

## THE NOTION OF CHAOS: FROM THE COSMOGONICAL CHAOS OF ANCIENT GREEK PHILOSOPHICAL THOUGHT TO THE CHAOS THEORY OF MODERN PHYSICS

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**Abstract.** *Due to the importance of modern science, the appearance of the notion of Chaos in ancient Greek cosmogonies and philosophical thought and the evolution of its meaning has been studied in this paper. In addition, a comparison has been made with the meaning of this important notion in modern Theory of Chaos.*

**Key words:** *Orpheus, Phanes, Cosmogony, chaos, Chaos Theory, fractals.*

### 1. INTRODUCTION-COSMOLOGICAL VIEWS

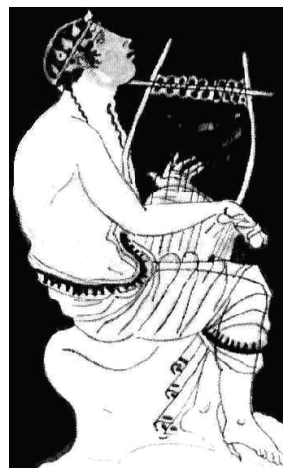
In the ancient Greek civilization where the first philosophers attempted to explain the creation of the Universe, the hymns of mysticist Orpheus proved to be of significant importance, by introducing the term 'Chaos'. According to Orpheus, Chaos condenses into the giant Cosmic Egg, whose rupture resulted in the creation of Phanes and Ouranos and of all the gods who symbolize the creation the Universe.

Later, Greek philosophers supported the view that chaos describes the unformed and infinite void, from which the Universe is created. So, this void in ancient Greek thought is not just an abstract term, but a kind of empty space with cosmogonical characteristics.

In modern physics, the term 'chaotic' describes systems whose parameters consist of many hidden laws, which are difficult to describe and can be changed any time. Due to the importance of the notion of *Chaos* in modern science, it is of interest to consider its appearance in ancient Greece and the evolution of its meaning, which is the aim of this paper.

During the early period of development of the first human civilizations, the refined thought of pioneer priests, astronomers and philosophers – through religious faith and empirical thought – attempted to explain the ‘first beginning’, through which the Universe came into being. According to Aristotle “*For it is owing to their wonder that men both now begin and at first began to philosophize*” (Aristotle, *Metaphysics*: 982b: 12-13). It is obvious that the first philosophers attempted to explain the origin of natural phenomena. In this context, wise people who originate from eastern civilizations supported the existence of gods. According to these people, there are two contingents which resulted in the creation the universe: a) The universe was created through divine energy, a theory which is known as *ex nihilo creation*, and b) There was an eternal matter as substrate, which finally was formatted by a God or Gods. A major point in this case is the fact that the creation of the Universe depends on the mixing and combination of cosmic elements (Theodossiou, 2007: 31).

In ancient Greece, the teaching of mysticist Orpheus (13th century B.C.) evolved, which proved to be the initial form of Greek religion, and consisted of poems and hymns of significant literary value (*Orphica*, 1805, *Orphicorum fragmenta*, 1922, *Orphic Hymns*, 2007).



Orpheus, picture on an ancient column crater from Gela. (ca. 450 BC, Staatliche Museen, Berlin)

## 2. ORPHIC COSMOGONY

According to the orphic cosmogony, initially the *ageraos* (never getting old) Chronos (Time) emerged. Once Chronos was created, he gave birth to the duality of Aether and Chaos. Then Chronos and Aether created the *cosmic silver Egg*, which through its fertilization, brought into being the second divine triad: the *protogonos* (the first to appear) Eros or Phanes, God of Light, Metis, the Goddess of wisdom, skill and craft and finally the life-giving Herikepeos. In the ancient tradition, it is claimed that Herikepeos had two genders, both the male and female.

The sixth Orphic Hymn ‘6. *Protogonos*’ speaks of Chaos which condenses into the giant Cosmic Egg. After the egg was ruptured, its upper part created Ouranos (the Sky), while the Earth was created from the bottom part. From the central part of the Egg, *Protogonos* (first created) or Phanes took form, whose name also means *luminous*.



Orpheus  
Picture from an ancient Greek vessel segment

6. *I invoke Protogonus, of a double nature, great, wandering through the ether, Egg-born, rejoicing in the golden wings, having the countenance of a bull, the procreator of the blessed gods and mortal men.*

It would be useful to note that in ancient Greek philosophy and astronomy, Eros symbolizes the spiritual power of nature that creates the Universe.

Then, Phanes with his sister Nyx (Nychta = Night) gave birth to Ouranos (Uranus), whose role was dominant among the Gods and Earth: *he was the king of the Gods after mother Night*. It is worth noting that the consecutive birth of Gods according to orphic cosmogony is similar to the version which is proposed by poet Hesiod in his poem *Theogony*. So, Ouranos is displaced by his son Cronus (Saturn), who was also displaced by Zeus, the creator and ruler of the world. An important person which appears in the orphic cosmogony is Dionysus Zagreus, son of Zeus and Persephone, whose birth marks the end of creation of divine beings in the world.

The Titans sliced and ate Dionysus Zagreus, but goddess Athena saved his heart, through which Zeus resurrected him. This unholy and desecrating action was punished by Zeus by striking them with a thunderbolt. The ash of the Titans was the matter through which God created human beings. But the fact that the ash of the Titans also included the ash of Dionysus, the human race consists of two natures: 1) the evil or *Titanic* nature, 2) the divine/spiritual nature.

Clemens Romanus, the third Bishop of Rome (88-97 or 92-101), in his '*Epistulae*' compares the hesiodic cosmogony to that of Orpheus "*Orpheus likens Chaos to an Egg, in which all the first elements can be found mixed. Hesiod perceives this Chaos as a substrate, called by Orpheus as Egg (Cosmic Egg), a creation that emerged from formless matter...*".

### 3. PHANES THE GOD IN THE RELIEF OF THE MUSEUM OF MODENA IN ITALY

In this relief of god Phanes, which on display in the Modena Museum in Italy, the god of light, truth and justice is depicted surrounded by the ecliptic, with the twelve signs of the Zodiacal constellations. In the four angles of the relief the winds of the four cardinal points are depicted, which correspond to the four initial elements: fire, earth, air and water. Inside the ecliptic we can see the Cosmic Egg divided into two parts. In the middle of the relief, Phanes appears through the flames in the form of a man with wings on his shoulders, since he is the creator Eros. Behind him the crescent of Selene, the Moon is displayed. Also, Phanes holds a scepter, as the ruler of the world (Phanes and Herikepeos), while in his right hand he holds lightning, just like Zeus, the father of gods and men (Cook 1925: 1051).

Herikepeos - Phanes - Metis: the Cosmic Egg in its triadic status, the light of Phanes, Mitis's wisdom and Herikepeos's life. A snake huddled around the body of Phanes, which reaches the top of his head, symbolizes the Earth (Gaia). He has animal hindquarters, just like the ancient god Pan, who is a Pancosmic (Universal) god (Theodossiou 2007: 33).



The God Phanes  
Modena Museum, 2<sup>nd</sup> c. A.D.

On Phanes's body three animal heads appear: of the ram, lion, and goat. Professor M. Papathanassiou claims here, that "*The heads of the ram and goat symbolize the astronomical phenomena which appeared during the construction of the relief in the 2<sup>nd</sup> century AD, when the vernal equinox was in the constellation of Aries, while the winter solstice was in the constellation of Capricorn. But the lion head displayed in the center under the chest is a remnant of ancient astronomical phenomena of the 2<sup>nd</sup> and 3<sup>rd</sup> millennium BC, when the vernal equinox was in the constellation of Taurus, the summer solstice in the constellation of Leo, and the winter solstice in the constellation of Aquarius*" (Papathanassiou, 2009: 296).

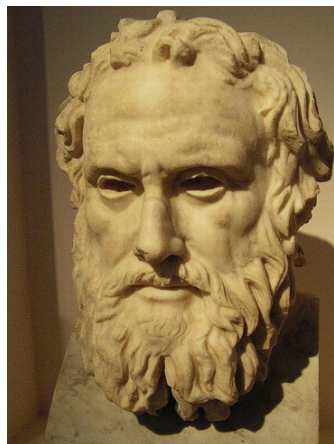
Inside the elliptical egg there is a faded inscription: [E]YPHROSU[NE ET] FELIX. Below, outside the ellipsis and above the heads of the winds, there are two capital letters 'P': P(ecunia) P(osuit) and below, at the edges of the rectangular sculpture we can see there is an inscription: FELIX PATER (sacrorum), according to Cook (1925: 1052).

#### 4. THE MEANING OF THE COSMIC EGG

It is important to note that the meaning of the Cosmic Egg in all cosmological myths symbolizes the unity from which the whole Universe emerges. Also, the Cosmic Egg that symbolizes the creation appears in the Orphic Hymns, in Hinduism, in Finnish legends (Theodossiou 2007: 33) and also in the tradition of the primitive tribe of Dogon, in the Mali of Western Africa (Griaule, M. and G. Dieterlen 1965).

The Cosmic Egg is the matrix which includes the sperm of cosmic creation. Almost all ancient legends refer to the Cosmic Egg, because, except for the fact that the egg is the symbol of creation, it is also the symbol of birth and new life (Danezis and Theodossiou 2003: 228-248).

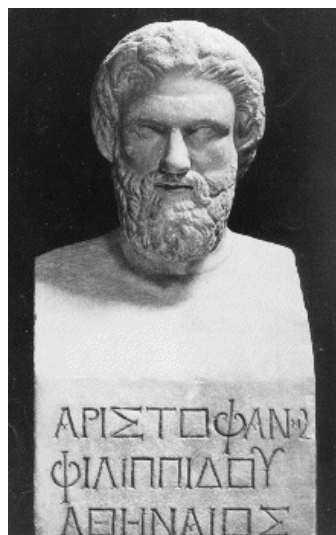
After the ancient Orphic Hymns, which were probably recorded in the 2<sup>nd</sup> century AD and also in Hesiod's *Theogony*, the creation of the world is one of the main subjects that philosophers and poets deal with. Let us see how Hesiod describes the first cosmogonic principles: "Verily at first Chaos came to be, but next the wide-bosomed Earth, the ever-sure foundations of all (4) the deathless ones who hold the peaks of snowy Olympus, and dim Tartarus in the depth of the wide-pathed Earth, and Eros (Love)." (*Theogony* 1914: lyl: 116-123)



Hesiod  
National Archaeological Museum  
of Athens (Roman copy).

Also, Aristophanes (448-380 BC) in his comedy named *Aves* (*The Birds*, 414 BC) writes: "At the beginning there was only Chaos, Night, dark Erebus and deep Tartarus. The earth, the air and heaven did not exist. First, the black-winged Night laid a germless egg in the bosom of the infinite deeps of Erebus, and from this, after the revolution of long ages, sprang the graceful Eros with his glittering golden wings, swift as the whirlwinds of the tempest. He mated in deep Tartarus with dark Chaos, winged like himself, and thus hatched forth our race, which was the first to see the light. That of the Immortals did not exist until Eros had brought together all the ingredients of the world and from their marriage Heaven, Ocean, Earth and the imperishable race of blessed gods sprang into being."

[Aristoph. *Av.* 693 (Chor der Vögel)]



Aristophanes

The great comedian also mentions Chaos in his comedy *Nebulae* (*Nephelae*). In this comedy, Aristophanes aims to squib Socrates and the *Sophists*. So, he describes the teachings in which Socrates initiates the naïve peasant Strepsiades. Socrates orders him to claim as gods only *Chaos*, *Language*, and *Nebulae* (Aristophanes, *Nebulae*: 423).

## 5. THE MEANING OF CHAOS IN THE ANCIENT GREEK PHILOSOPHICAL THOUGHT

It seems that the meaning of the term ‘Chaos’ – from the Greek root ‘cha’ (Polites 2004, 24) – which is the original situation of the cosmic matter before the creation of the universe, describes the unformed and infinite void. This void in ancient Greek thought is not just an abstract term, but a kind of empty space that consists of nebulae and darkness. Theoretically, Chaos is the infinite space that included, in the form of ‘seeds’, all the elements which were about to create the universe. Moreover, Chaos was the only creative principle through which everything emerged. Certainly, this unformed space between the Earth and the sky has no eternal being, but it was created at some time in the past. This conclusion originates from Hesiod’s text.

In his poem *Theogony*, Hesiod claims that Chaos was not present in the beginning of creation, but that it was created in the beginning, followed by Erevus and Earth. This means that Hesiod did not intend to answer the question of what existed initially, but what was created first. So, he does not speak about an eternal first cause of creation.

According to Jaeger (1953: p. 23), Hesiod does not by-pass the question of the first cause because of his unwillingness to give an answer, but because in his era, this philosophical question had not arisen. In ancient cosmogonies there is no ‘before’, because of the eternal existence of the universe. Even the Pre-Socratic philosophers, as well as Plato and Aristotle, were in favor of the idea of the eternal existence of cosmic matter. It is important to note that only the Christian Church Fathers and philosophers spoke of the *ex nihilo* creation of the universe.

So, the question of what existed before Chaos has no meaning for Hesiod.

In this context, in the *Old Testament* we can read that *in the beginning when God created the heavens and the earth* (Gen. A, 1), there is no reference to what existed before the creation of the universe by God, because the question of what existed before the first cause has no meaning.

Certainly for Hesiod the Heaven and the Earth are the basic elements of the visible universe, but they are not the first causes of cosmic creation. This cause is, according to Hesiod, Chaos. In fact, we can see in Hesiod’s poems and in all ancient Greek cosmogonies that there is no reference of any kind to a ‘personal God’ who creates the universe, but rather what first takes place and what continues to happen later (through the whole cosmogony) happens by its own power. This reflects the period in which the Pre-Socratic philosophers (6<sup>th</sup> century BC) separated completely the myth from reason.

As we have already seen, *Erevus* and *Nyx* who have emerged from Chaos, generated *Aether* and *Imera* (Day). Chaos also generated *Eros*, whose sense is definitely cosmological. *Nyx* was also an important cosmological power, towards which even *Zeus* showed great respect. Homer writes that *Nyx* was a consultant of *Zeus* in the creation of the universe (Homer, *Iliad* 1919: XIV 259). Her power resulted from her old age and her clairvoyance.

So, in *Theogony* Chaos, Earth and *Eros* were the three primal basic elements through which the universe came into being. Chaos is the receptor of every creation, while Earth symbolizes the solid ground of all living creatures. *Eros*’ nature is totally different, because he is the force which leads everything to its regeneration.

Gigon (1968: 26) claims that the meaning of *Eros* is not just cosmological, because he is a basic factor not only of human life, but of the entire cosmos. The late professor of Philosophy at the University of Athens, Theophilos Veikos claims that the “*human in the*

*early Greek thought is not an isolated part of the universe, but an integral part of the whole cosmos*" (Veikos 1988: 20).

In the Pre-Socratic philosophical thought several versions of expressing what existed before the cosmic creation can be found. For example, Leucippus and Democritus believed in the existence of a void. Anaxagoras spoke in favor of the existence of a mixture containing the matter of the universe, while Anaximander spoke about the *infinite*. Also, the lyric poet Alcman (7<sup>th</sup> century BC) claims that Chaos, keeping its original mythical characteristics, takes form in the name of matter that gives birth to Thetis, the creator of the universe (Kirk et al. 1983: 34, Danezis and Theodossiou 1999: 125-130).

Also, a very interesting aspect of the creation of the universe has been put forward by Plato, who in spite of the fact that he does not speak clearly about Chaos, although he describes the primitive situation of matter as chaotic, which was formatted by the *craftsman* "*He was good and the good can never be jealous of anything. And being free from jealousy, he desired that all things should be as similar to him as they could be. This is in the truest sense the origin of creation and the world as we shall do well to believe in the testimony of wise men. God decided that all things should be good and nothing bad, so far as this was attainable. Wherefore also finding the whole visible sphere not at rest, but moving in an irregular and disorderly fashion, out of disorder he drew order, considering that this was in every way better than the other*" (Plato 1902, 30a, 2-6). So, the cosmic creation consists of the change of matter from disorder into order (Kalachanis 2011: 89-90). Aristotle just repeats the teachings of Hesiod about the creation of the universe from Chaos (Aristotle *Metaphysics*, 984b, 28). Ovidius (Publius Ovidius Naso, 43 BC-17 AD) also considers Chaos "*a raw confused mass, nothing but inert matter, badly combined discordant atoms of things, confused in one place*" (Ovidius, 2002: lyr. 5-8).

Those cosmogonical aspects of ancient savants and also the meaning of the term "chaos" have contributed to the perception of chaos as an infinite space, an abyss, or as unformed matter, from which the universe evolved. The Professor Emeritus of Astronomy at the University of Thessaloniki, Nicolaos Spyrou, claims that "*a universe that emerges from Chaos represents the belief of ancient Greeks in an unpredictable Nature which is ruled by eccentric gods. However, during the 6<sup>th</sup> century BC in Ionia a new world view evolved, according to which the Universe is understandable, because of its inner order; inside nature there are regularities, which allow the exploration of its secrets and its operating principles. Nature is not completely unpredictable, because of its regularities, the rules which it must obey. This orderly and admirable aspect of the Universe was called Cosmos by the ancient Greeks, which means ornament, decoration*" (Spyrou 1998: 85).

## 6. THEORY OF CHAOS AND FRACTAL GEOMETRY

The late Ilya Prigogine (1917-2003), the 'father' of chaos theory and complexity wonders whether there are any laws within chaos. So, is chaos non-predictable by definition?

Awarded the Nobel Prize in chemistry (1977) for his research in thermodynamics, he considers that it is possible to include chaos in the laws of nature. So, he does not agree with the view of chaos as a kind of a non-predictable disorder. According to the classic view, physical law is deterministic, while the time is 'reversible', something which means that the future and past play the same role.



Chaos expands our perception of the physical law by implying the importance of ‘possibility’ and ‘irreversibility’. This radical change forces us to check again our basic description of nature. Deterministic laws produce seemingly random results. Or maybe God ‘by playing dice’ creates a deterministic universe governed by order. Using chaos theory results in the development of a new branch of physics, which deals not only with laws, but with a science that does not deny the evolution of modern scientific theories.

According to Barry Parker (1999), the Universe inspires admiration and a spontaneous desire for research. We do not know whether we will be able to provide satisfactory answers or not. Chaos Theory reminds us that unpredictability is a characteristic of our dynamic Universe. Chaos Theory along with Quantum theory and the theory of relativity are among the most important scientific discoveries of the 20<sup>th</sup> century.

Attempts to describe the universe based on a deterministic model are opposed to the physics of the 20<sup>th</sup> century, because determinism was refuted by Einstein’s theory of relativity or by Heisenberg’s uncertainty principle. Scientists could not describe the physical reality because of many chaotic parameters. Some examples of these parameters can be seen in meteorological systems, in the eddies of the rivers, even in artificial systems, like the stock exchange. In contrast with Laplace (Theodossiou 2008: 144), who claimed that everything in nature is predictable provided that we know all the basic elements of physical procedures, the scientists of the 20<sup>th</sup> century admitted that they could not predict phenomena like these. It is obvious that in such systems it is very difficult to know all the parameters, which can change at any time, as well as the hidden laws of nature. This is the simple definition of a chaotic situation. However, the Greek word is used in a different way in several cases. Thus, the term chaos has a different interpretation in Greek philosophy than in everyday life or in Modern Greek (chaos means confusion or disorder), or in its image of Mandelbrot sets (Mandelbrot, 1982). Also, the interpretation of chaos in science is quite different.

Thus, chaos theory was developed, considered the third scientific revolution of physics in the 20<sup>th</sup> century, after relativity theory and quantum mechanics. Chaos theory is a mathematical concept explaining that it is possible to get very different results from very similar initial conditions of a system. The main precept behind this theory is the underlying notion of small occurrences significantly affecting the outcomes of seemingly unrelated events. The new state that is being assumed by the chaotic system depends on the mathematical concept of *attractor*. However, this new *locus*, in which the system will be ‘settled’ by the attractor, has parameters whose predictability cannot be described with eternal deterministic laws. This concept of disorder has been the subject of scientific study since the 1970s’.

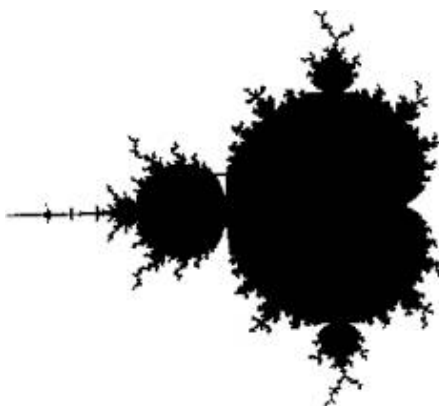
Physicists, astronomers, mathematicians, meteorologists, biologists, chemists and economists have been looking for connections among different types of non-normality. After the first surprising results from the study of chaotic models, scientists attempted to explain the chaotic movements of everyday life, such as weather conditions, the population of wild animal species and fluctuations in stock prices. They recreated those uncontrollable phenomena with non-linear differential equations on computers. That is how scientists discovered the hidden order that rules them, confirming the Pre-Socratic philosopher Heraclitus, according to whom *hidden harmony is better than obvious harmony* (Diels & Kranz, 1966, B 54, 1).



Nowadays we know that chaos theory is based on the fact that chaos and uncertainty are not due to the inability of technology, because they are basic characteristics of the universe. Chaotic systems are very sensitive, because a tiny and difficult to observe detail may cause a significant result, like the ‘butterfly effect’, according to which a butterfly in China may cause a storm on the western coast of USA. Another example of a chaotic system is the set of mathematical values of the four interactions of Universe (gravity, electromagnetism, strong and weak nuclear forces). In the case that these values differed minimally, the Universe would be extremely different. So, nature is a dynamical system which could not be described by linear equations. Also, in the field of astronomy it is admissible that chaos played an important role in the creation of the solar system. So, scientists started examining the chaotic systems not just in theory, but as applied sciences.

Peculiar movements in chaotic systems create an odd mixture of tracks and swirls which does not seem completely irregular. The American topologist Stephen Smale claimed that *the most significant feature of a dynamic system is its long time asymptotic behavior. This system chooses, through the entire system, a simpler set of movements* (as cited in Ian Stewart, 1998: 131). This repetitive behavior of a system finally creates a rudimentary geometric form, called a ‘strange attractor’ by mathematicians.

The support of chaos theory presupposed the proper mathematical model. This model was finally created by *fractal geometry*, developed by the mathematician Benoit B. Mandelbrot (1924-2010).



A typical Mandelbrot fractal

Such an object’s basic feature is self-similarity, because it contains small patterns of itself, in any scale it is examined. Observing the object at different scales, we see the original object unfolded. Still, starting from a simple original object – just like a triangle – and applying a simple geometric transformation continuously, we come to a fractal object of great complexity which is obviously chaotic. Suddenly, chaos acquires order. Fractal geometry proves to be very useful, to put order into chaos. Fractal structures were discovered in seemingly chaotic systems, like the buffering of wind and snow, in galactic structures, in human organs such as lungs, brain and kidneys. Other examples of fractal systems include the distribution of forests on the Earth’s surface, in the shape of the coastline, in the formation of the bronchi of the lungs and also in the music of famous compos-

ers, like Bach and Mozart. So, scientists speak now not of chaos and order, but of a super-order, in which random and chaotic is everything we cannot describe or identify. Those physical laws that rule such systems remain unknown. Therefore, according to Plutarch, the oracle of Delphi correctly supported the view: “that God eternally geometrizes” (Plutarch, *Symposiakon* 718 B, 8).

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**POJAM HAOSA: OD KOSMOGONIJSKOG HAOSA U STAROJ  
GRČKOJ FILOSOFSKOJ MISLI DO TEORIJE HAOSA U  
MODERNOJ FIZICI**

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*Razmotren je nastanak pojma haos u starim grčkim kosmogonijama i filozofskoj misli i evolucija njegovog značenja. Takođe je značenje ovog važnog pojma upoređeno sa onim u modernoj Teoriji haosa.*

Ključne reči: *Orfej, Fanes, Kosmogonija, haos, Teorija haosa, fraktali.*