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Understanding The properties of time-space, and matter based on the history of science

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ABSTRACT

The aims of this research are to explore the characteristics of three streams in the history of science, Newtonian mechanics, special relativity, and general relativity, regarding the relationship between space-time and matter in the universe. According to Newton's hypothesis, absolute space exists as an independent entity, it is fundamental, and resembles a container that is capable of holding objects in place while having no relationship with matter itself. Additionally, according to him, absolute time is unrelated to all natural events; it exists eternally, independent from the material world, in a continuous and constant manner. The attributes of immutability, time, space, and matter are all independent from each other. In other words, in metaphysical mechanical philosophy, time and space—unlike matter—possess the quality of "matter-independence," which means that they do not follow the natural laws. Conversely, the special theory of relativity suggests a "weak matter-dependence" of space-time at the level of relativization of space-time based on the objective motion of matter. The general theory of relativity, as indicated by Einstein field equations, clearly states a "strong matter-dependence" of space-time in that the distribution of matter directly determines the structure of space-time. Considering that the general theory of relativity hypothesizes situations that are more commonplace as compared to that of the special theory of relativity, it can be said that the strong matter-dependence of space-time is universally true for both theories of relativity. Therefore, the special theory of relativity is closer to Newtonian mechanics—a part of the school of metaphysical mechanical philosophy—while the general theory of relativity is closer to dialectical materialism.

Keywords: *special theory of relativity, general theory of relativity, dialectical materialism, matter-dependence*

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1. INTRODUCTION

Throughout the development of science, the human conception of space-time has experienced at least three radical changes. The first change broke the walls of the ordinary concept of space; this change was the introduction of classical Newtonian mechanics, including a 3-dimensional Euclidian concept of space, with a linear concept of time, that was established as the sole scientific concept of space-time.

The second revolution of space-time conceptualization occurred with the special theory of relativity, where the 3-dimensional Euclidian space was mixed with time as another axis, creating the concept of a 4-dimensional Euclidian space.

The third change occurred when the 4-dimensional Euclidian space evolved into a 4-dimensional non-Euclidian concept of space-time. The general theory of relativity tells us that time and space can be warped.

However, before we proceed to detailed discussions of such concepts of space-time, we must see what people thought of space-time in ancient times.

Following the ancient Greek school of thought, human beings believed that truth was eternal and immutable. There is a reason for people believing in immutable things as truths, if you look at the reasoning for deciding so. Human beings could not believe in something transient, something that changed constantly. That is why people started looking for immutable things.

The concept of being "singular," one of the most commonly mentioned premises of reasoning, is characteristic of having the innate quality of immutability. Such concepts, that is, the concepts that ensure immutability—are identical to the intrinsic thought structures of human beings. The concepts of absolute space and absolute time are also representatives of such qualities of human thought. All universal thoughts and feasible assertions must possess such qualities. Only when such prerequisites of absoluteness are fulfilled, human thought starts to accept change. Mathematics and logic are representative of this fact (Byung-Ok Song, 2004, p.79).

Plato's "chora" was considered a maternal space of creation, and Aristotle's "topos" was the space given to man and matter: they are both limited, and precede both man and matter. This leads us to believe that space and time are elements that precede man and matter. Above all, for Aristotle, the rules of the world were predetermined and given with the concept of "place." Space, in the concept of "place," was organized in the form of the natural universe: it was considered inevitable and limited.

Conversely, atomists accepted the existence of maneuvering room for atoms' movement and called it "kenon"—in other words, "void." The concept of void was distinct from the limited concepts of space held by preceding philosophers, in that it was unlimited in its potential as the stage for objects, comprising numerous atoms that occupied various places. From the concept of "place," that was limited in its nature, the next step was a move toward the concept of "space," that was gradually freed from limitations, moving toward a conceptualization of space with an unlimited and limitless nature. Holding infinite time and space as the prerequisites, it described the mechanical movement of matter. Above all, the path to objective knowledge was finally open, leaving behind the world of personal and subjective experiences (Lee, 2016). This was the movement toward the infinite space and time conceptualized by Newton. Aristotle's concept of natural and limited space was denied, since the uniform and infinite space

placed between objects had to be considered.

The purpose of this study is to determine the relationship between space-time and matter that exists within the fabric of space-time through the abovementioned three revolutionary changes in the conceptualization of space-time, spanning from classical Newtonian mechanics to the theory of relativity in modern physics; in other words, this study attempts to answer the following questions: does space-time actually exist in the matter and independence that take place within itself? And, if so, how has that relationship changed over time?

2. NEWTON'S ABSOLUTE TIME AND ABSOLUTE SPACE: METAPHYSICAL A PRIORI DEFINITIONS

Analytic geometry includes important conversions for certain characteristics of space— location, form, distance, and volume are all converted into algebraic numbers—that is, space is reduced to algebraic numbers, regardless of its numerous characteristics, such as its physical characteristics or religious meaning. It is calculated as homogeneously and algebraically as numbers, becoming an abstract space that is equally divisible by a constant unit.

Such a conceptualization of space—without form and qualities—is "empty space." When something is proposed to represent one of the points (an extension of the Cartesian concept) in this space, it takes on the quality of absoluteness as a measure for plotting relationship and change. The concept of absolute space continues to act as a transcendental premise for almost all modern scientists and philosophers. The concept of aether is a remnant of such transcendental premises.

The most decisive motivation for Newton was to understand all mechanical movements through a single principle; from this perspective, Kepler's laws of planetary motion and Galileo's law of free fall and mechanics of natural motion were explaining mechanics in a dualistic perspective. Thus, considering mechanical movements as the rate of change over time, other concepts related to motion are defined as follows: momentum (P) is the product of mass and velocity ($p=mv$), and force (F) is the product of mass and acceleration (Newton's second law: $F=ma$). Here, velocity (v) is the rate of change of displacement over time, and acceleration (a) is the rate of change of velocity over time.

However, here, the question is finding the mathematical definition of the rate of change of displacement over time or the rate of change of velocity over time. Defining velocity as $\Delta x/\Delta t$, wherein the denominator is time at uniform intervals, can also be seen as time described using distance-based qualities. In other words, this is a rate of spatial qualities, and is therefore not capable of representing rate of change over time. To address this issue, Newton invented calculus, a novel mathematical concept, which calculates the change in average velocity as the denominator of average speed, Δt, becomes infinitely smaller (dt). Through this process, it is possible to find the value of velocity in a given moment, that is, a specific value of the rate of change of distance over time. Thus, it is possible to find the value of velocity in a given moment, defined as the rate of change of distance over time ($v=dx/dt$); fundamentally, it represents velocity as a function of time, rather than as some interval (distance) of time. Acceleration can also be represented as a function of time; therefore, the framework was established for representing all motion as functions of time. In this sense, if Galileo can be said to have brought the abstract concept of time (t) into the realms of natural motions, Newton can be said to have established the framework for reducing all motion as functions of time.

Thus, absolute and abstract time have taken their places at the base of all physical phenomena. Time, essentially, has become the independent variable that secures the singular unity of the world and the universe.

In the end, Galileo's idea of calculating natural motions by bringing nature into the realm of mathematics—a characteristic of modern science—contributes to the conversion of space into an algebraic space—that is subsequently completed by establishing time as the absolute standard of all motion. In this sense, mathematics has created an inherently objective world, using universal building blocks of space and time that exist in the lifeworld.

Let us summarize the concepts of space and time, that are both the products and prerequisites of the modern scientific revolution. First, according to Descartes, any specific component of space is identical to space as a whole; the only apparent difference is quantitative in nature. In other words, he considered space to be capable of being divided into any given size. Therefore, Descartes was able to convert space into algebraic numbers, describing geometry and spatial characteristics using arithmetic. In this sense, space includes "mathematical space" and "abstract space."

The same is applicable for the concept of time. Time, as assumed by Galileo and Newton, is singular, unified, and divisible—in other words, time is represented in a chronometric sense. Any specific component of time is no different from other components of time, and they can be added or multiplied with each other.

This conceptualization extended to there being no limitations on the concept of negative time. A similar phenomenon was observed regarding the conceptualization of space; however, the problems induced by the consideration of negative space were discovered long before they were discovered in the realm of time. In other words, negative values were problematic in that they could not exist as geometric concepts of length or area; this could be addressed by "understanding" the negative values as indicative of the opposite "direction." The possibility of time flowing backward can be applied to various branches of dynamics, including Newtonian mechanics, the theory of relativity, and quantum mechanics, with the exclusion of statistical dynamics.

Here, it can be seen that when it comes to the case of the natural sciences, time is more fundamental than space. This indicates that temporal order is the prototype of causal delivery. Temporal order is the fundamental framework of causal connectivity (Reichenbach, 1957).

According to Newton's premises, absolute space exists as an independent entity, is fundamental, and resembles a container that is capable of holding objects in place while having no relationship with matter itself. As a result of the influence of Euclidian geometry, absolute space has the following characteristics: infinity, isotropy, and uniformity. Newtonian space, that also has characteristics similar to that of absolute space, is a 3-dimensional Euclidian space. Absolute time is unrelated to all natural events; it exists eternally, independent from the material world, in a continuous and constant manner. Absolute, true, and mathematical time flows independently of all external factors; this is also called continuance. It is primary and a priori, preceding all matter and events. Additionally, absolute space and absolute time are not physical entities ruled by natural laws; rather, they are qualities that are divine in essence, since the infinity of space and eternity of time are qualities that belong to deities (Lee, 2016, p.109, Oh, 2022).

If Earth were at the center of the universe, starting from the core, it is composed of heavy earth, water, air, and fire. Therefore, stones that have higher compositions of earth must move toward the direction that would increase their density in order to reach their destination on Earth's surface.

However, following the heliocentric view of the universe, such distributions of components are rendered meaningless. Additionally, Earth is in motion due to the effects of universal gravitation. Therefore, in situations where action at a distance forces are in effect, the surrounding environment is reduced to secondary situations; since the state of vacuum has no influence on motion, they must be actively removed or ignored.

The world of Newtonian mechanics is simple. It is the world of Democritus, reincarnated. This world is vast and uniform, composed of identical spaces at all times and in all directions, containing particles moving and interacting with each other over an eternity. Newton's world is the mathematical expression of Democritus' world (Rovelli, 2014, p.55).

Such concepts of absolute space and absolute time are realist and slightly materialistic, in that they perceive space and time as objective entities that exist independent of human perception. This is because space and time are matter-independent from the objects that exist within them. However, since this perspective of absolute space and absolute time consider space and time as immutable and fixed standards that describe unchanging motions of objects, it is more metaphysical than dialectical.

3. EINSTEIN'S SPACE-TIME BASED ON THE THEORY OF RELATIVITY

In Newtonian mechanics, space-time is independent, immutable, and fixed, wherein objects have unique characteristics. While there are numerous physical and philosophical questions raised by the theory of relativity, the challenges posed regarding Newtonian space and time have critical significance. This is because Newton's conceptualization gives space-time a materialistic foundation as a physical entity, leaving the realm of idealistic, subjective, and metaphysical definitions that dominated their conceptualization up to that point in time.

Space-time in the special theory of relativity

The special theory of relativity holds two principles as the premises of relative uniform motion between two coordinate systems.

The first principle is Galilean relativity, that states that the laws of motion are the same in all inertial frames. This is similar to the postulates of geometry. The second principle is regarding the speed of light, that is, the constancy of the speed of light regardless of the coordinate system or observer in coordinate systems of uniform motion; additionally, the speed of light is the maximum speed that can be achieved by matter. This can be proven mathematically using Maxwell's equations of electromagnetic waves, and can also be proven empirically.

Based on such premises, Einstein theorized a new physical and philosophical definition of the speed of light. First, he considered the material nature of waves—in other words, he accepted the physical and material existence of waves, rejecting the existing understanding of matter based on mechanical philosophy; subsequently, he accepted the law of constancy of the speed of light as an objective truth based on the properties of matter. Additionally, by rejecting the existence of aether, he stressed that only relative motion exists within objectively external space, instead of absolute space or absolute motion.

Thereafter, he rejected the concept of absolute time, since accepting the existence of absolute simultaneity for events occurring at large spatial displacements would be a violation of the fact that light has a limited speed; in other words, this would be the equivalent of making a mistaken assumption that "observing simultaneously" and "occurring simultaneously" are the same thing. This is the rejection of the absolute nature of Newtonian space-time as metaphysical a priori definitions.

The two premises of the special theory of relativity confirm that the novel understanding of matter and space-time is a physical truth. This is also a necessary component for converting the concept of space-time into a physical viewpoint from a metaphysical a priori viewpoint, that is founded on the materialistic bases of cognition derived from objective existence in the natural world.

The concept of relative space-time in the special theory of relativity is "slightly materialistic," since it considers space and time as objective entities that are independent of human cognition. This is because space and time are "slightly matter-dependent," in that they are dependent on the motion of objects that exist within them.

However, since the changes in space-time are observed through the motion of matter based on the convertibility of matter into energy—that depends on the principle of the constancy of the speed of light—it can be considered to be "slightly dialectical." The mass of matter does not affect the changes in space-time.

In the end, the special theory of relativity is still closer to Newtonian mechanics, a metaphysical and materialistic perspective regarding space and time.

Space-time in the General theory of relativity

The general theory of relativity expands special relativity to the realm of acceleration frames (non-inertial reference frames) and even to gravitational fields, and is also known as "gravity theory." In general, observing space-time in accelerated motion is crucial for the physical and philosophical (especially materialistic philosophy) understanding of space-time.

The general theory of relativity starts from the premise that gravity and inertial force are identical to each other. This is a generalization of the physical truth that gravitational and inertial mass are equivalent.

Based on the general principle of relativity, it is possible to observe the effect of gravitational fields on electromagnetic radiation, specifically, the phenomenon where "light is generally warped by gravitational fields as they travel." This asserts that the principle of the constancy of the speed of light in the special theory of relativity is no longer general but relative; simultaneously, it also considers that space-time structures in areas affected by gravitational fields cannot exist as 4-dimensional Euclidian space-time (as they would in the special theory of relativity).

Table 1. Realism and idealism

	Realism	Idealism
Epistemological perspective	We can perceive transcendental entities (independent from our conscience or mind).	We experience only what our mind experiences or constructs. Inherent idealism: asserts that the mind can only perceive what exists within itself. A priori idealism: asserts that the mind can only perceive what it constructs.
	Exaggerated realism; universal ideals exist within ourselves, and our existence is strictly synchronized or unified with these ideals. <Plato's realism> Moderate realism: generic (form) concepts exist within objects, and form is realized on an individual basis. <Aristotle's realism> Scientific realism: through scientific criticism of "mild realism," that considers the world of common sense to be the real world, scientific realists distinguish reality from perception. <Newton and Poincarè are scientific realists.>	
Metaphysical viewpoints	We can recognize and believe in the existence of transcendental beings.	Subjective idealism: beings that are considered to be external and independent from our mind are reduced to phenomena caused by the beings. Objective idealism: such beings are the phenomena of objective minds, in that they become the goal of said minds.
	Marx (1818-1883), Metaphysical realism	Hegel (1770-1831), Objective metaphysical idealism

Under the influence of gravitational fields, there exist many novel characteristics regarding the concept of space-time. First, within gravitational fields, space is warped—because gravitational fields are determined by the distribution of mass, space is not geometrically independent, and it is matter that determines the characteristics of space. If Newton's absolute space is a fixed container that exists independently of the presence of matter, in an a priori and metaphysical sense, if the space-time of the special theory of relativity is a 4-dimensional Euclidian space of a flattened nature, the space of the general theory of relativity is dependent on objects that exert gravity and their distribution. It has characteristics of a non-Euclidian warped space.

In Table 1, Scientific realism assumes that the universe—as described by science—exists in reality regardless of how it can be understood or interpreted. It also provides an answer to the question of "How can the success of science be explained?" In this sense, discussions on the success of science are mainly focused on the status of unobservable existences that have been clearly identified using scientific theories. In general, scientific realists hypothesize that they can make valid assertions about unobservable entities, unlike instrumentalists.

Newtonian mechanics are connected with Plato's realism, that strongly emphasizes the concept of Ideas, wherein absolute space and absolute time are fixed and objective entities. Conversely, Einstein's theory of relativity asserts that space-time exists, although it may be different from our perceptions and be warped by the mass, motion, and energy of matter that exist within space-time itself. This is a materialistic viewpoint to some extent, but Einstein is also a scientific realist. Newtonian mechanics and Einstein's theory of relativity hypothesize scientific realism that is built on strict rules of causality.

The theories of Descartes' philosophy are fundamentally realist. Time is the opportunity of moments that are not dependent on each other. Conversely, space is an object, and creates unique characteristics. In other words, it forms physical existence itself. Descartes describes matter as follows. "I believe that the expandability of matter—the qualities caused by its occupation of space—is not merely an independent existence, but rather its true shape and essence." In Descartes' universe, space is considered to exist on its own, and the concept of vacuum does not exist.

Newton's conceptualization of space is also realistic, but it differs from that of Descartes. Newton did not make the mistake of thinking space and existence as identical concepts. He accurately distinguished geometry, the science of space, from physics, the science of matter. However, he did see both in the same light. For Newton, space and time are real, and they are absolute frameworks. They exist independently of the objects and events that exist and occur inside themselves.

Here, we can see that there is an organic relationship between space, time, and matter. In the special theory of relativity, mere external factors (relative motion between objects) were the determinants; in the general theory of relativity, innate relationships—between the distribution of matter in space and the structure of space-time—are the determinants. This suggests that the general theory of relativity is closer to taking a materialistic approach toward space-time than the special theory of relativity.

Based on the objective perceptions of physical definitions of the theory of relativity, the concept of space-time in the theory of relativity is an excellent representation of the materialistic implications of space and time, and this is especially true for the general theory of relativity (Lee, 2016, p.128; Oh, 2024)

In Table 2, the concept of space-time in the general theory of relativity is "strongly materialistic," since it considers space and time as objective entities that are independent of human cognition. This is because space and time are "strongly matter-dependent," in that they are heavily dependent on the motion of objects that exist within them.

Additionally, since the mass and energy of matter are considered to be the factor causing warps in space-time, it is "strongly dialectical." In the end, the mass of matter exerts a constant influence on changes in space and time, rather than on the fixed framework of space-time.

In conclusion, the general theory of relativity can be said to be completely independent of Newtonian mechanics, a metaphysical materialistic viewpoint.

Table 2. Comparison between Newtonian mechanics, special theory of relativity, and the general theory of relativity

	Newtonian mechanics	Special theory of relativity	General theory of relativity
Space-time	Objective existence fixed by absolute space and absolute time, Scientific realism	Having the observer as the basis, space-time changes according to the relative speed of objective existence, Scientific realism	Space-time changes according to mass and energy but has objective existence, Scientific realism
	Independent existence unrelated to the observer	Based on the dependency of the observer's motion, the space-time of the counterpart is fixed and determined, and the mass and energy within that space-time are equivalent	Due to the dependence on the observer, the inertial force and gravity are equivalent

Relationship between space-time and matter Degree of materialism	Mass is preserved; independent from absolute space-time, "Space-time is matter-independent" Slightly materialistic, mechanical philosophy with fixed space-time and preservation of mass	Mass and energy are equivalent, space-time changes based on motion of observer's mass, "Space-time is slightly matter-dependent" Slight materialism	Mass and energy warp space-time, "Space-time has strong matter-dependence" Strong materialism
Law of absoluteness	Absoluteness of space-time, Metaphysics	Constancy of light speed, Slight dialectic	Physically unified world, Strong dialectic

Relationship between space-time and the theory of Relativity in Quantum mechanics

It is impossible to measure both the location and speed of a quantum object. This is the uncertainty principle of quantum mechanics. The observer and target affect each other mutually, that breaks strict causality; this is the true quality of nature. The other is quantum entanglement, that hypothesizes that quantum objects that are entangled are capable of exchanging information with one another, regardless of the magnitude of physical displacement between them. In other words, it contains the principle of non-locality, which suggests that the communication of information can surpass distances. This also conflicts with the special theory of relativity, which hypothesizes that the speed of information transfer cannot surpass the speed of light. Above all, it implies that time can also be surpassed. When an observer looks at an event 500 million light-years away, the event—that occurred 500 million years ago—can be changed: this logic disobeys the concept of the "arrow of time" (Oh, 2020, p.51).

Therefore, space-time in quantum mechanics is a platform that is closely intertwined with information of objects, and can be said to have "strong matter-dependence." Such space-time, a platform where entities affect each other, is dialectical in that it serves as a stage for creation and change.

Many people see quantum mechanics and General Relativity as fitting rather badly, the main point is that they both can be described as harmonizing with dialectical materialism. It is another case of "dialectical materialism," similar to Einstein's general theory of relativity, with the fundamental difference being that Einstein supports strict causality, while quantum mechanics is supportive and representative of probabilistic causality. Additionally, Einstein asserts locality through the limit set on the speed of information transfer, while quantum mechanics shows non-locality that is unrelated to the speed of information transfer.

4. THE SCIENTIFIC WORLDVIEW FROM AN ANALOGICAL PERSPECTIVE

The teleological and organic worldview of Aristotle of ancient Greece, and biological. It is a kind of cognitive space-time, Geocentrism, and there is a hierarchy of places called space centered on the Earth, and time is cyclical.

Aristotle, who dominated Western thought for 2,000 years with natural science, believed that humans can rationally understand the ultimate reality by logically deducing based on universal and self-evident principles. It is a self-evident principle that 'each of us has a unique hierarchy according to our own goals, and all things in the universe have their own unique place.' Therefore, it can be inferred that objects belonging to the ground fall to the ground, and smoke rises upward because it belongs above. It is a kind of deductive method.

The goal of Aristotle's science was to explain 'why' phenomena occur and 'why' events occur. However, the method of explanation was not a causal method, but a teleological method in which human intentions were involved. It was also a qualitative worldview in which hierarchy existed. It started from the biological metaphor that each human being is an active microcosm and the universe as a whole is a macrocosm.

The causal and mechanistic worldview of Galileo and Newton in the modern era is physical. It is a kind of mathematical space-time, Heliocentrism, but there is no hierarchy of places because there is no center, space has infinity, and time has linear eternity.

However, since the time of Galileo, science began to explain 'how' events occur, not 'why'. The mechanical universe that began with Galileo and the causal Newtonian mechanics that appeared in the next generation was revealed and evolved. Since the scientific theory was completed, the universe was fixed and static like a completed machine.

All processes in nature were predicted through Newton's amazingly accurate laws of mechanics or described as specific models, and it seemed that everyday experiences could be explained as examples. In other words, it was a causal quantitative worldview that explained causally, denying the hierarchy of the world. It was also a world of mechanics in which absolute motion exists in absolute space and absolute time, and only interacting forces exist.

Modern Relativity and Quantum Mechanics: An artistic and dialectical worldview that emphasizes the beauty of scientific theories.

The elements that first made physicists question their belief in a 'mechanistic universe' that operates regularly according to certain principles appeared. They began to appear vaguely in the limits of human knowledge, in the realm of atoms that cannot be seen with the eyes, and in the vast space of galaxies whose depth cannot be measured. As a result, two great theoretical systems were born between 1900 and 1927 that attempted to quantify and explain the phenomena occurring in atoms and galaxies. One is 'relativity theory' that comprehensively deals with the structure of space, time, and the universe, and the other is 'quantum theory' that deals with the basic components of matter and energy.

The theory of relativity is that there is no such thing as absolute motion, and there is only a path of motion due to inertia rather than interacting forces, so it is not a mechanistic world in which absolute motion and interacting forces exist. However, there is an entity called truth, and a strict causal worldview is identical to a mechanistic worldview. Therefore, the theory of relativity is a kind of dialectical integration, and the theory approaches the truth. Einstein also believed in the order and harmony of the universe that has continued since the ancient Greek Pythagoras and Plato (metaphysical belief). He also believed that those who constantly inquire would eventually obtain integrated knowledge of physical reality (scientific and dialectical realism). He also did not accept the approach of quantum mechanics, which is not strict determinism but probability theory, and the positivists' claim that science is simply recording observation results and finding correlations (strong causality and strict determinism like mechanism). To find the answer, he turned his gaze from the microscopic world inside atoms to the world of stars, and beyond that world to the vast and overwhelming world of empty space and time (Barnett, 2014, p.60).

It is integrated according to symmetry based on the absolute principle that the speed of light is the same, based on the historical view that it is continuously changing and creating over time. It is different from the mechanistic worldview that scientific theory is fixed because it is completed. Since symmetry and simplicity are expressed as the beauty of scientific theory, the worldview that looks at the world is artistic and dialectical in the sense that it is integrated according to symmetry. However, the view that scientific theory is integrated and changed historically like mechanism, but truth necessarily exists, is metaphysical. Therefore, the simplicity and symmetry that are aesthetic in scientific theory are in the same direction as quantum mechanics, but unlike mechanism, it is probabilistic causality rather than strict causality, and it explains natural phenomena well but is mathematical and instrumental. Therefore, such quantum mechanics is free from the mechanistic worldview. It is methodological naturalism.

5. CONCLUSION AND DISCUSSIONS

Newtonian mechanics conceptualized space-time as independent, immutable, and fixed, where matter has the unique quality of inertia; it is mechanical philosophy of a metaphysical nature. Additionally, absolute space-time is independent from the natural laws that apply to matter. Space-time in Newtonian mechanics is matter-independent.

Conversely, space-time in the theory of relativity has objective existence with material qualities. In the theory of relativity, entities such as matter in motion, waves, electromagnetic waves (special theory of relativity), and gravitational fields (general theory of relativity), have had their existence proven physically. The material qualities of space-time in the theory of relativity appear more distinctively in the general theory of relativity, as compared to that in the special theory of relativity. The special theory of relativity, outlining relativization of space-time based on the objective motion of matter, suggests a "slight matter-dependence" of space-time. The general theory of relativity, as shown by Einstein field equations, suggests a "strong matter-dependence" where the distribution of mass directly determines the framework of space-time. Considering the fact that situations suggested by the general theory of relativity are more generalized as compared to that suggested by the special theory of relativity, it can be said that strong matter-dependence is universal for the concept of space-time in the theory of relativity. In present-era physics—that is, after the advent of the theory of relativity—space and time have lost their singularity and absolute qualities as the fundamental measure of universal nature, being replaced with the speed of light. Additionally, unified "space-time" appears as warps in space-time caused by the distribution of mass and energy, which in turn affects mass and energy: it is a "chicken and egg" situation.

The approval of objectivity of space and time can serve to distinguish whether or not a viewpoint is materialistic. Even if we were to believe that space and time exist objectively independent of human perception, if space-time is strongly related with matter, it can be said to be strongly materialistic; if it is somewhat related or completely unrelated with matter, it can be said to be mildly materialistic.

Space-time in present-era science has found the smallest minute particle known to mankind, “quarks”—which are ever-changing and almost entirely empty. This is not very different from the macro-universe. In present-era science, matter is not fixed; it experiences motion in the fabric of space-time woven by gravity, morphing into something else as it is created and eliminated. Thus, changes in space-time can be said to be dialectical. We explore how cosmology is based on analogy through the characteristics of space and time. The results of such exploration are as follows: First, the cosmology of ancient Greece implies various bodies as biological organisms. Based on the analogy that individual humans are microcosms and the entire universe is the macrocosm, it is a worldview of the individual self-realization of the biological soul that is qualitative and bounded. It is a bounded place based on Geocentrism. Second, in Newton's universe, which is revolutionary and more integrated than the Greek view of nature, there could not be qualitative differences in nature that eliminated the biological soul. It is a physical mechanistic worldview that is quantitative and interactive, with only the analogy of a clockwork that operates according to time. In other words, it is a generalization of place based on the heliocentric theory. Third, since Darwin's theory of evolution, it has steadily changed to emphasize the temporal, historical interest, and theory creation. It is the claim that material forms are historically created rather than given, and that their differences are not reflections of supernatural forms but are naturally created

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