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ANAXAGORAS ON THE LIGHT AND PHASES OF THE MOON*

Introduction

In the previous paper, "Anaxagoras on the Milky Way and Lunar Eclipses",[1] I stated that two different theories about the shadow of the earth have been attributed to Anaxagoras. According to the first theory, the shadow of the earth was responsible for the phenomenon of the Milky Way, while according to the second, the shadow of the earth caused eclipses of the moon. I argued that these two theories are irreconcilable. I also argued that Anaxagoras' explanation of the Milky Way, which was underpinned by the notion that lights shine brighter in the dark, is better attested than his alleged adoption of the correct explanation of lunar eclipses and harmonizes better with the rest of his astronomical ideas, especially that of a flat earth. My first conclusion was that Anaxagoras could not have discovered or held the theory that lunar eclipses were caused by the shadow of the earth. My second conclusion was that the idea of one or more invisible bodies between the moon and the earth, which according to the doxography was merely additional to the true explanation, in fact must have constituted Anaxagoras' one and only explanation of lunar eclipses. I suggested that the source of the misunderstanding was probably a text in Aristotle that mentions some Pythagoreans and the notion of invisible bodies causing lunar eclipses. My interpretation did not, however, address one serious remaining problem, which does not concern eclipses but the light and phases of the moon. During the month, the moon exhibits phases, from new moon to waxing crescent, first quarter, waxing gibbous, full moon, and then back to waning gibbous, last quarter, waning crescent, and new moon. In the present paper, I will investigate how Anaxagoras could have explained these phenomena.

My method of investigation in this and the previous paper is to start with the most reliably documented aspects of Anaxagoras' astronomy

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[1] Couprie 2017, 181–207.

and to see whether it is possible, from that basis, to interpret the rest of the relevant doxography and to achieve a coherent overall understanding of his astronomical thoughts. As regards the subject of this paper, the most important certainty we have on Anaxagoras' astronomical thinking is that he believed the earth to be flat. Another of his best documented astronomical ideas is that the Milky Way was the band of stars not illuminated by the sun. Finally, it is well documented that he thought the heavens were inclined in relation to the flat earth's surface, that the heavenly bodies were relatively close and smaller than the earth,[2] and that the sun and the stars were of a fiery, stony nature.[3] A main presupposition of this paper's method is the conviction that the ideas of Presocratic thinkers like Anaxagoras form a consistent whole; they are not a mere collection of notions that might be overtly contradictory. A further methodological tool is to remember that some ancient ideas that may look strange to our eyes may nonetheless have made sense within the contemporary context. In the case of Anaxagoras, this includes observing the heavenly phenomena with the conviction that the earth is flat. A final methodological tool, akin to the previous one, consists of avoiding to read into the ancient records notions to which we are accustomed, the so-called anachronistic trap. In this paper, we will meet a typical example in expressions like "the moon receives its light from the sun". A special kind of this mistake, which the Greek doxographers were fond of, is to accredit the ancient Greek philosophers with being the first to have offered a given theory. I think this attitude is still not absent in the interpretative work of some modern scholars. Take, for instance, the recent claims that Parmenides and Anaxagoras were the first advocates of "heliophotism" – the idea that the moon is illuminated by the sun – and that Anaxagoras was the discoverer of the true cause of lunar eclipses, namely that the moon is eclipsed when the earth blocks the sun's light. The danger of such interpretations is that they easily tend to disregard data that do not concur with them. I must confess that I made this kind of mistake in what I wrote some years ago about Anaxagoras, eclipses and the moon's light. This means that I must withdraw most of what I wrote on page 177 of my *Heaven and Earth in Ancient Greek Cosmology*.[4] The present paper, along with "Anaxagoras on the Milky Way and Lunar Eclipses", offers

[2] The arguments are enumerated in my previous paper.

[3] The moon is also stony, but whether or not (and to what degree) it has a fiery nature is one of the topics investigated in this paper. As stated in my previous paper, I think an exception must be made for the so-called invisible bodies below the moon; they are obviously not fiery, and it can be argued that they are not stony either.

[4] Cf. Couprie 2011, 177.

my current ideas on these subjects. The studies that most provoked my thinking about Anaxagoras' astronomy were Dennis O'Brien's fifty-year-old paper "Derived Light and Eclipses in the Fifth Century"[5] and Daniel Graham's recent and innovative book *Science Before Socrates*,[6] even and especially when I disagree (from time to time fundamentally) with them.

Two preliminary reasons to doubt that Anaxagoras could have given the correct explanation of the moon's phases

The standard interpretation of Anaxagoras' explanation of the phases of the moon is that they display the shapes of the portion of the moon illuminated by the sun as seen by an observer on earth. The moon's phases are usually illustrated with the help of a diagram like this one:

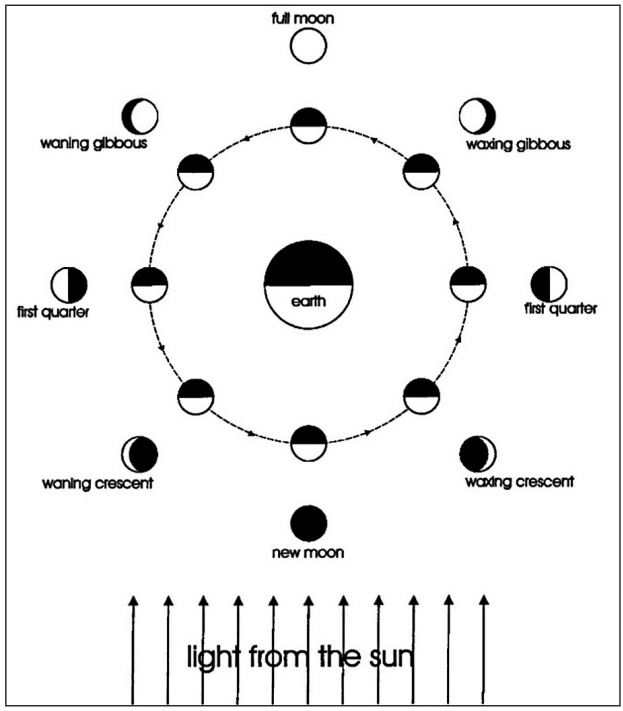

Fig. 1. The standard explanation of the phases of the moon[7]

[5] O'Brien 1968.
[6] Graham 2013.
[7] A similar diagram in Graham 2013, 98 Figure 3.1.

There are at least two reasons to doubt whether Anaxagoras could have understood the phases of the moon as we do. The first is that our understanding of the shapes of the moon's phases requires that the moon is spherical. Anaxagoras, in all probability, thought of the heavenly bodies as flat disks like the earth.[8] Several texts referring to his ideas state that he thought the moon had hills, and ravines, just like the earth, which he conceived of as flat.[9] Plato says that, according to Anaxagoras, the moon is earth (*Apol.* 26 D 1 = DK 59 A 35). Another report bluntly states the following:

A. *Schol. in Apoll. Rhod.* 1. 498 = DK 59 A 77

> This same Anaxagoras says that the moon is a flat place (χώρα πλατεῖα) (…).[10]

If the phases were caused by the light of the sun, the moon as a flat disk would always show full, except at new moon, as Cleomedes (2. 5. 37–40) argued: "So if the moon's shape were flat, it would be full as soon as it passed by the sun after conjunction, and would remain full until [the next] conjunction".[11] This can be elucidated by means of a picture:

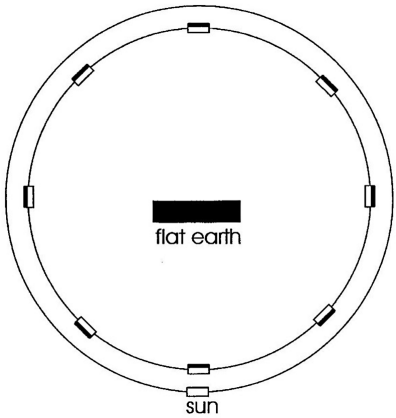

Fig. 2. The moon as a flat disk does not show phases (approximately to scale)

[8] An indication could be that Empedocles still believed that the moon does not have the form of a sphere but that of a disk, as is reported by Plut. *Quaest. Rom.* 288 b = DK 31 A 60, and Diog. Laert. 8. 77 = DK 31 A 1 (77).

[9] Cf. Diog. Laert. 2. 8 = DK 59 A 1 (8).

[10] Graham 2013, 251 n. 21, calls this text a "testimony of uncertain pedigree and value". It is, though, the only straightforward text we have on Anaxagoras and the shape of the moon.

[11] In: Bowen–Todd 2004, 146–147.

In much more recent times, Heath wrote, "Whether Anaxagoras reached the true explanation of the phases of the moon is doubtful. (…) it required that the moon should be spherical in shape; Anaxagoras, however, held that the earth, *and doubtless the other heavenly bodies also*, were flat. And accordingly, his explanation of the phases could hardly have been correct".[12] In other words, conceiving of the moon as flat, Anaxagoras could not have explained the phases of the moon as caused by the light of the sun.

Graham, convinced that Anaxagoras had discovered that the moon was illuminated by the sun, argues the other way around and claims that Anaxagoras must have held that the moon was spherical because, otherwise, his understanding of the phases of the moon would have been impossible.[13] Yet there exists no report that confirms that Anaxagoras conceived of the moon as spherical.[14] As far as I know, Aristotle was the first to state that the moon's spherical shape could be deduced from its phases (*Cael.* 291 b 18–23 and *An. post.* 78 b 4–12). In this paper, I take up the challenge contained in Graham's words: "Couprie (…) holds that Anaxagoras' moon is disk-shaped, which makes his understanding of the phases of the moon impossible".[15] Although I think Anaxagoras believed the moon to be a flat disk, like the earth, the two possible explanations given at the end of this paper for the moon's phases in Anaxagoras' astronomy are independent of the moon's shape.

The second reason why Anaxagoras could not have explained the phases of the moon as we do is found in his explanation of the Milky Way. Aristotle and several other sources assert that according to Anaxagoras (and Democritus) the phenomenon of the Milky Way results from the shadow of the earth, cast upon the stars by the sun. The optical theory behind this is that lights glow brighter in the dark. This explanation of the Milky Way is strange and definitely wrong, but it is one of the best attested of Anaxagoras' astronomical theories and I know of no author who questions its authenticity or has attempted to argue it away. The band

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[12] Heath 1913, 80–81, my italics. See also Tannery 1887, 278.

[13] See Graham 2013, 99: "the moon's shape is a *function* of its angular distance to the sun. This is what heliophotism, taken as a hypothesis, predicts".

[14] Graham's argument does not always seem consistent. He states that "if Parmenides fully understood heliophotism, he would see that the moon provides a model for all the heavenly bodies. (…) Heavenly bodies, including *the earth*, *must*, by parity of reasoning, *be spherical*" (Graham 2013, 114, my italics). Elsewhere, he declares that "it is important to notice that Anaxagoras seems to grasp *all the implications* of heliophotism" (*ibid.*, 124, my italics). However, Anaxagoras does not seem to have grasped *all* of the implications of heliophotism, since he believed that the earth is flat.

[15] Graham 2013, 254 n. 28.

of the Milky Way is inclined by about 60 degrees in relation to the ecliptic. The moon's monthly path among the stars, in its turn, is inclined about five degrees in relation to the ecliptic. This means that the moon regularly passes through the Milky Way, where it is visible and shows phases. If Anaxagoras really believed that the moon's light is reflected light from the sun, it is hard to see how he could have explained the visibility of the moon and its phases when the moon is in the Milky Way, where it does not receive light from the sun (see Fig. 3).

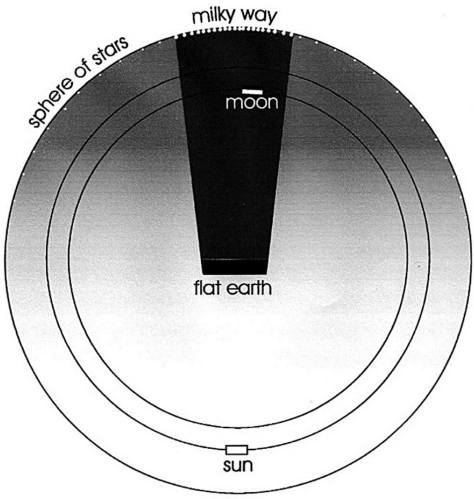

Fig. 3. The full moon in the shadow of the earth
(approximately to scale)

On the one hand, O'Brien underestimates the problem when he writes that "the shadow of the earth must therefore be *a fairly narrow band*, which would *occasionally* obscure the light of the moon", but on the other hand he overestimates the problem when he writes that "the moon would be eclipsed *night after night*".[16] The width of the Milky Way in the night sky is roughly 30 degrees, through which the moon passes twice per month for several nights. The suggestion that this problem may have escaped Anaxagoras' attention is hardly convincing, since it concerns a frequently recurring phenomenon that is simple to observe.

Except for one item regarding the moon's "monthly concealments" in Stobaeus' version of Aëtius, to be discussed below (text L), there exists

[16] See O'Brien 1968, 125 and 124; my italics.

no straightforward evidence of Anaxagoras' explanation of the phases of the moon. Anaxagoras' views on the phases of the moon must, of course, have been closely linked to his ideas about the nature of the moon's light, of which we have several reports. Aëtius' statements on the subject of the moon's light are scattered over four chapters. We will discuss them in the next sections and return to the moon's phases at the end of this paper.

Aëtius 2. 25 and analogous texts

The first relevant chapter is the particularly well-attested[17] chapter 2. 25, called "On the substance (περὶ οὐσίας) of the moon".[18] The item on Anaxagoras says:

B. Aët. in Ps.-Plut. *Plac.* 2. 25. 9 = DK 59 A 77

> Anaxagoras and Democritus [declare that it is] an inflamed solid mass (στερέωμα διάπυρον), which has in it plains and mountains and ravines.[19]

Anaxagoras' conception of the moon's substance was not exceptional. Almost all philosophers mentioned in Aëtius 2. 25 held that the moon was, in one way or another, fiery. Anaximander believed it to be "a wheel with a hollow rim and full of fire (πυρὸς πλήρη)"; Anaximenes, Parmenides, and Heraclitus that it was "fiery (πυρίνη)"; Xenophanes, "an inflamed condensed cloud (νέφος πεπυρωμένον)"; Posidonius and most of the Stoics, "combined out of fire and air (μικτὴ ἐκ πυρὸς καὶ ἀέρος)"; Cleanthes, "fire-like (πυροειδῆ)"; Empedocles, "compacted air, fixed by fire (πεπηγότα ὑπὸ πυρός)"; Plato, "formed for the most part from fiery material (τοῦ πυρώδους)"; Diogenes, "a sponge-like ignited mass (ἄναμμα)"; and Berosus, "half-inflamed (ἡμιπύρωτος)". The only exceptions are Thales ("earthy"), Aristotle ("formed from the fifth body"), Ion ("partly glass-like and transparent, partly opaque"), and Pythagoras ("mirror-like").[20] It should be noted that in the item on Anaxagoras no restriction or further qualification is added, unlike Posidonius, Cleanthes, Empedocles, Plato, and Berosus. That the moon, according to Anaxagoras, consisted of inflamed material is confirmed by Origen:

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[17] For this qualification, see Mansfeld–Runia 2009, 572.

[18] See Diels 1879, 355–357; Mansfeld–Runia 2009, 572–587.

[19] Trans. Mansfeld–Runia.

[20] Assuming that Pseudo-Plutarch's κατὰ τὸ πυροειδὲς σῶμα must be replaced by Stobaeus' κατοπτροειδὲς σῶμα. See Diels 1879, 357 n. 1 and Mansfeld–Runia 2009, 381 (c).

C. Origen. *c. Cels.* 5. 11, not in DK

> (…) nor will we call the sun, moon, and stars inflamed clumps (μύδρον διάπυρον) as Anaxagoras did.[21]

Achilles Tatius' chapter "About the Moon" does not mention specific names, but one statement is equivalent to that of Pseudo-Plutarch on Anaxagoras and Democritus:

D. Ach. Tat. *Introd.* 21 = DK 59 A 77

> Some (say the moon is) a solid ignited earth containing fire (ἕτεροι δὲ γῆν πεπυρομένην στερέμνιον ἔχουσαν πῦρ).

In the same sense, Hippolytus relates Anaxagoras' beliefs as follows:

E. Hippol. *Refut.* 1. 8. 6 = DK 59 A 42 (6)

> The sun and moon and all the heavenly bodies are fiery stones (λίθους ἐμπύρους) carried around by the revolution of the aether.

It is notable that in Aëtius' chapter 2. 20 "On the substance of the sun" the same or similar words are used in reference to the sun. In the case of Anaxagoras, almost the same characterizations are used in relation to the moon ("an inflamed solid mass", στερέωμα διάπυρον) as to the sun ("an inflamed clump or rock", μύδρος ἢ πέτρος διάπυρος).[22] Hippolytus calls both the sun and the moon "inflamed stones" (λίθοι ἔμπυροι) (text E). These texts leave no doubt that, according to Anaxagoras, the moon was an inflamed solid body like the sun and the stars. The most obvious interpretation is that these qualifications also describe the moon's light: the moon is fiery and shines with its own light. This seems to exclude the option that Anaxagoras considered the moon's light to be the reflection of the light of the sun. If we take seriously the proposition that, for Anaxagoras, the moon was a fiery, inflamed body – and I do not see any reason why we should not – this is another reason why Anaxagoras could not have understood the phases of the moon as we do. If these were the only texts about Anaxagoras and the light of the moon, I think nobody would ever have thought about ascribing to him "heliophotism" in the sense of light reflected from the sun. But let us see what the other texts have to say.

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[21] See Gershenson–Greenberg 1964, 150 (268).

[22] Aët. in Ps.-Plut. *Plac*. 2. 20. 6.

Aëtius 2. 28 and analogous texts

Aëtius' second relevant chapter is 2. 28, "On the lights (φωτισμῶν) of the moon".[23] In Stobaeus' version, Anaxagoras is mentioned as one of the successors of Thales:

F. Aët. in Stob. *Anth.* 1. 26 = DK 59 A 77

> Thales was the first to say that it is illuminated by the sun (ὑπὸ τοῦ ἡλίου φωτίζεσθαι).
> Pythagoras, Parmenides, Empedocles, Anaxagoras and Metrodorus (declare) likewise.

Instead of these lines Pseudo-Plutarch writes this:

G. Aët. in Ps.-Plut. *Plac.* 2. 28. 5

> Thales and his successors (οἱ ἀπ' αὐτοῦ) (declare that) it is illuminated by the sun.[24]

Mansfeld and Runia suppose that Pseudo-Plutarch shortened the original series of names that has been preserved by Stobaeus.[25] Assuming that they are right, the phrase "the moon is illuminated by the sun" seems to contradict what we found in Aëtius' chapter 2. 25: the moon is of a fiery substance. Another possibility is that Stobaeus felt obliged to offer his own exemplification of "Thales' followers". Be that as it may, Hippolytus also reports on Anaxagoras, a few lines after his remark that the sun and moon are fiery bodies:

H. Hippol. *Refut.* 1. 8. 8 = DK 59 A 42 (8)

> The moon does not have its own (μὴ ἴδιον ἔχειν) light, but [gets it] from the sun.[26]

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[23] See Diels 1879, 358–359; Mansfeld–Runia 2009, 601–612. They translate: "On the illuminations of the moon".

[24] See Diels 1879, 358.

[25] Cf. Mansfeld–Runia 2009, 603.

[26] Trans. Graham. I put the words "gets it" between brackets, because there is no verb in this clause.

And Plutarch writes:

I. Plut. *De facie* 929b = DK 59 B 18

> A favorable reception was given to our friend's exposition, which presented the Anaxagorean theory that the sun imparts (ἐντίθησι) to the moon its brightness (τὸ λαμπρόν).[27]

The oldest and at the same time most enigmatic record of Anaxagoras' thought on the moon's light is in Plato's dialogue *Cratylus*, when he discusses a curious etymology of the word σελήνη:

J. Plat., *Crat.* 409a7–b10 = DK 59 A 76

> Socr.: It seems to show that the view he has recently advocated – that the moon gets (ἔχει) its light from the sun – is quite ancient (παλαιότερον). (…)
> Socr.: This light (φῶς) around (περί) the moon is always (ἀεί) new (νέον) and old (ἔνον), if the followers of Anaxagoras are right. For as the sun is always traveling around the moon in a circle, presumably (που) it always sheds (ἐπιβάλλει) new light (νέον) on it, while the old (ἔνον) of the previous month persists (ὑπάρχει).[28]

I suppose that the somewhat clumsy expression "light around the moon" in text J simply refers to the light we observe on the moon. In text L, the word περιλαμπομένην is used in the same sense. The words "the sun is always traveling around the moon in a circle" are a somewhat strange way of saying that the sun and moon are in opposition once per month and are in conjunction half a month later. The words "the old light of the previous month persists" seem to have to do with the moon's phases. But why is "the moon *always* new and old"? Even more interesting is the question of the precise meaning of "the moon gets its light from the sun". Usually, this is assumed to mean that the moon reflects the light of the sun, which seems to contradict the contents of texts B – E. These problems will be discussed in later sections of this paper. Plato's text is referred to by Plutarch:

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[27] My trans. Curd 2010, 27, translates "the sun places the light in the moon".
[28] Trans. Graham, adapted.

K. Plut. *De E in Delph.* 15, not in DK

> (…) he said that Anaxagoras was embarrassed by the name of the moon, since he tried to claim as his own some very ancient opinion in regard to its illumination (περὶ τῶν φοτισμῶν). Has not Plato said this in the *Cratylus*?[29]

At first sight, these texts (F–K) seem to contradict what was said in the previous section (texts B–E). It is especially hard to understand how Hippolytus can state both that the moon is a fiery stone (text E) and that the moon does not have its own light (text H).

Aëtius 2. 29 and analogous texts

The third relevant chapter of Aëtius is 2. 29, "On the eclipse (περὶ ἐκλείψεως) of the moon".[30] Four items in this chapter, rather surprisingly, also contain opinions (of Anaximander, some unnamed youngers, Xenophanes, and Anaxagoras) on the phases of the moon. Anaxagoras is mentioned in Stobaeus' version of an item, part of which I have already discussed in my previous paper "Anaxagoras, the Milky Way, and Lunar Eclipses". The lines relevant to this paper read as follows:

L. Aët. in Stob. *Anth.* 1. 26. 3 = DK 59 A 77

> Thales, Anaxagoras, Plato, and the Stoics agree with the astronomers that it (the moon) produces the monthly concealments (τὰς μηνιαίους ἀποκρύψεις) by following the sun's path and being illuminated (περιλαμπομένην) by it (…).[31]

In Pseudo-Plutarch's version, however, Anaxagoras is not mentioned:

M. Aët. in Ps.-Plut. *Plac.* 2. 29. 6

> Plato, Aristotle, and the Stoics agree with the astronomers that it produces the monthly concealments by following the sun's path and being illuminated by it (…).[32]

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29 Trans. Babbit 1999.
30 See Diels 1879, 359–360; Mansfeld–Runia 2009, 613–623.
31 My trans.
32 See Diels 1879, 360.

In their reconstructed text, Mansfeld and Runia insert Aristotle, who appears only in Pseudo-Plutarch's version of this passage.[33] In my previous paper, I argued that, from the viewpoint of astronomical conceptions, Pseudo-Plutarch's enumeration, "Plato, Aristotle, the Stoics and the astronomers", all of whom were defenders of a spherical earth, makes more sense than Stobaeus' version. Strictly speaking, the words "monthly concealments" in this text allude only to the new moon, but one may suppose that by implication, the moon's phases are meant as well (reading something like "the moon's partial or total concealments during the month").

Hippolytus makes perfectly clear that by the term "illuminations", he means the correct interpretation of the moon's phases, when he straightforwardly states the following:

N. Hippol. *Refut.* 1. 8. 10 = DK 59 A 42 (10)

> He *first correctly explained* (ἀφώρισε πρῶτος) eclipses and *illuminations* (φωτισμούς).[34]

As we have seen (text E), Hippolytus said that, according to Anaxagoras, the moon was a fiery stone and also (in text H) that the moon did not have its own light but got it from the sun. Gershenson and Greenberg rightly comment, "He nowhere explains how (…) these statements [in texts E, H, and N] are to be reconciled".[35] This statement can be generalized as the question of how to reconcile what is said in Aëtius' chapters 2. 28 and 2. 29 with what is said in chapter 2. 25.

Two other items in Aëtius' chapter 2. 29 deserve our attention. One of them is interesting in the context of our enquiry, although Anaxagoras is not mentioned. In Pseudo-Plutarch's version, it reads as follows:

O. Aët. in Ps.-Plut. *Plac.* 2. 29. 4

> The youngers (οἱ δὲ νεώτεροι) [say that the phases of the moon appear] in accordance with the spreading of a flame (κατ᾽ ἐπινέμησιν φλογὸς) that is kindled little by little in an orderly manner (κατὰ μικρὸν ἐξαπτομένης τεταγμένως),[36] until it produces the complete full moon, and analogously diminishes (μειουμένης) again until the conjunction [of the sun and the moon], when it is completely quenched (σβέννυται).[37]

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[33] Mansfeld–Runia 2009, 622.

[34] Trans. Graham, slightly adapted; my italics.

[35] Gershenson–Greenberg 1964, 339.

[36] Mansfeld–Runia 2009, 622 translate "that slowly catches alight", which says pretty much the same.

[37] My trans. Cf. Diels 1879, 360 and DK 58 B 36.

Where Pseudo-Plutarch simply reads "the youngers", Stobaeus' version says, "there are some of the youngers in whose opinion…" (τῶν δὲ νεωτέρων εἰσί τινες οἷς ἔδοξε). After the words "the youngers", Mansfeld and Runia, who follow Stobaeus' version, put "members of the school" between brackets, and Huffman adds "Pythagoreans", but Dumont notes, "il n'est pas sûre que ses modernes soient eux aussi des pythagoriens".[38] Mansfeld and Runia read, "in whose opinion (an eclipse takes place)", but remark a few pages earlier, "note again the confusion between eclipses and phases".[39] Huffman reads, "who thought that [the phases of the moon?]" and Dumont adds, "La seconde explication (i.e. that in text O) rend compte des phases de la lune". According to me, this text is clearly not about eclipses but about the phases of the moon, as indicated by the sequence "full moon – until the conjunction". I added, between square brackets, "of the sun and the moon". According to Graham, "the most important feature of this account is that it seems confused: what the sentence describes is not a lunar eclipse – which happens in hours, not in the course of a month – but rather the phases of the moon".[40] In my view, the sentence is not confused but placed under the wrong heading.[41] At the end of this paper, I will return to its interpretation. "The conjunction" means the conjunction of the new moon with the sun.

Aëtius 2. 30 and analogous texts

The fourth relevant chapter is 2. 30, "On its [sc. the moon's] appearance (περὶ ἐμφάσεως) and why it appears to be earthy".[42] The item on Anaxagoras reads as follows:

P. Aët. in Stob. *Anth.* 1. 26 = DK 59 A 77

> Anaxagoras (declares the appearance of the moon is caused by) the unevenness of its composition on account of cold being mixed together with the earthy, the moon having some parts that are high, others that are

[38] Mansfeld–Runia 2009, 622; Huffman 1993, 237; Dumont 1988, 581 and 1405 n. 5 at p. 581.

[39] Mansfeld–Runia 2009, 618.

[40] Graham 2013, 196–197.

[41] For an analysis of Aët. 2. 29, see Bakker 2013, who argues that "two chapters have been conflated, the first dealing with the phases of the moon, while only those at the end deal with lunar eclipses" (Bakker 2013, 682).

[42] See Diels 1879, 361–362; Mansfeld–Runia 2009, 624–634. Gershenson–Greenberg 1968, 119 (172) translate: "Concerning the reflection of light from the moon", which is certainly not right.

> low, and others that are hollow. Moreover, (he declares that) the dark (τὸ ζοφῶδες) has been mixed in with the fire-like (παραμεμῖχθαι τῷ πυροειδεῖ), the effect of which causes the shadowy (τὸ σκιερόν) to appear; for this reason, the heavenly body is called "falsely appearing" (ψευδοφανῆ).[43]

Pseudo-Plutarch's version is much shorter:

Q. Aët. in Ps.-Plut. *Plac.* 2. 30. 2

> Anaxagoras (declares the appearance of the moon is caused by) the unevenness of its composition on account of cold being mixed together with the earthy, because (γάρ) the dark has been mixed in with the fire-like. For this reason, the heavenly body is called "falsely appearing" (ψευδοφανῆ λέγεσθαι).[44]

Mansfeld and Runia state that, in Pseudo-Plutarch's version, "the information about the unevenness of its surface is deleted".[45] I think it is also possible that Stobaeus inserted some clarifying text, freely borrowed from Aëtius' chapter 2. 25 (cf. text B). Pseudo-Plutarch's text makes clear, by means of the word γάρ, that the words "the cold is mixed with the earthy" are intended to mean the same as "the dark is mixed with the fire-like". Apparently, the dark spots on the moon must be considered as places that are less hot; this is a kind of mitigation of the fiery moon in Aëtius' chapter 2. 25. 9 (text B). As far as I can see, the issue of texts P and Q is the light and dark spots on the moon, or "the face on the moon". The same is the case with the other texts in Aëtius' chapter 2. 30, as its title, "On its appearance and why it appears to be earthy", indicates.

The manuscripts of Plutarch have the variants ψευδοφαῆ and ψευδοφανῆ. I followed Mansfeld and Runia's reading ψευδοφανῆ and their translation translation "falsely appearing".[46] The dictionary has for both terms "shining with false, i.e. borrowed, light",[47] but in texts P and Q, the issue is not whether the moon borrows its light from the sun but what the surface of the moon looks like.[48] Whatever this word may indicate,

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43 Trans. Mansfeld–Runia, slightly adapted.

44 Trans. Mansfeld–Runia.

45 Mansfeld–Runia 2009, 626.

46 See Mansfeld–Runia 2009, 628, n. 514; LSJ s.v. ψευδοφαής.

47 LSJ s.v. ψευδοφαής.

48 The term ψευδοφαής is used by Diog. Laert. 2. 1 in his account on Anaximander (DK 12 A 1 (1)), but DK (81 note at lines 11 and 12) comment: "das Theophrastexcerpt wohl von Anaxagoras fälschlich übertragen". With the exception of Dumont 1988, 22,

it does not have to do with the phases of the moon but with "the face on the moon", according to the title of Aëtius chapter 2. 30. The last lines are a duplicate with the text on Parmenides, two items further down.[49] Although ψευδοφανής fits nicely into a hexameter,[50] from Parmenides' poem (DK 28 B 14) we only know the word νυκτιφαές (shining by night). While Diels has argued that the word ψευδοφανῆ was falsely attributed to Parmenides, Mansfeld and Runia argue that it makes sense to reserve the last line of text Q for Parmenides. Nevertheless, they include it in their reconstructed text of Anaxagoras.[51]

Finally, a passage in Plutarch's biography of *Nicias* deserves our attention:

R. Plut. *Nic.* 23. 2 = DK 59 A 18

> Anaxagoras first put in writing in the clearest and boldest terms of all a theory concerning the radiant and shadowy (places) of the moon (περὶ σελήνης καταυγασμῶν καὶ σκιᾶς). This theory (λόγος), which was not ancient (παλαιός) or generally accepted, at this time still went about whispered in secret with caution rather than confidence among a few men.[52]

The interpretation of this cryptic text meets several difficulties. In the first place, Plutarch speaks, rather vaguely, about "a theory", and when he circumscribes it, he uses the word καταυγασμός that is not attested elsewhere, but is a verbal noun from καταυγάζω and translated in LSJ as "shining brightly". Then, he stresses that this theory is new and not generally accepted, using the words οὔτε παλαιός, which seems to be meant as a polemic against Plato (text J), who calls "quite ancient" (παλαιότερον) the view that the moon gets its light from the sun. Sometimes, however, the second sentence of text R is taken to be referring not to a theory but to Anaxagoras: "Anaxagoras himself was not venerated (παλαιός), nor was his doctrine the best known".[53] And finally, Plutarch calls this theory, whatever it was, both "written in the clearest and boldest terms" and "whispered in secret", which looks contradictory.

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compilations of texts of the Presocratics and handbooks usually omit this line or put it between brackets, following DK.

[49] Cf. Mansfeld–Runia 2009, 627–628.

[50] Cf. Mansfeld–Runia 2009, 628.

[51] Cf. Diels 1897, 110–112; Mansfeld–Runia 2009, 628 and 632. This paper is not the place to further discuss this question.

[52] Trans. Graham, adapted.

[53] Curd 2010, 85.

Plutarch's text can be interpreted in at least three different ways, two of which can be found in the translations and commentaries. Gershenson and Greenberg, like Panchenko, translate περὶ σελήνης καταυγασμῶν καὶ σκιᾶς as "of the phases of the moon" or "about the waxing and the waning of the moon.[54] Similarly, Gilardoni and Giugnoli translate: "una teoria sui periodi di illuminazione e di oscuramento della luna" and comment that the text is about "fasi lunari".[55] Curd translates this as "about the changing phases of the moon", but elsewhere, she explains that the text is about eclipses.[56] Graham writes that Plutarch's text is "concerning the illumination and shadow of the moon"[57] and adds: "Hippolytus agrees: He [Anaxagoras] first correctly explained eclipses and illuminations".[58] Laks and Most write, "concerning the illuminations and darkenings of the moon", and summarize elsewhere that this text is about the light of the moon.[59] According to Guthrie, the text is about lunar eclipses.[60] We may conclude that these recent commentators hesitate whether Plutarch is speaking about Anaxagoras' explanation of the phases of the moon or about his (alleged) theory of eclipses. In favor of the former interpretation may speak that the most natural translation of περὶ σελήνης καταυγασμῶν καὶ σκιᾶς seems to be that the theory was about the changing phases of the moon. In favor of the latter interpretation one can point at the context, in which Plutarch is speaking about eclipses. On the other hand, it sounds somewhat strange to introduce a theory of eclipses with the word "shining brightly" (καταυγασμός). Moreover, the text does not seem to speak about the shadow of the earth, as would be the case in an explanation of lunar eclipses, but about shadows (on the surface) of the moon. I would like to add a third possible interpretation, according to which the issue is the light and dark spots on the moon or "the face on the moon" (compare the word σκιᾶς in text R and τὸ σκιερόν in text P, which is clearly

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[54] Gershenson–Greenberg 1964, 128 (197); Panchenko 2002, 326. This is also Perrin's translation in the Loeb edition.

[55] Gilardoni–Giugnoli 2002, 61 and 254.

[56] Curd 2010, 85 and 211.

[57] Graham 2013, 138. Graham quotes this text first in a discussion about the relative ages of Empedocles and Anaxagoras and a second time when he summarizes the thesis of his book – that Parmenides and Anaxagoras were the heroes of early Greek astronomy (Graham 2013, 138 and 247) – but not when he discusses Anaxagoras' alleged heliophotism and states that he "seems to grasp all the implications of heliophotism" (*ibid.*, 124).

[58] Graham 2013, 138.

[59] Laks–Most 2016, 81 (D 38) and 27 (P 25 b).

[60] Guthrie 1965, 306.

about the moon's appearance). This interpretation would explain why the theory had to be "whispered in secret with caution": it had to do with Anaxagoras' blasphemous conception of the heavenly bodies as (fiery) stones, for which he was condemned.[61] To me, it is not clear, whether or not Laks and Most's interpretation that the text is about the light of the moon fits into one of these three interpretations or is meant as a separate one. In the end, I think we must conclude that Plutarch's text does not help us very much, because, whatever interpretation we prefer, it remains unclear what precisely the content of the "theory" in question is supposed to have been.

Problems and earlier suggestions to solve them

The texts collected in the previous sections show that the question of Anaxagoras' conception of the moon's light and phases is quite complicated. Sometimes evidence can be found in a chapter of Aëtius in which we would not expect it. It is not always immediately clear whether a text is about eclipses, about the waning and waxing of the moon, or about the light and dark spots on the moon.[62] The Presocratics did not always distinguish clearly between phenomena like the waning and waxing of the moon, eclipses, and the risings and settings of the heavenly bodies, in all of which a heavenly body disappears partially or totally for some time, to appear again at a later time.[63] In Aëtius' rendition of Xenophanes' cosmology, for instance, the setting of the sun is treated under the heading "On the eclipse of the sun".[64] Xenophanes seems to have classified settings, eclipses, and moon phases together as "quenchings".[65] In Anaximander's cosmological conception, the opening in the wheel of the moon closes partially or totally both during lunar eclipses and during the monthly phases of the moon.[66] We may wonder how far Anaxagoras had advanced on the path of distinguishing between settings, eclipses, and the waning and waxing of the moon.

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[61] Cf. Diog. Laert. 2. 12 = DK 59 A 1 (12).

[62] Cf. Mansfeld–Runia 2009, 661.

[63] Perhaps star occultations must be added to the list, but, as far as I know, there are no reports of star occultations in Greece from these early times. According to Stephenson 1997, 47, "tens of observations of this kind are described in Babylonian history, but East Asian history is replete with such reports".

[64] Cf. Aët. in Ps.-Plut. *Plac.* 2. 24. 4 = DK 21 A 41.

[65] Laks–Most 2016, 47, note at this testimony (D 34 in their numbering): "The important point for Xenophanes seems to have been disappearance in general".

[66] Cf. Hippol. *Refut.* 1. 6. 4 and 5 = DK 12 A 311 (4 and 5).

As regards the question of whether the moon has its own light or receives its light from the sun, there seems to be a crucial divergence between the accounts in Aëtius' chapter on the substance of the moon (*Placita* 2. 25) and those in his chapter on the illuminations of the moon (*Placita* 2. 28). In 2. 25 most Presocratics are said to hold that the moon is fiery in one way or another. Apart from the dubious testimonies on Thales (the moon is earthy) and Ion (the moon is partly glass-like and transparent, partly opaque) the only exception in this chapter is Pythagoras, who is said to have held that the moon is a mirror-like body (κατοπτροειδὲς σῶμα).[67] From this, we would expect that, in 2. 28, we would be told that almost all Presocratics held that the moon has its own light and that only Pythagoras held that the moon is illuminated by the sun, but this is not the case. Not only Pythagoras, but also Thales, Parmenides, Empedocles, Anaxagoras, and Metrodorus are mentioned as thinkers who said that the moon is illuminated by the sun (ὑπὸ τοῦ ἡλίου φωτίζεσθαι) (text F) whereas only Anaximander, Xenophanes, and the sophist Antiphon are said to have held that the moon has its own light (ἴδιον φῶς, ἰδιοφεγγής). Apparently, there is no consistent correlation between the notions of the moon "being fiery" and "having its own light". And in Stobaeus' version of chapter 2. 29,[68] not Pythagoras but Thales and Anaxagoras are mentioned as saying that the moon's monthly concealments result from its being illuminated (περιλαμπομένην) by the sun (text L). As regards Anaxagoras, this means that we must investigate whether the apparent contradiction between texts B–E (the moon is an inflamed solid mass) and texts F and H–N (the moon is illuminated by the sun) can be resolved within the context of Anaxagoras' astronomy.

The simplest solution, which is widely held, seems to be that the moon not only has its own light, which is sometimes visible as "earthshine" or as a "blood moon", but is also, except during a new moon, illuminated by the sun, whose light normally overpowers the moon's much fainter light. This was the stand taken, with some slight variations, by O'Brien, Wöhrle, Panchenko, and Graham, and also by myself some years ago.[69] The text that is usually referred to as evidence is that of Olympiodorus, of which I showed in my previous paper how confused it is:

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[67] Cf. Stob. *Anth.* 1. 26. 1; not in DK, but cf. Diels 1879, 357. For the reading κατοπτροειδὲς σῶμα also in Pseudo-Plutarch's corrupted text, see Mansfeld–Runia 2009, 581.

[68] See Diels 1879, 359–360; Mansfeld–Runia 2009, 613–623.

[69] Cf. Dreyer 1953, 32, n. 1; O'Brien 1968, 126–127; Wöhrle 1995, 245; Panchenko 2002, 329–331; Graham 2013, 131; Couprie 2011, 177.

S. Olympiodor. *In Arist. Meteor.* 67. 33, not in DK

> A third view is that of Anaxagoras and Democritus. They say the Milky Way is the proper light of stars not illuminated by the sun. For the stars (τὰ ἄστρα), he [sc. Aristotle] says, have their own light as well a light acquired from the sun. And the case of the moon makes this clear. For this has one kind of light of its own and another from the sun. *Its own light is coal-like, which the moon's eclipse shows us.* However, they say, not all the stars receive additional light from the sun and those which do not, compose the band of the Milky Way.[70]

O'Brien rightly comments that "the parallel with the moon seems to be Olympiodorus' own illustration (…). It would be wrong therefore to take Olympiodorus' words as positive evidence for Anaxagoras". Nevertheless, he suggests that "in this instance, Olympiodorus' idea seems to have a good chance of representing Anaxagoras' view".[71] Panchenko sees in this text "direct evidence that Anaxagoras assigned a double nature to lunar light".[72] He translates τὰ ἄστρα as "the luminaries",[73] which is definitely wrong here because the reference is to the explanation of the behavior of the stars within and outside of the Milky Way. Graham also reads this text as a confirmation that Anaxagoras believed in the double nature of the moon's light. He comments: "Anaxagoras (…) wanted to account for the light that is emanating from the moon even during its complete eclipse. The moon must have a natural source of light that is normally overpowered by its reflection of the sun's light".[74]

What these authors (and Olympiodorus in the first place) overlook is that, if the moon has its own source of light, this must also be visible when the moon is in conjunction with the Milky Way. When this happens, the rays of the sun cannot overpower the moon's light because the Milky Way is the consequence, according to Anaxagoras, of the earth's shadow, which implies that the moon's own light would shine brightly in the dark, just like the stars of the Milky Way. But since the moon's phases were thought to be due to its illumination by the sun, the moon's own light in the Milky Way would always be seen as a full moon. As noted earlier, it is hardly believable that this problem has escaped Anaxagoras' attention. The supposition that Anaxagoras' moon had a mixed light, one reflected from the sun and another of its own, does not, therefore,

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[70] Trans. Graham, Gershenson–Greenberg (last sentence), my italics.
[71] O'Brien 1968, 126.
[72] Panchenko 2002, 329.
[73] *Ibid*.
[74] Graham 2013, 131.

solve the problem of the explanation of the moon's light and phases in Anaxagoras' astronomy.

Most authors also bring up Plato's words in the *Cratylus* (text J) as evidence for this interpretation of Anaxagoras' ideas about the light and phases of the moon. In Panchenko's words: "If we take the Platonic words seriously, it follows that the moon not only shines by reflection, but also in some way absorbs and stores the light received from the sun".[75] Again, this does not solve the problem of the moon's phases twice a month during several nights when it is in conjunction with the Milky Way. Moreover, Plato's text does not speak of "reflection" but says, successively, that the moon gets (ἔχει) its light from the sun, that the light is around (περί) the moon, and that the sun always sheds (ἐπιβάλλει) new light on the moon. Ferguson explicitly maintains, "This is a theory of borrowed light, but it is not a theory of reflection".[76] This brings us to the fundamental ambiguity to be discussed in the next section.

Ambiguities

The question is, then, whether there might not be another explanation for the light and phases of the moon that would be compatible with Anaxagoras' other astronomical ideas (the Milky Way as caused by the earth's shadow, and the earth and the heavenly bodies as flat disks) and that would reconcile the texts attributing to him the view that the moon is an inflamed solid body with the texts that report him as saying the moon gets its light from the sun.

In a commentary on Empedocles, Ferguson wrote, " 'the moon has its light from the sun'. This apparently simple statement bristles with difficulties. (…) The actual words do not necessarily mean that the moon shines with *reflected* light; they are not incompatible with the idea that the moon is *kindled* by the sun".[77] O'Brien picked up this idea more specifically with regard to Anaxagoras: "The proper solution, I suggest, lies in breaking the (…) assumption: that derived light means reflected light. This is in fact a modern assumption, which was not shared in later antiquity".[78] We are easily tempted to interpret the words "the moon receives its light from the sun" in conformity with our modern conception of the moon reflecting the light of the sun, but we may question whether

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[75] Panchenko 2002, 329. See O'Brien 1968, 127; Wöhrle 1995, 246; Couprie 2011, 177; Graham 2013, 132.

[76] Ferguson 1968, 100.

[77] Ferguson 1968, 99. Cf. DK 31 A 30 (Ps.-Plut. *Strom.* 10).

[78] O'Brien 1968, 122.

this was as evident to the ancient Greeks as it is to us. In other words, this could be a case of the anachronistic fallacy at work.

We may even wonder whether a similar bias already affected the accounts of Presocratic conceptions in the doxography. In other words, the authors of these texts could have understood expressions like "the moon receives its light from the sun" as meaning "the moon reflects the light of the sun" in conformity with their acquaintance with the right explanation of the moon's phases. Additionally, it is important to note that the expression "the moon has its own light" is also ambiguous. It might imply that the light of the moon does not reflect the light of the sun, but it is not at odds with theories according to which the moon is ignited by the sun. Once the moon has received its light by being kindled by the sun, this light could be said to be the moon's own light. In the same sense, we say that a candle is ignited by a match but, once kindled, has its own light.

In the context of Anaxagoras' astronomical ideas, it is highly plausible that expressions like "the moon receives its light from the sun" should be read as meaning that the moon is, in one way or another, ignited or kindled by the sun. To quote O'Brien again, "It is not explicitly stated that Anaxagoras' moon shines by reflection. Plutarch's (…) sentence shows that the moon's light is derived light, but not whether it is derived by kindling or by reflection".[79] Elsewhere, O'Brien writes, "A fiery moon, even a partially fiery one, would seem to be inconsistent with the moon's deriving her light from the sun, if derived light means reflected light".[80] To quote O'Brien once more, "the simple theory of a moon whose light is kindled from the sun will at once resolve the difficulties in the evidence for the fifth century. For derivation by kindling, as distinct from reflection, is not inconsistent with, in fact it demands, a fiery moon".[81] Unfortunately, as we have seen, O'Brien, does not come to grips with the full impact of his own words because he does not take into account the implications of Anaxagoras' explanation of the Milky Way. Graham neglects the ambiguity of the expression "The moon receives its light from the sun".[82] In his book, "derived light" equals "reflected light" as his definition of

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[79] O'Brien 1968, 125, referring to Plut. *De facie* 929 b = DK 59 B 18 (see text I).

[80] O'Brien 1968, 121.

[81] See O'Brien 1968, 123.

[82] In an earlier paper, he discusses this ambiguity. See Graham 2002, 364, where he concludes: "L'ensemble de l'explication n'est pas nécessaire. Car, quoi que puisse être la physique de la lumière de la lune, il s'avère que l'éclairage de la surface de la lune par le soleil est toujours une condition nécessaire pour que la lune émette de la lumière". It is this presupposed necessity that is questioned in this and the next section of this paper.

heliophotism shows: "Heliophotism makes a causal connection between the phases of the moon and the sun: the sun's light is *reflected* from the surface of the moon".[83] Significantly, Graham, who advocates that Anaxagoras defended heliophotism,[84] almost completely ignores the texts that say the moon is fiery just as he almost completely ignores the texts that say the Milky Way is caused by the earth's shadow.[85]

The moon's light and phases according to Anaxagoras; a new interpretation

Parmenides said that the lighted side of the moon is always turned towards the sun.[86] It is hard to believe that he was the first to discover this. We can read it as a statement of a well-known fact since it is a primary observational datum. Thales had already studied and tried to predict eclipses of the sun. He could not have done this without being acquainted with the observational fact that a solar eclipse occurs during new moon and a lunar eclipse during full moon and that the phases of the moon occur between these two events. As the cases of Anaximander and Xenophanes show, this knowledge did not automatically lead to a correct explanation of the light and the phases of the moon. There is no reason to doubt that Anaxagoras was also acquainted with this observational fact. However, as we have seen, its correct explanation would have been incompatible with the rest of his astronomical ideas. As defended above and in my previous paper, Pseudo-Plutarch's version of Aëtius' text on the right explanation of the moon (text M) does not mention Anaxagoras and has to be preferred above the version of Stobaeus (text L).[87] This means that we do not

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[83] Graham 2013, 109–110 (my italics).

[84] See Graham 2013, 87–88.

[85] Graham mentions text B once, in a footnote, but only in relation to the claim that the moon has plains, mountains, and ravines. And his only comment on text E is this: "the sun, moon, and stars are fiery stones, hence solid, massive bodies of presumably spherical shape". See Graham 2013, 123 n. 14, and 124. He does not mention texts C and D.

[86] See Plut. *De facie* 929 b = DK 28 B 15. A lot has been written about Parmenides' alleged discovery of heliophotism. Even after the recent thorough studies on this subject (e.g., Mourelatos 2013), I remain skeptical as to whether someone who called the moon νυκτιφαές (or νυκτὶ φάος) and who reportedly called it fiery (πυρίνη) could have developed the theory that the moon reflects the light of the sun. But a discussion of this issue would be far beyond the scope of this paper.

[87] Even Graham 2013 does not use Stobaeus' version as an argument for his interpretation of Anaxagoras.

possess direct information on Anaxagoras' explanation of the moon's phases. Nevertheless, given our knowledge of his other astronomical ideas and taking into account the ambiguity of expressions like "the moon receives its light from the sun" and its equivalents (in texts F–J and even in L and M), we can make a reasonable guess. As far as I can see, two options deserve serious consideration.

O'Brien and Panchenko questioned whether a pure theory of derived light, kindled by the sun (not reflected), ever existed.[88] In this, they overlooked text O, according to which unnamed "youngers" defended a full-fledged theory of a fiery moon and its phases. If my analysis in this paper is correct, Anaxagoras may have been one of this theory's advocates. His conception of the earth as flat and his explanation of the Milky Way implied that the heavenly bodies must be relatively near and smaller than the earth. This means that, when the moon and the sun are in conjunction during new moon, the two luminaries must be very close to each other, as is shown in Fig. 4. At this point, the heat of the sun on the back of the moon – the side that is turned away from the earth – would necessarily be very intense, enabling it to ignite the moon.[89] However, during new moon, we do not see this light of the heated moon because the side that is kindled is the one that is turned away from us.

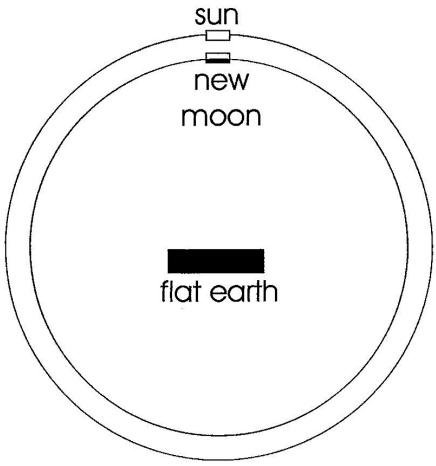

Fig. 4. During new moon, the sun is very close to the moon (approximately to scale)

[88] Cf. O'Brien 1968, 123; Panchenko 2002, 328.

[89] Cf. Panchenko 2002, 333: "At the time of conjunction (…), the side of the moon turned to the sun is turned *from* us, while the side which is not affected by heating is turned towards us".

Subsequently, this light, which is actually the glowing stony surface of the moon, expands. We see the first glimpse of fire creeping over the rim of the moon when we observe the small sickle a few days after new moon. As the moon goes through the phases of waxing crescent, first quarter, waxing gibbous, and finally full moon, the glow gradually spreads, covering an ever-growing part of the moon and finally its whole surface. We may compare this process with a fireplace that is lit on one side with a small fire that grows bigger and bigger until the whole fireplace is burning. However, because the moon is stony, it is not ignited with a raging fire but with the quiet glow we observe. After full moon, when the sun is farthest away from the moon, the glow shrinks again, gradually diminishing as the moon passes through the phases of waning gibbous, last quarter, and waning crescent, until it is finally extinguished at new moon and then is kindled again. With this explanation of the phases of the moon there is no question of reflected light. The light that we see on the moon is not the reflection of the sun's light but the glow of the moon's heated surface. In this explanation, expressions like "the moon receives its light from the sun" are understood literally: the moon is kindled by the sun. Although it must be kindled anew every month, once kindled, it can be said to have its own light, just like a lamp that is lighted has its own light.

This is the explanation of the moon's light and phases that is ascribed to unnamed "youngers" in text O. Although the text does not mention how the flame is kindled, the most natural reading is that the moon is kindled by the sun as described above. It might even be argued that this explanation of the moon's light and phases was offered as an improvement over those of Anaximander and Xenophanes, which did not explain why the opening of the vents in the celestial wheels or the kindling started during new moon and then followed the rhythm of the lunar month. Usually, text O is thought to be about "younger Pythagoreans", but it is hard to see who these younger Pythagoreans could have been,[90] who allegedly rebelled against the Pythagorean theory that the moon, functioning like a mirror (κατοπτροειδής), has its light by reflection (ἀνταυγείᾳ).[91] Moreover, text O is about the phases of the moon whereas the immediately preceding text is about the Pythagorean (Philolaic) theory of lunar eclipses. If we assume that, in text O, not Pythagoreans but others are meant, the most likely candidate would be Anaxagoras (and his followers), in whose system this explanation of the phases of the moon would fit very well.

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[90] Cf. p. 23–24 with n. 38 above.

[91] Cf. Aët. in Stob. *Anthol.* 1. 26, not in DK, but see Diels 1879, 357; Aët. in Ps.-Plut. *Plac.* 2. 29. 4 = DK 58 B 36.

This explanation also makes sense in relation to Plato's text in the *Cratylus* (text J). Socrates can call this explanation "ancient" because it presupposes a fiery moon as did almost all other Presocratic thinkers (cf. the remarks on Aëtius' chapter 2. 25 after text B). The light of the moon can be called "always new" because the moon's light is kindled anew every month. We can easily imagine that what we see during the month as the dark part of the moon has a faint afterglow, comparable with a peat-moor fire that spreads underground as the remnant of an earlier ignition. Usually, we do not see this faint afterglow because it is outshined by the light part (in this theory: the burning part) of the moon. Only when the light of the crescent moon is very small can we observe it as what we now call earthshine. Because it is the faint afterglow of the extinguished fire, this light can also be called "old". Socrates uses the words "the followers of Anaxagoras" (οἱ Ἀναξαγόρειοι), which can be compared with "the youngers" in text O.

An explanation similar to the one suggested above has been proposed by Sider in his interpretation of Anaxagoras' fragment B18 (text I). I quote: "The sun actually gives up some of its λαμπρόν (in the form of bright aither), which becomes part of the moon during and, to a lesser extent, after the time of direct illumination". And somewhat further: "Only if some light was physically absorbed could the moon glow from the light of the sun when the sun no longer shines directly on it". And again: "(…) the sun had physical substance which would penetrate into the moon's surface".[92] In Sider's interpretation, too, the moon's light is not reflected light from the sun, but in a way kindled by the sun, although according to him in the form of bright aether, while in the interpretation suggested above it is the sun's fire that starts the moon's glow.

The other possibility that deserves to be mentioned is an extrapolation of the conception of invisible heavenly bodies, which I argued in my previous paper must have been Anaxagoras' one and only explanation for lunar eclipses. Earlier thinkers like Anaximander and Xenophanes made no distinction in the way they explained eclipses and phases of the moon. Anaximander said they were both due to the closing of the apertures of the moon wheel. Xenophanes considered them to be quenchings. Anaxagoras may well have found it satisfying to propose a uniform explanation for eclipses, occultations, settings, and phases, explaining them with reference to a body that obstructs our vision of another celestial body: the moon (in solar eclipses and star occultations), the earth (in the settings of sun, moon, and stars), or an invisible body (in the case of lunar eclipses and

[92] Sider 2005, 158–159 (= Sider 1981, 122–123).

phases). In this scenario, too, the moon must be a fiery stone ignited by the sun's heat. The phenomenon of "earthshine" during the crescent waxing or waning moon could be explained, in analogy with the explanation of the "blood moon" during lunar eclipses, by the temporary transparency of the air-like invisible heavenly body, perhaps because of its proximity to the sun. This second suggestion of an explanation of the moon's phases, however, would not explain why the cycle starts during new moon and follows the rhythm of the lunar month.

Conclusion

According to Graham, "Anaxagoras profoundly changed the understanding of the heavens irreversibly and forever".[93] In my opinion, on the contrary, Anaxagoras inventively defended ideas that were already outdated when he wrote them down – about the shapes of the earth and of the other heavenly bodies, the Milky Way, lunar eclipses, and the light of the moon – in opposition to what we would now consider more progressive ideas. Taken together, however, his ideas formed a coherent whole. Anaxagoras' main achievement in astronomy was his acknowledgement that the heavenly bodies are fiery stones, and for this idea he had to go into exile. But as regards his general understanding of the heavenly phenomena, perhaps, after all, he is best described as a tragic figure.

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[93] Graham 2013, 242.

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This paper is a sequel of "Anaxagoras on the Milky Way and Lunar Eclipses" (Couprie 2017). Doxographic reports state that, according to Anaxagoras, the moon receives its light from the sun. Most authors understand it as meaning "the moon reflects the light of the sun". This conflicts, however, with several testimonies that say clearly that the moon is a fiery stone, using essentially the same words as they do for the sun. O'Brien (1968) has already pointed out that the expression "the moon receives its light from the sun" is ambiguous. I argue that, within the general context of Anaxagoras' astronomy, it is more probable that "the moon receives its light from the sun" means that the moon's light is ignited by the sun. Unfortunately, we do not possess information on Anaxagoras' explanation of the moon's phases.

I suggest two options. In one, the moon is ignited by the sun when, during new moon, the two luminaries are close together. After that, the fire spreads and extinguishes during the monthly cycle of phases. In the other, the moon's phases are due to an invisible body, just like during a lunar eclipse.

My conclusion from both papers is that Anaxagoras was not the great discoverer of the real cause of lunar eclipses and the moon light as he is depicted in recent publications. Anaxagoras inventively defended a coherent set of ideas that were already outdated: the flat earth, the Milky Way caused by the earth's shadow, the moon a fiery stone, and lunar eclipses caused by invisible heavenly bodies. As regards his general understanding of the heavenly phenomena, he is best described as a tragic figure.

Настоящая статья служит продолжением публикации "Анаксагор о Млечном пути и лунных затмениях" (Couprie 2017). Согласно доксографическим свидетельствам, Анаксагор утверждал, что луна получает свет от солнца. Большинство ученых понимают это в том смысле, что луна отражает солнечный свет. Между тем, это противоречит ряду других свидетельств, в которых отчетливо говорится, что луна – это огненный камень, причем используются почти такие же слова, как в описании солнца. На двусмысленность выражения "луна получает свой свет от солнца" указывал еще О'Брайен (O'Brien 1968). В рамках общего контекста астрономии Анаксагора представляется, что эти слова с большей вероятностью означают, что луна получает свет, воспламеняясь солнцем. К сожалению, у нас нет сведений о том, как Анаксагор объяснял смену лунных фаз. Автор предлагает два возможных объяснения. Согласно первому, луна воспламеняется солнцем, когда в период новолуния два светила оказываются близко друг к другу. После этого огонь распространяется и затухает в течение месяца, в соответствии с фазами луны. Согласно второму – фазы луны обусловлены невидимым небесным телом, как в случае лунных затмений.

Из обеих статей следует вывод о том, что, вопреки новейшим публикациям, Анаксагор не был автором великого открытия – объяснения причин лунных затмений и природы лунного света. Напротив, он с изобретательностью отстаивал систему согласующихся между собой, но устаревших представлений: плоскую форму Земли, тень от Земли как объяснение Млечного Пути, луну в качестве огненного камня и невидимые небесные тела как объяснение лунных затмений. Если говорить о понимании Анаксагором небесных явлений в целом, ему лучше всего подходит определение "трагическая фигура".

CONSPECTUS

Статьи сопровождаются резюме на русском и английском языке
Summary in Russian and English