

NECESSITY¹ AND CHANCE² IN DEMOCRITUS' COSMOLOGY

В настоящем исследовании мы попытаемся представить новый подход к широко обсуждаемой проблеме соотношения необходимости и спонтанности, рассматриваемой почти исключительно сквозь призму «космического вихря» Демокрита. Мы должны ограничить свой поиск в концептуальном отношении сферой работы Аристотеля «Физика». В книге «В» этой работы Аристотель соотносит свою точку зрения с мнениями своих предшественников. Тем не менее, в главе 4 этой книги есть сюжет о спонтанном происхождении мира, каковой сюжет, хотя и повторенный в аристотелевском «Корпусе», здесь является более подробным, и, кроме того, содержит важные различия, не будучи до сих пор объектом пристального внимания.

Ключевые слова: Аристотель; Демокрит; Физика; необходимость; случайность (контингентность)

In the present study we shall attempt a new approach by looking through the much discussed problem of necessity and spontaneity, concerning exclusively the cosmic vortex of Democritus. As far as chance and spontaneity are concerned, we shall limit this search within Aristotle's conceptual scope, and in particular in his work of Physics. In Book B of this work, Aristotle deals with this matter from the point of view of his predecessors. Yet in the chapter 4 of this Book, there is a passage on the spontaneous origin of the world, which, though repeated in the

The indication D.K. 67 will be noted when referring only to Leucippus. Testimonies on Democritus will be noted without the codex number 68, in the H. DIELS-W. KRANZ, *Die Fragmente der Vorsokratiker*, II, 1972.

¹ There is no opposition between necessity and spontaneity in the extant fragments of Democritus. This problem arose by the criticism concerning the incompatibility between the concept of spontaneity in Democritus, according to doxography, since there is no relevant fragments, and the so-called atomic determinism.

² I use the terms chance and spontaneity as synonymous, in order to be in agreement with the prevailing use of chance, though the proper term, at least as used by Aristotle, is spontaneity. (See note). Concerning the term chance, to which the followers of Aristotle, but also himself, ascribe the origin of the world, has no such a notion in Democritus' extant frs.: in fr. 119, chance is presented as an image, which is used by idiot men to justify their ignorance, since it rarely conflicts with intelligence. In fr. 176, a contrast between chance and nature is drawn, in frs. 3, 176 and 197, chance has the meaning of a generous fortune, in fr. 210, chance means luck and in frs. 269 and 293, it has the ordinary meaning of fortune – fate. The most important among them is the fr. 119, which is sometimes used as a proof against the view supporting the existence of chance in Democritus: “Men have invented an image of chance as an excuse for their own folly...”. Yet, in testimonies, there is another version of it, coming from Aristotle (Physics, B 4 196 b 6): chance is “a cause obscure to human understanding”, (“since it is divine and miraculous”. The second sentence must refer to popular beliefs about fortune. See GUTHRIE, W.K.C., *History of Greek Philosophy*, Cambridge Univ. Press, 1974, II, p. 419). Cf. also, D.K. 59 A 66: “unclear cause to human reason”. This is in part corroborated by the fr. 118, according to which, Democritus confesses that “he would prefer to find an explanation, than acquire the kingdom of Persians”, what means he was always searching for an explanation. (For the entirely contrary attitude, see part IV, of this paper.)

Aristotelian corpus, is more detailed than the others, and, furthermore, contains an important discrimination, not being so far an object of much attention.

Key words: Aristotle; Democritus; Physics; necessity; chance (contingency)

I. NECESSITY

Leucippus³, friend and teacher of Democritus, invented a theory, compatible with sense perception, which enabled him to postulate change, in the widest sense of the term, without violating Parmenides' canon against the possibility of genesis – corruption, motion and a multiplicity of beings. He therefore conceived the unalterable parmenidean reality, which according to him was not a unity but a plurality, as consisting of infinitely many and too small corpuscles, which are indivisible, that is the atoms⁴, perpetually moving, in the void (“κενον”)⁵. And he further explained their coming-to-being as the aggregation of atoms and their passing-away as the dissolution of these aggregates.

Democritus, like Leucippus, believed that the atoms could also explain change, i.e., the conventional generation and corruption of all things, which is thus reduced in their combination and separation. According to him, the atoms have only size and magnitude⁶, which is usually considered to mean that their eternal⁷ motion is deprived of direction, because of lack of weight. Consequently, they are moving freely, towards anywhere⁸, like the motes in a sunbeam⁹, they collide – though they never actually come in contact – and they form configurations of any kind. As a result they create infinite, contemporary world systems which are dissimilar between them¹⁰. At some time, an infinite number of atoms concentrated in the same area and formed such a configuration, imagined as a huge bulk of various shaped atoms, which was separated from the whole, that is the vortex which precedes our own world¹¹.

³ I consider Leucippus' argument, as described by ARISTOTLE (On Generation and Corruption, A 8, 325 a 23-32), representative of the founder of Atomism and I put a summary of it as an introduction.

⁴ In ancient Greek, things that cannot be divided further are called “ατομα”.

⁵ David SEDLEY, Two Concepts of Vacuum, *Phronesis*, XXVII, 1982, pp. 175-193. According to him, the Atomists' void, from a theoretical point of view, is a negative substance, occupying space, and not the space itself, a doctrine which was developed later. What is interesting for us here, is the fact that the concept of the vacuum, a generally accepted atomic view, still retains some inherited features, not much attended.

⁶ D.L. IX (44), D.K. A 1., AETIUS I 3, 18, D. K. A 47.

⁷ HIPPOLYTUS, *Refut.* I 13 (2), D. K. A 40. Cf. John FERGUSON, Dinos, in *Essays in Ancient Greek Philosophy*, Ed. By John P. Anton and Anthony P. Preus, Part I, Pre-Socratics, p.6. According to Aetius, I 3, 16, D.K. A 47, the motion of atoms is due to their mutual impact.

⁸ According to O' BRIEN, the atoms, though they have weight, are able to circulate without going downwards. For the difficulties of this view, see the criticism of D. FURLEY David, *Greek Cosmologists...*

⁹ ARISTOTLE, *On the Soul*, I, 403 b 31

¹⁰ D. L., IX (31) and (44), D. K. 67 A 1, SIMPL. on the Heavens, 202.16, D.K.67 A21, DIONYSIUS ap. EUSEVIUS, P.E. XIX 23, 2. 3, D. K. A 43

¹¹ SIMPL. on Phys., 327. 24, D.K., A 67.

The vortex is formed from atoms and is not something different of them. See, D.FURLEY, op. cit. On the contrary Cyril BAILEY, *The Greek Atomists and Epicurus*, Oxford Univ. Press, p. 138, holds that the atoms are “fell into the particular motion of the whirl”.

In the present study we shall attempt a new approach by looking through the much discussed problem of necessity (“ἀναγκη”) and spontaneity (“αὐτοματον”) – contingency, or chance (“τυχη”) ¹², concerning exclusively the cosmic vortex – “δινη” – of Democritus, starting from the very concept that necessity¹³ has in both Atomists, since this term is authentically atomic. As far as chance and spontaneity are concerned, we shall limit this search within Aristotle’s conceptual scope, and in particular in his work of Physics, because we do not possess anything extant from Democritus’ physical system. In Book B of this work, Aristotle deals with this matter from the point of view of his predecessors¹⁴. Yet, the most important is, that, in the chapter 4 of this Book, there is a passage on the spontaneous origin of the world, which, though repeated in the Aristotelian corpus, is more detailed than the others, and, furthermore, contains an important discrimination, not being so far an object of much attention. According to this passage, spontaneity concerns the pre-cosmic vortex, namely, only the origin of the world, not the whole word order. If this is accepted, it might be supported that only Democritus’ cosmogony is subjected to chance, not the whole heavens, as Aristotle maintains, drawing a superficial conclusion, applied to both: the origin of the world and the heavens. There remains to be seen whether the spontaneous appearance of the cosmic vortex is compatible with the deterministic principles of Atomic theory, as established by Leucippus.

Leucippus, one of the two Atomists, is usually considered to be the first supporter of determinism, which is due to his famous dictum, “Nothing happens at random, but everything comes to being from reason and by necessity”, as exposed to his single extant fragment. Yet, if we are to avoid any anachronism, we have to see his determinism only within the scope of his own physical system, and take into consideration, that Leucippus’ determinism did not have yet the sense of its later view, according to which, everything that happens is determined physically by a cause¹⁵, which is necessary and sufficient to produce a given effect.

His friend and student Democritus, who elaborated subtly the atomic theory, is considered to share, yet not entirely, the determinism of his teacher, since, according to incontrovertible testimonies, he introduces spontaneity. Furthermore, though he was famous for his excellent explanations of various

¹² According to ARISTOTLE’S Physics, the spontaneous has a wider meaning than chance, since it applies to physical things too, in contrast to chance, which concerns only human affairs (B, 5-6,196 a 35), that is purposeful actions, even if their result does not coincide with that expected. Albeit their serious difference, Aristotle sometimes uses chance in the generic sense, and spontaneous in the sense of species. See f.e. Parts of Animals, A 1, 641 b 23. “There are those who affirm that...the heaven in all its glory was constructed by mere chance and came to be spontaneously...” . Cf. also, Metaphysics A 3, 984 b 15. “.. some Pre-Socratics commit the orderly disposition of everything to spontaneity and chance.”. Our sources from Aristotle onwards use these two terms as synonymous. See f. e. Simplicius, (ARISTOTLE’S Physics, Book B, ch. 4), 327.25.

¹³ I shall use the terms spontaneity and chance as distinct, when referring to the cosmic vortex.

¹⁴ Aristotle’s own views on chance will remain outside of this study.

¹⁵ For the conceptual evolution of the term cause, (closely connected with the notion of legal responsibility) see FREDE M. , “ The original notion of cause”, in the Essays in Ancient Philosophy, Minneapolis , 1987,125-150, and in particular, p. 132.

natural phenomena, he did not have yet acquired the concept of an explicit, causal relationship¹⁶, in the sense that there is a necessary and constant conjunction between two events – or states – in such a way, that the former brings about the latter. [On the contrary, among his rather speculative explanations, he includes, apart from necessity, nature too.]

In contrast, rather surprisingly, according to the extant testimonies, Democritus' concept of physical necessity is very close to the traditional concept of necessity-Ananke, conceived as a violent power, and directly related to that great, intelligent power, that is, Fate, which pervades the totality of things in their space-temporal development¹⁷. Thus Leucippus' and Democritus' "necessity" belongs to final "causes"¹⁸, a fact due to which there are the difficulties which Democritus must have met in his attempt to explain the nature of the motion of atoms¹⁹, the appearance and function of the vortex²⁰, the sustaining of the world²¹, all assigned to another kind of necessity, which belongs to the mechanical "causes".

In general, the concept of necessity – "ανάγκη", in ancient Poetry²² as well in Pre-Socratic Philosophy²³ – has a rich past, as a strong binding force, closely connected with fate, which may have influenced both Atomists. Yet what must have influenced them more, and especially Democritus, is the evolution of this

¹⁶ It is the medical writers of the Hippocratean corpus who first gave currency to this term and to the idea. For its influence on philosophy, see, W. C. GREENE, *Moirai, Fate, Good and Evil in Greek thought*, Harper Torchbooks, N. York, Evanston, 1963, p. 285 ff. See also VEGETTI Mario, "Culpability, responsibility, cause, Ed. by A. A. Long, Cambridge University Press, 1999, p. 272.

¹⁷ Doxography is rich enough regarding this aspect of necessity, which is closer to a confusion of fatalism with determinism. Concerning Leucippus, Aetius (I 25, 4, D. K. fr. 2), who saves the single extant fragment from his work, "on the Mind", writes, introducing it. "L. (believed that) all are due to necessity, which is identified with fate ("εἰμαρμένη"). Concerning Democritus' notion of necessity – fate, we mention some of the most important of the relevant testimonies. 1. "According to Parmenides and Democritus, everything happens by necessity ("κατ' ἀνάγκην"). She is the same as the fate ("εἰμαρμένη"), and justice ("δική") and providence and the world making force ("κοσμοποιόν"), Aetius, I 25, 3. And in another testimony is said. 2. "All things, "both past, present and future" (these three words are considered to be authentic by H. Diels) were determined by necessity". Plutarch., Strom. 7, D. K. A39, where the mention of the things in their totality as well as the temporal dimensions, make manifest necessity's connection with fate. Aetius 3. "All things are created by fate, so that fate would give them the power of necessity. This is the opinion of Democritus, Heraclitus, Empedocles and Aristotle [Anaxagoras Karsten]. Cicero, de fato 17, 39. D. K. A 66. 5. Lactantius' testimony, D. K. A 70, concerning Democritus and Epicurus, "everything is controlled, not by providence but by chance". Though providence does not seem to have any place here, it not a proper reason to regard this testimony as not reliable. For a Christian, chance is opposed to providence, and it actually has a kind of power, in both philosophers.

¹⁸ BARNES Jonathan, in the Proceedings of the International Congress on Democritus, Xanthi 1983, pp. tries to show that the determinism of Leucippus is compatible with teleology

¹⁹ AETIUS I 26, 2, D.K. A66. (On the nature of necessity) Democritus, the resistance, locomotion and impact of matter

²⁰ D. L., IX 34 ff. (44), D.K. A 1 "... the vortex...he calls necessity". SEXTUS IX 113, D.K. A 83. According necessity and by the vortex...the world would not be able to move.

²¹ The world will be preserved until another, stronger necessity...destroy

²² Ananke is related to the fate in Euripides' *Foen.*, 1000, 1763. In Aeschylus (Prom. I052), "ananke" is associated with "dine" and is very strong. «Within the stubborn whirls of Ananke ("ἀνάγκης στερραῖς διναις)", (where Prometheus, body is going to be drawn). Though it is said metaphorically the whole image is conceptually near to that of a dine created or dominated by strong Ananke.

²³ According to Pittacus, even Zeus is subject to necessity. And Thales of Miletus also believes that necessity is very strong, because it holds everything ("τοῦ παντός")

term, from the concept of fate to that of a kind of causally acting agent, which began with Parmenides and was developed in Empedocles.

In Parmenides' way of Truth, Reality-Being is controlled by "strong Necessity" {fr. 8. 30}, that is also called Fate ("μοιρα") {fr.8. 37} and Justice ("δικη") – {fr. 8.14}, the task of which is the same to that of necessity. Moreover, necessity is connected with all three temporal dimensions, a fact that shows the connection of the concept of necessity to that of the Destiny (even if Parmenides rejects what is not "present"). On the other hand, in the way of Opinion, a goddess (δαμων), who is Fate (or Justice or Necessity) controls the mingling of opposites. {fr. 12}. Nevertheless the most important is the differentiation of the concept of necessity, in the way of opinion, when it acquires a cosmic role {fr.10.6-7}. Under the new circumstances, it becomes a strong force-cause that compels the heavens to hold the edges of the stars, conceived as the diurnal heavenly rotation.

Yet only in Empedocles, there becomes clear the conceptual transformation of concept of necessity-fate {fr. 30. 3., fr.115.1}, which holds the elements within the "Σφαίρα", under ample oaths, into the concept of necessity-agent, which plays the role of Love, binding the opposing powers and controlling the vortex²⁴. Necessity-Love is conceived then as a kind of causal agent of the cosmic vortex²⁵ as well as of the motion, which creates the whole world and what it contains.

Influenced by the tradition, and at the same time needing a notion of cause²⁶, Democritus adopts both notions of necessity. a. under a static aspect, as a remote law, which pervades everything, closely connected with fate, and functioning like an end-attaining cause, since it predetermines and arranges everything, and b. under a more or less dynamic perspective, that is, when necessity is connected with the coming-into-being, as an active agent – the primitive form of efficient cause – which has the power to produce something.

Consequently, necessity-fate, in the first meaning, manifests a dependence on the eternal, all pervading fate, thanks to which everything happens invariably, without any interference, or exerting command. In the second meaning, necessity, without being a cause *stricto sensu*²⁷, it does have a relationship with what happens, but it is not connected to some physical law, with thorough validity, which imposes a causal connection in what happens, or at least contains explanations of some regularities. Of course, necessity progressively is inevitably connected with the powers which are active within the nature and thus becomes itself, too, a strong agent, acting as a kind of cause. That is why it is then possible

²⁴ In fr. 19 Love is called binding ("σχεδονην")

²⁵ The vortex is called "δινη", which is synonym with "στροφαλινηξ" {both of them in fr.35.3}, as Simplicius explains (De Caelo,508.17-18). The empedoclean influence of the connection of vortex with see EDMUNDS, Necessity, Chance and Freedom, Phoenix, p.348

²⁶ The word cause ("αιτια") is found only once in Democritus' fragments, under the notion of reason.

²⁷ This is confirmed by Aristotle, who knows that Democritus uses necessity in a non causal way, regarding it as a principle, according to which he tries to explain some cosmic phenomena, by saying, "this is how they are always formed" (Generation of Animals, B 6, 742 b 20 ff.).

to be identified with the cosmic vortex, albeit the difficulties, as we already have seen.

II. CHANCE

According to the often repeated complains of Aristotle as well as to those of some of his commentators, to the accusations of Plato²⁸ and to the information passed to us from Epicurus, Aetius, Cicero e.t.c. , Democritus assigned the creation of the heavens to the automaton and chance²⁹.

More illuminating is the passage, Physics B 2 196 a 24 (D.K.68 A. 69), where one may see where to exactly Aristotle's accusations about the existence of chance in Democritus³⁰, are referred. "Some (that is Democritus,³¹) indeed attribute our Heaven and all the worlds to (chance happenings) spontaneity ("το αυτοματων"), because they are saying that the vortex and the motion [Loeb.

²⁸ The locus classicus against the Atomists is considered the passage Laws, X, 889 B-C. "It is by chance all these elements (sc. The earth, sun, moon, stars) move and all other halfhazard combinations that inevitably ("κατά τυχήν εξ αναγκής") resulted when the opposites were mixed. This is the process to which all the heavens ...owe their birth...the cause of all this ...was neither intelligent, nor a deity nor art but nature and chance". (Trnsl. By T.J.SAUNDERS, in J. M. Cooper, ed., Plato's complete works, Hackett-Indianapolis, 1997) . In my opinion, Plato's target here is not only the Atomists, but also Empedocles and Anaxagoras. Both of them concern with mixtures, and the latter, in particular, with opposites. The mention of "mind" reinforces this view, because Plato disapproves elsewhere too (Phaedo 100) Anaxagoras for the inertness of his "mind".

²⁹ Among the most important [relevant] testimonies, concerning chance in atomic system, and especially Democritus' cosmic system, are the following. 1. ARISTOTLE'S passages, a. Parts of Animals, A ,641 b 21 ff. "There are those who affirm that , while living creature has been brought into being by nature and remains into being thereby, the heavens in all its glory was constructed by mere chance and came to be spontaneously, although there is no evidence of chance or disorder in it." b. Physics, B 4, 196 a 24 ff., D. K. A 69
2. SIMPLICIUS' two commentaries on ARISTOTLE'S Physics .a. Physics, 327.24-26. "D. where he says" a whirl consisting of all the sorts of shapes was separated from the whole" (D. K. B 167), seems to beget the whirl from spontaneity and chance" and b. , Physics , 330.14-17 (Eudemus fr. 22, D. K. A 68). "According to the venerable argument for the elimination of chance", which seems to have been said concerning Democritus, because, though he had apparently used chance in the creation of the world, as far as the particular things are concerned, he denied that chance is the cause of any of them, searching [mentioning] for other causes , as for example the digging (as the cause) of finding a treasure..."
3. THEMISTIUS' commentary on Physics (B 4, 195 b 36), 49. 13-16:"the infinite heavens and the vortex ... did not assigned to any other cause but only to chance and spontaneity..."
4. PHILOPONUS' commentary on Physics B 4, 195 b 28 – 196 a 24), 262. 2: "Democritus...the infinite worlds came into being by chance" (Luria 346), 261. 31 : "the cause of the creation of the whole is the spontaneity", 265. 6 : "the vortex which arranged in this order ... came into being by spontaneity and chance" (Luria 370).
5. EPICURUS, On Nature (Arrighetti fr. 34.30, D. K. A 69). "The Atomists make necessity and spontaneity able for everything". (Admittedly, Epicurus would not like to be considered as ascribing both names to a single reality, but to mention these two entirely different notions as responsible for the formation of Atomists' cosmic system. His synoptic way of describing them clearly shows that it is [almost trivial] very well known to which areas these notions should be attributed.)
7.CICERO, On the Nature of the Gods, I 24, 66, D. K. 67 A11, referring to both Atomists' theory , attributes the formation both, of the heaven and the earth to the fortuitous concentration of various shaped atoms , without nature' oppression.

³⁰ Aristotle is believed that reproach against chance is usually believed that it is due to the fact that chance in his system has only an epistemological, not an ontological status. For the contrary view, see, KAPANTAIS Dukas, presentation in the Meeting at Delfi , 2005

³¹ Diels inserts this passage to Democritus' Testimonies, A67 and A69. Simplicius, Physics ,331.16, attributes the first part of this passage to Democritus, on the authority of Eudemus, and the second part, to the Atomists in general. The mention, however, of mind as explanatory cause, shows that Aristotle included also Anaxagoras, since Democritus never uses mind, at least in the Aristotelian references. Yet it is generally accepted that this part regards Democritus too. Cf. C.Bailey, The Greek Atomists and Epicurus, Oxford, Oxford Univ. Press, 1928, p.139.

sifting] that disentangled the chaos and established the cosmic order came by spontaneity... , (196 a 33;) yet the heaven and the divinest things that our sight reveals come about spontaneously (“απο του αυτοματου”) and have no such causes (sc. Nature, “φυσιν”, or Mind, “νουν”, or what else, “τοιουτου τι ετερον”), as animals and plants have.” (196 a 35).

Aristotle actually does not accuse Democritus for assigning the formation of the heaven, in general, to a spontaneous event³², but only indirectly, by means of the cosmic vortex. He first explains why he assigns spontaneity to the heavens, by saying that the Atomists believe that the appearance of the vortex is due to spontaneity, and then relates the latter to the cosmic order which follows this appearance, as if it also were due to spontaneity. Then he justifies the rejection of the Atomists’ theory about the spontaneity – used by them only to explain the creation of the vortex – by ascribing it not only to the origin of the world, caused by the vortex and “the motion which brought about order”, but to the heavenly order itself, as well. This is an explanation that neither one who would have considered the heavens to be something divine (as Aristotle himself) would accept, nor Democritus himself, who was too great a geometrician, to ignore the regularity of the motions of the heavenly bodies.

Aristotle, however, is not entirely wrong. The anti-teleological view of Democritus concerning the world is widely known to us, by Cicero and Lucretius, among others. If then, the idea that there is neither a design of the world nor an intelligent active agent is combined with its initial spontaneous creation, one easily may believe that everything, at least in the heavenly area, came into being spontaneously and by chance, that is, in opposition to the design and end, imposed by nature or mind. The lack of a design and of an end in the process of cosmogony, are in complete agreement not only with an initial state of spontaneity but also with a world view, which is not cosmos. If a vortex should produce orderly results, for Aristotle, why does this have to be so for Democritus also?

Of course there is still necessity, which, according to Aristotle, is involved by Democritus in the explanation of the eternal things. Yet, there is no any indication that the vortex has any close relationship with the remote necessity, which is a mere teleological cause. Concerning, however, the results caused by a vortex, they might be necessary³³, in the sense that they take place under constraint of something else, preceding them, in this case, the motion of the vortex. Yet, Aristotle would never have permitted them to be regarded as orderly, since, being created under constraint, that is by violence, they are, ipso facto, in opposition to nature and to order.

Nevertheless, though Democritus did not believe in a design, which had predetermined the world, there are serious indications that he also faced it as a

³²According to A. the concept of automaton is more general than that of chance. The former concept applies not only to animals but also to natural phenomena.

³³CORNFORD F. M. , Plato’s Cosmology, London, Routledge and Kegan Paul, 1937, p. 169.

regular and well ordered system, where everything is disposed in its place. This seems from the excellent examples he gives³⁴, for the orderly concentration of similar things, and proves his attempt to explain the same natural phenomenon, as that described above, belonging in the macroscopic level, without betraying his mechanistic principles. [Besides, Democritus knew that world is characterized by other “regularities”, as they are its growing up and its decline].

Coming back to the Aristotelian passage, mentioned above, it actually seems that it includes some of what Democritus approximately believed, that he actually had connected the cosmic vortex – a spontaneous event – with the origin of the world, mentioned as “the cause of the heavens”, in the end of ch. 6 of Book 2, of Physics (198 a 5 ff.). “Spontaneity and chance are accidental and not per se” causes. Since then nothing accidental is prior to what is per se , the accidental cause is not prior to the cause per se. Spontaneity and chance are therefore posterior to reason and nature; so that even spontaneity is the cause of the heavens , reason and nature are prior causes of the universe and of many things in it.”³⁵ With this statement he places spontaneity and chance under nature and reason, as expected, but, nevertheless, he seems to accept it, even hypothetically, because of the argument.

It is true, that Aristotle’s intention here is to limit the action of chance within nature, in order to let free the room for the development of his teleology.³⁶ Thus he has to show that, as the per se cause (“καθ’ αὐτην”) precedes that which is per accident (“κατὰ συμβεβηκος), in the same way nature-reason – the real cause of order – precedes spontaneity and chance – the accidental causes of disorder. Consequently, according to this argument, Democritus and, in general, all those who share the Atomists’ view are completely wrong in thinking that disorder precedes order.

According to the chapters 5 and 6 of Book 2 of Physics, spontaneous and chance events 1., occur par excellence, being for this reason, accidental causes (196 b 14 ff.) 2., are distinguished into those where there is some degree of deliberation, that is the case of chance (197 a 6 – b 8), and into those where there is not, that is the case of spontaneity. The latter has a wider meaning than that of chance, since it applies to lifeless events too (197 a 36 ff., b 13). Spontaneous events give the impression that they [are related] attain to an end, [to the effect produced,] but actually they take place independently from their so called effects. (197 b 20 – 35). This way, spontaneity has the aspect of a natural process, taking place in vain, which producing a result that might have been, but it was not

³⁴ D.K. B 164. Living creatures consort with their kind , as doves with doves...So it is with inanimate things, as one can see with the sieving of seeds and with the pebbles...In the former, through the circulation of the sieve, beans are separated and ranged with beans...; in the latter, with the motion of the wave, oval pebbles are driven to the same place as oval, and round to round, as if the similarity in these things had a sort of power over them which had brought them together. (Trnsl. Of Cathleen Freeman). Cf. Simplicius, On the Heavens, 294. 33 ff., from ARISTOTLE, On Democritus, fr. 202, (ROSS ,Aristotle, Fragmenta selecta, Oxford , D.K. A 37,where the repulsion of unlike atoms and the entanglement of similar atoms, belonging to various categories, is described.

³⁵ Trnsl. By W.D.ROSS, Aristotle’s Physics, Oxford, Clarendon Press,1966,p., 355

³⁶ CALFAS V., Aristotle’ Physics, Book 2, Introduction, translation, commentary, Athens, ed. Polis, 1999,p.197.

predetermined. 3. They are efficient causes, acting by nature – reason, and constituting (accidental) causal processes which are indeterminate (198 a 5).

Let us turn now to the serious problem of the spontaneous appearance of the vortex. It corresponds exactly to the main prerequisites of a spontaneous natural phenomenon, in the atomic terms and could meet Democritus' theory too.

1. Concerning its exceptional character, vortex is indeed an unusual pre-cosmic configuration, consisting of atoms. According to the extant testimonies, Democritus believed in the existence of various world systems³⁷, a fact meaning that, what would precede their own special arrangement; it would be different than the pre-cosmic vortex of our own world too. 2. Spontaneous events, according to Aristotle, have to do with natural processes which merely imitate the motion of the normal ones, and look as if they attain an end. Democritean vortex also belongs to the category of natural phenomena, which have no predetermined end, though their effects are similar to these ends. 3. Spontaneous events, without being caused by the efficient cause per se, but only by the accidental one,³⁸ (as for example in the case of matter imitating the definite motions of a seed) could be derived by nature or by reason. According to Democritus, these processes, that is, the fortuitous accumulation of atoms in a huge space, result in a vortex, which indeed could have been created by an extra natural agent too. Yet, Democritus did not believe in any such agent, able to create a vortex, such as Empedoclean Love, or Anaxagorean Mind and so this process, leading to its formation, though it is an existing one, is indefinite.

In conclusion, since the atoms were borne around in a primordial motion, without any force imposed on them, why then, should we expect that Democritus was obliged to invent such a force, able to undertake this particular concentration of atoms, resulting in our own unimportant, worth laughing world? In addition the pre-cosmic atoms were entirely dissimilar. Perhaps Democritus made the thought that, since there was not any known attractive power, which would exert its impact on dissimilar atoms and concentrate them in a place, consequently the only reasonable alternative was the hypothesis of a fortuitous concentration, in the way Aristotle defines this phenomenon, that is, as due to many indefinite reasons, what we would call initial conditions, entirely unknown to us.

It is true that Democritus, a philosopher who was so bold to conjecture, based only upon his mere rationale, various, infinite co-existing worlds, not alike to each other, may also be able to imagine various formations of the cosmic matter, either preceded, or not, to these worlds. One amongst them, created by the fortuitous accumulation (“αθροισμος”) of atoms in a huge space (“εν μεγα κενω”), and separated from the whole, consisting of atoms of all kinds of shapes, just happened to have the form of a vortex, which usually coincides with the

³⁷ D. L. IX (31), D.K. A 1, HIPPOLYTUS, Ref. , I,13(2),D.K. A 40. D. Cf. SIMPL. , on the Heavens, p. 310.5, D.K. A 82.

³⁸ Concerning the question in what degree, in these chapters Aristotle concedes to his predecessors' accounts, which differ from his own, as exposed elsewhere, as f.e. in his *Metaphysics* , see, Richard SORABJI, *Necessity, Cause and Blame*, London, Duckworth, 1980, p. 23.

origin of a world. Many other cosmic formations could have occurred, without having created a cosmos, or at least this particular cosmos. The spontaneous appearance of the vortex, thus conceived, is not due to our weakness to know its initial conditions of formation. It is an ontological event, though it is postulated by the principle of sufficient reason too, like the similar postulation of the formation of many various worlds, since there is infinity of atoms in an unlimited space.

III. THE VORTEX

Yet if the vortex is created spontaneously, two questions arise: a. how can orderly results be produced by a spontaneous event, and b., how spontaneity can be compatible with necessity³⁹ (under its first meaning, that is, as an all-pervading power). In my opinion, Democritus solution to the first problem – a major one among contemporary cosmologists who do not adopt a divine intervention in the formation of the world – is the choice of the traditional model of a vortex, the results of which, made Empedocles and Anaxagoras adopting it as well, and its connection with necessity⁴⁰ (under the second meaning), that of a powerful active agent, like the empedoclean Love and Strife, or the anaxagorean Mind.

This is entirely confirmed by Diogenes Laertius. “Everything happens according to necessity, the vortex being responsible for the coming-to-be of all things, and he calls this necessity”⁴¹.

If then the above hypothesis, derived from Aristotle, is accepted, namely, that the vortex was formed in a spontaneous way, as well as, the fact that Democritus did assigned the regularities presented by our cosmic system to necessity, as he usually did, it is most probable that he discerned between two temporal stages, concerning the cosmogenetic vortex, a., the fortuitous

³⁹ Jonathan BARNES, *The Presocratic Philosophers*, Vol. I I, p. 122ff., focuses on the problem of the incompatibility between necessity and chance, in the above Aristotelian relevant passage. Yet, he does not make a distinction between chance and spontaneous here, but he holds that the whole problem is a verbal one, for the solution of which he resorts to a passage from Plato’s *Laws* (10,889 B-C), where chance is combined with necessity: “in accordance with chance from necessity”. Hence he generalizes, “In that sense, every event in a wholly deterministic world might occur by chance”. GUTHRIE, *op.cit.*, p. 417 ff., uses the same combination of chance with necessity in a similar expression, as an indication that there is no great distance between necessity and chance. The former is thought of as an internal cause-“the nature of a thing” which governs its behavior- and the latter, as something subjective, which exceeds our power of prediction, remaining obscure (tyxhe adelos D.K. A). Consequently, chance can take its place in the system, without prejudice to the ruling idea of an all pervading necessity. (Necessity’s power here is not derived from its connection with fate, as I personally have supposed.). Thus necessity has the notion of something internal, which concerns each individual atom and, at the same time, its usual deterministic concept.

⁴⁰ Cyril BAILEY, *The Greek Atomists and Epicurus*, Oxford 1928, p. 138, believes that the formation of the world is due exclusively to the vortex. He also considers it to be the necessity “par excellence” (p. 139). For a similar view, see G.S. KIRK-RAVEN, *The Presocratic Philosophers*, Cambridge Univ. Press, p. 412, John FERGUSON, *Dinos*, *Phronesis* 16, 1971, p. 102 and MOUTSOPOULOS E., *The Presocratic Thought*(in Greek),Ed. Grigoris, Athens 1978, p. 56.

⁴¹ D. L. IX (45) , D.K. A 1. Diogenes’ testimony is reinforced by Sextus’ argument against the possibility of the use, both, of necessity and of a vortex, which confirms that they were connected: “...it is impossible for the world to be moved by a vortex, under necessity” (IX 113, D. K. A 83).

appearance of the vortex, which is due to spontaneity, and b., its definite and well known function, based on necessity. So, what really follows the appearance of the vortex is not but another aspect of necessity, which is connected to the physical phenomenon of a vortex, and controls it totally, in order to produce concrete and definite effects, that is the world. This presupposes of course that vortex is identified with the pre-cosmic state of the world, in its embryonic form, and it continues to exist, after the becoming of the world, as the diurnal rotation of the stars – the relics of the initial velocity of the vortex – which reminds to any observer of the world that its past situation was under the scheme of a vortex.

The first function of a vortex⁴² is to separate the dissimilar whilst concentrating the similar material stuff. Thus within it, after the disentanglement of the various atoms, thanks to the principle of “like to like”, a concentration of similar atoms takes place and thereby all composite bodies are generated, the earth (placed first of all⁴³), the air, the water and the fire, that is, the great members of the world. Probably, all of them – not only the fire – consist of atoms of similar shape⁴⁴. Its second task is to keep the heavy bodies in the centre and to push the light ones to the periphery⁴⁵. Thus the corpuscles that can form the earth concentrate towards the bottom of the vortex, whereas those able to form the heavenly bodies went up and composed them. These latter, although they have been composed of smooth and spherical atoms – of the same kind the soul is constituted⁴⁶ – are heavy conglomerations⁴⁷. Until now, the separation of atoms is due to the mechanically acting principle of “like to like” and their shifting up is the result of the vortex own mechanical movement. But Democritus has also to

⁴² Democritus must have taken into consideration the anaxagorean model, as described in the fr. 12. 21-25, where the opposites are separated, and the fr. 15, where the similar members of each couple of those opposites, form two similar groups: a., the superiora, which tend towards the heavens, and b., the deteriora, which come to the area of the earth. For a more detailed account of the model of the democritean vortex, as well as its difference from Leucippus' model of the vortex, see, A.ARAVANTINOUBOURLOYANNI, *The Cosmological Model of Democritus*, in *Texts for Democritus*, Ed. By L. Benakis, Xanthi 1983, pp. 211-232. Cf. Lowell EDMUNDS, *Necessity, Chance and Freedom in the Early Atomists*, J. FERGUSON, op.cit., 1971, p. 9

⁴³ HIPPOL. Ref. I 13, (4), D.K. A 40.

⁴⁴ AETIUS IV 19, 13, D.K. A 128

⁴⁵ Concerning the mechanical function of the vortex, see Theodor GOMBERZ, *The Greek Thinkers*, London 1969, Vol. I. p.337 ff., and the answer of John BURNET, *Early Greek Philosophy*, London 1945, p. 221ff. Cf. Manlio MAZZIOTTI, *The Theories of Democritus from Abdera*, Trnsl.into Greek by A. A. Papaioannou, Xanthi 1982, p. 58.

⁴⁶ D.L. I X 44, D.K. A 1.

⁴⁷ According to AETIUS (II 13, 4, D. K. A 85 and II 20, 7, D.K. A 87), Democritus believed that the stars are made of stone and the sun, of fiery stone. It is then very possible that he had adopted Anaxagoras' doctrine, the first physiologist who had exposed such a theory, having as a start the empirical event of the fall of a meteorite to Aegos Potamoi, in 467 B. C. Nevertheless, it is doubtful whether the doxographer rightly attributed this view to Democritus too, since the latter accused Anaxagoras for plagiarism of the ancient doctrine concerning the earthy nature of the stars, which actually belongs to Anaximenes, but it has nothing in common with that of Anaxagoras. It is true that Anaximenes also believed that the stars have earthy constitution. Yet this is due to the fact that they are formed from the wetness of the earth, as one can see in the testimony A 7 (coming from HIPPOLYTUS, Ref. I 7(5), which is more analytical than that transferred by PS. PLUTARCH, Strom. 3 D.K.13 A 6). It is possible then that Democritus had no detailed knowledge of the new theory, and confused it with that of Anaximenes, otherwise he would not have accused him. So it is more safe to accept the testimonies which are referred to the sun ...as consisting of eyolista and round shaped atoms which go up as shifting away.

explain the *caeli turbo*⁴⁸, the “diurnal revolution of the whole heaven as well as the revolutionary movement of the sun and the moon”⁴⁹, visible above us. This means that, apart from its cosmological role, the vortex has also a cosmological role, since it continues to rotate. However, in this rotation there participate heavy conglomerations of atoms which constitute the heavenly bodies participate. The existence of a great velocity can be a satisfactory account of this phenomenon. Yet this is not sufficient, as one can see from Anaxagoras’ similar theory. Therefore, the cosmic Mind undertakes not only to initiate this rotation but also to maintain it, by decorating it⁵⁰. In the same way, we are allowed to imagine that necessity’ main role concerning the vortex is to support and preserve the whole system of the parts of the world. This must be the role of that necessity, which, according to Aristotle, comes in from the surrounding and destroys this world, being stronger”, which makes sense, if we suppose that it means “stronger” than the necessity sustaining our own world. Aristotle here speaks of the necessity, instead of the world, that is in a synecdochical way. This is confirmed by the information that our world will exist until it will be destroyed by another world, stronger than our own⁵¹.

IV. SPONTANEITY – NECESSITY

The second question deals with the problem, of spontaneity and whether or not it can co-exist and is compatible with Atomists’ peculiar deterministic system, pervaded by necessity. In this paper, we have avoided references to modern theories about determinism⁵², causation, necessitation. We just adopted the commonly accepted view, that the Atomists’ determinism has the meaning that everything that happens, comes out of a cause, by necessity.

The search of this subject, however, showed that the concept of necessity retains some older futures, as for example its connection with fate, and cosmic intelligence. Necessity, albeit blind, is never chance. On the contrary, it is associated with design and purpose. Necessity is powerful, since it pervades the totality of the things that happen and intelligent, since it is able to predetermine everything, in a very remote and rather negative way, by restricting it to its own limits. Each particular mechanical law, such as, coming into being and passing away – reduced in atomic combinations, – “the like to like” and the separation of dissimilars, the motion of round atoms up, and whatever happens according to a

⁴⁸ LUCRETIUS, *De Rerum Natura*, v. 624, D.K. A 88. According to EPICURUS’ Letter to Pythocles (91), the vortex has a rim. This fact might be associated with the information (coming from Lucretius, v. 630-636) that the distant stars move more swiftly than those being closer to the earth.

⁴⁹ D. R. DICKS, *Early Greek Astronomy to Aristotle*, Thames and Hudson, 1970, p. 80 ff., holds that these astronomical views of D. are but an amalgam of anaxagorean theories. I personally think that this view is unfair. For the relevant confusion between some opinions of these two philosophers, see, Andrei LEBEDEV, “Physis talanteyoysa”, in *Proceedings of the 1st International Congress on Democritus*, Ed. By L. Benakis, Xanthi 1983, pp. 13-18.

⁵⁰ D.K. 59 B 12. 18-21. Mind (νοῦς) decorated everything, as well this rotation, in which the stars and the sun and the moon ... are rotating.

⁵¹ D.K. A For the information coming from Aristotle, which has been mentioned again, see note.

⁵² See for a modern aspect of view, R. SORABJI, *Necessity, Cause and Blame*, London, Duckworth, 1980, and among others, Ernest Sosa and Michael Tooley, Editors, *Causation*, Oxford-N. York, Oxford Univ. Press, 1999.

principle-law, are under this general-still primitive-legal concept of necessity⁵³. Necessity' function in the universe is not of course like the laws of Newtonian Mechanics, which have general validity and they are connected with any particular law, in a necessary causal way, producing invariable effects, nor has the more recent meaning of necessary and sufficient initial conditions, which would thus necessitated causally predetermined results. All the same, it is also a law, irrevocable and unbreachable, functioning as a final cause, since it acts towards an end, in a non mechanical way. Necessity is then the condition, according to which everything comes to be and passes away within the whole universe, where an eternal motion – in the widest sense – prevails, as far as both the microcosm and the macrocosm are concerned.

It is true that Democritus cannot be considered to be consistent with the determinism inherited by Leucippus, since he accepts chance. Nevertheless, he assigns his various explanations to necessity; though some times, he refuses them, maintaining that such things, as the eternal ones, need not to be explained.

On the authority of Aristotle, and in Aristotelian terminology, we can confirm the use of this kind of necessity, by Democritus himself. Necessity is involved by him as a kind of principle-cause, in a context where he explicitly denies the use of causes which regard the eternal heavenly things: “They are wrong that the necessity is involved in the cause, those people who say that “this is how they are always formed” and regard it as a principle in these cases. Their argument is this: What is limitless has no principle. But the cause is a principle, and what is always is limitless; therefore, says Democritus, to ask for a cause to connection with anything of this kind (sc. that always is) is the same as trying to discover a principle in something which is limitless”⁵⁴.

Aristotle says that the attempt of identifying necessity with cause is wrong. And a couple of lines below, he describes Democritus' argument, by which, the latter tries to prove that there is no cause-principle, for example, of the infinity. Why then had Democritus used necessity and what is the meaning of Aristotle's words, “are wrong”? This is a peculiar case, because necessity is here referred to, as a principle, though in the same passage, it is explicitly said that Democritus refused to give any explanatory cause. Aristotle then may have misunderstood the role of necessity here, conceived as a principle, and rightly regarded as wrong, those who involved it in the cause.

The reason may become clearer, from the testimony of Ps. Plutarch. “The causes of things that are now coming into being do not have any principle (αρχην), but in general everything, past, present and future is already dominated (προκαταχθεσθαι) by necessity (τη αναγκη) from above, from limitless time”⁵⁵.

⁵³“Greek scientific speculation, from Anaximander on, stands under the sign of Necessity, since it is of the nature of reason and provides the causal invariants.” Giorgio de SANTILLANA, *The Origins of Scientific Thought*, The Univ. of Chicago Press, 1970, p. 116

⁵⁴ *Generation of Animals*, B 6, 742 b 20-25.

⁵⁵ [PLUTARCH] *Strom.* 7, D.K. A39(Trnsl. by F.M. Cornford). In order to get an idea of this concept of necessity as develops later, we quote from Aetius. I 29, 7, D.K. 59 A 66. “...According to Anaxagoras and D. and the

The language reminds us an Aristotelian passage from Physics: “Nor yet is it sound reasoning to conclude that you have reached a fundamental principle (”αρχην”) when you have shown that this or that always is, or always occurs, or always occurs, thus and no otherwise. Democritus, it is true, held it to be enough for the establishment of determining principles (“εφ’ ο Δ. αναγει τας περι φυσεως αιτιας”) to have shown that this or that has been so in all former times, and did not feel bound to seek any principle for what has always been”.⁵⁶

I personally believe that Democritus uses necessity in all three cases, in its first meaning, as the irresistible power which pervades everything, to which the causes-principles are reduced, without itself being a cause.

This concept of necessity is not of course incompatible with any spontaneous event. Spontaneity would threaten a deterministic system, the parts of which would be causally connected in an uninterrupted chain.

Consequently, spontaneity simply co-exists with this kind of necessity, which, in the case of the initial stage of the vortex, that is, of its formation, is not connected causally with any particular law of motion, since the random motion of atoms could not be thought of as consisting such a kind of law, preceding its formation.

However, even in the case of spontaneous events, produced either by processes unknown to us or by nothing at all, we have to accept that, so far the necessity-fate controls and determines everything that happens, it has a regulative role, even upon chance [contingent] events.

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Stoics ... things happen by fate(καθ’ εμαρμενην”), or by spontaneity (κατα το αυτοματον), or by deliberation (κατά προαιρεσιν), or by chance (κατα τυχην).

⁵⁶ Physics, V III. 1, 252 a33-b2