WHAT IS TIME? AT THE BOUNDARIES OF REALITY AND HUMAN PERCEPTION

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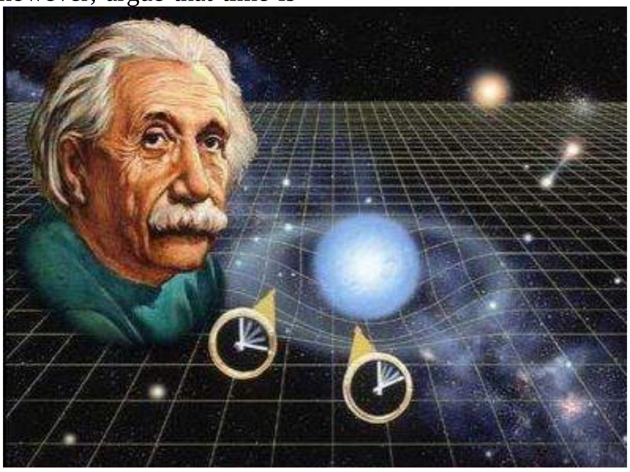
Abstract

Time has been a phenomenon that has interested people throughout history. From the moment science began to take shape until today, we have not been able to reach a common decision about the essence of time. However, time is the concept we use most in our daily lives. We use time in the course of events, that is, in their study. Time is not just a flowing concept, but one of the main elements that plays an important role in understanding the Universe and building its fundamental structures. Therefore, in order to create a final theory, it is absolutely necessary to include the concept of time in the theory. That is, a perfect explanation of all the properties of time should be obtained from the final theory. It is clear that the main goal is to include time in the theory of everything, placing it alongside the other fundamental elements of the Universe - energy, space, matter and field, and thus get one step closer to a complete model of reality. To achieve this goal, we must first clarify what time really is. If we look at the ideas of time that have been formed throughout history, we will see that there are different approaches to the concept of time in classical physics, quantum mechanics and the theory of general relativity. It is clear that the essence of the final time that we define should be the same in these fields. The conclusions drawn from this explanation should answer questions about the existence of other phenomena related to time (time travel, quantum time, etc.). On the other hand, it is necessary to pay attention to the issue of how time is perceived by humans. Because reality can be completely different from what is thought. This article delves into the depths of the concept of time, examining both its scientific and philosophical aspects. Against the background of the historical development of time, extensive space is devoted to how it is explained in classical physics and quantum mechanics, as well as its place in the theory of general relativity. Unusual aspects of time and other phenomena related to time are highlighted. Finally, an attempt is made to explain the essence of the concept of time and show how it can be included in the theory of the Universe. The article presents both a thought-provoking and enlightening perspective for anyone trying to understand what time is.

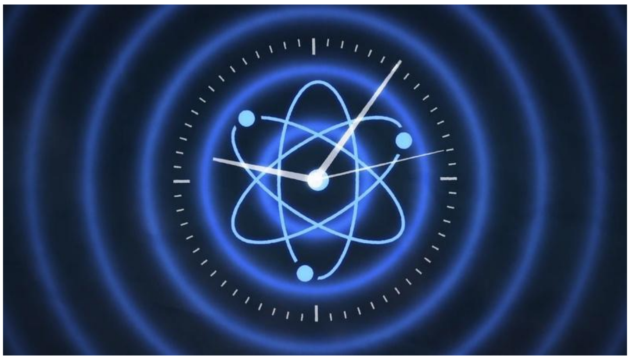
Keywords: beginning of time, reality of time, time travel, quantum time travel, time loop, end of time.

İntroduction. Time is a concept that we encounter and experience at every moment of our lives. It is virtually impossible to talk about movement and dynamics without the concept of time. When talking about an event, it is quite realistic to ask where and when it happened. In time, space is a marker for identifying events, like coordinates. However, the difference between time and space lies in how we perceive it in everyday life. While we can move freely in any direction on spatial coordinates, our only direction with respect to time is forward, and the tempo remains constant[1]. This is similar to our perception of cosmic space. Time is considered in physics and other natural sciences as a measure of our Universe. Since time cannot be explained by fundamental phenomena, it is estimated by measurement and is related to any changes in matter that occur in the Universe. That is, it is clear that even if we do not come to a complete conclusion about the meaning of time, we do not experience any problems in the process of measuring it. Time is one of the concepts in physics that requires the most precise measurement. Time is measured morally in units of hours, minutes, seconds, and larger. These measurements are used to analyze the sequence of events and to understand how much time has passed since a certain starting point. In this regard, the measurement of time is very important because people use the measurement of time to plan and organize their lives[2]. Time is the substance we characterize as past, present, and future, with which we interact every day. The progression of time is embodied in our experience, the future becoming the present, and the present becoming the past.

People have tried to measure time throughout history using various methods. In the past, it was enough for people to simply know the times of rain, snow, cold, and heat.[3] As some groups and tribes in history have understood, time is not something that progresses from the past to the future. We use time in almost every event. However, we have a hard time understanding the essence of time. Even the ancient philosopher Aurelius Augustine said about time: What is time? Who can explain it so simply and clearly? Who can grasp it in their minds so as to express it in words?[4] The concept of time is a very difficult subject to grasp in reality. Time is a flow without cosmological dimensions. In this regard, the concept of time has been one of the important fields of research in philosophy, mathematics and physics throughout history. In philosophy, there are various approaches to the essence and nature of time. Some philosophical theories hold that time is simply a sequence of passing moments. Others hold that time is a real thing and is directly related to existence. Certain philosophical approaches, however, argue that time is an illusion, that is, we perceive it based on changes in objects.[5] Such approaches question the real existence of time. In fact, time is mainly used to measure the sequence and intervals of physical events. According to Aristotle, time emerged as a result of motion, that is, it is the result of motion.[6] Newton considered time to be a universal and unchanging dimension, meaning that it works the same everywhere. His own view on this was that "Real, absolute, and mathematical time flows continuously, independently and by its own nature, despite external factors."[7] However, with Albert Einstein's theory of relativity, time turned out to be much more complicated. His own interesting view on this is that time and space are the ways we think, not the conditions we experience.[8] The theory of relativity showed that time and space are closely related and that time passes more slowly due to the force of gravity on Earth. This proves that time can change not only globally, but also in individual dimensions, that is, time is a relative quantity.[9]

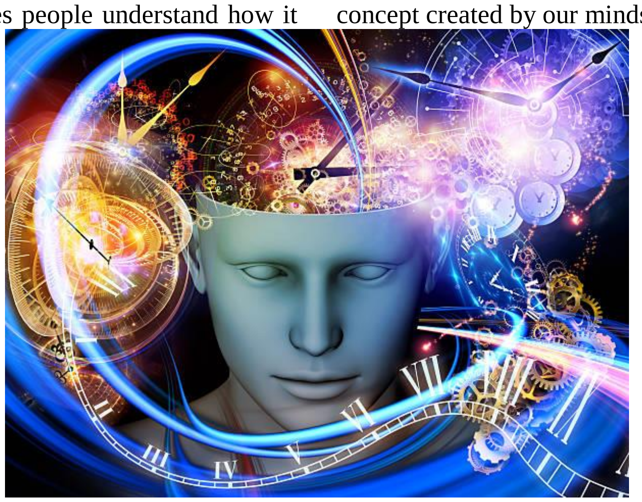


The phenomenon of time is refined along with space in the theory of relativity. As it is put forward, every object existing in space is in time. According to the theory of relativity, if an object moves quickly, it can travel into the future in time. That is, as matter approaches the speed of light, time slows down. Subatomic particles such as tachyons are thought to move at the speed of light[10]. That is, time is thought to flow from the future to the past for them. It is clear that the correct measurement of time is of paramount importance for the correct explanation and comparison of physical phenomena. Therefore, it is necessary to pay attention to the correct measurement of time. A time unit is any definite time interval expressed as a standard way of measuring or expressing time. According to the International System of Units, the standard unit of time is the second. One second is defined as the number of times a cesium-133 atom vibrates (dances) between two definite energy levels 9,192,631,770 times[11]. This concept is the most accurate time standard that has been achieved since the discovery of atomic clocks and is internationally accepted. Atomic clocks operate on this principle and ensure that the unit of second is measured uniformly throughout the Universe. Since physical phenomena are divided into micro and macro levels, time measurement is divided into 2 levels: the atomic measurement level and the dynamic measurement level. The atomic measurement level is an extremely accurate measurement standard based on the transitions between the energy levels of atoms in the measurement of time[12].



Dynamical measurement uses the gravitational movements of celestial bodies. These measurements have led to the development of lunar and solar calendars[13].

Measuring this phenomenon helps people to make their lives easier. In this regard, it is also very interesting how time is perceived by humans. Time is one of the most important resources in our daily lives. As people understand the value and limitations of time, they pay more attention to their lives and act more efficiently. The things we do every day, the goals we want to achieve, and our plans for life depend on the management of time. Sometimes we think time can pass very quickly, while at other times we feel that it passes very slowly. In psychology, this diverse experience of time can be described as the "elasticity of time".[14] As a result, time is an integral part of our lives, both as a physical and psychological phenomenon, and takes on different meanings and descriptions in different fields. Thinking about time makes people understand how it works and how it affects us. As Jean Paul said, time is the most precious of all things, because it is the condition of all other experiences.[15] In order to fully define the essence of time, it is necessary to clarify all its characteristics and understand how it is perceived by humans. Reality can be completely different from human perception. The first fact that comes to mind in this comparison is the question of whether time is a reality or an illusion. This question is still at the center of philosophical and scientific debate. Although it has been proven in physics that time has objective and changing properties, its essence and how it is experienced are questions that have no clear answer. Time can be both real and experienced, but some argue that it is part of the natural world, while others argue that it is only a concept created by our minds.



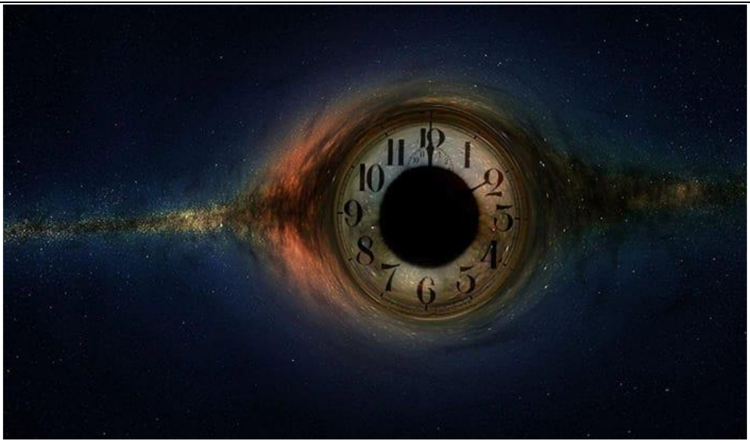
The American mathematician Kurt Gödel proposed that the concept of time itself cannot be interpreted in a formal system, because time involves a process that is not closed[16]. In order to determine how time is understood by humans, the scientific nature of time in general must be fully explained. Quantum mechanics agrees with classical physics when it comes to the concept of time. Time moves at a constant speed and is used to mark the marker of events. One of the common features of classical, quantum, and relativistic mechanics regarding time is that none of the theories can define the time axis. In general, the relationship between time and quantum mechanics is a very interesting and complex topic in scientific research. Quantum mechanics is a theory that explains the motion of subatomic particles. In this theory, time and space are approached differently from the views of classical physics. In particular, concepts based on the uncertainty principle and the wave function make the nature of time more complex. Quantum mechanics understands how time works and its nature differently, because the quantum world exhibits behaviors that are different from those of classical physics. Quantum mechanics presents the passage of time in a much more uncertain and elastic way than classical physics[17]. British physicist David Deutsch has advanced new perspectives on the ambiguity and parallelism of time and space in quantum mechanics. He discusses how time is related to quantum mechanics and how the two concepts can be unified. He also argues that the ambiguity of quantum mechanics is not an impossibility for time to pass in multiple possible ways, and that it is possible to live in multiple parallel times.[18] David Deutsch has shown that time has multiple aspects in his analysis of quantum mechanics and the theory of parallel worlds. David Deutsch emphasized the possibility of time travel, another property of time, with his theory. Time travel is a broad topic ranging from science fiction to real science discussions. Time travel means moving forward or backward in time, just as we can move between different points in space. As A. Einstein said, time travel is only possible if an object moves at the speed of light[19]. That is, as an object approaches the speed of light, time slows down for it. For example, if a person travels in a spaceship at a speed very close to the speed of light, 1 hour can pass for a person on the ship, while 1 year can pass on Earth. A. Einstein showed in his theory of relativity that time and space are interconnected and explained how time changes as speed increases. This theory has been proven by experiment. The following statement by A. Einstein shows how time changes (time dilation) with the special theory of relativity:

•Time dilation (according to Einstein)

$$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

•t- time according to the observer
•t'- time for a moving object
•v- velocity of the object
•c- speed of light [20].

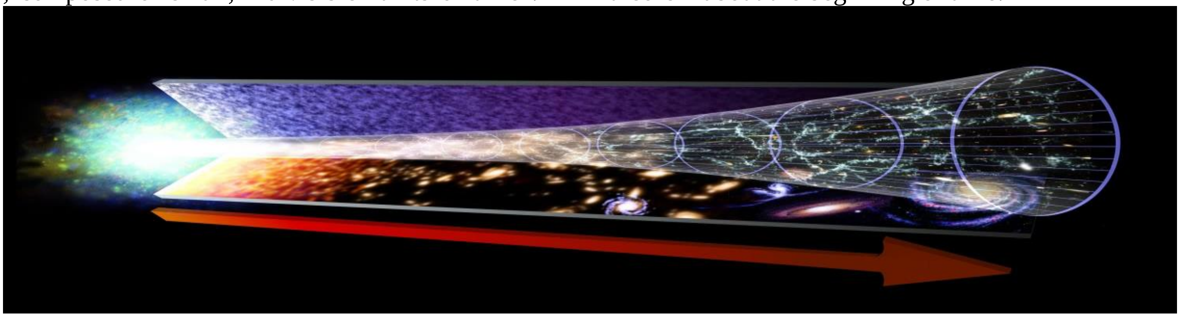
This theory that time is not actually fixed has brought new approaches to the problem of time travel. According to Einstein's theory of relativity, it is possible to travel forward in time. Since the astronauts are far from Earth on the space station, the force of gravity is weaker there. According to Einstein's theory of general relativity, as gravity weakens, time passes faster. Therefore, the gravitational effect takes them "forward in time", albeit a little.[21] However, traveling back in time still causes problems. Because, traveling back in time can lead to a time paradox. If a time traveler goes back and changes an event in his past, he may find himself in a paradoxical situation regarding his own existence. This naturally changes the structure of the Universe.[22] A similar paradox is the "grandfather paradox". According to the paradox, if you travel back in time to a time before your mother and father were born and kill your grandfather, you can make your own birth impossible.[23] Some theoretical models (e.g., time loops, space tunnels) theoretically explain this possibility, but there is no experimental evidence yet. In fact, when we look at the sky, we are looking into the past of stars and galaxies. Because it takes a very long time for light photos from them to reach us. However, seeing the past and experiencing the past are different phenomena. Seeing the past is technically possible, but we are watching a past version of that event from a certain point - we do not return to it. Physically returning to the past is considered practically impossible due to energy, stability, and other paradoxes. For all these reasons, many physicists believe that time travel is impossible, but other scientists say that it might be possible, according to the theory of parallel worlds. All real thought has focused on traveling forward in time. Another issue that makes time travel possible is the existence of black holes. Black holes slow down time itself, which can cause very strong gravitational effects. According to the British astronomer Stephen Hawking, black holes could provide a time warp, potentially opening the door to time travel.[24]



It explains time warping and how this phenomenon can theoretically be used for time travel. As you can see, these sentences present the most popular scientific theories and perspectives on time travel. The issue of time warping and travel is a topic of great debate, especially in the fields of relativity theory and quantum mechanics. That is, events that occur with the warping of space (space tunneling, etc.) can lead to time travel.

It is understandable that time travel is very complicated for macroscopic objects. On the other hand, the effect of time on microparticles should also be taken seriously. Quantum time travel is a controversial topic within modern physics and quantum theory. Traditional time travel is mainly based on the idea that an object can travel to the past or future, which is mainly found in science fiction works and movies. However, quantum mechanics provides an important foundation for our understanding of such concepts. Quantum time travel attempts to explain time travel based on some basic quantum theories and phenomena. Quantum mechanics suggests that time can be measured not only as a point or instant, but also as a "moment" or "wave" in several ways.[25] Quantum mechanics discusses the fact that time is a phenomenon consisting of many waves and possible states, and how this affects the nature of quantum mechanics. The main reason for the emergence of this field is the existence of phenomena such as "quantum entanglement", "quantum superposition", and "quantum tunneling". Due to quantum superposition, quantum systems can be in more than one state at the same time.[26] This situation could theoretically make it possible to observe an event in the past or to exist in different states over time. However, this is only a situation where particles are in microscopic states, and such a state has not yet been observed in the macroscopic world. Quantum entanglement, on the other hand, suggests that two particles can influence each other even over very large distances.[27] This raises the question of whether particles that are entangled in space can also be entangled in time. This phenomenon sometimes raises interesting questions about how the connections between particles work over time. Quantum entanglement may provide some theoretical explanations for whether concepts such as time travel are physically possible.

Quantum tunneling reveals counterintuitive properties of time and space. In this case, a particle can be transformed into an impossible state, breaking the traditional boundaries of time and space.[28] This phenomenon allows particles to move against the flow of time and allow for events that would normally be impossible. Quantum time travel faces several important physical challenges. In quantum mechanics, the state of a system is uncertain until it is measured. Time travel further complicates this measurement process. The measurement of time, in the context of quantum mechanics, reveals that the role and perception of the observer play a significant role, not only in the environment but also in the behavior of the observer.[29] The quantum version of time suggests that it passes in a straight line, but rather that the nature of time is modeled by "probabilities" at different points in time.[30] This approach explains that the passage of time within the framework of quantum mechanics is based on probabilities and uncertainties, and this view is different from the static concept of time. This is where the concept of quantum time comes in. Quantum time is an attempt to approach time-space using the principles of quantum physics. Classical physics considers time as a continuous (continuous) flowing dimension. However, according to quantum theory, time may be discrete, that is, composed of small, indivisible "units of time". In other words, time itself may be "quantized" in some way[31]. Attosecond processes, for which the Nobel Prize was awarded in 2023, have shown that it is actually possible to find a complete explanation for many phenomena in small time intervals. They have made it possible to take a "photograph" of electrons inside atoms. It is as if they have captured the life of electrons in super-slow motion[32]. As can be seen, these approaches show that classical and quantum theories take completely different approaches to measuring time. When gravity and quantum mechanics are combined, they create new difficulties in the measurement and passage of time. The quantum version of time also raises new questions about black holes and other phenomena. We can solve these problems by clarifying how time began. According to the American physicist Alan Guth, the expansion of the Universe led to the "Big Bang", the point at which time and space began.[33] The Big Bang theorem is the most convincing theorem about the beginning of time.



However, recent discoveries have challenged scientists' beliefs about the Big Bang theory. The James Webb Space Telescope, which will be launched in 2022, is set to revolutionize astrophysics as a device that can produce precise observations.[34] However, none of these discoveries are expected to disprove the Big Bang theory. Because the Big Bang theory has so much observational scientific evidence that it cannot be wrong. The Big Bang is said to have occurred 13.82 billion years ago, while James Webb can only show us 250 million years later.[35] The information James Webb provides us with may cause us to reconsider theories of galaxy evolution, not the Big Bang.

If we want to study the Big Bang itself, we need devices like the Large Hadron Collider at CERN. These devices can recreate the conditions that existed a trillionth of a second after the Big Bang, but unfortunately, that is not enough. Because the general theory of relativity still works for the dynamics of the Universe down to 10^{-43} seconds[36]. The question of how all these scientific results are understood by the human mind plays a crucial role. People experience time in a certain flow, but the subjective experience of time varies depending on the perception of the brain[37]. The true sense of time is the time experienced internally, as opposed to the external time that is measured.[38] The human brain is designed to track time. The brain's neurons receive stimuli from the external environment, work to create conscious experience. If a lot of new and unusual information is received by the brain in a moment, the neurons are forced to work harder, more synaptic transmission occurs, and the flow of information intensifies. At this time, the amount of information processed by the brain increases, and as a result, the impression is created in consciousness that the moment lasts longer. That is, time subjectively feels "stretched". On the contrary, during everyday, repetitive, and familiar events, relatively little new information enters the brain. In such cases, neuronal activity becomes more standard and stable. This leads to the feeling that time "passes quickly"[39].

problem statement: It is clear that important scientific innovations discovered in modern times prove that the structural dynamics of the Universe are subject to very complex laws. It is believed that the causes of each of these phenomena originate from a common point. From this point of view, it is thought that it may be possible to unite all the laws of the Universe around a general theory. For this, it is necessary to provide a qualitatively complete explanation of physical phenomena and explain how they are derived from the final theory. One of these phenomena is undoubtedly the concept of time. It becomes clear that in order to complete the general theory, it is necessary to clarify what time really is. It is necessary to determine whether time is a reality or just an illusion. If we want to clarify the full essence of time, we need to answer all the questions related to time. Is it possible to travel in time with the help of our modern technologies? Why do we think that time flows in only one direction? Why does time flow differently for each object? Does time have an end? How can time be included in a general theory? How is time perceived by humans? The answers to these and many other questions must be consistent with other phenomena. The general meaning of time should be common to classical and quantum mechanics, that is, not time itself, but its essence should be the same everywhere. The process of how the essence of time is perceived by humans must be explained correctly.

Problem solving: The existing three-dimensional space is generally composed of a network of strings. It is clear that the universe as a whole is built on a single energy. The single energy creates strings and makes them vibrate.[40] However, the effect of this energy on higher-dimensional spaces leads to a different distribution of energy in each part of space. Different energy distributions lead to different vibrations, and different vibrations lead to the creation of different particles. The vibrations of the strings at different frequencies lead to different distances between them. This difference in distance creates the form of matter in some parts, and the form of a physical field in the remaining parts, that is, one part of the unit energy forms matter, the other part forms a physical field. In general, the energy of 3-dimensional space is equal to the sum of the energies of the strings. On the other hand, it is known that the gravitational field belongs to 4-dimensional space. We called the material that forms this field a space-time fragment. It is clear that the unit also forms the matter and space-time component of energy. As we know, every particle existing in 3-dimensional space is in motion, and this motion results in covering a certain distance in space. As we mentioned above, the reason for this motion is the supply of energy to them[41]. It is clear that the spatial movement of particles occurs due to the supplied energy.

Time=space/motion

From this expression, we see that the expression that connects these concepts is time. Time is the amount of energy given to any event in three-dimensional space. Since energy constantly affects objects, it is not observed that they stop in time. Motion causes the passage of time. Since the smallest dimensional motion is the motion of strings, the concept of time begins precisely from there. Since it is very difficult to stop the motion of strings, it is impossible to stop time at one point. Changes in energy and space also lead to changes in time. So, in reality, time travel is possible. By controlling a single energy flow, one can travel to any time. Here, travel is understood as going to the past. Here, the reason for the flow of time forward is the continuous flow of energy. The beginning of this flow began with the Big Bang and it is possible that the glow is still continuing. The universe is constantly expanding and the volume of 3-dimensional space is increasing. However, this piece can expand up to a certain point. If the piece of space-time completely disappears (if a big rift occurs or all matter is transformed into a field), the concept of time will also end. Since black holes are defects in space, the laws of time and space manifest themselves differently there and time slows down. Microparticles are interconnected according to string theory. However, since energy transfer occurs at a certain limit speed, there is no instantaneous event. The size of microparticles is very small compared to space, and since their energy is high, their movement occurs in a very short time. Particles differ from macroobjects in this feature. Since no process is instantaneous, there is a smallest value in time. Similarly, according to quantum time theory, time consists of very small time units. The value of this time unit can be taken as follows:

Smallest unit of time = Smallest distance between strings / Maximum speed limit of the universe.

The concept of time as we define it may not exist in other higher dimensions or may work differently. However, one of the main problems is how the human brain perceives time. Since we cannot imagine how this energy transfer occurs, we cannot imagine time like other events. It should be noted that even if a person goes back in time, time will always flow forward for him. Because, for a person, time is an orderly sequence of events. In this regard, time cannot be stopped for the mind.

Result: By combining all these approaches, the possibility of including the concept of time in a general final theory was concluded. Since there is a constant exchange of energy in the universe, every existing object is in motion. Time, in turn, is the result of motion. The different distribution of a single energy in space leads to the movement of objects in different forms and speeds. This fact, in turn, causes time to be different for each object. If there were no motion and change in the universe, time would be meaningless. Therefore, it can be said that time is the rhythm of change. Each defect formed in a piece of space affects the flow of time. From this point of view, time works differently in the environment of these defects. These defects can be created by giving objects a speed (energy) up to the speed of light. The beginning of general time is based on the Big Bang, and its disappearance is based on the destruction of a piece of space. Since we cannot prevent this energy flow, time is observed to stop in the Universe. By applying string theory, we observe the formation of the concept of quantum time. That is, time is actually considered quantized and its smallest value exists. Due to the large size difference between micro and macro objects, the time intervals for their movements also differ. Since time is actually a derivative of energy, it is possible to travel to any time by obtaining the necessary amount of energy. Since we cannot understand this energy flow and exchange that occurs in high-dimensional spaces, we cannot understand and observe time like other events. Our memory creates the past, and our imagination creates the future. In this sense, time is both objective (reality) and subjective (human perception). Events occur one after another, but we perceive them differently. Time cannot be stopped by the mind, it flows in one direction. That is, time is not actually an additional spatial dimension, but simply a sequence of events, which is why we fall into this error. Thus, we see that the time we think of is actually an illusion. Combining all these facts, we can say that the definition of time is common to micro and macro objects and the entire Universe: time is the observed sequence of changes and sequences that occur as a result of the transfer of a single energy into 3-dimensional space. This change occurs in the 4-dimensional spatial structure and is determined by the distribution of energy at both the classical macroscopic level and the quantum microscopic level. Time is therefore a relative but physically real energy flow created by energy flow and subjective observation. In order to build a theory of the Final Universe, it is necessary to pay attention to the mainly real side of time.

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