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On the Concepts of Time, Space, Vacuum and Domain of Investigation among Contemporary Physics, Philosophy, and Theological Reflection[1]

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Research Article

Abstract

Contemporary theology is realizing the importance of integrating the knowledge of modern/contemporary physics into the metaphysical and ontological categories used to consider God and the God-world relationship. Time is a complex notion with different meanings, characterized by a plurality of uses. The concept of time opens up to broader conceptions than those of physics, mathematics, and philosophy and reveals that the human being, the earth, and the cosmos are not the center of space or time. The concepts of space, time, and matter, to which the concept of vacuum is connected, are of central importance in any modern physical theory, and particularly in the theories of unification. It is being discovered that spacetime is absent at the most fundamental level and only emerges at an appropriate limit. This emerging image of time leads to new conceptual challenges that must be faced in parallel with philosophy and theological research to achieve its correct understanding. It is a comparison of the viewpoints of the three investigative domains concerned with understanding the nature of consciousness, namely science, philosophy, and metaphysics. This thought process is connected to the intuitions of the contemplative and mystical traditions and seems to be in line with current scientific thought, which can be mathematically expressed. Recent scientific research struggles to grasp the subjective aspect of consciousness; subjective experience is in conflict with the figure of the observer classically understood in the scientific sense. The evolution of life and the relationship with the transcendent could have their information

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basis in a hyper-complex multi-dimensional space; recent efforts try to explain how mental states exist in the higher dimensions of this hyperspace; some recent models of unification integrate matter and consciousness through the use of this primordial multi-dimensional dynamic space. Ontological interpretations of quantum theory have been given, leading to patterns of bidirectional flow of consciousness between an explicate and an implicate order, supporting both local and non-local phenomena in the cosmos. The paper aims to offer an overview of the indicated issues with a trans-disciplinary method and through interesting hints for thought.

Keywords

Time, Space, Vacuum, Science, Philosophy, Theology, Matter, Mind, Consciousness.

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Introduction

In science, and in particular in physics, we have always found fundamental concepts of ordinary language, such as space, time, matter, vacuum, studied within their theories in order to make them more precise; this has led over time to a radical change in their meaning, with a consequent conflict with common sense, from which science in any case starts (Krauss, 2013).

Theological discussions on the relationship between God and the world have used the metaphysical categories of a specific era, and these, in turn, were linked to the dominant physical theory. Consequently, today we witness attempts to build ontologies that prioritize intersubjectivity on the basis of quantum mechanics, one of the two pillars of modern physics, together with Einstein's theory of relativity, carrying both dangers and promises.

Quantum mechanics is a well-established theory from a phenomenological point of view, but its interpretations still present many controversies; despite this, an analysis that limits itself to areas of consensus reveals inter-relational intersubjectivity as a fundamental ontological fact.

Quantum mechanics indicates reality as fundamentally intersubjective and interrelational; this is also supported by some streams of philosophy (Whitehead, 1947), supporting the idea that this process is useful, or even necessary. This relates to theological discussions on the God-world relationship which, seeking to root metaphysics in the physical sciences, adduce quantum mechanics for an ontology of interrelated intersubjectivity. Quantum mechanics, together with general relativity, is the basis of all canonical attempts to create unified theories; unified *holistic* theories, which also consider subtle energies and try to explain issues such as that relating to consciousness, are excluded from this process (Di Sia, 2021a).

In the remainder of the paper, an overview of the concepts of time, space, and vacuum is considered, seen from a scientific, in particular physical point of view, followed, before the conclusions, by a paragraph relating to the relationship between science, philosophy, and religion/faith.

On the concept of time

Time and physics

Einstein's position on time is well known, namely that it seems to be only an illusion; this position is implicit in the two pillars of modern physics, quantum mechanics and relativity. The laws underlying these theories are "time-symmetric", that is, they describe the same physics regardless of whether

the "time" variable increases or decreases (Einstein, 2014; Di Sia, 2023a). Furthermore, they say nothing about the point that in the common sense we call "now"; it is a special moment for the human being who lives "moment after moment", but apparently indefinite when we talk about the universe in a global sense.

According to some important theories of physics, the universe appears to be a fixed block in which time seems to pass; it is the so-called "block universe", a static block of space-time in which there is no flow of time, and which therefore is supposed to be a mental construct or another illusion. The resulting timeless cosmos is also called the "block universe" (Proctor, 2022). The block universe is described as a single four-dimensional block of space-time, containing all events that have happened, are happening, and will happen, according to our usual perception of time. To understand the distinction between past, present, and future, we need to immerse in this block universe and ask ourselves how we perceive time. One of the attempts of current physics is to replace this model with a physical theory of time.

Not everyone agrees with this position, arguing that the task of physics should not only be to explain "how time seems to pass", but also "why it passes", and that the universe is not static. For them, the passage of time is physical and the future ontologically does not exist; the future would not be real in the present and there can be no precise facts regarding the question of the future. What is real would be the process by which future events are generated from present ones (Smolin, 2014).

There are some facts that everyone seems to agree on; one concerns the directionality of time that we observe in the macroscopic world, which appears very real. This is connected to the concept of entropy, a physical quantity that gives a measure of disorder in a system; it always increases, a fact codified in the second law of thermodynamics. Entropy explains why events are more likely to evolve in one direction rather than another and represents the so-called "arrow of time" (Boltzmann, 1999; Di Sia, 2021b).

Boltzmann explained why the entropy of the universe increases in the future compared to the present, but this description does not explain why we live in a universe in which this law holds. To try to justify the fact that entropy increases over time and not vice versa, physics has proposed that the universe began in a very special state of low entropy, called the "past hypothesis"; entropy would increase because the Big Bang, the event that gave rise to the universe, produced a universe with exceptionally low entropy (Callender, 2013).

Alternative origins of time

Some physicists argue that it is gravity and not thermodynamics that directs the arrow of time; gravity leads matter to concentrate, to get closer, defining an arrow of time that aligns with the growth of complexity (Barbour, Koslowski, & Mercati, 2014; Ellis & Di Sia, 2023). This point of view would allow to overcome the need for the "past hypothesis".

Another idea is that time moves in more than one direction and that we inhabit a section of the cosmos with a single, locally defined arrow of time (Carroll & Chen, 2004).

In the "evolving block universe" model, the block universe is thought of as evolving, a volume of space-time increasing over time, with the surface of this volume understood as the present moment, the present instant; the direction of time should be understood by observing which part of the universe is fixed (the past) and which is changing (the future), that is, while the past is fixed and immutable, the future is open and dynamic (Ellis, 2014).

Another approach that tries to reconcile the apparent passage of time with the block universe is the "causal set theory" (Rideout & Sorkin, 1999); it is based on the idea that space-time is discrete rather than continuous. Although the universe appears continuous at a macroscopic level, being able to observe phenomena at the Planck scale, that is, to the reference scale that defines the limit of applicability of the two pillars of current physics, the universe would be composed of elementary units or "atoms" of space-time. The number of these atoms would give rise to the volume of space-time, while their sequence would give rise to time (Dowker, 2014).

The problem of the future

Conventional physics, integrated with what the human being has learned in recent decades from cognitive science and psychology, can recover "the flow of experience"; from this point of view, time would not be an illusion, but is directly experienced (Ismael, 2017). Using tools of quantum mechanics, mathematical calculations show that each moment we experience represents a finite interval of time, so we would not infer the flow of time, but it is part of the experience itself.

We need to frame this "first-person moment" experience within the static block universe proposed by physics, for examining what the world looks like from the evolving frame of reference of an embedded perceiver. Future events exist, they just don't exist "now".

Some scientists consider our brain as a hologram reader; in this perspective, only the present, describable mathematically, would exist, while the past and the future would be two wave functions that overlap in the present moment. The idea of the passage of time would be neuro-physiologically perceived due to the change of the eternal present, a single present that continually changes (Pribram & Carlton, 1986).

This involves a revisiting of the "principle of cause and effect"; according to quantum thermodynamics, the cause of an event would be located both in the past and in the future and the effect would be in the present. Placing a clock outside the universe, it would not signal the existence of time, but if placed inside, it would give rise to the idea that time flows (Bohm, 2002; Di Sia, 2023b).

The characteristic of timelessness appears at extremely small physical scales, at the level of the Planck scale, which is approximately 10^(-33) cm, particularly at the beginning of the universe, according to the Big Bang Theory. In this case, it is not an observed or observable phenomenon, considering the enormous magnitude of the involved energies, but an implication of the used mathematical procedures, that is, the non-commutative geometry, which in quantum mechanics describes with great precision many experimentally verifiable phenomena (Di Sia, 2020a).

Perspectives and interpretations of time

Life appears to us to be essentially irreversible, because human beings have a beginning and an end, decidedly distinct from each other and with a non-reversible evolution in the middle. We can identify two perspectives of time:

- *Naturalistic-objective*, that is, time as the becoming of reality, a movement in which man is also part;

- *Spiritualistic-subjective*, where there is an intimate relationship between becoming and spirit, between movement and subject, and every human being feels and experiences the passage of time as something personal.

Various interpretations of time have been proposed; among the most studied, we remember:

a) *Statistical interpretation*: if we consider the example of two liquids together, for example, coffee with milk, it could actually happen that they separate, but the probability of this event is so low that the time necessary for its realization would be greater than the life of the universe.

b) *Microscopic interpretation*: among the elementary particles studied with

quantum mechanics, for which essentially reversible laws apply, some have been discovered (the kaons) whose behavior does not appear to be completely reversible, presenting a small temporal asymmetry (Mishra, Schramm, & Greiner, 2008). To date, the question remains unresolved whether this minimal temporal asymmetry, concerning particles that do not appear to be decisive in the construction of matter, is sufficient to account for macroscopic irreversibility.

c) *Cosmological interpretation*: it is also possible that we experience time as an arrow because we live within a universe that has a history and is therefore itself an arrow that is evolving. This evolution could have significant effects on the way in which the structure of space changes and therefore on our perception of time.

d) *Cyclical interpretation*: time repeats cyclically itself, continuously bringing the same situations back to the present; this interpretation can be traced back to classical Greek thought.

e) *Linear interpretation*: linear time is a linear process that continues to flow from the past to the future; among its various images there is the arrow, the flowing river. The cyclical conception teaches of the eternal return of things, of resignation, while the linear conception allows to search for a meaning and a future for human history.

f) *From mythological time to philosophical time*: the oldest conception of time handed down to us by philosophy is the circular one. An evocative image of it is offered by Empedocles in the text "Love and Hate" (Kingsley & Parry, 2020). There are two great cosmic forces that unite and divide, love and hate. Plato, in Timaeus, confirmed the natural cyclicality of time, considering time as something different from eternity (Plato, 2016).

g) *Time as movement*: the etymology of the term "time" refers to the idea of measurement, of order. Aristotle thought a lot about time; according to him, time is not thinkable without movement, however, it cannot be identified with that, but can be considered its property. Time can be defined as an interval between two "now", and numbers allow to measure movement (Aristotle, 2008). He comes to believe that time is eternal.

h) *Spiritual time*: Aristotle strongly posed the problem of the relationship between time and soul and Plotinus identified time with the life and the productive activity of the soul (Ferroni & Taormina, 2022). St. Augustine is the true interpreter of a subjectivist conception of time, with past and future having effects in the present, because they are present in our present (spiritualist vision) (St. Augustine, 2021). The past and future exist as there is

memory and waiting; time passes without decreasing or increasing, what passes and decreases is our time.

i) *Time as a lived flow*: it is lived time, made up of qualitatively different instants of time, unrepeatable but not independent (Bergson, 2019), different from scientific time; it is a lived time made up of moments flowing into each other (Savater, 2001).

j) *Time as a relationship*: it is the time experienced as a relationship with the other, in a dynamic "self-other" relationship. The way in which human beings experience relationships with others, profoundly depends also on their way of experiencing time, creating possibilities of time liveability (Lévinas, 1996; Tosti, 2021).

On the concept of space

The conception of phenomena as ephemeral manifestations of an underlying fundamental entity is not only a basic element of the "field theory" of physics, but also a basic element of the Eastern conception of the world, with phenomenal manifestations seen as illusory.

It is a reality seen as the essence of all phenomena and therefore beyond all concepts and ideas; the quantum field, however, only explains physical phenomena. Brahman of Hinduism, Dharmakâya of Buddhism, and Tao of Taoism could be seen as the fundamental unified field, the basis of a "primordial dynamic space", from which all phenomena, not just physical ones, arise (Capra, 2010).

In this sense, reality is interpreted as a local condensation of this unified field, concentrations of energy (Capek, 1962). It is an emptiness that is not "non-being", but the essence of all forms, a vacuum with infinite creative potential, with manifestations that are not static and permanent, but dynamic and transitory.

As in field theory, the "ch'i" is the underlying essence of all material objects and also carries their mutual interactions; it is a dynamic unity between the vacuum and the forms created by it, which are two aspects of the same reality (Govinda, 1997). Form is emptiness, and emptiness is actually form (Surhone, Timpledon & Marseken, 2010).

According to the field theory, all interactions occur through the exchange of particles, with their creation and destruction. Therefore, they are seen as dynamic figures, involving a certain amount of energy which is redistributed giving life to new particles. Field theory leaves the classic distinction between

material particles and vacuum, from which "virtual particles" are spontaneously generated. These particles are generated in a very short time interval, of the order of 10^(-23) sec; they are different from real particles because they exist only for the duration of the exchange, that is, the time interval admitted by the "Heisenberg uncertainty principle". The vacuum is therefore far from being empty, it is a dynamic reality containing the potential of all forms of the particle world (Di Sia & Bhadra, 2021c; Di Sia, 2021d).

On the concept of vacuum

The vacuum of physics

The "nothingness" of physics is what remains when any material content has been eliminated from a region of space; this operation, as far as we know to date, does not lead to the "absolute vacuum", understood in common sense, but finds in it the fields responsible for fundamental interactions.

Understanding the minimum energy that would be obtained by carrying out this hypothetical operation is one of the biggest open problems in contemporary physics; it is a non-zero energy, due to the quantum fluctuations of the fields, called "zero-point field". This is the state of physical emptiness, which is not nothingness (*Zero-point field*, 1997).

Among the recent physical models of the universe, there is the "cosmic inflation" model, which allows the description of the appearance of the entire observable universe and all its material content from a random quantum fluctuation, starting from a pre-existing state of emptiness. It is a model not yet understood in all its details, but it seems convincing in its general lines. It is to this model that those, who speak of the origin of the universe from "nothing", refer (*Cosmic inflation*, 2023).

Another hypothesis followed by many cosmologists today is that of the so-called "multiverse"; our universe would be a region within a larger multiverse, composed of countless regions of space-time that randomly emerged from the vacuum, in a process that could be infinite in both space and time. This is a difficult hypothesis to empirically test, and it also does not seem to answer the question of "why there is a multiverse and not nothingness" (Di Sia, 2020; Tegmark, 2003; Ellis & Silk, 2014).

The superfluid vacuum

According to some theoretical developments, the physical vacuum is a special superfluid medium filled by an enormous quantity of virtual particle-

antiparticle pairs, whose motion is described by the modified Navier-Stokes equation, with a time-dependent viscosity which on average reduces to zero, but not its variance.

In this medium, vortex structures arise, with a radius fluctuating around an average value, which exchange energy with the zero-point fluctuations of the vacuum and have zero orbital velocity; these structures can be considered as a model of a particle with spin. The modified Navier-Stokes equation can be reduced to the Schroedinger equation which describes the behavior of a particle in vacuum understood as a superfluid medium (Sbitnev, 2015).

The quantum-relativistic vacuum

One of the fundamental questions of metaphysics concerns "why there is something and not nothing". If the question refers to the creation of the world "ex nihilo", it takes a theological assumption, as if God chose between a state of nothingness and one of being and considered the second as preferable to the first one.

In philosophy, people have always talked about emptiness, in particular since the time of Democritus. The vacuum discussed by physics is not absolute nothingness, but something much more interesting; particularly in contemporary physics, nothingness is not understood in the sense it has in ordinary language. Quantum mechanics considers the quantum vacuum to be the ground state of the physical universe; it is not a complete absence of being, but a place where particular events occur, such as field fluctuations and very fast creations and annihilations of pairs of particles (Berryman, 2023; Di Sia, 2018).

According to general relativity, a region of empty space contains gravitational waves; the absence of matter is therefore not equivalent to an "absolute nothingness". The physical nothingness is also relevant in the attempts of unification in physics of this century; the vacuum of quantum field theory is a different state of matter, it is like a sea full of activity.

Emptiness is full and fullness is empty

Considering the atomic structure of matter and the structure of the atom, it has been scientifically proven that 99.9999999999996% of atoms are made up of empty space. This empty space is, in fact, "not empty", if we consider the zero-point field/energy. Then, there is unlimited high-frequency energy in the universe; several experiments are highlighting the relationship between this vacuum energy and phenomena such as the influence of our thoughts and the

connection of everything. The human being is not only a physical matter-made body but there is a spiritual part that plays a significant role, with a potential that we do not yet know.

Among the attempts to explain the structure of the vacuum, recently the so-called *primordial dynamic space research* search to rigorously define the structure and the global intrinsic properties of space. It is a space with a multi-dimensional hypercomplex structure, with toroidal, fractal, entanglement, synchronic, and holonomic properties, from which three-dimensional ordinary space would emerge (or spaces with dimensions higher than three, used in recent unified theories, such as superstring theories). This space also involves the presence of subtle energies and entities such as the consciousness (Di Sia, 2020b, 2021c).

On the relationship between science, philosophy, and faith Man, life, and death

In scientific research, questions emerge that concern the future of being, which take us back to issues more traditionally addressed by philosophical and theological reflection.

In-depth reflection on time has not been easy in the past and is not easy today, due to the multiple perspectives that temporality presents, and considering that this topic deeply involves the human being. Often man avoids thinking about it, since doing so means confronting our limits and seeing the image of death. The temporal dimension is a constitutive and essential reality of human existence, open to multiple possibilities, singular and common, boundless and limited, to experience time as a significant human space.

In a vocational connotation, God plans and calls man and the world in the time of creatureliness and historical precariousness; in this period of temporariness, hope and commitment to responsibility are required.

Science, fundamental for our time, presents an exemplification of what this field of investigation offers about the concept of time, showing the complexity of scientific reflection and the difficulty of finding a unifying definition.

The conceptions of time expressed by philosophers and literary men present a variety of questions on temporality, in the search, ultimately, for the meaning of man's existence. The many facets of the human struggle to live try to understand the temporariness of time in relation to fullness, to eternity. The logic of time has a precise role in the history of thought, starting from Aristotle's reflections up to the use of temporal logic in information

technology.

Contemporary theology has understood the importance of integrating what we know from contemporary physics into the metaphysical and ontological categories used by theology to consider God, the world, and the God-world relationship. The categories of subjectivity and relationality are gaining greater importance in these types of discussions.

Comparing science, philosophy, and religion

Two of the fundamental reasons for people's distancing from believing concern:

a) "Supernatural" arguments weighed through the lens of science;

b) The presence of evil in the world, irreconcilable with the idea of a loving God.

These are two reasons already considered by St. Thomas in Summa Theologiae (Aquinas, 1999).

Many scientists declare themselves neutral (agnostic) regarding the question of the existence of God, but in practice this neutrality is weak; to the question of "why there is something instead of nothing", science never seems to have found the answer (*Sandage*, 2023). The problem concerns wanting to answer this type of question by resorting only to the physical sciences, and even more concretely, to scientific cosmology (Larson & Witham, 1999).

There are different forms of truth and we speak of "two orders of knowledge": that of natural reason (where we find philosophy and sciences) and that of faith; they are, in various aspects, in contact (*Dogmatic Constitution Dei Filius*, 1870). On the one hand, the doctrine of double truth is not admissible, because it is in conflict with the principle of non-contradiction; on the other hand, we must recognize the limits of each of these orders, and how they need mutual help in the search for truth.

In science, there are, even implicitly, presuppositions and principles of a philosophical order, and also of a religious order. Modern science was born in the sign of a religious Western culture, and many of the greatest scientists of all time, such as Copernicus, Galileo, Newton, Planck, Einstein declared themselves believers in something divine, albeit in different ways. Those who engage in scientific research, admit as a presupposition that the world is not a chaos, but a "cosmos", that there is an order and natural laws, that man can learn and think, and that this order and laws have a certain affinity with the spirit (Planck, 1988).

In order for an adequate relationship between these different orders of knowledge, one must admit, on the one hand, their legitimate and necessary autonomy, and on the other, their complementarity and harmony; therefore both religion and science must retain their autonomy and distinction.

Religion is not based on science and science is not an extension of religion; each of them has its own principles, its own way of proceeding, different interpretations, and its own conclusions; they can rely on each other as distinct dimensions of global human culture, without claiming to be the necessary prerequisite of one another, in a common interactive relationship in which each discipline retains its own integrity while remaining radically open to the discoveries and intuitions of the other one.

In order to achieve this harmonious relationship, it is necessary to avoid the extremes of a radical separation, as well as an invasion of the field of investigation of the other type of knowledge, with the confusion of concepts, principles, and methods, giving rise to an epistemological syncretism (Tipler, 2001; Guitton, 1992).

It is thus possible to argue that God does not properly enter the horizon of scientific investigation, considering that scientific evidence, in the phenomenal sense of the word, is valid only for things perceptible to the senses starting by the higher dimensions and moving down to the lower ones (the 3D reality) of a primordial multi-dimensional complex-like space. In higher dimensions, and with the characteristics of the primordial dynamic space indicated above, reality would be timeless and phenomena immediate.

Modern physics has overcome the notion of "clear separation" among objects, introducing the concept of "participant" in place of that of "observer"; the concept of mind-consciousness is increasingly present in the process of describing the world and searching for a unified "not purely material" theory with non-local features using fractal-holographic-like space-time complex geometries.

Modern physics, having quantum physics as its basis, is progressively attenuating the divergences and harshness of the debate between science and religion. Science and religion are two windows through which it is possible to look at for understanding the mysteries of the universe; they offer different points of view but can complement each other. The problem arises when they claim the right to be infallible.

The development in the study of the vacuum properties will give a great impetus to the understanding of reality as a whole. There is not still a real knowledge of what consciousness is, but we must also consider what is

outside the realm of human beings.

Conflict of Interests

The author has no competing interests.

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