AUTHOR	Visa Helenius
TITLE	Lucretius' Atomism as an Ideological Forerunner of Modern Astronomy
YEAR	2025
VERSION	Publisher's PDF
LICENSE	CC BY

Faravid – Journal for Historical and Archaeological Studies
56/2025, pp. 73–92

Visa Helenius

Lucretius' Atomism as an Ideological Forerunner of Modern Astronomy

The Roman poet and philosopher Titus Lucretius Carus (the first half of the first century BCE) wrote the Epicurean manifestation entitled *De rerum natura* ('The nature of things'), hereafter *DRN* for short.[1] The work has remained complete, but was likely not finished.[2] Although Lucretius' influence in his own time is unknown,[3] the DRN is a classic in its own right,[4] and it has been an influential work during later times.[5] In this article, I argue that Lucretius' atomism and his astronomy are an ideological forerunner of modern astronomy. I explore this argument by analysing Lucretius' astronomical views, by discussing the after effects of the DRN on later science and by pointing out important connections between Lucretius' philosophy and modern astronomy.

The preliminary observations of this article are as follows: first, I will concentrate on the ideological and philosophical aspects of astronomy here than scientific and

1 I refer to the DRN by the abbreviation "Lucr." with a reference to the book of the DRN and the related lines. My primary source is Joseph Martin's edition of the DRN (Joseph Martin (recensvit), *T. Lucreti Cari De rerum natura*. Lipsiae in aedibus B. G. Teubneri MCMLXIX). Concerning commentaries and translations, I have used the following works: Cyril Bailey, *Titi Lucreti Cari. De rerum natura*. Oxford University Press, Oxford 1947; Lee Fratantuono, *A Reading of Lucretius' De Rerum Natura*. Lexington Book, Lanham, Boulder, New York, and London 2015; Paavo Numminen, *T. Lucretius Carus. Maailmankaikkeudesta*. WSOY, Porvoo and Helsinki; W. H. D. Rouse and Martin Smith, *Titus Lucretius Carus. De Rerum Natura*. Loeb Classical Library 181. Harvad University Press, Cambridge (MA) and London 1992.

2 Simon Trépanier, "Lucretius". *The Stanford Encyclopedia of Philosophy* (Winter 2023 Edition). Edited by Edward N. Zalta and Uri Nodelman, *passim*. URL: https://plato.stanford.edu/archives/win2023/entries/lucretius/ (6.10.2024).

3 Elizabeth Rawson, *Intellectual Life in the Late Roman Republic*. Duckworth, London 1985, 285.

4 Rawson 1985, 4.

5 Stuart Gillespie and Philip Hardie, "Introduction". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007(b), 8. DOI: https://doi.org/10.1017/CCOL9780521848015; Rawson 1985, 285.

VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

technical aspects, such as astronomical devices and mathematical astronomy.[6] Briefly, this article concerns the after effects of Lucretius' DRN at a general level, and it is not a study of the history of astronomy, albeit that such a study could also be useful to it. Second, I will focus solely on Lucretius' DRN and do not consider the arguments of Epicurus here because the DRN can be seen, in my view, as an independent work; as I have argued elsewhere.[7] Third, the methods of this article are contextualization, close reading, comparison and contrasting. Concerning the methodology, I presume, based on recent studies,[8] that the DRN has inspired many notable thinkers and scientists of the early modern period. Fourth, my approach is more descriptive and qualitative rather than a systematic and a comprehensive study about the connection between the DRN and astronomy – this is due to the complexity and extent of the subject; I believe that this kind of study would require a broader study, such as a monograph.

I begin by contextualizing the subject. Next, I introduce the foundations of Lucretius' materialistic ontology and examine his astronomical views. In the third section, I clarify rediscovery, the transmission and the after effects of Lucretius' DRN and explain in what way his atomism is an ideological forerunner of modern astronomy.[9]

The starry sky above us, the ancients, and one Roman epicurean

Human beings have wondered about the starry sky for a long time. The night sky filled with stars is something exiting, which separates our terrestrial ordinary life from the extraterrestrial and astonishing one: our proximate world, Earth with its atmosphere,

---

6 For more on Hellenistic surveying instruments, see Tracey Rihll, "Hellenistic Surveying Instruments". *Hellenistic Astronomy: The Science in Its Contexts*. Edited by Alan Bowen and Francesca Rochberg. Brill, Leiden and Boston 2020, 221–231. DOI: https://doi.org/10.1163/9789004400566_023. For more on the Antikythera mechanism, see Jo Marchant, "Ancient astronomy: Mechanical inspiration". *Nature*, Volume 468, 2010, 496–498. DOI: https://doi.org/10.1038/468496a. For more on the prehistoric astronomy, see David Kelley and Eugene Milone, *Exploring Ancient Skies: An Encyclopedic Survey of Archaeoastronomy*. Springer 2005, 157–209. DOI: https://doi.org/10.1007/978-1-4419-7624-6.

7 Visa Helenius, "Lucretius and the Body-Environment Approach". *SENSORIVM: The Senses in Roman Polytheism*. Edited by Antón Alvar Nuño, Jaime Alvar Ezquerra and Greg Woolf. Brill, Leiden and Boston 2021, 52–70. DOI: https://doi.org/10.1163/9789004459748_004.

8 For more on the reception of Lucretius' DRN in different times, see *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007(a). DOI: https://doi.org/10.1017/CCOL9780521848015; Trépanier 2023, the eight section. For more on the connection between the DRN and modernity, see *Lucretius and Modernity*. Edited by Jacques Lezra and Liza Blake. Palgrave Macmillan, London 2016. DOI: https://doi.org/10.1007/978-1-137-56657-7.

9 I would like to thank two anonymous referees for valuable feedback and the editors of *Faravid*.

differs from the distant and mysterious space. Modern astronomic findings are indeed incredible: there is an infinity of planets, stars, stellar systems, galaxies, galaxy clusters, not forgetting black holes, supernovas (an immense explosion of a colossal star), and celestial giants.[10] Concerning modern cosmological theories, it is most likely that the Bing Bang occurred, and even the infinity of parallel universities of the multiverse cosmology may exist.[11] Accordingly, we, the human beings, are a very tiny part of the universe are not the centre of the universe, which is a humbling experience.

The puzzling observations about sky and space have led to profound contemplations about the nature of our world. Fundamental questions include: What are the celestial bodies, and what are their constituents? Can there be extraterrestrial life? What is the origin of the world? What is our part in this strange reality in the end? As we will see, Lucretius gives answers to these questions from the Epicurean point of view.

The question of the essence of celestial objects and other phenomena has led to the scientific study of the sky and the beginning of *astronomy*, the study of the extraterrestrial physical world beyond Earth in general; astronomy studies everything in the observed universe beyond Earth's atmosphere. It includes, *inter alia*, *cosmology*, which studies the structure of the universe, *cosmogony* or the study of the origin of the universe, and *archaeoastronomy*, or the historical and archaeological study of astronomy.[12] Concerning the connection between the subfields of modern astronomy and Lucretius' DRN, I claim that the following thematic branches can be detected in his philosophy: (1) *astrophysics*, which uses physical laws and ideas to explain the behaviour of the celestial objects; (2) *physical cosmology*, which concerns the evolution of the universe from the earliest known perceptual discovery; (3) (physical) cosmogony; (4) *stellar astronomy* or the study of stars; and (5) *solar astronomy* or the study of the Sun. Regarding *astrology*, there was a vague doctrine about the celestial bodies, which was popular in ancient times, and especially in Rome. For example, the stars were occasionally identified with deities.[13] Importantly, Lucretius explicitly opposes all kinds of astrological beliefs in the DRN: he states that the world and its parts are not deities, and that the gods (if they exist) do not have a causal effect on the world.[14]

---

10 Largest known stars, such are UY Scuti and Stephenson 2 DFK 1, are over 1700 times greater than Sun and are, therefore, celestial giants.

11 For more on these subjects, see Stephen Hawking and Leonard Mlodinow, *The Grand Design*. Bantam Press, London 2010.

12 For more on archaeoastronomy, see Hannu Karttunen, *Vanhin tiede. Tähtitiedettä kivikaudesta kuulentoihin*. Tähtitieteellinen yhdistys Ursa, Helsinki 1996, 8–18; Kelley and Milone 2005.

13 Karttunen 1996, 27; Kelley and Milone 2005, 249, 250. For more on the history of astrology, see Karttunen 1996, *passim*; Kelley and Milone 2005, *passim*.

14 Lucr. 5.110–125 and 5.146–194.

Concerning the ancients, understanding the sky was more important for them compared with modern man. Hannu Karttunen explains that understanding and knowledge of celestial phenomena were crucial in prehistoric times because the sky was a clock, a calendar and a compass for ancient man.[15] In other words, the sky was a prerequisite of life since it offered usable information about the world. For this reason, it has been claimed that astronomy is the oldest science.[16]

The sky was observed and studied by various means in early civilizations. For example, it is likely that Stonehenge, dolmens (i.e., a structure of megaliths), and pyramids had astronomical functions.[17] However, since astronomy was subordinated to governmental and religious needs in the early civilizations, it was not an independent field of science. In antiquity, astronomy developed because theoretic and scientific thinking became more permissible and popular. As a result: Eudoxus of Cnidus (c. 395–390 BCE) propounded a geometrical model for the motions of planets, Aristotle (384–322 BCE) argued that Earth is spherical,[18] Heracleides of Pontus (fourth century BCE) claimed that Earth rotates around its axis once a day, Aristarchus of Samos (c. 310–230 BCE) offered a heliocentric model of the world, Apollonius of Perga (c. 240–190 BCE) propounded a theory of epicycles, according to which planets are moving in certain epicycles, which go round in geocentric (imaginary) circles, and Hipparchus (second century BCE) was concerned with the orbits, distances, sizes and eclipses of Sun and Moon, determined the length of the year rather accurately and compiled, allegedly, an early star catalogue.[19]

With reference to Lucretius, he praises Epicureanism in the DRN.[20] The work is written in dactyl hexameter and consist of six books. Its main subjects are (1) atomism including its principles and manifestations, (2) the nature of the human (material) mind and perception, the absurdity of the fear of death, (3) and atomistic cosmogony,

---

15 Karttunen 1996, 8.

16 Karttunen 1996, 8.

17 Karttunen 1996, 10–17, 36–38; Kelley and Milone 2005, 203.

18 Aristotle argues in *On the Heavens*: "If then the earth has come into being, this must have been the manner of its generation, and it must have grown in the form of a sphere. [– –] Besides this argument for the spherical shape of the earth, there is also the point that all heavy bodies fall at similar angles, not parallel to each other; this naturally means that their fall is towards a body whose nature is spherical. Either then it is spherical, or at least it is natural for it to be so[.]" Aristotle, *On the Heavens*. Translated by W. K. C. Guthrie. Loeb Classical Library 338. Harvard University Press, Cambridge, MA 1939, 251.

19 For more on the golden era of Greek astronomy, see Karttunen 1996, 40–57; Kelley and Milone 2005, 239–248.

20 Lucretius is an Epicurean beyond doubt. See e.g., Lucr. 1.62–79, 5.1–54, 6.1–42; Fratantuono 2015, 23, 316–318, 410–412. For more on the connection between Epicurus and Lucretius, see Rawson 1985, 4, 58, 59, 285; James Warren, "Lucretius and Greek philosophy". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 19–32. DOI: https://doi.org/10.1017/CCOL9780521848015.002.

cosmology, meteorology, and geology.[21] Concisely, the DRN is a *materialistic theory of everything*.[22]

Lucretius drew his inspiration especially from Leucippus' (the fifth century BCE) and Democritus' (c. 460 BCE) atomic philosophies and Epicurus' hedonism.[23] The first two endorsed *reductionistic ontology*, according to which the (material) world can be understood only by its parts, the atoms (αἱ ἄτομοι (*hai atomoi*)).[24] With reference to Epicurus, he argues for rational pleasures (ἡδονή (*hēdonē*)) and avoidance of pain and suffering (ἀλγηδών (*algēdōn*)).[25] This leads, according to him, to *ataraxy* (ἀταραξία (*ataraxia*)), that is, 'peace of mind', which is of the greatest good for the human being.[26] Accordingly, Lucretius endorses *Epicurean atomism* in the late Roman frame of reference.[27] Concerning astronomy, he has a scientific mindset,[28] and he gathers information from the ancient views and theories in the Epicurean context.[29] However, it is to be noted that Lucretius was not an astronomer or natural scientist but an Epicurean philosopher.[30] For this reason, he also propounds some obscure and exotic astronomical and ontological views, as we will see below.

---

21 For more on the structure and the content of the DRN, see Joseph Farrell, "Lucretian architecture: the structure and argument of the *De rerum natura*". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 76–91. DOI: https://doi.org/10.1017/CCOL9780521848015.006; Fratantuono 2015.

22 For more on the connection between Lucretius and naturalism, see Gilles Deleuze, "Lucretius and Naturalism". *Contemporary Encounters with Ancient Metaphysics*. Edited by Abraham Greenstine and Ryan Johnson, translated by Jared Bly. Edinburgh University Press 2017, 245–253. DOI: https://doi.org/10.1515/9781474431194-016; Gillespie and Hardie 2007(a), *passim*.

23 Gillespie and Hardie 2007, 3; Warren 2007, 25. Lucretius was also influenced by Empedocles of Acragas' (490–430 BCE) and Ennius' (239–169 BCE) poetry (Trépanier 2023, the third section).

24 See Diogenes Laertius, *Lives of Eminent Philosophers, Volume II*. Translated by R. D. Hicks. Loeb Classical Library 185. Harvard University Press, Cambridge (MA) and London 1931, 572, 573.

25 Diogenes Laertius 1931, 653–659.

26 Diogenes Laertius 1931, 660, 661.

27 For more on this topic, see Helenius 2021, 61–65.

28 See e.g., Lucr. 1.50–61 and 1.127–148.

29 For more on Epicurus' astronomical views, see Diogenes Laertius 1931, 613–643.

30 Bailey 1947, 1419. For more on Lucretius' empiricism and theory of perception, see Lucr. 4.54–821.

Lucretius' natural philosophy and astronomy

Although the DRN includes references to ancient mythology[31] and suffers from internal inconsistencies,[32] which was common in Roman didactic poetry,[33] Lucretius' atomistic theory is, in my view, elegant. Namely, he propounds two principles and two postulates, by which everything is explained. The principles are (1) *nothing can arise out of nothing* – this is commonly called the *ex nihilo nihil fit* ('nothing comes from nothing') principle[34] – and (2) *nothing can be reduced to nothing*; if these principles would not be true, Lucretius believes, anything could arise from anything, such as that species could generate other species. Accordingly, causality could not be balanced and consistent, and, respectively, anything, which exists, could perish suddenly without a cause.[35] My example of the latter is that the planet Mars could be destroyed by the slightest touch. Consequently, there must be, Lucretius reasons, something in the macroscopic beings, which enables their consistent and predictable comings-to-be and passings-away. As regards what this "something" is, I proceed now to the two postulates, (3) *atoms*, which move, or, better, drop, and collide with each other in a boundless (4) *void*.[36]

In summary, Lucretius' ontology is based on the principles of *ex nihilo nihil fit* and of indestructibility and the existence of atoms and the void. It follows that the world has a regularity function and is thoroughly material including the human mind. The only exception to this is the void.[37] I conclude that this foundation is sufficient for the objective of theoretic simplicity. Another question is, of course, whether it is true or plausible.

The question then arises as to what are the properties of atoms and their combinations? Lucretius specifies that atoms are solid, imperishable, indivisible, though they have inner extreme points (*extremum cacumen*), unchangeable, and infinite in number. They also do not have colour, heat, sound, odour, taste, and feeling.[38] Furthermore, atoms *swerve* (*declinare*[39]) randomly from their original

---

31 See e.g., Lucr. 1.1–43, 5.837–854.

32 James O'Hara, *Inconsistency in Roman Epic*. Cambridge University Press, Cambridge 2007, 55–76. DOI: https://doi.org/10.1017/CBO9780511618567.

33 For more on the trend, see O'Hara 2007.

34 I discuss the combinations of atoms and their behaviour below.

35 Lucr. 1.215–260.

36 Lucr. 1.146–365, 1.418–483. Concerning the falling of atoms in Lucretius, see Lucr. 2.184–215. For more on this view, see Fratantuono 2015, 98, 99; Trépanier 2023, the fifth section. For more on the Epicurean atomism, see Pierre-Marie Morel, "Epicurean atomism". *The Cambridge Companion to Epicureanism*. Edited by James Warren. Cambridge University Press, Cambridge 2009, 65–83. DOI: https://doi.org/10.1017/CCOL9780521873475.005.

37 Concerning the first, see Lucr. 3.94–416, and concerning the latter, see Lucr. 1.329–369.

38 Lucr. 1. 483–634, 1.1008–1051, 2.730–756, 2.842–885.

39 See Rouse and Smith 1992, 113, fn. e.

path sometimes; this theory is called *the swerving of atoms* (*clinamen atomorum*). It follows that the nature is *indeterministic* for Lucretius; events are not at least completely determined by the previous events.[40] Concerning natural laws, indeterminism enables an interesting possibility that the laws are not permanent but changing. Concerning the combinations of atoms, like planets and cats, one may ask why there are only a limited number of species, if there are an infinite number of atoms. Lucretius' answer is, in my view, brilliant: atoms have different shapes, but their number is limited.[41] In other words, there is an infinity of atoms but a limited number of possible combinations of atoms due to the limited number of their shapes. Consequently, only certain beings are possible.

Concerning divinities, Lucretius mentions the remote Epicurean gods here and there in the DRN.[42] Importantly, he explicitly claims, nevertheless, that the gods are not causally active in the world.[43] Assuming the gods really exist,[44] their only effect is their vague images (*simulacra*), of which it follows that their essence and powers are a complete mystery for the human being.[45] One thing is certain: there are no causally active divine entities in the world.[46] It therefore follows that nature works independently, which is a characteristic argument in Lucretius' philosophy.

Before the astronomical section in the fifth book of the DRN, Lucretius offers a few preliminary astronomical remarks. First, *Earth does not have a physical centre*, which would attract matter. Instead, Earth's formation and structure have resulted from the weights of atoms[47] – I describe this more thoroughly below. Accordingly, Lucretius would not accept gravitational theory (i.e., physical objects are attracted towards one another by the gravitational force): he explains the gravitational phenomena by the properties of atoms. Second, *there are other worlds* like Earth in the infinity of space (i.e., atoms, which are falling in the void) since atoms gather and form planets here and there in boundless space – Lucretius describes that the

---

40 Lucr. 2.216–293. Lucretius also deduces human freedom from the swerving. For more on his view of freedom, see Don Fowler, *Lucretius on Atomic Motion: A Commentary on Lucretius: De Rerum Natura Book Two, Lines 1–332*. Oxford University Press, Oxford 2002. DOI: 10.1093/actrade/9780199243587.book.1. For more on Epicurus' view of freedom, see Jeffrey Purinton, "Epicurus on 'Free Volition' and the Atomic Swerve". *Phronesis*, volume 44, number 4, 1999, 253–299. DOI: 10.1163/15685289960464601. Lucretius' idea is that freedom requires indeterminism. However, this is philosophically problematic since it is not clear how indeterministic events are determined, such as by volitions. In other words, indeterministic events seem to be fundamentally accidental.

41 Lucr. 2.333–380, 2.478–521.

42 For more on the Epicurean gods and religion, see Bailey 1947, 66–72; Dirk Obbink, "The Atheism of Epicurus". *Greek, Roman and Byzantine studies*, volume 30, number 2, 1989, 187–223.

43 Lucr. 1.44–49, 5.146–194.

44 I have argued elsewhere that Lucretius may endorse atheism indirectly. Helenius 2021, 57–61.

45 For more on Lucretius' theories of images, vision, and perceptual errors, see Lucr. 4.26–481.

46 Lucr. 2.167–181, 2.1090–2.1104, 5.110–234.

47 Lucr. 1.1052–1113.

atomic reality is like the animal kingdom of Earth, which consists of a variety of living organisms.[48] Consequently, extraterrestrial life and other lifeforms exist, and their manifestation are restricted only by the shapes of atoms since only certain combinations are possible.[49] Third, *no world is eternal*. Every world has, therefore, a beginning and an end and periods of prosperity and decay.[50]

I proceed to the fifth book of the DRN. Its middle section concerns cosmogony, cosmology, and astronomy (the first part is about the natural origin and infinitude of Earth and the last about the origin and development of living creatures and human civilization). At the beginning of the book, Lucretius refutes theological and mythical explanations explicitly because, for him, only empirical and rational explanations are acceptable.[51] As an example of the harmfulness of mythical explanations, Lucretius mentions the myth of Phaethon,[52] which has caused false beliefs. According to the myth, Phaethon fell from the sky to the surface of Earth, and it was believed that this mythical event caused wastelands. Lucretius disagrees with this view and argues that only atoms (and their interactions) can explain the origin of wastelands.[53] He continues that there are the following *four elements* of the elementary atomic compounds, which are *earth* (*terra*), *water* (*aqua*), *air* (*aer*) and *light* (*lumen*) or, better, *fire* – Cyril Bailey has noted that light and heat are concrete objects for Lucretius, and that they consist of fire particles.[54] The four elements also are "mortal" (*mortalis*), that is, impermanent,[55] despite consisting of the imperishable atoms.[56]

Concerning the astronomical section, I think that Bailey's assessment provides a suitable, general opening remark: he notes that this part is difficult and includes obscurities.[57] I agree with him since this is quite evident, as we can see below. An obvious problem is, as I note, that Lucretius' argumentation is also very condensed through the whole part.

---

48 Lucr. 1.1047–1089. For more one Lucretius' biological views, see Lucr. 1.660–729, 5.783–987.

49 It should be noted that Lucretius denies the possibility of biological evolution due to the shapes of atoms, which determines the actual species. Lucr. 1.700–729, 5.837–924.

50 Lucr. 2.1105–1149. Lucretius repeats this idea elsewhere in the DRN, see Lucr. 5.91–109, 5.351–415. Concerning Earth, Lucretius judges in the DRN somewhat paradoxically that it is both old but new. Cf. Lucr. 2. 1150–1179, 5.324–350.

51 Lucr. 5.64–90. See e.g., Lucr. 1.50–145.

52 In classical mythology, Phaethon was the son of Helios, the sun-god.

53 Lucr. 5.396–410.

54 Bailey 1947, 1363.

55 Lucr. 5.247–305. Cf. Lucr. 3.231–257.

56 Lucr. 1.581–599.

57 Bailey 1947, 1394. According to Bailey, especially three things explain the difficulties: Lucretius' geocentric view, Lucretius' carelessness about the earlier physics, and the problematical Epicurean theory of perception (Bailey 1947, 1393, 1394), of which I discuss below. I remark that the original Epicurean sources have not remained completely, which would likely have clarified Lucretius' philosophy.

Lucretius starts by explaining *the origin, development and structure of Earth*: our world has come into existence randomly by collisions and adhesions of certain kinds of atoms.[58] Therefore, Earth does not have a divine origin or a specific teleological function. In other words, Earth is not designed, and its existence does not have any particular purpose. Lucretius continues that Earth was at first aggregated and confused mass (*moles*) of different kinds of atoms.[59] During this period, chemical compounds, such as water, had not yet arisen. In the second stage of Earth's evolution, atoms of the same weight began to form wholes, and the heavier atoms moved towards the centre of the atomic mass while pushing the lighter atoms further out. When the process of differentiation of atoms continued, *ether* (*aether*)[60] and *the upper atmospheric air* emerged.[61] Therefore, in Lucretius' philosophy Earth and its satellites came into existence due to the different weights of atoms and not by dynamic processes[62] or gravitational forces. As regards the Sun (*sol*) and Moon (*luna*), Lucretius explains that they began to exist because the weights of their atoms were not heavy enough for them to have sunk below the crust of the Earth nor light enough for them to rise into space – for him the Sun and Moon are situated between the upper atmospheric air (i.e., the zone of ether) and Earth. The seas, air or *the lower atmospheric air* and the landforms of Earth also emerged at the same time.[63] Lucretius ends by stating that the four atomic compounds from the heaviest to the lightest are earth, water, air, and aether, and that inner space (i.e., Earth and its atmosphere) and outer space (i.e., planets and stars) take their shape subsequent to this aggregation.[64] It is important to note that our planetary system has come into existence naturally and gradually in Lucretius' philosophy: since the celestial bodies have emerged by the combination of atoms, they are not created, as in Plato's philosophy, in which the demiurge creates the world from the initial chaos,[65] or in the Christian tradition, in which God creates the world *ex nihilo*.

---

58 Lucr. 5.416–431.

59 Lucr. 5.432–445.

60 Cf. αἰθήρ (*aithēr*). NB: The lower air is *aer* (cf. ἀηρ (*aēr*)). (*The Latin Dictionary, s. v., aether* and *aer*).

61 Lucr. 5.432–470.

62 E.g., according to the Cartesian theory of vortices, the plenum of the dynamic matter particles revolves around Sun in different vortices.

63 Lucretius' examples of aether include mist and vapour of air.

64 Lucr. 2.432–508.

65 Plato argues: "For God desired that, so far as possible, all things should be good and nothing evil; wherefore, when He took over all that was visible, seeing that it was not in a state of rest but in a state of discordant and disorderly motion, He brought it into order out of disorder, deeming that the former state is in all ways better than the latter." Plato, *Timaeus, Critias, Cleitophon, Menexenus, Epistles*. Translated by R. G. Bury. Loeb Classical Library 234. Harvard University Press, Cambridge, Massachusetts and London 1929, 55.

After dealing with cosmogony and cosmology, Lucretius proceeds to more common astronomical points. He considers first *the motion of stars* (*astrum*[66]): either (1) the whole sky turns round by the pressure of air, or the sky itself does not move but the stars are moving either (2) by ether or (3) by air, which comes from outside (*extrinsecus*) the Earth's atmosphere, or (4) by the powers of stars themselves.[67] Bailey remarks that all these views are quite unclear,[68] and I agree: Lucretius mentions only very briefly their central ideas and does not explain them properly. I clarify that either air moves the whole sky, or ether or air moves only stars but not the sky itself, or stars have inner powers to move themselves and the sky does not move.

Since Lucretius is uncertain about the correct view on the motion of the stars, he concludes that:

> *what may be done and is done through the whole universe in the various worlds made in various ways, that is what I teach, proceeding to set forth several causes which may account for the movements of the stars throughout the whole universe; one of which, however, must be that which gives force to the movement of the signs in our world also; but which may be the true one, is not his to lay down who proceeds step by step.*[69]

I conceive this remark as very important: Lucretius comes to aporia[70], that is, puzzlement, by acknowledging that understanding the sky is difficult due to its complexity and the lack of knowledge. Namely, if there is not enough evidence or reasons for something, aporia is philosophically acceptable, such as was famously taught by Socrates. Lucretius' uncertainty shows, in my view, a cautious and critical attitude: he admits explicitly that he does not have enough reasons and experience for the correct view. I presume that the four possibilities are also meant to be hypotheses for further scientific study. As demonstrated below, Lucretius continues with the aporic line in the remainder of this astronomical section.

Lucretius argues for *the geocentric view* next, according to which Earth is at rest in the middle of the universe.[71] However, since atoms are falling in the void, Earth is moving all the time, therefore it follows that it does not have a fixed point in space. Lucretius continues that Earth and its atmosphere form an organic whole since they consist of the gradually formed structures of atoms. According to him, the

---

66 According to Bailey, "astrum" refers to stars, in which Lucretius also includes Sun and Moon. Bailey 1947, 1399.

67 Lucr. 5.509–533.

68 For more on interpretations of the section, see Bailey 1947, 1395–1399.

69 Rouse and Smith 1992, 419.

70 In rhetoric, aporia means situation, in which one comes to uncertainty as to how to proceed or to thought.

71 The heliocentric view replaced the geocentric view in the early modern period.

structure is manifested as follows: (1) our bodies function consistently; (2) there are thunderstorms because the lighter and heavier atoms are linked; and (3) our (material) soul and body are intermixed.[72] Here, Lucretius' main point is that only geocentricism enables these phenomena. Bailey remarks importantly that Lucretius likely did not think that Earth is spherical but a flat and round body, like a tambourine. In that case, the atomic elementary structures (or zones) are not organized spherically but are in a flat shaped form. Bailey adds, nevertheless, that we have no direct evidence of this, in which case it is also possible that Lucretius conceived Earth as spherical.[73]

Lucretius continues by arguing controversially that *the sizes of the Sun*, *Moon*, *and the stars* are fully or nearly the same as they are in our common observations.[74] In which case, the celestial objects are very small compared with the size of Earth. I note that although this is an incorrect view by later scientific knowledge, Lucretius' theories must be, of course, judged through his time. The above-mentioned controversial view is based on the Epicurean theory of perception, according to which direct perceptions are fully reliable, despite being prone to errors in certain circumstances. Because of this foundation, we must also trust our visual experience in the case of the celestial bodies.[75] Since Lucretius is uncritical on the subject of human perception, he represents a naïve and unsophisticated theory of human perception. On the one hand, this point of view is more understandable in the ancient context, and although the effect of distance by sight is easily detectable (the objects of visual perception become smaller when the distance increases and *vice versa*), it is very difficult to deduce the real sizes of celestial bodies by common observation. On the other hand, the Epicurean naïve theory is immediately problematic since the effect of distance can easily be verified by ordinary experience (e.g., if I touch a tree, I become aware of its real size compared with my visual sensation of the tree from

[72] Lucr. 5.534–563. For more on the materiality of the soul, see Lucr. 3.94–416.

[73] Bailey 1947, 1403.

[74] Lucr. 5.564–596.

[75] For the trustworthiness of the perception, see Lucr. 4.482–521. For more on the errors of perception, see Lucr. 4.379–521. For more on the Epicurean theory of perception, see Bailey 1947, 51–60, 1407–1410.

far away). Concerning this obvious criticism, Bailey notes that the Epicurean theory was already ridiculed in antiquity, for example, by Cicero.[76]

Pertaining to *the composition and properties of the Sun*, Lucretius starts by asking how so small body can be so powerful. He offers three possibilities: either (1) the Sun is like a magnet, which attracts atoms, which causes warmth and light, or (2) the Sun is a solid object (but not an atom[77]) with an emergent property of being hot, so that it kindles air, of which follows that the surrounding area is also kindled – for Lucretius, the Sun is situated in the lower atmospheric air[78] – or (3) the Sun has a quality of invisible heat (*caecus fervor*), in which case it does not necessarily have the ability to produce light but the ability to radiate and transfer heat.[79] My clarification is that the Sun has an indistinct formation basically in the first possibility since it is a loose composite being but has a more solid body in the latter two possibilities. Furthermore, Lucretius' had to rely on metaphysical speculation here because direct experience does not show what the Sun's composition is.

Next, Lucretius discusses *the orbits of the celestial objects*. Bailey notes that this section is notoriously difficult partly because of the complex phenomena itself[80] and partly because Lucretius' lack of judgment concerning his authorities and sources. Lucretius begins that annual circulation of the Sun and monthly circulation of the Moon are complex phenomena and thus not easily explicable. He refers to the zodiac, that is, the belt-shaped region of the sky, where the Sun, the Moon and the planets of our solar system move when viewed from the Earth. He also refers to Democritus' theory, according to which the distance between Earth and the orbiting bodies determines the speed of their motions, so that the nearer a body is to the Earth, the slower is its motion (Earth itself does not move except for falling in the void). For example, the Moon, which is located nearer the Earth, moves slower than the Sun, which is further away. Lucretius adds that air also impacts the motion of the celestial bodies in this theory since wind direction either hinders or strengthens their motion.[81]

---

76 Bailey 1947, 1407. Cicero criticizes in *Lucullus* (section 82): "Why do I talk about a ship? for I saw that you think the illustration of the oar contemptible; perhaps you want bigger examples. What can be bigger than the sun, which the mathematicians declare to be nineteen times the size of the earth? How tiny it looks to us! to me it seems about a foot in diameter. Epicurus on the other hand thinks that it may possibly be even smaller than it looks, though not much; he thinks that it is not much larger either, or else exactly the size that it appears to be, so that the eyes either do not lie at all or else not much." (The last sentence in Latin: "Epicurus autem posse putat etiam minorem esse eum quam videatur, sed non multo; ne maiorem quidem multo putat esse, vel tantum esse quantus videatur, ut oculi aut nihil mentiantur aut non multum." Cicero, *On the Nature of the Gods*. *Academics*. Translated by Harris Rackham. Loeb Classical Library 268. Harvard University Press, Cambridge, MA 1933, 570, 571).

77 See Lucr. 2.477–521.

78 Lucr. 5.585–595.

79 Lucr. 5.590–613.

80 Orbits and orbital periods of satellites and planets are fluctuating for many causes.

81 Lucr. 5.614–649.

I remark that Lucretius repeats Democritus' theory briefly and does not explain the motions and the orbits of the celestial objects properly, which is a pity.

In the next section, Lucretius considers *the causes of night and day* and *their varying lengths* and describes *the structure of the Sun*. The section includes exotic ontological views. He begins that night comes either because (1) the Sun loses its powers daily, or (2) the Sun dies down among the zone of air, or (3) the Sun moves beneath ("sub terras") the Earth.[82] I comment that the third explanation is a fair conjecture – in fact, the Earth orbits around the Sun, although everyday observation suggests that Earth itself does not move. The first two views are, however, reasonable because there are analogical physical and biological processes (e.g., volcanic eruption, flowering), which happen repeatedly both randomly or regularly. Lucretius continues that the cause of dawn is either (1) the Sun, which returns from beneath the Earth, or (2) those atoms, which cause light and heat, gather and create the Sun every day.[83] In my view, the first explanation is, again, a fair conjecture, and the latter reasonable in that sense that there are similar physical phenomena, such as the process of formation of diamonds, where high pressure and heat cause carbon to form a new allotropic shape (i.e., a different physical form of the same chemical substance). Lucretius concludes that day and night have different lengths in different seasons, which occurs because either (1) the orbital period of the Sun varies,[84] or (2) the thicker and thinner compositions of air have an effect on the motion of the Sun, or (3) the fire particles in the repeatedly emerging and dying Sun gather together.[85] Concerning these possibilities, the first is a fair conjecture, and the latter two are reasonable because interaction of different kinds of matters is common and because there are similar random (e.g., volcanic eruption) or regular (e.g., periodic flowering) physical phenomena.

Lucretius argues that the three possibilities causing *the different phases of Moon* are as follows: either (1) sunbeams cause the light of the Moon, but the positions of the Moon and Sun affect the process, or (2) the Moon has the ability to light up, but another body or bodies weaken or prevent its light, or (3) the ability does not apply to the whole structure of the Moon, in which case only some part or parts of the Moon emit light.[86] After Lucretius has briefly described the rotation of the seasons (it is like a procession of ancient gods), he concludes that it is possible that (4) the Moon can be born and die periodically, like the Sun.[87] I would like to point out that the first

82 Lucr. 5.650–655.

83 Lucr. 5.656–679.

84 In *equinox*, the centre of the sun is above the Equator, which divides Earth's surface into the northern and southern hemispheres, twice a year, when and day and night are approximately equal in length.

85 Lucr. 5.680–704.

86 Lucr. 5.705–736.

87 Lucr. 5.737–750.

possibility is correct in principle (although the Sun does not orbit the Earth), and the second a fair conjecture since clouds affect the light path of the Moon and the latter two are understandable in the ancient context.

Lastly, Lucretius explains *the eclipses of Sun and Moon* in the astronomical section as follows: the first occurs either (1) because the light of the Sun is blocked by the Moon or (2) by other celestial body or bodies, which are between the Earth and the Sun, or (3) the Sun has declined temporarily due to the regions of air. Regarding the eclipses the Moon, this phenomenon occurs because either (1) the light of Sun, which is reflected from the surface of the Moon to the Earth, is blocked by the location of the Earth or (2) by some other celestial body or bodies, or because (3) the Moon's own ability to emit light is prevented by regions of matter in the sky.[88] The first two possibilities are, I note, correct – the light of the Sun or its reflection from the surface of the Moon is prevented by either Earth or by clouds, and the last is exotic but understandable.

I have described the foundation of Lucretius' philosophy and analysed his astronomical views in this section. The foundation of his atomism consisted of the two principles and the existences of atoms and the void. His preliminary astronomical remarks included: Earth does not have a physical centre; other worlds exist; no world is eternal; theological and mythical cosmological explanations are false on the grounds of atomism; there are four the elementary atomic compounds or elements, which are related to astronomical phenomena in different ways, as described above. In its entirety, the astronomical section contains different arguments, ideas, possibilities and views. Lucretius begins with the motion of stars but ends in aporia. Concerning this, my interpretation is that Lucretius probably wanted to offer general astronomical hypotheses for further considerations. In the next two sections, Lucretius argues for the geocentric view, which is understandable by common observation (it seems that the Earth does not move), and claims controversially and problematically that the sizes of the celestial objects are fully or nearly as they are in observation. In my view, this section is the weakest part of the astronomical section. The sections about the Sun and the orbits of the celestial objects have similar problems. However, in the sections about the causes of night and day and their lengths, the phases of the Moon and the eclipses of the Sun and Moon, Lucretius propounds fair and correct conjectures and claims. Importantly, these results have mainly been obtained by observation and empirical reasoning.

[88] Lucr. 5.751–770.

Lucretius, an ideological forerunner of modern astronomy?

In this section, I examine how Lucretius' DRN has influenced and inspired modern science and astronomy. I begin by clarifying Lucretius' after effect in science and proceed to argue that he is an ideological forerunner of modern astronomy.

As reasoned previously, the DRN includes, in addition to correct and fair views, implausible, obscure and incorrect astronomical views. Moreover, Lucretius was not an astronomer. For these reasons, the DRN is not the optimum manual of ancient astronomy.[89] Despite this fact, his work has been an influential source about ancient atomist physics in history,[90] and especially in the early modern period. Nevertheless, the transmission of the DRN occurred by change:[91] only a small part of the ancient written material has survived, and it has often been by pure coincidence that a work, such as the DRN, has survived.[92]

Concerning rediscovery and the transmission of the DRN in the Middle Ages,[93] its availability in the ninth century is proved by the three extant manuscripts. Between the ninth and the fifteenth centuries, the DRN was read, although there is an absence of the extant manuscripts of the work written in the period. In the fifteenth century, an increasing number of references were made to Lucretius.[94] Valentina Prosperi clarifies that there are two critical moments for the reception of the DRN during the Italian Renaissance: Poggio Bracciolini (1380–1459), a papal secretary, rediscovered the DRN in 1417 and made it known, but at the beginning of the next century, the ecclesiastical authorities conceived the work as threatening due to its Epicurean materialism. However, Lucretius's thoughts already had many cautious admirers at the time, from which it followed that the DRN remained available in Italy and was not banned or lost.[95]

Concerning the after effects of the DRN in the modern era, Bernardino Telesio (1509–1488), a philosopher and natural scientist, and Giordano Bruno (1548–1600), a philosopher and astronomer, drew inspiration from Lucretius during the Italian

---

89 Cf. e.g., Hipparchus' achievements.

90 Monte Johnson and Catherine Wilson, "Lucretius and the History of Science". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 131–148. DOI: https://doi.org/10.1017/CCOL9780521848015.009.

91 Trépanier 2023, the first paragraph.

92 Cf. Rawson 1985, 285.

93 For more on these subjects, see Trépanier 2023, the eight section.

94 Michael Reeve, "Lucretius in the Middle Ages and Early Renaissance: Transmission and Scholarship". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 205–214. DOI: https://doi.org/10.1017/CCOL9780521848015.013.

95 Valentina Prosperi, "Lucretius in the Italian Renaissance". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 214. DOI: https://doi.org/10.1017/CCOL9780521848015.014.

Renaissance.[96] In early modern France, René Descartes (1596–1650), a philosopher and cosmological theorist, and the *libertins*, such as Pierre Gassendi (1592–1655), a scientist and astronomer who endorsed empiricism, were influenced by the DRN.[97] Regarding the English Renaissance, Stuart Gillespie explains that Henry Percy (1564–1632), the ninth Earl of Northumberland and a patron of natural scientists, and his friends, such as the astronomer Thomas Harriot (1560–1621), studied the atomistic philosophies of Democritus, Epicurus and Lucretius. In addition, Francis Bacon (1561–1626), one of the leading figures in natural philosophy and science, and Thomas Hobbes (1588–1679), a classical materialist philosopher, drew inspiration from Epicureanism and Lucretius' DRN.[98] Slightly later, Isaac Newton (1642–1727), a key figure in the modern natural sciences and the founder of modern analytic celestial mechanics, was certainly influenced by Lucretius' atomism.[99]

In relation to the Enlightenment, Eric Baker emphasizes that almost every thinker was familiarized with Lucretius' thoughts. Lucretius' views were used for different purposes, such as to justify *naturalism*. I would like to note that this is related to *metaphysical naturalism*, which is a popular philosophical and scientific standpoint today; according to which, there are no supernatural entities in the world, which is also Lucretius' view. Baker specifies that the three tenets of the naturalism of the Enlightenment are as follows: (1) the world is based on the natural order; (2) this order is the principal object of philosophical study; and (3) some variety of empiricism is required.[100] According to this standpoint, all beings and events in the world are natural including the celestial phenomena (albeit God is still possible). I remark that this kind of naturalism is compatible with scientific thinking and Lucretius' philosophy since both rely on natural explanations. It is important to note, at this point, that many ancient thinkers have held naturalistic ideas and views. For example, Ionian natural philosophy flourished in the sixth and ancient Greek atomism in the fifth century BCE. As for Rome, *Naturales quaestiones* ('Natural Questions') by the Stoic Lucius Annaeus Seneca (4 BCE–65 CE) and *Naturalis Historia* ('Natural History') by the scholar Pliny the Elder (23–79), *inter alia*, are

96 Johnson and Wilson 2007, 133–135.

97 Johnson and Wilson 2007, 135–137. Philip Ford, "Lucretius in Early Modern France". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 227, 228, 240. DOI: https://doi.org/10.1017/CCOL9780521848015.015. Lucretius was admired widely. E.g., Michel de Montaigne (1533–1592), a classical humanist, conceived Lucretius as a model thinker.

98 Stuart Gillespie, "Lucretius in the English Renaissance". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 251, 252. DOI: https://doi.org/10.1017/CCOL9780521848015.016.

99 Johnson and Wilson 2007, 141, 142.

100 Eric Baker, "Lucretius in the European Enlightenment". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, 274. DOI: https://doi.org/10.1017/CCOL9780521848015.018.

basically naturalist works. Nevertheless, Lucretius' DRN is special in that sense that it was one of the earliest Roman and Latin works – Simon Trépanier notes that the DRN "was a pioneering accomplishment in Latin literature"[101] – concerning naturalistic approach and natural explanation of the world. Furthermore, Lucretius' theology departs from other mainstream ancient philosophies, such as Platonism, Aristotelianism, and Stoicism,[102] since Lucretius' gods (if they exist) are not causally active.

With regard to modern times, Gillespie and Donald Mackenzie have argued that the connection between Lucretius' views and naturalism has been emphasized.[103] However, they note that in the second half of the twentieth century the focus was no longer on "the physical science" of the DRN.[104] Concerning Lucretius' "modernity", I should point out that this is a complex and disputable issue because the ancient and the modern scientific views are usually very different.[105] For example, David Konstan clarifies that despite Epicurus' and Lucretius' philosophies being popular and influential, "it would be absurd to claim that Epicurus and Lucretius achieved anything like the rich theoretical vision of modern physics[.]"[106] In other words, Lucretius' Epicurean atomism is not similar to modern physics due to their fundamental differences; for example, Lucretius' "atom" is very different from the modern concept of an atom, which consists of protons, neutrons and electrons.[107]

Regarding the claim that Lucretius' atomism is an ideological forerunner of modern astronomy, I continue by examining how Lucretius' astronomical views and certain branches of modern astronomy match. As I mentioned previously, the five branches, which are related to the DRN, are astrophysics, physical cosmology, (physical) cosmogony, stellar astronomy, and solar astronomy. To be precise, Lucretius' DRN includes astronomical views, which are related thematically to the other branches as follows: first, Lucretius propounds an astrophysical system of celestial bodies which consist of atoms and are thus individual atomic agglomerations with different kinds

---

101 Trépanier 2023, the first paragraph.

102 Plato speaks of the demiurge (i.e., the divine craftsman) and Aristotle the unmoved mover, which is the source of all motion. The Stoics postulated the corporeal God, which is the intelligent designer of the world. Marion Durand, Simon Shogry, and Dirk Baltzly, "Stoicism". *The Stanford Encyclopedia of Philosophy* (Spring 2023 Edition). Edited by Edward N. Zalta and Uri Nodelman, the second section. URL: https://plato.stanford.edu/archives/spr2023/entries/stoicism/ (12.2.2025).

103 Stuart Gillespie and Donald Mackenzie, "Lucretius and the Moderns". *The Cambridge Companion to Lucretius*. Edited by Stuart Gillespie and Philip Hardie. Cambridge University Press, Cambridge 2007, *passim*. DOI: https://doi.org/10.1017/CCOL9780521848015.020.

104 Gillespie and Mackenzie 2007, 307.

105 For more on this topic, see Lezra and Blake 2016.

106 For more on this, see David Konstan, "Lucretius the Physicist and Modern Science". *Lucretius and Modernity*. Edited by Jacques Lezra and Liza Blake. Palgrave Macmillan, London 2016, 61. DOI: https://doi.org/10.1007/978-1-137-56657-7_4.

107 Cf. Lucr. 1.483–635.

of properties; second, he offers a frame of reference for a physical cosmology by his atomism since the celestial bodies and phenomena can only come into existence by the interaction of atoms, thus all objects in the sky are physical (i.e., perceptible) and material (i.e., consisting only material parts); third, since Lucretius argues that the Earth and stars have emerged by random atomic interaction, he offers a physical cosmogony, in which the origin of the world is explained materially and naturally; fourth, according to Lucretius' stellar astronomy, stars consist of atoms and have certain properties and behaviour, although he admits that he does not always know their exact functions; fifth, concerning solar astronomy, the Sun is a special kind of powerful celestial object for Lucretius, but he is, similarly, hesitant about its exact properties. The Sun may be a solid or a loose continuous compound body, or it may have discontinuous and cyclical existence, as is explained above. In summary, Lucretius discussed astronomical things within an empiricist, materialistic and atomist framework, and his astronomical views correspond with the five branches of modern astronomy in the above-mentioned way.

The claim that Lucretius is an ideological forerunner of modern astronomy can be supported by the following points. First, his approach is, I claim, both *scientific*, since he endorses experience, empirical observation and the study of nature, and *critical* because he accepts aporic results, refutes mythic and supernatural explanations and does not make assumptions or extrapolations easily; such as in the case of celestial bodies – these are perceptible but hard to explain in detail, when no modern scientific apparatus is available. Therefore, I conclude that there are weighty grounds to see Lucretius as an early *naturalist*. Concerning this possibility, Baker, Gilles Deleuze and Esko Valtaoja have interpreted that Lucretius represents naturalism in one way or another.[108]

Second, Lucretius argues that there are many worlds similar to Earth. Accordingly, life on Earth is not unique. Valtaoja points out in the astronomical context that this view is, in fact, topical.[109] Namely, in the light of the recent scientific understanding, extra-terrestrial life is probable due to the universality of physical and chemical elements of biological life (however, extra-terrestrial life is infrequent in the universe because of the rarity of auspicious conditions for biological life). Furthermore, if a Multiverse exits (i.e., the whole of the parallel universes), then biological life would be much more common supposing many universes are like our universe, which is favourable to life.[110]

Third, David Webb clarifies that Lucretius' theory about the swerving atoms allows the basis for the radical possibility that natural laws are law-like regularities, yet

[108] Baker 2007; Deleuze 2017; Esko Valtaoja, *Avaruudesta*. Tähtitieteellinen yhdistys Ursa, Helsinki 2019, 7, 8.

[109] Valtaoja 2019, 142, 143.

[110] For more on the theory of multiverse, see Hawking and Mlodinow 2010, *passim*; Valtaoja 2019, 144–153.

fundamentally random, and thus not universal but local regularities.[111] Interestingly, the origin and character of natural laws are central subjects in modern cosmology. For example, Stephen Hawking and Leonard Mlodinow consider that

> *[w]e seem to be at a critical point in the history of science, in which we must alter our conception of goals and of what makes a physical theory acceptable. It appears that the fundamental numbers, and even the form, of the apparent laws of nature are not demanded by logic or physical principle. The parameters are free to take on many values and the laws to take on any form that leads to a self-consistent mathematical theory, and they do take on different values and different forms in different universes. That may not satisfy our human desire to be special or to discover a neat package to contain all the laws of physics, but it does seem to be the way of nature.*[112]

Thus, Lucretius' theory of indeterministic atoms enables the possibility for different kinds of natural laws. In which case, the theory may describe the characteristic of fundamental reality (supposing there can be different natural laws altogether[113]).

Conclusion

There is a basis for the claim that Lucretius is an ideological forerunner of modern astronomy, despite his many views and ideas about astronomy being obscure or incorrect. The reasons for the claim are as follows: first, Lucretius' thoughts have influenced scientists and astronomers, as shown by the modern research; second, since Lucretius' astronomical views and the branches of astrophysics, physical cosmology, physical cosmogony, stellar astronomy and solar astronomy of modern physical astronomy agree, his materialism can be seen in this respect as a forerunner; third, Lucretius' represents naturalism quite evidently, which is a modern scientific standpoint (concerning this, he endorses atomism and natural explanations, refutes supernatural explanations and divine causal powers, demands scientific and critical attitude and, as a bonus, allows aporic results); fourth, Lucretius' arguments about many worlds and extra-terrestrial life are compatible with the current understanding and theories about the universe; fifth, Lucretius' theory about the swerving atoms is compatible with the possibility that there are different worlds (or universes) with different kinds of natural laws.

---

111 David Webb, "On Causality and Law in Lucretius and Contemporary Cosmology". *Contemporary Encounters with Ancient Metaphysics*. Edited by Abraham Greenstine and Ryan Johnson. Edinburgh University Press 2017, 254–269. DOI: https://doi.org/10.1515/9781474431194-017.

112 Hawking and Mlodinow 2010, 113, 114.

113 For more on this subject, see Hawking and Mlodinow 2010, second chapter.

Based on the recent studies on the influence of Lucretius' DRN, which I have discussed above, I conclude that Lucretius undeniably has a noteworthy status in the development of modern natural sciences including astronomy. His thoughts have had various influences at different times and have affected at least indirectly the development of early modern astronomy through Bruno, Gassendi, Harriot and Newton, to name a few. To be precise, at a minimum the DRN has inspired many astronomers. However, Epicurus and Lucretius were not, of course, the only important figures in the early modern period because there were many other classical authorities who were influential in those times, not to mention ancient physicist and astronomers. I claim, therefore, that Lucretius' DRN is for many reasons a special work in the history of astronomy. However, it is not unprecedented.

Abstract

The modern astronomic picture of the universe is astonishing: outer space is filled with a myriad of planets, stars, galaxies, and black holes, and it seems that the universe has come into existence through a primordial explosion. The modern image has required highly developed scientific devices, such as powerful telescopes. In antiquity, the description of the celestial world was established by ordinary observation of the sky, empirical reasoning and primitive astronomical devices. Titus Lucretius Carus, a poet, philosopher and an adherent of Epicureanism in the late Roman period, favoured experience and empirical reasoning. Although he is not an astronomer and propounds incorrect, obsolete, and unclear astronomical views, I argue in this article that he is an ideological forerunner of modern astronomy. Specifically because (1) his work *De rerum natura* was a source of inspiration for natural scientist especially in the early modern period, (2) his astronomical views and modern astronomy have points of contact and (3) he discusses matters, which are topical in modern astronomy.