical perspective. In ancient Greece, Anaximander of Miletus, Zeno of Elea, Plato, Aristotle and others made some explorations into the nature of time at an abstract level, and gave preliminary metaphysical explanations of movement and change in space. In modern times, the problem of time and space has become an important issue debated by philosophers of different schools, and these issues are related to the formation of their entire

philosophical thoughts. Among them, the views of time and space of Newton, Leibniz and Kant are, on the one hand, the typical representatives of three different views of time and space in modern times, establishing the absolute view of time and space, the relational view of time and space and the transcendental view of time and space in turn; on the other hand, the formation of Kant's view of time and space is inseparable from the thoughts of the other two, but also has significant differences from them. Many foreign scholars such as Allison Henry E and Friedman Michael, as well as Chinese scholars such as Wang Yongshi and Hu Chaodu, are devoted to the study of modern times, especially Kant's view of time and space. This paper aims to analyze and compare the views of time and space of Newton, Leibniz and Kant, and explain the evolution of the view of time and space in modern philosophy as well as the transcendence of Kant's view of time and space. The paper is divided into three parts. The first part analyzes Newton's definition and metaphysical explanation of absolute time and space in *Mathematical Principles of Natural Philosophy*. The second part expounds Leibniz's refutation of Newton's view of time and space and his relational view of time and space. The third part first expounds the connotation and characteristics of Kant's transcendental view of time and space, and then demonstrates Kant's synthesis and transcendence of Newton's and Leibniz's views of time and space. By sorting out the evolution of three representative views of time and space in modern Western philosophy, this paper strives to provide a clear and consistent clue for understanding typical modern philosophical and scientific thoughts from small clues.

2. Newton's view of absolute time and space

The view of absolute time and space has exerted a profound influence on the development of physics and metaphysics. This section aims to clarify Newton's definition of absolute time and space, as well as the background of its proposal and the key role played by British empiricism in the establishment of this view.

Newton advocated a view of absolute time and space, holding that time and space are independently existing substances. In his work *Mathematical Principles of Natural Philosophy*, Newton clearly defined quantities as mathematical and universal in the "Definitions" at the beginning, in order to prevent people from relying too much on their sensory experience of objects and falling into the trap of relativity and appearance. Newton defined time as a substance independent of external things, which does not change due to external motion or measurement. He pointed out: "Absolute, true and mathematical time, of itself, and from its own nature, flows equably without relation to anything external." [1] Similarly, the nature of absolute space is also independent of anything external, always remaining similar and immovable. In summary, Newton upheld the view of absolute time and space, holding that time and space exist in themselves, while measurement and sensation are only cognitive tools used by human beings to determine the positions of objects.

Newton's view of absolute time and space is rooted in the tradition of British empiricism and also has a metaphysical dimension. First, he was deeply influenced by Bacon's inductive method, firmly believing that natural philosophy must "proceed from phenomena" and induce universal principles through experiments and observations, rather than adopting the hypothetical deduction under Descartes' transcendental rationalism. Therefore, Newton emphasized that his concept of absolute time and space is an empirical concept derived from observing celestial motions, not a product of pure speculation. This thought has a strong phenomenological character and also laid a foundation for the later development of phenomenology. Second, this ultimate framework itself has a strong metaphysical and theological dimension. Absolute and uniformly flowing time and infinite and immovable space together constitute the sensorium of God's eternal existence and infinite

omnipresence, and physical space is the result of God's emanative effect [2]. In other words, Newton's view of absolute time and space not only provides a physical foundation for kinematics, but is also regarded as a transcendental condition for God to act on the world and maintain the order of the universe. Therefore, the background of Newton's view of absolute time and space includes not only a physical foundation, but also the background of theism and cosmology.

The way absolute time and space explain the motion of objects has a far-reaching influence, and the classical mechanical system established by Newton in his later years also follows the theoretical background of absolute time and space. Determining the positions of all things in the universe requires two dimensions: the spatial order of positions and the successive order of time. Under this order, Newton distinguished absolute motion from relative motion, and spatial terms such as "place" and "translation" used in the definitions were employed to replace perceptible "measurement", further confirming the fundamental explanatory power of the background of absolute time and space in the field of physics. Therefore, the first edition of *Principia* can be regarded as a purely mathematical work on mechanics, in which concepts such as time, space, motion and force are only treated as pure scientific concepts, without concerning whether absolute time and space really exist at the theological level, but only defining concepts from the perspective of dynamics. From a physical perspective, time and space are hypostatized as an independently existing "container", separated from the motion of objects.

As contemporary scholarly research shows, Newton presupposed absolute time and space as uniformly flowing substances independent of the motion of objects, [2] thus providing classical mechanics with a solid metaphysical foundation. However, this presupposition violates the law of sufficient reason: it cannot explain the difference in the positions of objects in the "container" of absolute time and space, nor can it explain why the universe is here rather than elsewhere in absolute space. Based on the principles of his rationalist philosophy, Leibniz raised fundamental questions about Newton's view of absolute time and space and solved the problems unsolvable in Newton's ideological system from the perspective of ideality, marking a profound shift from "absolute substance" to "relational order" in the history of philosophy and directly challenging the metaphysical foundation of Newton.

3. Leibniz's relational view of time and space

Leibniz opposed Locke's and Newton's empirical and substantialized view of time and space, and formally put forward an ideal and recognizable relational view of time and space in his debate with Clarke. This section systematically demonstrates the connotation of Leibniz's relational view of time and space, its role in the evolution of modern views of time and space, and its defects.

On the surface, Leibniz's relational view of time and space seems to be put forward only to make up for the limitations of Newton's absolute view of time and space and explain problems that Newton could not solve. But if we look back at the philosophical background of this period, we will find that the fundamental reason why Leibniz created idealist views such as the "Theory of Monads" and "Pre-established Harmony" was to reconcile the philosophical theoretical foundations of the old and new religious sects and to make up for the theoretical limitations of Descartes, Locke and others.

In *New Essays on Human Understanding*, Leibniz criticized Locke's *An Essay Concerning Human Understanding*. In Chapter 17, Leibniz refuted Locke's definition of time and space as real and infinitely divisible substances, arguing that time and space should be ideal and mental things. In Book 3, Chapter 3, Leibniz also explained common nouns such as "time" and "space" as the most typical abstract ideas, whose meaning lies in being mental tools created to promote communication

among human beings. He pointed out that "these particular nouns are useless; the main purpose of language is to arouse an idea similar to mine in the mind of the person who listens to me." [3] In his refutation of Locke, Leibniz's view of time and space gradually became clear. Especially in *On the Infinite*, he believed that the infinity of time and space is a "potential possibility of the mind" rather than the sum of actually existing infinite parts. This view not only refuted Locke but also denied the substantial nature of Newton's absolute time and space.

Leibniz's direct refutation of Newton's absolute view of time and space is mainly reflected in *The Leibniz-Clarke Correspondence*. Contrary to Newton, Leibniz held that time and space are recognizable relations in ideas rather than real substances. He pointed out that "if space were an absolute being, something would happen for which there would be no sufficient reason, which is against our axiom... Space is something absolutely uniform; and without the things placed in it, one point of space does not absolutely differ in any respect whatsoever from another point of space." [4] *The Law of Sufficient Reason* and the *Identity of Indiscernibles* were the main arguments Leibniz used to refute Newton's view. His refutation of time was based on similar reasoning, namely that "there can be no reason to explain why these things were done at such moments rather than at others." [4] In his refutation of Newton, Leibniz formally put forward his own view of time and space and positively defined time and space as a kind of "order": space is an order of coexistence, and time is an order of succession. Like space, time is purely relative rather than absolute. When several things exist together, people perceive the order among them.

Leibniz emphasized the "ideality" and "relativity" of time and space, which is inseparable from his idealist philosophical position. In the seventeenth-century Western European philosophical circle, there was a fierce competition between empiricism and rationalism. Bacon, a materialist, believed that "knowledge is power" and that knowledge comes from experience, initially establishing the principle that knowledge originates from experience. On the contrary, Descartes, an idealist, founded the theory of innate ideas, making philosophy start from self-consciousness for the first time, shifting the foundation of truth to human inwardness, and opposing the empiricist view that truth comes from experience in the real world. By the end of the seventeenth century, Locke's *An Essay Concerning Human Understanding* had thoroughly criticized the theory of innate ideas and systematically demonstrated the principles of empiricism. Leibniz's idealist position was established precisely to defend the theory of innate ideas. Leibniz believed that the rational order of the world was pre-established and well-arranged without human adjustment, and human cognition is only a kind of "correspondence" confirmed in pre-established harmony, rather than an empirical source as Locke and others believed. As early as when Leibniz was 15 years old, he realized that the mechanistic materialist views in scholasticism had many shortcomings. Later, when he worked as a diplomat under the Archbishop of Mainz, he participated in the negotiations for reconciliation between the old and new churches, which greatly strengthened his desire to reconcile them. However, he believed that Descartes' judgment on the nature of material substance was irreconcilable with both sects. Therefore, Leibniz began to create an idealist theory of substance, namely the "Theory of Monads", in which the relations between monads are in a kind of "pre-established harmony" and have been preset. Leibniz's relational view of time and space exactly originated from this idealist position. Different from empiricism which advocates real existence, idealism emphasizes existence in human ideas, and existence depends on metaphysical and theological presuppositions. This leads to the fact that the view of time and space put forward by Leibniz on the basis of idealism cannot be real existents but must be a connection of human ideas to existence.

Leibniz's contribution to the view of time and space mainly lies in explaining such a grand concept as time and space within the scope of human cognition and enabling his insisted idealist position to function in the field of natural science. This transcendence is undoubtedly worthy of recognition and also laid a foundation for later rationalism in natural science. However, although Leibniz's relational view of time and space took a key step in criticizing the substantialization tendency of Newton's absolute time and space, his theory itself also faces profound internal dilemmas. First, Leibniz reduced time and space to a perceptual order with "pre-established harmony" among monads, which fundamentally deprived time and space of independent status, making them subordinate to the rational order preset by a higher spiritual entity (God) and a "phenomenal" expression under reason. Although this position avoids the substantial dilemma of Newton's type, it completely attaches the objectivity of time and space to a metaphysical presupposition: the universal validity of the spatio-temporal order is not because it is rooted in the universal structure of human cognitive ability, but because it is pre-arranged as a harmonious relation between monadic perceptions. Second, Leibniz's "intellectualization" of time and space, treating them as relational concepts abstracted by the understanding from experience, cannot explain why time and space can serve as the a priori foundation of mathematical knowledge (especially geometry and arithmetic). If time and space are only vague phenomenal relations between things, then geometric propositions taking them as objects (such as "the straight line between two points is the shortest") can only be a posteriori inductive conclusions that may be revised by experience, which contradicts their universal and necessary self-evident status. Third, Leibniz's view of time and space ignores the originality and immediacy of perceptual intuition in cognitive activities: we do not first perceive objects and then rationally infer that they are in time and space; on the contrary, time and space are the preconditions for objects to appear to us. It is precisely these theoretical dilemmas of Leibniz's view of time and space — dependence on theological presuppositions, weakening of the a priori foundation of mathematical knowledge, and obscuring of perceptual immediacy — that put forward a fundamental philosophical task for Kant: to re-ground the objective validity of time and space on the premise of neither substantializing time and space (like Newton) nor intellectualizing them (like Leibniz). Kant thus opened the epistemological turn to the problem of time and space.

4. Kant's transcendental view of time and space

This section systematically expounds Kant's transcendental view of time and space. It first analyzes the core meaning of his epistemological turn, then explains in detail the arguments in the "Transcendental Aesthetic" of Critique of Pure Reason regarding time and space as pure forms of intuition, clarifies the key properties of time and space—"empirical reality" and "transcendental ideality"—which seem contradictory but are actually unified, and finally demonstrates how Kant achieved the synthesis and transcendence of Newton's and Leibniz's views of time and space.

The "Copernican Revolution" in Kant's philosophical system ultimately points to the a priori conditions for the subject to know, namely the forms of time and space and the categories of the understanding. Throughout the development of modern philosophy of time and space, Newton's absolute time and space and Leibniz's relational time and space constitute a profound dualism. The former establishes time and space as independent substances in physics and even metaphysics, while the latter defines them as the rational order of coexistence and succession between substances. However, these two opposing ideas actually share a premise: the cognition of time and space is in fact an attribute of the knowing subject itself, and the subject itself has the ability to cognize temporal and spatial representations, whether as attributes of substances or as relations between substances. Kant's philosophical revolution lies in the fundamental questioning of this premise.

Through his "Copernican turn", Kant completely shifts the problem of time and space from the ontological field of "what the world itself is like" to the epistemological field of "how the cognition of the world is possible". In the preface to the second edition of *Critique of Pure Reason*, Kant clearly points out that the predicament of traditional metaphysics stems from a deeply rooted cognitive model: we always assume in advance that all human knowledge must conform to objects, that cognition comes from objects, and that cognition can only take place with objective substances as its carrier. According to this assumption, the concept of the thing-in-itself does not appear in objects; reason can only grasp the thing-in-itself directly through concepts, yet ultimately falls into the mire of skepticism. Kant's revolutionary idea lies in attempting the opposite assumption: assuming that objects must conform to human knowledge to be cognized, reversing the logical positions of the cognized object and the cognizing subject. This reversal is not a simple psychological or subjectivist turn, but a profound transcendental philosophical turn. Its core purpose is to explore the a priori cognitive conditions that make empirical objects possible and objective knowledge valid.

This means that the objectivity of knowledge no longer comes from the passive conformity to some "object" external to the mind, but from the ability of the cognizing subject itself to legislate universally for all possible experience. Human cognitive capacity possesses an inherent structural form that precedes all experience (yet makes experience possible). This form appears as space and time at the level of sensibility, and as twelve pairs of categories at the level of the understanding [5]. The world we cognize, and even all phenomena that can be cognized by human beings, are not things-in-themselves, but appearances produced by things-in-themselves affecting our senses. Things-in-themselves provide us with the sensory manifold, which is finally formed into our objects of cognition through the reception of the subject's forms of sensory intuition (time and space) and the unification of the categories of the understanding (such as causality, substance, etc.). Henry E. Allison summarizes Kant's philosophical position as transcendental idealism, which aims to establish that "the objective conditions of cognition are at the same time its subjective conditions", thus grounding objectivity in subjectivity [6].

This epistemological turn is decisive for the problem of time and space. For this formulation completely changes the debate about the view of time and space: time and space are no longer an ontological question of "what things-in-themselves (whether substances or relations) are", but a transcendental epistemological question of "how, as pure forms of our sensory intuition, they make mathematical cognition of things (such as geometry and arithmetic) possible". Kant thus opens up a third path, different from both Newton's absolute realism and Leibniz's rational relationalism, namely that time and space are the subjective a priori forms of the subject's sensibility. Precisely because this form exists universally and necessarily in all human cognitive subjects, it endows the phenomenal world with an objective spatio-temporal order. This lays a solid philosophical foundation for the Transcendental Aesthetic and even Kant's entire theoretical philosophical system.

In the "Transcendental Doctrine of Elements" in Chapter One of *Critique of Pure Reason*, Kant puts forward the concept of "Transcendental Aesthetic". "Transcendental" does not take human knowledge as its object, but takes the cognitive ways that make human knowledge possible as its research object. As Kant states, "I call all knowledge transcendental which occupies itself not so much with objects as with the mode of our knowledge of objects in general, in so far as this mode is to be possible a priori." [7] The word "sensibility" (*Ästhetik*) comes from ancient Greek, meaning the capacity of "perception" or "sensation". Kant holds that all knowledge begins with experience, but not all knowledge arises from experience. Our cognitive capacity first passively receives the stimulation of objects through the senses and obtains manifold representations, and this process is

called "intuition" (*Anschauung*). For intuition to take place, two elements are necessary: one is the matter provided by the affection of things-in-themselves, and the other is the form possessed a priori by the subject to organize this matter. Time and space are precisely such pure forms of intuition, thus belonging to human sensible cognitive capacity and characterized by passive receptivity [8].

First, the metaphysical exposition aims to reveal the nature of the concepts of space and time. Taking space as an example, Kant puts forward four key arguments: (1) Space is not an empirical concept abstracted from outer experience or objective objects, because the representation of space must already exist as a prerequisite if we are to refer outer experience to something "outside me" and represent objects as alongside one another. (2) Space is a necessary a priori representation that underlies all outer intuitions. We cannot imagine a world without space, but we can easily conceive of space as empty of objects. The ability to imagine in space is one of the basic capacities of human cognition, proving that humans as objects in the world exist alongside other objective things. (3) Space is not a discursive universal concept like "triangle", but a single and infinite whole. Individual "spaces", such as a room, are only limited parts of this single infinite space, resulting from division, and do not belong to the same level as the general concept of space a priori. (4) Space is represented as an infinite given magnitude, which also shows that it is an a priori intuition, since no concept can contain an infinite amount of content. The exposition of time follows a parallel structure, whose core is to show that time is the necessary foundation of all intuitions, both inner and outer, and that it possesses unity, infinity, and givenness prior to experience [7].

Second, the transcendental exposition is even more crucial. It answers the question: Can regarding space and time as a priori forms of intuition explain the possibility of certain existing a priori synthetic knowledge? Is it certain that such synthetic knowledge arises from a priori forms of intuition? Kant points out that the existence of geometry, the science of space, and arithmetic, which depends on the succession of time, confirms the transcendental ideality of space and time. Geometrical propositions such as "the straight line between two points is the shortest" are universal and necessary, yet they cannot be intuitively and then rationally analyzed directly from concepts like "point" and "line", nor can they be induced from changeable experience. There is only one explanation for their possibility: they derive from the a priori forms and rules that the knowing subject follows when constructing spatial relations in intuition, rules that every human being possesses inherently. Geometry studies the pure form of our outer intuition itself, so our study of geometry has a reliable foundation. Similarly, arithmetic is based on the succession of time. For instance, the synthetic judgment that $7+5=12$ requires us to synthesize units one by one in the temporal sequence [7]. Therefore, Kant concludes: "Space and time are the two pure forms of all sensible intuition, and thereby make a priori synthetic propositions possible." [7] This exposition is of great importance: it successfully connects the transcendental status of space and time with the objective validity of mathematical sciences through a causal chain, providing an epistemological guarantee for the objectivity of knowledge. The objectivity of mathematical sciences can indeed be verified on the basis of the transcendental status of space and time. However, Kant's argument has certain limitations. Paul Guyer argues that Kant's transcendental exposition is actually a "counterfactual argument from necessity": if space and time were properties or relations of things-in-themselves, geometry would become an empirical science subject to revision by future experience, which contradicts its self-evident and necessary status [9]. Only by admitting that space and time are our forms of intuition can the a priori necessity of geometry be preserved.

Based on the above expositions, Kant put forward his core conclusion about the nature of time and space: time and space have "empirical reality" (*empirische Realität*) and "transcendental ideality" (*transzendente Idealität*) at the same time [7]. These two concepts form the core

characteristics of Kant's view of time and space, and are the key to understanding how he synthesizes and surpasses his predecessors.

The so-called "empirical reality" means that space and time have objective validity and reality without exception for all objects of possible experience, that is, for all appearances and things in the world. In the world we experience, all things necessarily stand in spatial relations of juxtaposition and extension and temporal relations of succession and duration without exception. Whether describing grand physical laws or small daily events, defining them, or predicting their development, we must rely on the framework of space and time. In this sense, Kant fully agrees with and defends the universal objective validity of space and time in the empirical world presupposed by Newtonian physics. Unlike skeptics or subjectivist sensationalists, Kant firmly insists that the spatio-temporal order is neither an illusion arising from doubt nor a vague subjective sensation, but a real and necessary element that constitutes the objective structure of the phenomenal world. Nevertheless, this objective validity does not stem from the independent existence of space and time as absolute substances, as Newton believed. Kant argues that the reality of space and time is limited to the empirical domain and can never reach the unknowable realm of things-in-themselves. Once we attempt to go beyond this empirical boundary and apply space and time to thinking about things-in-themselves, such as God, the world as a whole, or the soul, we produce meaningless "transcendental illusions", which cannot be grasped by space and time as the transcendental laws of the empirical world.

Complementary to "empirical reality" is "transcendental ideality". First, "ideality" here does not mean that space and time are individual, subjective, or arbitrary mental imaginations, but that they do not belong to things-in-themselves and exist only as inherent cognitive forms of the human subject, applicable only to objects of human cognition. Second, in their origin, space and time are "ideal": they are properties of the subject and a priori conditions provided by the subject for cognitive activity. The subject is indispensable in this a priori nature. In other words, space and time apply universally and necessarily to all appearances in the world precisely because they are the necessary forms and preconditions through which all possible appearances to humans can be received and ordered. We cannot step beyond the limits of cognition to know anything that is not processed by our forms of intuition.

Empirical reality and transcendental ideality are two sides of the same nature of space and time. Using Kant's famous metaphor: if we look at the world through blue glasses, everything appears blue. The blueness is not a property of things themselves but of our sensory lenses, yet it truly applies to every object we see [7]. Zheng Xin accurately points out that "transcendental ideality" is the "substance" of space and time, while "empirical reality" is their "function", and the two together interpret space and time as forms of transcendental sensible intuition [10]. The blue glasses are the "substance" of space and time, and the blue world we see is the manifestation of their "function". As Mr. Qi Liangji also states, these two properties are "two aspects of the same thing" and cannot be separated [11]. Hu Chaodu also notes that "transcendental ideality is the essential attribute of the representations of space and time, while empirical reality is the necessary inference of transcendental ideality" [12]. Kant's transcendental view of space and time aims to avoid both the empirical idealism resulting from Leibniz's excessive intellectualization of space and time, which weakens their objective reality, and the transcendental realism of Newton, who substantializes space and time and leads to empty speculation. The renowned Kant scholar H.J. Paton argues that Kant's idealism "is not a doctrine about the existence of things, but about the way we know things", and that it is precisely the only reliable foundation for the objectivity of empirical sciences [13]. This

also shows that for Kant, the ideality of space and time is precisely the reliable basis for their reality and objectivity.

Based on the dialectical unity of "empirical reality" and "transcendental ideality", Kant carries out a profound and multi-layered critical synthesis of Newton's and Leibniz's views of space and time. This synthesis is not a simple summary or combination, but incorporates them into a higher-level epistemological system, revealing their respective insights and shortcomings on that higher level, and ultimately achieving transcendence by distinguishing appearances from things-in-themselves. Although some scholars such as Rockmore and Höffe claim that there is no so-called "Copernican Revolution" in Kant's philosophy, [14-15] there is no doubt that the fundamental transformation of thinking proposed by Kant has exerted an influence in philosophy comparable to that of Copernicus' heliocentric revolution in astronomy [16]. The transcendental view of space and time is precisely the concrete unfolding of the Copernican Revolution of Kant's entire epistemological system in the field of sensibility. Through the synthetic criticism of Newton's and Leibniz's views of space and time and his own epistemological turn, Kant's transcendental view of space and time achieves innovative development.

First, Kant's critique and absorption of Newton's absolute view of time and space are dialectical. On the one hand, Kant highly recognizes the great success of Newtonian physics in the empirical world and fully acknowledges the universal and necessary objective validity of time and space in reality. This is the fundamental meaning of his insistence on the "empirical reality" of time and space. Newton's contribution lies in proving through his physical system that without such a unified and absolute frame of reference for time and space, the mathematical description and reasoning of classical mechanics would be impossible. Kant inherited this requirement and provided the philosophical foundation that Newton failed to give in his *Metaphysical Foundations of Natural Science*.

On the other hand, Kant firmly opposes Newton's metaphysical presupposition of substantializing or realizing time and space. In Kant's view, if time and space are regarded as independently existing absolute substances or attributes of God, just like "things-in-themselves", it would be a fallacy of "transcendental realism". This view wrongly projects the subjective conditions of our cognitive forms as the existential conditions of things themselves. Its philosophical consequences are serious: first, it leads to meaningless speculations about "empty space" and "empty time" that can neither be verified nor falsified in experience; second, as Leibniz criticized, it violates the law of sufficient reason (why is the universe here rather than elsewhere? This question cannot be answered). Therefore, Kant criticizes that Newton's absolute time and space, as existences in the sense of things-in-themselves, are untenable and meaningless in the empirical world. What Kant affirms is the universal necessity of time and space as objective forms of appearances and their absolute function for objects of cognition, rather than their absoluteness as substances of things-in-themselves. Kant's time and space are oriented (toward objects of cognition) and limited (cannot transcend the scope of cognition, unlike Newton's absolute time and space). By reinterpreting them as transcendental ideal forms, Kant not only retained the empirical core of Newtonian physics but also stripped away its untenable metaphysical shell, achieving a critical refinement of Newton's view.

Second, Kant's critique and absorption of Leibniz's relational view of time and space are equally profound. Kant highly appreciates Leibniz's emphasis on the ideality of time and space and his new definition of the interpretation of time and space. Leibniz pulled time and space down from the status of independent substances and regarded them as the rational order of coexistence and

succession of things. This insight deeply inspired Kant. Kant agrees that time and space do not belong to the world of things-in-themselves, which is the idealist position shared with Leibniz.

However, Kant severely criticizes Leibniz's tendency to "intellectualize" time and space, arguing that this tendency has limited explanatory power. This is because, in Leibniz's monadological system, time and space are ultimately reduced to vague, phenomenal relations between monadic perceptions, namely "confused perceptions", whose real foundation is the logical order of pre-established harmony among monads. In other words, for Leibniz, time and space are vague relational concepts abstracted and deduced by the understanding from experience, rather than transcendental and original forms of intuition. But this causes great problems. In Kant's view, it commits two fatal mistakes: first, it cannot explain the possibility of the a priori synthetic nature of geometry and arithmetic. If time and space are concepts abstracted a posteriori, then mathematical knowledge based on them can only be inducted a posteriori, thus losing their universal necessity. Second, it weakens the immediacy and original givenness of time and space in sensory experience, reducing them to deduced and verifiable relations. In fact, we do not first perceive objects and then rationally infer that they are in time and space; on the contrary, time and space are the preconditions for objects to appear to us.

Kant's brand-new view of time and space holds that time and space are a priori forms of sensory intuition and preconditions of cognition. This definition perfectly sublates previous theories, reflected in three aspects: 1. Critical retention of Newton: Kant accepts the universal necessity (objective validity) of time and space at the empirical level, but denies their absolute reality at the transcendental level (the level of things-in-themselves). The "absoluteness" of time and space is repositioned as the universality of the subjective forms of the cognitive subject. 2. Critical development of Leibniz: Kant accepts the core of transcendental ideality of time and space proposed by Leibniz, but finds it necessary to shift them from the field of understanding concepts to the field of sensory intuition, paying attention to their logical position relative to the subject. Time and space are no longer vague reflections of relations between things, but the inherent sensory conditions that enable us to clearly recognize every object. 3. Kant's own innovation and insight: time and space are neither substances nor relations, but constitutive intermediate forms connecting the subject and the phenomenal world, possessed by human beings. They are the yardsticks of human sensory faculty; all external appearances must obtain positions within them, and all events must obtain orders and be measurable. Only in this way can we form any definite experience, further develop in mathematical description and reasoning, and broaden our understanding of the phenomenal world. It is these a priori forms originating from the subject that guarantee the objectivity and intelligibility of the spatio-temporal order of the phenomenal world.

The forms of time and space and the categories of the understanding are the subjective cognitive conditions targeted by Kant's "Copernican Revolution", which means that human cognition does not originate from passive conformity to objective objects, but the subject itself possesses the ability to process cognition. This epistemological turn plays a decisive role in modern problems of time and space, bringing time and space into the scope of the subject's a priori cognitive ability rather than empirical objects. In the "Transcendental Aesthetic" of *Critique of Pure Reason*, Kant elaborates on the "transcendental exposition" and "metaphysical exposition" of time and space, demonstrating that time and space are human sensory intuitions, on which the verification of a series of mathematical a priori synthetic knowledge is also based. "Empirical reality" and "transcendental ideality" constitute the core viewpoints of Kant's view of time and space, being two sides of the same coin and complementing each other. On the one hand, this transcendental view of time and space upholds the empirical verifiability of Newton's absolute view of time and space; on the other hand, it opposes

metaphysical presuppositions. With Leibniz, Kant shares his idealist position, but also holds that his view has limited explanatory power in the cognitive deduction of the scope of understanding. Through the critical synthesis of previous views, Kant proposed a brand-new transcendental view of time and space, elevating the problem of time and space to a new height.

In short, Kant critically synthesized previous views and founded the transcendental view of time and space. The "Copernican Revolution" incorporated time and space into the subject's a priori cognitive ability rather than empirical objects. Through transcendental exposition and metaphysical exposition, Kant demonstrated that time and space are forms of sensory intuition, on which mathematical a priori synthetic knowledge is grounded. Empirical reality and transcendental ideality are the core characteristics of Kant's transcendental view of time and space, which not only retain the empirical verifiability of Newton's view of time and space but also share Leibniz's idealist position, with the two being two sides of the same coin and complementing each other.

5. Conclusion

Newton's absolute view of time and space initiated the first systematic inquiry into time and space in human history, regarding time and space as independent substances on a metaphysical basis. Leibniz criticized this substantialized conception, abandoned the metaphysical background, redefined the view of time and space as a kind of relational order, involved human cognitive logic in the construction of time and space, and defined time and space as relative and successive relations determined by human cognitive logic. The philosophical significance of Kant's transcendental view of time and space is revolutionary. It means that from then on, the answer to the philosophical inquiry into time and space lies neither in the absolute structure of the external world (Newton) nor in the logically order of rational abstraction (Leibniz), but in the innate cognitive structure of human beings and the transcendental critique of human cognitive ability itself. Kant's construction of the entire view of time and space, from metaphysical exploration to the delineation of human cognitive structure, is one of the clearest clues of his "Copernican Revolution". It marks the completion of the decisive turn of modern philosophy from exploring "the structure of being" to exploring "the conditions for the possibility of cognition", and leaves a rich legacy and challenges for the later philosophical development from Hegel to phenomenology.

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