



# The cosmology of the pre-Socratic Greek philosophers

E. Theodossiou and V. N. Manimanis

Faculty of Physics, Department of Astrophysics, Astronomy and Mechanics, National and Kapodistrian University of Athens, Panepistimiopolis, 15784 Zographou, Athens, Greece  
e-mail: [etheodos@phys.uoa.gr](mailto:etheodos@phys.uoa.gr)

**Abstract.** The views of the ancient Greek pre-Socratic philosophers from Ionia opened new paths for the study of nature using human logic. Starting from the worship of the Earth as a goddess, they proceeded to examine its position in the Cosmos (Universe), proposing a spherical shape for our planet. They pioneered the unifying approach for the physical world, assuming one element as the basis for everything in the Universe (this was water for Thales, air for Anaximenes, infinity for Anaximander, fire for Heraclitus). The genesis and the decay of worlds succeed one another eternally. Anaximenes believed, like Anaximander, that our world was not the only one that existed. Heraclitus believed that, of the vast richness of the natural creation with its unpredictable changes, nothing remains stable and motionless. There is not constancy, but only an eternal flow, a perpetual motion. This is exactly what we accept today in quantum physics; the apparent stability and immobility is an illusion of our limited senses. According to Heraclitus, matter is constantly transformed. All the natural philosophers of Ionia distanced God the Creator from nature and history, keeping always a respect for the beliefs of their fellow people; most probably they, too, kept a form of God in an area of their minds, in his spiritual and moral dimension.

**Key words.** History of science – Philosophy of science – Natural philosophy

## 1. Introduction

The views and the theories of the ancient pre-Socratic philosophers from Ionia indicate the relation of the ancient Greek world with the mother-Earth and the natural environment, Cosmos. The pre-Socratic thought has much to reveal to us as a kind of travel back to the primal sources. The pre-Socratic philosophers of Ionia were carefully observing in the 6<sup>th</sup> century B.C. the natural phenomena and their contribution to the challenging of myths was crucial. They attempted to extract all possible con-

clusions from the observation of nature by using mainly their logic.

Ancient Greek natural philosophers were preoccupied by the “cosmic riddle”, i.e. the questions of the origins, the structure and the construction of our Universe. At the same time, a sudden and rather unexpected shift took place, from mysticism and religious world-view towards reasoning thought; a switch with very deep consequences for humanity. Of course, most pre-Socratics were natural monist philosophers, in the sense that they were interested in defining the ultimate substance or principle, the primal element from which all

---

*Send offprint requests to:* E. Theodossiou

things of our world originated. So they created philosophical systems that would enable them to explain rationally the relation between humans and nature. This is the reason that their thought is relevant today and that the natural component of pre-Socratic philosophy is of such a great importance. For the first time in world history, the total decoupling of myth from rational intellect was expressed with pre-Socratic views. Here it will be shown how out of myth physical thought appeared and was shaped during the first scientific revolution, in the 6<sup>th</sup> century B.C.. Then philosophers tried to answer two basic questions they were pre-occupied with: the first was on the origins of the world and the second was on its structure or form. This was the reason they became the founders of philosophical thought and of science itself.

## 2. The place of the Earth in worship and inside the Cosmos

### 2.1. The worship of the Earth

A starting point could be the worship of the mother-Earth. In parallel to the primal worship of the Sun, a prominent place in religion was held by mother-Earth, the universal mother. In a sense Earth was the supreme goddess, and for this reason Greeks called her *Hypertatan* (Supreme) Earth (the word for earth in Greek language is of the feminine gender). It should be noted, however, that Gaia (the Earth) was never worshipped as a celestial body or as anthropomorphic deity, but rather as *gaia-chthon*, as the nature (with its ground, soil and interior) where humans live and get their food from. Man is “accused” by the tragic poet Sophocles (5<sup>th</sup> century B.C.) as the creature daring to annoy the supreme goddess, not hesitating to inflict pain on her: “by ploughing her with his plough, trenching it ceaselessly year after year” (Sophocles *Antigone*, 1899, v. 330).

The conversion of earth-nature to an omnipotent goddess-mother most probably took place when the agricultural societies developed agricultural festivals-mysteries, pertaining to the eternal cycle of life (sprouting, bearing fruits, ripening, decline and death, seed,

sowing, rebirth). Beginning from the depths of antiquity, it can be said that the primitive human from his first cognitive observations of life on Earth understood that, like him, the rest of animal and plant life forms were also tied to the triptych life-development-death. Man’s survival was connected to vegetation, since, like the rest of the animals, was eating what was available in nature.

Earth (*Gaia*) and Sky (*Ouranos*) constitute the first divine couple, united by Eros; in this symbolism of erotic cosmogony the Sky embraces and fertilizes Earth with “his” rain. Their union is therefore presented as an extremely powerful and force of reproduction, which united and multiplied the deities, an aspect revered and sung by mythical Orpheus as product of the original Chaos or Erebus and the illuminated part of the day. This union is also symbolized by the love affair of Semele, which represents the Earth, and Zeus (Jupiter), a celestial god who fertilizes his beloved woman with his thunders, harbingers of the precious rain. Similar is the way Zeus fertilizes the earthly Danae, after he is transformed into golden rain in order to penetrate into her subterranean cell. Symbolically, the sky god softens with his beneficial waters the dried body of the Earth in order to grow life in it.

### 2.2. The place of Earth in the Cosmos

Earth in the Homeric Universe was considered as a circular flat disc surrounded by a vast circular “river”, the Ocean. This model first appears in the Homeric *Iliad* (1924): “*And the Ocean encircles the Earth in its waters*”. The Sky rises upon Earth. In the Orphic Hymns the Sky is mentioned as the master of the World (Cosmos), encompassing the Earth as a sphere (our Celestial Sphere). The Sky is the abode of the blissful gods and it moves in rotations, spinning (Orphic Hymn 4: *Incense to Ouranos*, 1999).

According to ancient Greek traditions the Sky was a canopy made of copper or iron, supported by tall columns; in other traditions the Sky was a giant. Homer combines these two views by having Atlas supporting the columns himself (*Odyssey* 1:53-54). Hesiod

adds (*Theogony* 517) that his fate of supporting the sky was assigned to him by Zeus. So in ancient Greece the Sky was thought to be made of a solid, metallic, material. For this reason, in the Homeric poems is referred as *chalcous* (of copper, *Iliad* 17:424) and *polychalcus* (made of much copper, *Iliad* 5:504, *Odyssey* 2:458, 3:2, 16:364, 19:351), or as *siderous* (of iron, *Odyssey* 15:329, 17:565). The space between the Sky and the Earth, according to the beliefs registered by Homer, was filled with the (comparatively dense) air in its part towards the Earth (*Iliad* 14:288). Towards the Sky this intermediate space was filled with the clean and transparent *aether* (the ether), a kind of “light air”. Beyond the ether there was the starry Sky. Of course, one must not believe that the Sky was a bare metallic dome. It was, as Homer mentions, full of life, a life offered by the stars that decorate it. Because of this it was called *asteroeis*, i.e. full of stars (*Iliad* 6:108, 15:371, *Odyssey* 9:527). On this celestial dome travels the Sun (*Odyssey* 1:7-9), hence called *ouranodromos* (running on the sky). Homer in his epic poems, dated *circa* 900 to 800 B.C., describes the Earth as flat and circular with the Ocean around it, while Hesiod in his *Theogony* (1914) describes the Universe as spherical, divided in two parts by the plane of the flat Earth.

Pythagoras (6<sup>th</sup> century B.C.) is generally credited as the first supporter of the idea of the spherical Earth (Theodossiou 2007). He expressed the opinion that, since the Sun and the Moon are spherical, the same should apply to the Earth, which was sitting motionless in the center of the Universe. Pythagoras was teaching that Earth was spherical, isolated and inhabited; it should be noted that Anaximander also supported that the Earth was isolated, while Empedocles stated that the Earth floats freely in space. Thus, Pythagoras and Pythagoreans were supporting the spherical shape of the Earth mainly for symmetry reasons and because they regarded sphere as the most perfect form a solid body can take. The same view was upheld by Parmenides in the 5<sup>th</sup> century B.C. (Theodossiou 2007). Influenced by Pythagorean views, many other major Greek philosophers and astronomers adopted similar views, such as Aristotle,

Hipparchus, Crates of Miletus and others (Theodossiou 2007). Aristotle dedicates a significant portion of his book *On the Heavens* to support this view, stating that “*the Earth has a spheroid shape, as is necessary to it*” (*On the Heavens*, B, 297b, 18-19). However, as with many other pioneering views, ideas and theories of the ancient Greek philosophers (e.g. the heliocentric system of Aristarchus) the spherical Earth hypothesis was forgotten with the decline of ancient Greece and the rise of the practical Roman spirit. It was therefore natural for the simpler view to prevail in the Middle Ages and this was the flat Earth theory. The teachings of scholars who tried to restore the old view for the shape of the Earth were intensely fought by simpler people, who basically were arguing that it would be impossible for the Earth to be spherical, because in such a case the people living on the diametrically opposite point of the Earth would stand upside down and would fall into the abyss! Of course it must be stressed that accepting a spherical shape for Earth would mean not only abandoning the “obvious” flat shape of our world, but the deeply entrenched notion in the mind of medieval people that in space there is one absolutely defined direction: the “up” and “down” one. This was an age without physics and the seemingly easy for us to comprehend idea that all material bodies are attracted towards the center of the Earth was even for educated people of that period utterly incomprehensible. From the 15<sup>th</sup> century on, when the scholars of the age had a better look at the Aristotelian text, the debate on the shape of the Earth started again. It must not be forgotten that, based on this view of Aristotle (and of the other Greek philosophers) and guided by the writings of Ptolemy on geography, Columbus dared his voyage to the West in order to discover another way to India.

### 3. The pre-Socratic cosmological approaches

In the 6<sup>th</sup> century B.C., with the philosophers from Miletus and the rest of Ionia, a real revolution took place in philosophy and science. The scientific philosophy was born, its theory,

notions and objective physical-mathematical science. At first, Thales of Miletus, the founder of monism, proposed that the basis of everything was water (Theodossiou 2007). Then, Anaximander proposed infinity, Anaximenes the air, while Heraclitus of Ephesus proposed the fire as the primal element (Theodossiou 2007). The variety of their answers to the question of the basic element characterizes their philosophy.

Thales, the founder of the Ionian school and the first theoretician of geometry and astronomy, was the first to express the opinion that the polymorphic world of natural phenomena has single base, originating from one creative common natural entity, the water according to him. Water was for Thales the essential component of all things, beyond any divine interventions; all entities in nature were mutations of that original material. For Thales water was representing the primal essence from which all forms of matter were emerging and to which they were returning time and time again. According to Thales beings have a common natural origin and reason, water, and all physical entities are created as transformations of that original element through “condensation” or diluting. Water (*hydor*) is the element that expanding through its evaporation creates the air, while with its contraction and condensation produces the earth; this can be verified, Thales believed, with the appearance of alluvial deposits from the rivers. Not only our planet, but the whole Universe according to Thales was based on water and it had the form of a hemisphere. Its interior was full of air, while its surface was the sky, the celestial dome. On the plane of its base there was the stationary Earth, which he thought it was floating on water: “floating as a piece of wood or something similar” (Aristotle: *On the Heavens*, B, 294a, 28-34).

Anaximander believed that in the Universe there is a kind of natural law, a cosmic “justice” keeping the 4 principal elements in balance, as they are continuously in a state of antagonism due to their different essence and texture (Theodossiou 2007). Their natural relation, according to Anaximander, should be conserved in eternity, so that no one of the four basic ele-

ments could subordinate the rest. Anaximander was rejecting the idea of his teacher Thales that the basic element was the water, because if this was the case then the natural balance of “justice” among the four elements would be in error. If one of the elements had an advantage over the others, then it would have absorbed the rest, and the Universe would be not only entirely different, but it would be headed for its final destruction. Anaximander was the first who dared to map the known world. He also proposed a most intriguing origin for the human species; according to it the first humans were created from fish-like beings [Hippol. Ref. I 6, 86 (D. 559 W. 10)]. Other pre-Socratic Ionian philosophers, like Empedocles, had made such conjectures concerning the origin from dead matter or the various transformations of the first life forms (Theodossiou 2007); for Empedocles they had disappeared because of lack of adapting ability. These first attempts to formulate a theory of natural history and a reasonable explanation of the phenomenon of life were agreeing in a “spontaneous creation”, and not in the creation of life by some Creator God, as Plato supported later in his *Timaeus*. Thus, the idea that no life form is eternally unchanged, but it evolves in its attempt to adapt to a changing environment did not originate with Charles Darwin (Darwin 1866), but with Anaximander.

Anaximenes also accepted (as the rest of the Ionian philosophers) the basic principle of monism common to the Ionian school that everything stems from one origin and finally goes back to it (Theodossiou 2007). According to him, the origin of everything was the air, which for Anaximenes was infinite, that is indeterminate and eternal. Air was the vast material mass to which everything was or could be reduced. The air of Anaximenes was constantly moving, exactly as Anaximander’s infinity. Out of this perpetual air motion, all the variety of things and phenomena was created. Fire originated from the air through thinning, while the condensation of the air created the waters and the Earth. The genesis and the decay of worlds succeed one another eternally. Anaximenes believed, like Anaximander, that our world was not the only one that existed; he also supported

the idea that the vast mass of the air incorporated innumerable worlds that were being created and died incessantly, emerging from and returning back to the initial infinity (Diogenes Laertius 1935). Heraclitus considered fire as the originating essence of our world. He believed that, of the vast richness of the natural and celestial/Universal creation with its unpredictable changes, nothing remains stable, motionless and granted. There is not constancy, but only an eternal flow, a perpetual motion. This is exactly what we accept today in quantum physics; the apparent stability and immobility is an illusion and is due to our limited senses. According to Heraclitus, matter is constantly transformed, while in our finite Universe the elements “fire”, “air” and “earth” are just different states of one and only material.

All the ancient natural philosophers of Ionia distanced God the Creator from nature and history, keeping always a deep respect for the beliefs of their fellow people; most probably they, too, kept a form of God in some area of their minds and souls, in his spiritual and moral dimension.

After the natural philosophers of Ionia, in Socrates we see the rejection of the distinction man-animal kingdom, while in Plato we find a philosophical treatment of the Earth and the celestial bodies. In Plato's *Dialogues*, especially in *Gorgias* (1959), we find the following position: “*Society keeps together sky and earth and gods and men*” (508), while in the cosmological *Timaeus* (1977) Socrates tackles, as we mentioned, our relation with the animal and plant kingdoms: “*Blending it with other shapes and senses they engendered a substance akin to that of man, so as to form another living creature: such are the cultivated trees and plants and seeds which have been trained by husbandry and are now domesticated amongst us; but formerly the wild kinds only existed*” (*Timaeus*, 77a). Finally, Socrates concludes that there is no essential difference among the 3 broad categories of living creatures (humans-animals-plants): “*Thus, both then and now, living creatures keep passing into one another in all these ways, as they undergo transformation by the loss or by the*

*gain of reason and unreason.*” (*Timaeus*, 92b-c), and: “*there were two kinds of living beings, the human race and a second one, a single class, comprising all the beasts*” (*Statesman*, 263c, Plato, Complete Works, 1997).

## References

- Aristotle, *On the Heavens (De Caelo)*. The Loeb Classical Library, with an English Translation by W.K.C. Guthrie, M.A., William Heinemann Ltd. Cambridge, Mass., Harvard Univ. Press, MCMLIII (First printed 1933, reprinted 1936, 1947, 1956).
- Darwin, C.R., 1866, *On the Origin of Species by means of natural selection, or the preservation of favoured races in the struggle for life*. London: John Murray. 4th edition.
- Diogenes Laertius, 1935, *Lives of Eminent Philosophers*, translated by R. D. Hicks. Two volumes, Loeb classical library, New York.
- Hesiod, 1914, *The Homeric Hymns and Homeric Theogony*. Heinemann, London (The Loeb Classical Library; English translation by Hugh G. Evelyn-White, reprinted 1954).
- Hippolytus, 1857-1866, *Philosophumena or Kata Pason Aireseon elegchos (A Refutation of all Heresies)*. Migne Patrologia Graeca, P.G. X. Migne, J.-P., Patrologiae cursus completus, series Graeca, Parisiis.
- Homer, 1924, *The Iliad*. Heinemann, London (The Loeb Classical Library; English translation by A.T. Murray).
- Homer, 1919, *The Odyssey*. Heinemann, London (The Loeb Classical Library; English translation by A.T. Murray, revised by G.E. Dimock, reprinted 1995).
- Plato, 1959, *Gorgias: A revised text with introduction and commentary by Professor E.R. Dodds* - Oxford University Press, London
- Plato, 1977, *Timaeus and Critias*. Penguin Classics, London
- Plato, 1997, *Plato: Complete Works*. Cooper, John M. and Hutchinson, D.S. (eds.), Hackett Publishing Co., Inc. (*Statesman*)
- Sophocles, 1899, *Antigone*. With an English Translation by G. H. Palmer - verse (Boston:

Houghton and Mifflin)  
Orphic Hymns, The Hymns of Orpheus, 1999.  
Translated by Thomas Taylor, 1792, Kindle  
Editions. University of Pennsylvania Press,  
USA.

Theodossiou, E. 2007, The abdication of the  
Earth - The struggle between the geocentric  
and the heliocentric system, Diavlos publ.,  
Athens [in Greek]