Reinterpretable Explananda in the Posterior Analytics

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Abstract

By examining Aristotle's presuppositions concerning the scientific episode of the lunar eclipse, I try to show that, in the Aristotelian philosophy of science, the sense of the *explanandum* (and thus also that of the *definiendum*) cannot be the same before and after the discovery of the cause and formulation of the *explanans*. As a result, I propose that, for Aristotle, there are some essential properties known solely through the discovery of the cause and formulation of the *explanans*. If my interpretations is correct, the characterization of the Aristotelian conception of demonstrative knowledge merely in terms of the systematization and apprehension of explanatory connections between propositions and their corresponding facts, and thus devoid of any heuristic power, that is to say, devoid of any capacity for discovering new truths, must be rejected.

Introduction[1]

Interpreters of the Aristotelian philosophy of science tend to assume (uncritically) that, for Aristotle, the discovery of the cause (as being the cause[2]) and resulting formulation of the *explanans* do not affect the sense of the *explanandum*[3]. Accordingly, they assume that the Aristotelian distinction between knowledge of that (*to hoti*) and knowledge of why (*to dioti*) can be formulated adequately and independently of considerations involving the sense of the *explanandum*, since it remains unaffected throughout the heuristic process by which the cause is discovered, the *explanans* formulated (e.g. as a syllogistic demonstration[4]) and thus the truth expressed through the *explanandum* (here understood as a sentence) raised to the valuable level of demonstrative knowledge (*epistêmê apodeiktikê*)[5].

[1] I would like to acknowledge Mateus Ferreira, Paulo Ferreira, Lucas Angioni, Raphael Zillig, Rodrigo Guerizoli, Fernando Mendonça, Breno Zuppolini, and my colleagues, Araceli Velloso, Andre Porto, Cristiano Novaes, Vitor Bragança, and Anderson Borges, for the enriching discussions and helpful suggestions. Additionally, I want to thank CNPq for the financial support for my research project, "Aristotelian Paradigmatism", of which some of the ideas here presented are results.

[2] In this paper, by "discovery of the cause" and similar expressions, I mean the identification of the cause *as being the cause*. As we know, Aristotle conceives knowledge of the cause as being the more important feature of the so-called demonstrative knowledge (see *Posterior Analytics* I 14, 79a23-24, I 6, 75a35, I 13, 78a25-26).

[3] By '*explanandum*' I refer to the linguistic item, i.e. the sentence P, which persists along the investigative process that goes from the question "Why P?" to the answer "P because Q" during a scientific research.

[4] I am assuming the syllogistic demonstration as the emblematic way of formulating the *explanans*, but not the unique way, since a demonstrative *definiens* (also called "syllogistic definition"; see Deslauriers (2007)) and what Aristotle calls "continuous demonstration" (see *Posterior Analytics* II 10.94a6-8), that is, the answer to a correlated why-question, can also be considered as formulations of the *explanans*, due to sharing the same *logos*.

[5] See Barnes (1969/1975), Burnyeat (1981), Ferejohn (1991, 49-50), and, more recently, Bronstein (2016).

In fact, if the sense of the *explanandum* remains unaffected along the heuristic process that extends from the question "Why P?" (which opens the investigation of the cause and presupposes the knowledge of that P) to the answer "P because Q" (which closes the investigation of the cause and raises the knowledge of that P to the level of demonstrative knowledge[6]), interpreters will be right in formulating such a distinction independently of considerations regarding the sense of the *explanandum*, because the difference between the two types of knowledge cannot be established by pointing out what both have in common, namely, one and the same sense underlying the *explanandum* "P". Besides that, the conjectural assumption according to which the sense of the *explanandum* "P" is not the same in its occurrence both in the question "Why P?" and the answer "P because Q" seems to imply that such an answer cannot be *genuine*, because then the sentence "P" would express a distinct and peculiar thought or proposition in each occurrence. As a result, the conjecture seems to reveal itself as being implausible and not worthy of attention.

Such an outcome is so widely accepted in the debates surrounding the Aristotelian epistemology and philosophy of science that the interpreters do not even bother to formulate the question of knowing *whether or not* the sense of the *explanandum* remains the same throughout the transition from the knowledge of that P (*to hoti*) to the knowledge of why P (*to dioti*), that is, from non-demonstrative to demonstrative knowledge. Rather, they simply assume that the sense of the *explanandum* is one and the same in both the question "Why P?" and in the answer "P because Q".

The implicit acceptance of an *explanandum* whose sense does not change throughout the heuristic process of discovering the cause and formulating the *explanans* is one factor that has been steering interpreters towards a characterization of the Aristotelian conception of demonstrative knowledge mainly in terms of the interrelations among the elements of a body of knowledge and their corresponding clippings of reality[7]. More precisely, in this "interrelational model", the Aristotelian conception of demonstrative knowledge operates by

[6] The obtainment of an answer like "P because Q" (or "C is A because of B") can represent the transition from pre-demonstrative to demonstrative knowledge of P. For Aristotle, adequate answers to why-questions are demonstrations too, more precisely, continuous and not syllogistic demonstrations (see *Posterior Analytics* II 10, 94a6-8). For a different understanding of what a continuous demonstration is, see Barnes (2002, p. 225).

[7] Another important factor is the way Aristotle distinguished the knowledge of *that* (*to hoti*) from the knowledge of *why* (*to dioti*). A helpful formulation of the distinction can be found in Barnes' commentary (2002, p. 155) on *Posterior Analytics* I 13: "We might well think we could distinguish between understanding a fact and understanding an explanation in less subtle ways than those Aristotle devises; but in fact Aristotle, despite his language, is not concerned with this distinction at all: rather, he wants to distinguish between understanding a fact 'through' its explanation (i.e. knowing that *P* on the basis of *Q*, where *Q* explains why *P* is the case), and understanding a fact not though its explanation (i.e. knowing that *P* on the basis of *Q* where *Q* does not explain why *P* is the case). Cases of the second type, which Aristotle divides into two groups, are not, strictly speaking, cases of understanding at all; perhaps with ordinary usage in mind, Aristotle is here countenancing a weaker sense of 'understand' than his official one". In fact, the constraint of distinguishing two different ways of understanding a fact *P* together with the implicit acceptance of an *explanandum* whose sense does not change along the heuristic process has led interpreters to characterize the Aristotelian conception of demonstrative knowledge solely in terms of the systematization and apprehension of explanatory connections, so that it cannot produce any new proposition.

grasping the explanatorily asymmetric connections of both a delimited set of facts (not rarely independently known) and their corresponding propositions[8]. Thus, the knowledge that (*to hoti*), for example, the Moon suffers eclipse and the knowledge of why (*to dioti*) this occurs cannot be distinguished by considering the sense of the sentence "the Moon suffers eclipse", since one and the same sense underlies both the occurrences of the sentence at issue. Rather, the distinction is grounded in the apprehension of the explanatorily asymmetric connections involving the sentence "the Moon suffers eclipse" and the other sentences pertaining to the theory, the so-called first principles (*archai*) of the (Optical) Astronomy, by which the sentence taken as an *explanandum* is scientifically explained or understood[9]. According to this sort of interrelational model, demonstrative knowledge is concerned with the explanatory systematization of a body of truths (not rarely) acquired independently, and demonstrations have no heuristic power, that is to say, no capacity for discovering a new truth[10].

It is true that demonstrative knowledge involves the apprehension of the interrelational conjuncture connecting facts, on the one hand, and their corresponding propositions on the other, according to the explanatorily asymmetric relations they maintain with each other. However, it is noteworthy that this interrelational model does not entirely fit when one tries to explain why definitions produced by demonstrative knowledge, e.g., those of lunar eclipse,

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[8] See, for example, Burnyeat (1981). Commenting on the interrelational model, Ferejohn (1991, p. 49-50) writes: "[…] as Burnyeat also points out, Aristotle's *Posterior Analytics*, no less than Plato's *Theaetetus*, is firm in its insistence that the title of 'knowledge in the unqualified sense' (or, equivalently, of 'understanding') [ἐπιστήμη μετὰ λόγος]) cannot be conferred on a single belief taken in isolation (no matter how 'real' its objects), but must instead be presented in appreciation of the place that belief occupies in a sufficiently wide and systematic body of other beliefs. In other words, Aristotle, like Plato, subscribes to the interrelational model". Such a description of the interrelational model is correct, and Aristotle is clearly committed to it. However, this view gradually becomes tied to a restriction that I intend to reject, according to which Aristotelian demonstrations have no heuristic power.

[9] A certain version of this interrelational model was sustained recently by Bronstein (2016, p. 39): "[…] the scientist's learning [sc. by demonstration] does not consist in deducing a new conclusion from known premises. Rather, it consists in discovering a previously unknown explanatory connection among facts of which the scientist already has knowledge but not demonstrative scientific knowledge". A similar description of what demonstrative knowledge is can be found in Ferejohn (1991, p. 2): "[…] these works [*sc.* the two *Analytics*] proceed from the standpoint of a 'finished' science whose research is complete, and are largely focused on questions about the characteristic patterns of reasoning through which one might prove, or 'demonstrate' (*apodeiknymi*), that certain independently discovered particular facts of interest follow from, and are thus explained by, general scientific principles already in hand". See also McKirahan (1992, p. 233): "[…] experts do not learn from demonstrations since they already know. They not only know the principles better than the provable propositions, but also know them *as* principles of those propositions, which is to say they already know the relations of logical consequence and real dependence that proofs display. Proofs only reaffirm what they already know […]". McKirahan contrast two experts that already know the cause, when the relevant comparison involves an expert still investigating the cause (therefore, an expert that does not know the cause) and an expert already provided with knowledge of the cause and thus with demonstrative knowledge.

[10] See, for example, the comparison made by Burnyeat (1981, p. 137-138) between the Aristotelian and the Stoic notions of demonstration (*apodeixis*): the Aristotelian notion has to do "[…] with explanatoriness and deducitility of a conclusion from the highest level self-explanatory first principles of a science", whereas the Stoics make "[…] of demonstration an instrument for the increasing of knowledge, for inferring or justifying explanations, rather than for systematizing explanations and understanding knowledge which for the most part has been independently acquired". See also Bronstein (2016, p. 39-40): "Learning by demonstration, then, effects not so much the change from ignorance to knowledge as the change from non-scientific to scientific".

thunder, ice, or anything "whose cause is other" (see *Posterior Analytics* II 9), which I will call "demonstrative definitions", must express the cause of the defined item.

In fact, the doctrine inherited from the *Posterior Analytics* (mostly from Book II) suggests that the discovery, for example, of the cause of the lunar eclipse, has its outcome, somehow, in the apprehension of the essential nature of this astronomical phenomenon, as if the astronomer would have, before the discovery of the cause and formulation of the *explanans*, at most, part of the demonstrative *definiens*[11] and, therefore, would know only a limited portion of the essential nature of the lunar eclipse, whereas, after the discovery of the cause and formulation of the *explanans*, the astronomer would get to know the entire essence of the lunar eclipse, since the demonstrative *definiens* would then be totally available to him or her[12]. The discovery of the cause and the resulting formulation of the *explanans*, for Aristotle, must lead the scientist from ignorance about some aspect of the essential nature of the lunar eclipse to full knowledge of the essential nature of this astronomical phenomenon, which seems to imply that Aristotelian demonstrative knowledge actually expands one's knowledge of the essential nature of the lunar eclipse.

Certainly, the discovery of the cause and the formulation of the *explanans* play, for Aristotle, a definitional[13] (and, therefore, also taxonomical) role, one that cannot be easily formulated by appealing solely to the systematization and apprehension of the explanatory relations in which the lunar eclipse performs as a *relatum*. In fact, if systematization and apprehension of explanatory connections are everything the astronomer can obtain from demonstrative knowledge of the lunar eclipse, so that Aristotelian demonstrations are unable to provide the scientist with any new proposition (as posits the interrelational model), then, for Aristotle, it should be enough to know the cause without mentioning it in the *definiens* of "lunar eclipse". In fact, the explanatorily asymmetric connections involving this astronomical phenomenon and its cause would still be granted, once they result from acquiring knowledge of the cause (and not from expressing such knowledge inside the *definiens* of "lunar eclipse"). However, Aristotle is clearly unsatisfied with mere knowledge of the cause: he wants to express such knowledge in the *definiens*! Why is it not enough, for Aristotle, to know the cause, for example, of the lunar eclipse, without mentioning it in the *definiens* of "lunar eclipse"?

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[11] By qualifying the *definiens* with the adjective "demonstrative", I am referring to the exotic type of *definiens* designed by Aristotle to items "whose cause is other" (see *Posterior Analytics* II 8, 93a7 and b19, II 9, and II 10, 94a10-14).

[12] See the use of the expression "*ti autou tou pragmatos*" in *Posterior Analytics* II 8 (93a22), where Aristotle assumes that the scientist already knows something of the item to be investigated before discovering its essence and thereby formulating its definition. I am endorsing Barnes' position, according to which what we know, before discovering the cause, is not a nominal definition, but "a part of the essence of the object" (p. 218). See also McKirahan (1992, 200-203), who speaks in terms of superficial and deep essences. See also Sedley (2015): "Whether expressed in terms of what *x is* or of what *x*'s name *signifies*, this kind of definition can be represented as, or compared to, a bare conclusion of deductive reasoning (type-(3)), by contrast with those more explanatory definitions that have the causal premise of a demonstrative deduction built into them (type-(2)). Such is Aristotle's main contention in *APo*. 2.10, and it has nothing to do with any theory of 'nominal definition'".

[13] That is why he connects why-questions to what-is-it-questions. See *Posterior Analytics* II 1-2.

The point can be pushed further. Consider that, among the ways demonstrative knowledge[14] can be contrasted with other types of knowledge, Aristotle recognizes the decisive role played by a demonstration in the process of deciphering the essential nature of items "whose cause is other", that is to say, items of which can there only be demonstrative knowledge[15]. In the last paragraph of the notorious chapter 8 in Book II of *Posterior Analytics*, Aristotle summarizes the main (presumed[16]) achievements of the chapter, among which are two noteworthy results that he takes for granted: (i) for those items "whose cause is other", items for which demonstrative *definientia* were designed, *what* the item defined is becomes "*clear* through syllogism, that is, [becomes *clear*] through demonstration [δῆλον μέντοι διὰ συλλογισμοῦ καὶ δι' ἀποδείξεως]" (93b15-20); (ii) for those items "whose cause is other", it is not possible "to know the 'what it is' without demonstration" [οὔτ' ἄνευ ἀποδείξεως ἔστιν γνῶναι το τί ἐστιν, οὗ ἔστιν αἴτιον ἄλλο]. I think Aristotle supposes that the results are explanatorily attached: it is not possible to have (full) knowledge of the essence of an item *x* ("whose cause is other") without demonstration, because it is not possible to make clear *what* an item *x* essentially is unless through demonstrative knowledge[17]. For Aristotle, demonstrative knowledge is the unique way of acquiring full knowledge of the essence of an item *x* ("whose cause is other"). What is Aristotle's motivation for committing his philosophy of science to such a severe assumption?[18]

A tentative answer can be found in *Posterior Analytics* II 10 (94a1-2, 12-13), where Aristotle states that demonstrative *definientia* and syllogistic demonstrations express the same account (*logos*) under superficial differences. In that chapter, Aristotle goes as far as asserting that the demonstrative *definiens* is a "syllogism of what something is", which differs from a syllogistic demonstration in disposition (*thesis*) and arrangement (*ptôsis*)[19]. Thus, if demonstrative *definientia* are (linguistically) rearranged demonstrations, as Aristotle seems to propose in 93b15-20, then we can expect the second result, announced in the last paragraph of *Posterior Analytics* II 8, viz., it is impossible to acquire full knowledge of the essence of an item *x* ("whose cause is other") without demonstration. Although surely correct, this way of answering is still explanatorily poor, since it attempts to clarify an intriguing Aristotelian claim by means of an even more intriguing one. In other words, it attempts to clarify the impossibility of knowing the essence without demonstration by appealing to a certain relation of mutual derivability between demonstrative *definientia* and syllogistic demonstration. Such

[14] See, for example, the six requirements of the premises of a scientific syllogism in *Posterior Analytics* I 2.
[15] See *Posterior Analytics* II 9.
[16] Barnes (2002, p. 221).
[17] Therefore, I am avoiding any deflationary reading of "*dêlon*", preferring to understand the lack of clarity mentioned by Aristotle in such a way that it cannot be dissipated *unless* by demonstrative knowledge.
[18] Commenting on the last paragraph of *Posterior Analytics* II 8, Barnes (2002, p. 221) writes: "Strongly construed, this claim <sc. 'Without a demonstration you cannot get to know what something is'> is entirely unsupported: *B* 8 has done nothing to show that we can *only* come to grasp a definition by first constructing an appropriate demonstration. But perhaps Aristotle has a weaker thesis in mind: whenever you have grasped a definition, you can always construct an appropriate demonstration without more ado".
[19] *Posterior Analytics* II 10 (94a1-2, 12-13). On "differing in disposition (*thesis*)" and "differing in arrangement (*ptosis*)", see Barnes (2002, p. 224-225); see also Charles (2000, p. 68), who speaks in terms of "differing only in syntactic arrangement".

a strategy does not effectively elucidate the point, but simply changes the question we must address: What are Aristotle's motivations for imposing to a syllogistic demonstration the features of a *definiens*?[20]

As far as I know, there is no more promising text than *Metaphysics* H 4 (1044b9-15) in terms of indicating how demonstrative knowledge can make clear (*dêlon*) *what* something is and thus making a unique contribution to the process of acquiring knowledge of the essence of an item *x* of which there may be demonstrative knowledge[21]. There, Aristotle employs, with some adaptations, his hylemorphic analysis to the case of the lunar eclipse[22] and asserts that the *definiens* (*logos*) of "<lunar> eclipse" (i.e. "privation of light <from the Moon>") is somehow *unclear* (*adêlos*) until it is tied to its *explanans* (i.e. the interposition[23] of the Earth between the Sun and the Moon). According to Aristotle: "The <cause> *qua* form is the *definiens*; however, the *definiens* (i.e. 'privation of light <from the Moon>') is *unclear* (*adêlos*), unless it is with the <efficient> cause [τὸ δ' ὡς εἶδος ὁ λόγος, ἀλλὰ ἄδηλος ἐὰν μὴ μετὰ τῆς αἰτίας ᾗ ὁ λόγος][24]. His pronouncement here deserves further attention.

Aristotle seems to have in mind a contrastive relation whose *relata* are the pre-demonstrative and demonstrative *definiens* of "lunar eclipse", more precisely, the expressions (i) "privation of light from the Moon" and (ii) "privation of light from the Moon caused by the interposition of the Earth between the Sun and the Moon". Thus, Aristotle may

[20] An important part of the answer can be found in Charles (2000), who evokes the dependence relations among our practices of defining and explaining: "Aristotle's overall strategy can be formulated in terms of a mutual dependence between our practices of definition and of demonstration. While some of this claims about defining follow from his views about explaining, the constraints he imposes on structural explanation are (in some measure) grounded in the practice of definition. Each of these practices is incomplete without resources drawn from the other. […] Aristotle's account of the interdependency of the practices of definition and of demonstration involves a further thesis: the co-determination of essence and causation. Essences play a central role in a certain style of causal explanation, but the relevant type of causal story itself involves essences. This metaphysical thesis grounds Aristotle's epistemological claim that in knowing the answer to the 'Why?' question we know what the kind in question is. We achieve knowledge of essence by tracing back a certain pattern of explanation to its roots in a particular type of cause. But the relevant type of explanatory structure is one in which essences must be the basic *explanantia*. Essences and structural causation stand or fall together" (p. 217). Further: "In Aristotle's account, definition and explanation are mutually dependent. […] Neither definition nor explanation can be completed without resources drawn from the other" (p. 221). See also p. 243-251. I think we should avoid speaking in terms of *mutual* dependence between definition and explanation (and *co-determination* of essence and causation), since the definitions on which the explanations (or demonstrations) depend are not the same as those that depend on explanations (or demonstrations).

[21] Interpreters have already pointed out the connection between scientific knowledge and a certain notion of clarity to which Aristotle seems to be committed. On *saphêneia* (clarity) and scientific knowledge (or demonstrative knowledge), for example, see Lesher (2010, p. 143-156).

[22] In fact, the phenomenon of lunar eclipses and sleepiness are peculiar examples, since they do not involve a genuine material cause, but something analogous. For an accurate reconstruction of this chapter, see Code (2015).

[23] Technically, in the Aristotelian cosmology, the Earth does not interpose itself between the Sun and the Moon, since it is stationary. Still, I think that my point stands.

[24] See Code's translation of the passage: "And [the cause] 'as form' is the account, but the account is unclear unless the [efficient] cause is added" (2015, p. 25). Reale (2004) seems to understand the passage, in his translation, in the same way I am suggesting here: "La causa formale è la nozione di eclissi; ma questa non risulta chiara se non è accompagnata dalla causa efficiente".

be assuming that the pre-demonstrative *definiens* is unclear (*adêlos*) by virtue of omitting the (efficient) cause (i.e. the interposition of the Earth between the Sun and the Moon). According to this reading, the comparison involves two different expressions, the pre-demonstrative and the demonstrative *definiens,* and imposes to the unclearness that affects the expression "privation of light from the Moon" a reading marked by an informational incompleteness, so that the lacking information is precisely that which concerns the (efficient) cause of the lunar eclipse, communicated by the expression "caused by the interposition of the Earth between the Sun and the Moon"[25].

It is worth noting that the portion of the *definiens* of "<lunar> eclipse" that Aristotle describes as being unclear in *Metaphysics* H 4 (1044b9-15) is the one expressing the cause *qua* form (*to hôs eidos*) of the phenomenon at issue, that is to say, the expression "privation of light <from the Moon>", so that it should also be what has been clarified by being explanatorily related to the (efficient) cause through the formulation of the *explanans* (i.e. the expression "caused by the interposition of the Earth between the Sun and the Moon"). It may be said that the cause *qua* form is the whole essence of the lunar eclipse[26]. But then it becomes difficult to see how to speak reasonably about the cause *qua* form of the lunar eclipse being unclear *without* the (efficient) cause, since, in that case, it would not be the *whole* essence of the lunar eclipse, but at most a portion of it.

Nevertheless, it is not necessary to interpret the contrastive relation that Aristotle has in mind in *Metaphysics* H 4 (1044b 9-15) as if its *relata* were the pre-demonstrative and demonstrative *definiens,* that is to say, the expressions "privation of light from the Moon" and "privation of light from the Moon caused by the interposition of the Earth between the Sun and the Moon". Although it is plainly true that the latter expression is much more informative than the former, Aristotle might be making a more technical point about his conception of demonstrative science. He might well be taking as *relata* of the contrast pointed out at *Metaphysics* H 4 the pre-demonstrative *definiens* under two different conditions: firstly, unconnected to any *explanans* and pre-demonstratively interpreted; secondly, connected to the *explanans* or demonstratively interpreted. If such a reading is correct, what is unclear (when it is unconnected to the efficient cause) and, one presumes, becomes clear (when it is connected to the efficient cause), are one and the same item, namely, the cause *qua* form (here understood not as the whole essence, but only as the privation of light),[27]

[25] This is how Bronstein (2016, p. 104) seems to understand the passage: "In *Metaphysics* 8.4 (1044b12-15), Aristotle says that *another* possible definition (eclipse is loss of light from the moon) is 'unclear' because it omits the cause: the Earth screening".

[26] See Bronstein (2016, p. 98): "The formal cause is the whole essence, which must include what Aristotle calls 'the cause' (1044b13, 15) […]". I do not understand exactly how the formal cause might be the whole essence of the lunar eclipse, since that, in this case, the material and efficient causes, one presumes, would be component parts of the formal cause.

[27] Commenting on *Posterior Analytics* II 8, Barnes (2002, p. 218) correctly evokes *Metaphysics* Z 17 (1041b2-9) and H 4 (1044b9-20), and then suggests that what the scientist grasps of the thing in itself, before discovering the cause and formulating the *explanans*, "is the matter of the object" (e.g. the Moon in the case of the lunar eclipse). Additionally, he suggests, "we are still in search of its form", as if the form would be unknown until

firstly conceived independently of the efficient cause and then as the effect of such a cause. Since the cause *qua* form is linguistically referred by the expression "privation of light", Aristotle might be thinking that this expression, devoid of any attachment to the *explanans* (i.e. "caused by the interposition of the Earth between the Sun and the Moon"), is unclear or informatively poor, but becomes clear or semantically enriched by being attached to the *explanans*. In short, the expression "privation of light <from the Moon>" becomes more informative through the discovery of the cause and formulation of the *explanans*, that is, under a demonstrative interpretation[28].

Let me summarize the interpretative direction I am arguing toward. As in the case of *Posterior Analytics* II 8, as well as here, in *Metaphysics* H 4 (1044b9-15), Aristotle seems to be committed to the idea that the discovery of the cause and formulation of the (correct) *explanans* play a decisive role in the process of deciphering the essential nature of those items to which causal *definientia* were designed (e.g. lunar eclipse, thunder, ice etc.). He seems to think that, before the discovery of the cause and formulation of the *explanans*, the *logos* of <lunar> eclipse (i.e., the pre-demonstrative *definiens* of "<lunar> eclipse", namely, the expression "privation of light <from the Moon>") is somehow unclear (*adêlos*), but becomes clear (*dêlon*), presumably, when the (efficient) cause is discovered and the *explanans* formulated, that is, when demonstrative knowledge of the lunar eclipse is finally acquired. While certainly intriguing, this scenario is not only compatible with that of *Posterior Analytics* II 8 (which is also intriguing), but may be explanatorily connected to the use of "*dêlon*" at 93b15-20. Thence, what lunar eclipse is "[…] becomes clear through demonstration" because the *unclear* (*adêlos*) *definiens* of "<lunar> eclipse", which is responsible for indicating the cause *qua* form of this phenomenon (i.e. the expression "privation of light <from the Moon>"), by being tied to the *explanans*, becomes clear (*dêlon*). Thus, the discovery of what a lunar eclipse is results from the dissipation of the unclearness that marks the cause *qua* form and its corresponding linguistic expression, the *definiens* of "<lunar> eclipse" (i.e. "privation of light <from the Moon>")[29].

In both passages (*Post. An.* II 8.93b15-20 and *Met.* H 4.1044b9-15), Aristotle reveals himself to be committed to the idea that demonstrative knowledge can raise the cognitive value of definitions, because solely this type of knowledge can clarify *what* something

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the discovery of the efficient cause. In my opinion, what the scientist knows before discovering the cause could be part of the form, so that he or she would not be provided with full knowledge of the form.

[28] Bostock (2003, p. 275) seems to recognize in the words of Aristotle the alternative reading I am suggesting here, but takes Aristotle's pronouncement in *Metaphysics* H 4 (1044b9-15) as being incorrect: "It <i.e., the lunar eclipse> also has a formal cause, which is the definition of what an eclipse is. Aristotle recommends us to build into this definition a specification of the efficient cause […]. He says that unless we do this, the definition will not be 'clear', but that does not seem to be right: the original definition was perfectly 'clear'. What he has in mind, one presumes, is that the expanded definition will give a more informative answer to the question: 'What is an eclipse?'".

[29] For different interpretation of the last paragraph of *Posterior Analytics* II 8, see McKirahan (1992, p. 200): "Aristotle has sketched a method for grasping the deep essence, and the deep essence is not the conclusion of a deduction or proof, but comes to be clear though deduction and demonstration since we discover it by constructing a proof with it as a middle term immediately related to the attribute of the superficial essence".

("whose cause is other") is. It seems, therefore, that demonstrative knowledge provides the scientist with some knowledge of the essence, for example, of the lunar eclipse. How can that be different from discovering some essential property of the lunar eclipse through demonstrative knowledge, that is, through the discovery of the cause and formulation of the *explanans*?[30] By merely recognizing the explanatory connection between the lunar eclipse and the interposition of the Earth between the Sun and the Moon, is the astronomer acquiring knowledge of *what* a lunar eclipse is, that is, of the essence of the lunar eclipse?

Consider, for example, an astronomer who knows that (*a*) the Moon suffers eclipse, that (*b*) the Earth interposes itself between the Sun and the Moon, and that both events occur (when they occur) at the same time, so that, if *a*, then, *b*, and vice versa. Now, suppose that our astronomer does not recognize the interposition of the Earth between the Sun and the Moon *as being the cause* of the lunar eclipse. For Aristotle, such an astronomer cannot be provided with demonstrative knowledge of the lunar eclipse, since the cause and resulting explanatory asymmetry between the events *a* and *b* still need to be grasped by him or her. However, as we know from *Posterior Analytics* II 8 (93b15-20), regarding those items for which causal *definientia* were designed (including the lunar eclipse), it is not possible to know *what* something is unless through demonstrative knowledge. Thus, Aristotle seems to think that demonstrative knowledge of the lunar eclipse can reveal some hidden essential property of this astronomical phenomenon. Our astronomer, therefore, in Aristotle's view, does not know all of the essential properties of the lunar eclipse, since he does not know the cause and thence does not know *what* a lunar eclipse is.

However, it seems that nothing more can be discovered by our astronomer beyond the causal asymmetry connecting the events expressed by the sentences *a* and *b*. The question, then, is, this: by recognizing the causal asymmetry between those events and thus solely acquiring demonstrative knowledge of the lunar eclipse, is our astronomer also discovering some unknown essential property of the lunar eclipse? Aristotle seems to be committed to an affirmative answer in the last paragraph of *Posterior Analytics* II 8, by stating that *what* something is, for example, *what* a lunar eclipse is, cannot be known except through demonstrative knowledge. Thus, it is reasonable to wonder which unknown essential property of the lunar eclipse our astronomer does not know, but can discover merely by recognizing the causal asymmetry involving *a* and *b*. Is the very asymmetric relation in which the lunar eclipse performs as a *relatum* an essential property of this astronomical phenomenon? How can such an explanatory connection reveal *what* a lunar eclipse is, that is to say, the essence of this phenomenon, without triggering the discovery of any unknown

[30] It may be alleged that, for Aristotle, it is not possible to know *what*, for example, lunar eclipse is without demonstration because lunar eclipse is one of those items of which, according to *Posterior Analytics* II 9, 'the cause is other', and that cannot be defined unless by expressing within their definitions the corresponding causes, so that before the discovery of the cause and the formulation of the *explanans*, the *definiens* of 'lunar eclipse' is incomplete. Such a pronouncement is, of course, correct. However, it implies additionally that the expression 'lunar eclipse' does not have the same sense before and after the discovery of the cause, since by discovering the cause, the (Aristotelian) astronomer inserts a new information inside the *definiens* of 'lunar eclipse' (i.e. the information concerning the cause). How can the astronomer do that without modifying the concept of lunar eclipse?

essential property of the lunar eclipse? How can the attribution of the metaphysical predicate "*x* is caused by *y*" to that ordered pair of events (namely, the lunar eclipse and the interposition of the Earth between the Sun and the Moon) be involved in the revelation of the essential nature of the lunar eclipse without generating new propositions concerning the essence of this astronomical phenomenon?

What I am going to suggest is that, by discovering the cause and formulating the *explanans* (e.g. as a syllogistic demonstration), the scientist reinterprets the sentence taken as *explanandum* (in a peculiar way, we could call it "semantic enrichment" or "demonstrative interpretation") and thus increases his or her knowledge of the fact or event expressed though that sentence. In other words, by applying the metaphysical concept of cause to an ordered pair of events, *x* and *y*, and thus assuming that *x* is caused by *y*, the scientist further recognizes that *x* has essential properties that cannot be known except by assuming that *y* is the cause of *x*. My interpretation depends on the abandonment of the uncritically accepted view according to which the sense of the *explanandum* does not change through the heuristic process of discovering the cause and formulating the *explanans*. It also depends on abandoning the equally accepted view according to which the knowledge of *that* P (*to hoti*) and the knowledge of why P (*to dioti*) cannot be distinguished by considering the sense of the sentence P, since it supposedly remains the same throughout the heuristic process that expands the knowledge of that P (*to hoti*) to knowledge of why P (*to dioti*).

Interpretative puzzles in *Posterior Analytics* II 8 (93b3-6)

Aristotle ascribes to different sentences the role of *explanandum*[31], and somehow seems to take them as equivalent. Consider, for example, another of Aristotle's favorite examples of items of which there can only be demonstrative knowledge, namely, thunder. It seems that, for Aristotle, the scientist may open the investigation of the cause, and thus, the search for demonstrative knowledge by asking either "Why does the cloud make noise?" or "Why does the cloud thunder?" (or even "Why does it thunder?"), so that both sentences on which the why-questions focus, that is to say, (i) "the cloud makes noise" and (ii) "the cloud thunders", can equally play the role of *explanandum*. In fact, he seems to think that *i* and *ii* mutually imply each other. As we know, Aristotle goes as far as substituting the predicate of the sentence *ii* ("to thunder") for the predicate of the sentence *i* ("to make noise")[32]. *Mutatis mutandis*, the same equivalence seems to hold with regard to lunar eclipse, ice, and any other items among those of which there can only be demonstrative knowledge. While recognizing the importance of distinguishing sentences like *i* from sentences like *ii*, considering that, for Aristotle, the sentence *i* is the conclusion of the demonstration of what thunder is (see

[31] Technically, the *explanandum* consists on the item to be explained, so that its genuine formulation should occurs only in the question "Why P?" and not in the answer "P because Q", since in the answer there is nothing *to be* explained, but already explained. However, I am employing the term "*explanandum*" to refer to both occurrences of the sentence "P", whether in the question "Why P?" (before grasping the explanation) or in the answer "P because Q" (after grasping the explanation).
[32] *Posterior Analytics* II 8, 93b7-12.

Posterior Analytics II 10, 94a7-9), such a distinction is not relevant to my present purpose of showing that the sense of both *explananda*, *i* and *ii*, changes through the heuristic process of discovering the cause and formulating the *explanans*. Therefore, hereafter, I shall conflate both sentences for the sake of simplicity and use the following formulation for the *explanandum*: "the cloud makes noise (thunders)". However, as we are going to consider a passage concerning another of Aristotle's favorite examples, namely, that of the lunar eclipse, I shall focus on the *explanandum* "the Moon suffers privation of light (eclipse)", which results from the conflation of (i') "the Moon suffers privation of light <in some full moons>" and (ii') "the Moon suffers eclipse". Finally, here is the short passage that we are going to examine:

> However, being granted that [*dêlou d'ontos hoti*] 'A' <i.e. eclipse> is predicated of C <i.e. Moon>, to seek 'Why is it predicated?' is to seek 'what is B?': whether it is (1) interposition <of the Earth between the Sun and the Moon> or (2) rotation of the Moon <on its own axis> or (3) quenching <of flames> (*Posterior Analytics* II 8, 93b3-6).

Aristotle has in mind a context in which the knowledge a scientist has of the lunar eclipse still cannot be considered demonstrative, because the scientist knows *that* (*to hoti*) the Moon suffers privation of light (eclipse), but does not know why (*to dioti*) it happens; he or she does not know what is the cause of the lunar eclipse (although candidates are indeed available). Thus, it is a context in which the scientist has mere pre-demonstrative or descriptive knowledge of the lunar eclipse, but no causal knowledge; the scientist does not have demonstrative *episteme*[33].

In this pre-demonstrative or descriptive context, Aristotle recognizes three candidates for the role of cause of the lunar eclipse: (1) the interposition (*antiphraxis*) of the Earth between the Sun and the Moon, (2) rotation (*strophê*) of the Moon, and (3) quenching (*aposbesis*) of the lunar surface's fire. It is not easy to reconstruct all of the details involved in each of the running theories. Nevertheless, it can be formulated at least in general lines how each theory was thought to explain this astronomical phenomenon. To start, the question opening the scientific investigation at issue (i.e., the investigation of the cause) must be set, since it introduces one and the same *explanandum* to which the three *explanantia* have been proposed:

(Q) "Why does (E) the Moon suffer privation of light (eclipse)?"

In accordance with the first proposed cause of the lunar eclipse, which comes from Anaxagoras, the Moon suffers privation of light (eclipse) because the Earth interposes itself between the Sun and the Moon, blocking the light of the Sun and consequentially casting its shadow over the sunny face of the Moon. In the Anaxagorean theory, which depends on the heliophotic hypothesis of Parmenides, the Moon does not shine by itself, i.e., independently

[33] It would not be wrong, however, to say that, by formulating hypothetically possible answers, as it occurs in the passage, the scientist simulates explanatory contexts and, therefore, hypothetically possible scientific contexts. See, for example, 74b27-28.

of the Sun. Rather, it borrows its brightness from the Sun[34]. From this theory comes the following explanation:

> **Explanation 1:** (E) the Moon suffers privation of light (eclipse), because (R1) the Earth interposes itself between the Sun and the Moon.

In turn, according to the second proposal, the Moon suffers privation of light (eclipse) because it has only one flaming face and rotates on its own axis, which hides the shining or flaming face from an observer on Earth. Technically, the Moon continues shining; only the direction and region affected by its brightness change. From this theory comes the following explanation:

> **Explanation 2:** (E) the Moon suffers privation of light (eclipse), because (R2) the Moon rotates on its own axis.

Lastly, according to the third proposal, the Moon suffers privation of light (eclipse) because the fire on the Moon's surface quenches and thus its brightness is interrupted. In this case, the Moon actually stops shinning. From this theory comes the following explanation:

> **Explanation 3:** (E) the Moon suffers privation of light (eclipse), because (R3) the fire on the surface of the Moon quenches.

This is the scenario Aristotle seems to have in mind at 93b3-6. Since each of the explanations reformulated above identifies a different factor as the cause of one and the same phenomenon, the lunar eclipse, we can assume that, for Aristotle:

> (A) all three explanations are different answers ascribed to one and the same question Q ("Why does (E) the Moon suffer privation of light (eclipse)?").

It is significant to observe that, if this reconstruction of the passage at issue (93b3–6) is correct, then we are forced to admit that the pre-demonstrative occurrence of the *explanandum*[35] (E) "the Moon suffers privation of light (eclipse)" in question Q does not presuppose neither the hypothesis (α) "the Moon *is* incandescent" nor the hypothesis (β) "the Moon is *not* incandescent". Otherwise, we cannot assume (as we have done above) that (A) all three competing explanations are genuine answers ascribed to the same question.

Why not? Because a question and its answer cannot be committed to incompatible assumptions. An answer is always committed to all the presuppositions of the question to which it is an answer. Such a commitment consists of nothing more than a formal condition to be met by any genuine answer (even by those committed to false assumptions!). When a

[34] As far as I know, Parmenides is responsible for developing a cosmology in which the Moon was thought to reflect the Sun's light. In doing so, he has paved the way for the correct comprehension of the lunar eclipse by Anaxagoras. On the merits of Parmenides, see Graham (2013, p. 156-159): "Parmenides' insight of heliophotism provides the starting point for a set of implications that includes the possibility of explaining eclipses by reference to antiphrasis". On the merits of Anaxagoras, see Burnet (1920, p. 198), Curd (2007, p. 233), and especially Graham & Hintz (2007, p. 333).

[35] By "prescientific occurrence of the *explanandum*" I mean any occurrence uncommitted to an *explanans*.

supposed answer does not satisfy such a condition, it cannot be considered a genuine answer. Consider, for example, the following sentence: "The Earth is *not* in the center of the universe". This sentence cannot be considered a genuine answer to the question "Why *is* the Earth in the center of the universe?". In fact, such a sentence is the rejection of a presupposition on which the question at issue depends in order to be successful. By stating the sentence, one rejects the presupposition and annihilates the question[36]. Now, where there is not a question, there cannot be an answer[37].

Accordingly, since Aristotle takes all the three explanations alluded to in the passage (93b3-6) as running answers to the question Q, he must take all three explanations as satisfying at least this formal requirement according to which no presupposition of the answer is incompatible with the presuppositions of the question. In other words, Aristotle takes the three explanations as genuine answers, grounded in presuppositions that are compatible with those of the question Q. However, as I am trying to maintain, if the pre-demonstrative occurrence of the *explanandum* E in the question Q presupposes either the hypothesis α or the hypothesis β, the required compatibility between question and answer that I mentioned above unavoidably disappears.

Let us admit that the *explanandum* E presupposes the hypothesis α (i.e., that the Moon *is* incandescent) and see what happens. If the *explanandum* E presupposes α, then the question (Q) "Why does the Moon suffer privation of light (eclipse)?" also presupposes α. However, explanation 1 ("the Moon suffers privation of light (eclipse) because the Earth interposes itself between the Sun and the Moon") is based on the crucial (and Parmenidean) hypothesis according to which (β) the Moon is *not* incandescent, since it reflects the Sun's light – a hypothesis flagrantly incompatible with hypothesis α! Given such incompatibility, explanation 1 cannot be a genuine answer ascribed to question Q, since question Q and explanation 1 are committed to incompatible assumptions. It seems, then, we cannot assume both that the *explanandum* E presupposes α and that explanation 1 is a genuine answer to question Q. Thus, if we want to maintain the view that, for Aristotle, (A) all three explanations (1, 2, and 3) are genuine answers ascribed to one and the same question Q, we have to reject the initial assumption according to which the *explanandum* E presupposes the hypothesis α.

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[36] See, for example, van Fraassen (1980): "[…] questions have *presuppositions*, and *do not arise* unless their presuppositions are true. The paradigm example is 'Have you stopped beating your lover?', but almost any question will do: 'What colour did the litmus paper turn, blue or red?' is a question which does not even arise unless the litmus paper changed colour. If someone responds 'But it did not change colour at all' we say that he has *corrected* the question. Similarly, the question 'What sort of metal is this?' can be given a *direct answer* ('Gold') or a *corrective answer* ('It isn't any sort of metal, it is a plastic') which says that the question has a false presupposition and hence does not arise".

[37] One reason for taking for granted the identity of the sense of the *explanandum* "P" both in the question "Why P?" and the answer "P because Q" might be the following assumption: a question and its (genuine) answer must be committed to the *same* presuppositions. In my opinion, such an assumption is false. In fact, nothing prevents a question and its genuine answer from sharing *different* presuppositions, provided that two conditions are met: (a) all the presuppositions of the question are also presuppositions of the answer; and (b) the presuppositions of the answer are compatible with the presuppositions of the question.

In turn, let us admit that the *explanandum* E presupposes the hypothesis β (i.e., that the Moon is *not* incandescent) and then see what happens. If the *explanandum* E presupposes β, then the question (Q) "Why does the Moon suffer privation of light (eclipse)?" also presupposes β. However each of the explanations, 2 ("the Moon suffers privation of light (eclipse) because it rotates on its own axis") and 3 ("the Moon suffers privation of light (eclipse) because the fire on the surface of the Moon quenches"), is based on the scrapped hypothesis according to which (α) the Moon *is* incandescent – a hypothesis flagrantly incompatible with β! Given such incompatibility, neither explanation 2 nor 3 can be a genuine answer ascribed to question Q, since question Q and each of the explanations at issue (2 and 3) are committed to incompatible assumptions. It seems, then, we cannot assume both that E presupposes β and that each explanation (2 and 3) is a genuine answer to question Q. Thus, if we want to maintain the idea that, for Aristotle, (A) all three explanations (1, 2, and 3) are genuine answers ascribed to one and the same question Q, then we are forced to reject the initial assumption that the *explanandum* E presupposes the hypothesis β.

It therefore seems that the question (Q) "Why does (E) the Moon suffer privation of light (eclipse)?", with which the scientific or causal investigation of the lunar eclipse is opened in the pre-demonstrative context considered in the text at issue (93b3–6), as well as the pre-demonstrative occurrence of the *explanandum* (E) "the Moon suffers privation of light (eclipse)" in such a question, cannot presuppose neither that (α) the Moon *is* incandescent nor that (β) the Moon is *not* incandescent. Otherwise, the initial compatibility assumed by Aristotle between the question Q and each of the answers (1, 2, and 3) suggested in the passage disappears.

Altogether, I hope to have shown that the pre-demonstrative occurrence of the *explanandum* in question Q, since it is uncommitted to any *explanans*, involves a vague conception of Moon, according to which it is not determined whether the Moon is incandescent or not[38]. Now, if the *explanandum* maintains the same sense before and after the discovery of the cause, then the sense that the *explanandum* has in the pre-demonstrative occurrence in question Q must be the same that it has in the demonstrative occurrence in explanation 1.

Next, let us consider the demonstrative context that emerges from the discovery of the cause and resulting dismissal of the other proposed explanations of the lunar eclipse, and contrast such a context with the previous and pre-demonstrative context that we have tried to reconstruct from the passage under examination (93b 3-6). In short, let us take a look at what results when the scientist already knows that (1) the Moon suffers privation of light (eclipse) because the Earth interposes itself between the Sun and the Moon, and compare such knowledge with that which the scientist had before the discovery of the cause. It is not yet necessary to discuss the decision-making process by which explanation 1 is endorsed and the others (2 and 3) are discarded, although, surely, we must recognize that this step is crucial in

[38] Ferejohn (2013, p. 144-145) seems to have a similar opinion on the thunder example, speaking in terms of a "phenomenal (or 'thin') conception of thunder".

order to cross the line separating pre-demonstrative (or prescientific) from demonstrative (or scientific) knowledge, and therefore, to solve the so-called problem of the value of knowledge[39]. For now, it is enough to suppose that the scientist is in a scientific context, I mean, it is enough to admit that the astronomer already knows that lunar eclipses are caused by the interposition of the Earth between the Sun and the Moon.

As we have observed above, explanation 1 ((E) "the Moon suffers privation of light (eclipse) because the Earth interposes itself between the Sun and the Moon") is grounded in the Parmenidean hypothesis that (β) the Moon is *not* incandescent, which is a hypothesis that the question (Q) "Why does (E) the Moon suffer privation of light (eclipse)?" cannot presuppose. Consequently, it seems that, for Aristotle, the answer to question Q (explanation 1) requires a hypothesis, β, which cannot be presupposed by question Q. This does not mean, of course, that question Q and answer 1 (explanation 1) are then incompatible with each other, since hypothesis β cannot be presupposed by, but is compatible with question Q. It is not the case, then, that explanation 1 cannot be a genuine answer to question Q.

However, we now have a challenge to deal with, which consists of explaining how the sentence (E) "the Moon suffers privation of light (eclipse)", occurring both in question Q and explanation 1, might be and not be committed to hypothesis β. In fact, whereas the demonstrative occurrence of sentence E in explanation 1 depends on a conception of Moon according to which it is *not* incandescent (otherwise, the *explanandum* could not be explained through *antiphraxis*[40]), the pre-demonstrative occurrence of sentence E in question Q presupposes a more vague conception of Moon, since the *explanandum* E can presuppose neither β nor α. How then might both occurrences of sentence E (the pre-demonstrative and demonstrative ones) carry the same sense or express one and the same thought or proposition, and even invoke distinct conceptions of Moon?

No doubt, the *explanandum* E is one and the same sentence (type) both in question Q (its pre-demonstrative occurrence) and in explanation 1 (its demonstrative occurrence). However, when confronted with such an incompatibility between each occurrence of sentence E in relation to hypothesis β, can we still assume that the thought or proposition underlying the pre-demonstrative and demonstrative occurrences of the *explanandum* E are one and the same? If we are dealing with one and the same thought or proposition, how can we explain the different notions of Moon assumed in each case? The distinct conceptions of Moon invoked in each context seem to require an acceptance that the sentence (E) "The Moon suffers privation of light (eclipse)" cannot express the same thought or proposition before and after the discovery of the cause and formulation of the *explanans*.

Similar considerations can be made concerning the predicate of sentence E by passing from the pre-demonstrative to the demonstrative context. In the pre-demonstrative occurrence of sentence E, when all that the scientist is provided with is descriptive knowledge (he or she knows *that* the Moon suffers privation of light (eclipse), but does not know *why*),

[39] *Meno* (96d-98c).
[40] See Graham (2013, p. 156-159).

the predicate "to suffer privation of light (eclipse)" expresses a very vague interruption of brightness, an interruption that (once again) can be committed neither to the hypothesis that (α) the Moon *is* incandescent, nor to the one that (β) the Moon is *not* incandescent[41]. However, in the demonstrative occurrence of sentence E, when the scientist knows *that* and especially *why* the Moon suffers privation of light (eclipse), such a predicate expresses a much more precise condition; it expresses the casting of the Earth's shadow over the sunny surface of the Moon. Therefore, we must admit that the predicate of the sentence taken as *explanandum* (i.e., "to suffer privation of light (eclipse)") does not express the same notion of privation of light (eclipse) in each context. Thus, once again, it seems we are forced to admit that the sentence (E) "The Moon suffers privation of light (eclipse)", by force of the distinct senses of its predicate in each context, cannot express the same thought or proposition before and after the discovery of the cause and formulations of the *explanans*.

In favor of the variance in the sense of the sentence (E) "The Moon suffers privation of light (eclipse)" throughout the heuristic process, it worth to consider, additionally, the variance in its truth conditions. In the pre-demonstrative context, it is supposed that E is made true by the occurrence of any one among three hypothetically possible events or situations: (S_1) the casting of the Earth's shadow over the sunny surface of the Moon; (S_2) the rotational hiddenness of the incandescent face of the Moon (from an observer on the Earth); (S_3) the extinguishing of the lunar surface's flames. All three hypothetically possible situations[42] are considered acceptable truth makers of the sentence "the Moon suffers privation of light (eclipse)", even while being recognized as mutually exclusive. However, in the demonstrative context, that is to say, when the scientist already knows that the interposition of the Earth between the Sun and the Moon is the cause of the lunar eclipse, only situation S_1 is expected and recognized as a truth maker of the sentence E. Anything other than the Earth's shadow being cast over the sunny surface of the Moon is completely discarded, and the hypothetically possible events or situations S_2 and S_3 are no longer even expected to be truth makers. We have then distinct expected truth makers for pre-demonstrative and demonstrative contexts, for distinct occurrences of one and the same sentence, the *explanandum*.

Now, if the truth makers of the *explanandum* E are not the same in the pre-demonstrative and demonstrative contexts, it seems we are forced to conclude that the truth conditions of the *explanandum* at issue have changed, which means that, by passing from one context to the other, the *explanandum* suffers some alteration of sense. Although the sentence type (E) "the Moon suffers privation of light (eclipse)" remains the same in both

[41] A similar understanding of pre-demonstrative knowledge, that is, of the so-called "knowledge that (*to hoti*)", and with which I tend to agree, can be found in Ferejohn (2013, p. 140-141): "we should keep in mind that according to the distinction between 'knowing that' and 'knowing why' in *Posterior Analytics A* 2, the fact in question is 'closer to perception' […]", so that the knowledge with which the scientist is provided, when he or she knows only that (*to hoti*) and not why (*to dioti*), "is necessarily confined to its phenomenal qualities".

[42] By "hypothetically possible situations" I mean epistemic possibilities, to which might or might not correspond real possibilities.

contexts, once its truth conditions have changed, the underlying thought or truth bearer expressed through this sentence in each context can no longer be the same[43].

Deciphering essential properties through demonstration

As we know from the last paragraph of *Posterior Analytics* II 8, Aristotle is committed to the strong view according to which demonstrative knowledge is the unique way of knowing *what* those items "whose cause is other" (e.g. lunar eclipse, thunder, ice etc.), what the objects of demonstrative knowledge, essentially are. In fact, he seems to think that to know *what* these items are, that is to say, to acquire full knowledge of their essential properties, is impossible, except through demonstrative knowledge (93b15-20). How can Aristotle sustain such a strong position?

A deflationary interpretation of the text might suggest that Aristotle simply has in mind that exotic thesis of *Posterior Analytics* II 10, according to which the *definientia* of those items of which there can only be demonstrative knowledge are linguistically reformulated syllogistic demonstrations (94a1-2, 12-13). As already noted, I prefer to avoid this line of interpretation, because it simply leads us from one problem to another, namely, to that of knowing why Aristotle intends to impose to a syllogistic demonstration the features of a *definiens*, which is also to say the role of a *definiens*. Instead of accepting such an itinerary, I am suggesting an interpretation of the last paragraph of *Posterior Analytics* II 8, whereby Aristotle is really saying that what certain items are (e.g. lunar eclipse, thunder, ice etc.), that is, their essential properties, cannot be fully known except through demonstrative knowledge. Then, Aristotle accepts that there are some essential properties whose knowledge cannot be acquired without demonstration (or demonstrative explanation). Aristotle would thence be committed to the existence of essential properties decipherable solely through causal knowledge. Is this philosophically defensible?

Let us again consider the case of our astronomer who knows that (*a*) the Moon suffers eclipse, that (*b*) the Earth interposes itself between the Sun and the Moon, that both events occur (when they occur) at the same time, so that, if *a*, then, *b*, and vice versa, but does not recognize the interposition of the Earth between the Sun and the Moon *as being the cause* of the lunar eclipse. As we have seen, there are solid reasons to think that, for Aristotle, this astronomer does not have demonstrative knowledge of the lunar eclipse, since he or she does

[43] Thus, an *explanandum* sentence is true (or false) not in itself, but as far as the thought it expresses is true (or false). I would like to point out that this view is compatible with that of Crivelli (2004, p. 72-75), according to which "Aristotle probably thinks that every sentence which is true or false is an utterance, i.e. an event which occurs over a relatively short portion of time, i.e. an expression-token and not an expression-type", in the sense that an expression-token could be conceived as an event in which the user of a language employs an expression-type under a certain interpretation in order to express his thought. However, Crivelli (p. 75-76) seems to eliminate this reading by considerations on *relative truth*, saying that "Aristotle does not make the truth of a sentence relative to an interpretation". If by "sentence" he means "sentence-token", then I think that he is right and his view, if I understand it correctly, does not affect my claims. However, if he means "sentence-type", then I am inclined to disagree, since we can conceive sentence-tokens as interpreted sentence-types.

not know what the cause of this astronomical phenomenon is[44]. Now, according to the strong thesis of *Posterior Analytics* II 8 (93b15-20), this astronomer does not have full knowledge of the essential properties of the lunar eclipse, because it is not possible to know *what* items "whose cause is other" essentially are without demonstrative knowledge, which leads us to seek at least one of the essential properties of the lunar eclipse that are unknown to this astronomer. Is it the (metaphysical) property of being caused by the interposition of the Earth between the Sun and the Moon? That is, by employing the metaphysical predicate "*x* is caused by *y*" to the ordered pair of events, *a* and *b*, can the astronomer discover some essential property of the lunar eclipse? The answer I want to suggest is affirmative.

It is important to note that, by ignoring the interposition of the Earth between the Sun and the Moon *as being the cause* of the lunar eclipse, this astronomer cannot be aware of some crucial information concerning the essential nature of this astronomical phenomenon. In fact, the astronomer cannot know, for example, that the shadow cast on the surface of the Moon belongs to the Earth (and not to another celestial body); the astronomer cannot know that the shadow is heliophotic, that is to say, that this shadow consists of a privation of *solar* light (and not of any light, such as that produced by flames on the surface of the Moon); nor can the astronomer know that the very privation of light from the Moon, observable to the naked eye during some full moons, in reality, is no more than a shadow (and not, for example, darkness resulting from the extinguishing of fire on the incandescent surface of the Moon)! In short, this astronomer cannot know that the privation of light from the Moon, also called "lunar eclipse", is in fact the shadow of the Earth cast on the sunny surface of the Moon. In fact, in order to know that, the astronomer must recognize the interposition of the Earth between the Sun and the Moon *as being the cause* of the lunar eclipse.

Now, two questions emerge. Firstly, can an astronomer know *what* the lunar eclipse is without knowing that the privation of light from the Moon and the shadow of the Earth cast over the sunny surface of the Moon are not distinct phenomena? Secondly, how can the astronomer be aware of being faced with one and the same phenomenon except by taking the interposition of the Earth between the Sun and the Moon to be the cause of the lunar eclipse?

What I am suggesting is that, for Aristotle, the discovery of the cause and the resulting formulation of the *explanans* reveal essential properties of an item *x* (e.g. lunar eclipse, thunder, ice etc.), which are knowable solely through causal knowledge. Generally speaking, *x* is essentially *y* if and only if *x* is caused by *z*. In order to see how exactly this works, consider again the three candidates for the role of *explanans* of the lunar eclipse alluded in *Posterior Analytics* II 8 (93b3-6), namely: (1) the interposition of the Earth etc., (2) the rotation of the Moon on its own axis, and (3) the extinguishing of fire. It is noteworthy that the understanding of what the lunar eclipse is radically changes in accordance with the *explanans* endorsed. If the lunar eclipse is caused by (1) the interposition of the Earth between the Sun and the Moon, then it is essentially the shadow of the Earth cast over the sunny surface of

[44] For Aristotle, to know the cause is a *sine qua non* condition for demonstrative knowledge. See, for example, the six requirements for demonstrative knowledge in *Posterior Analytics* I 2.

the Moon. If it is caused by (2) the rotation of the Moon on its own axis, then it is essentially the hiddenness of the flaming face of the Moon (from an observer on the Earth). If it is caused by (3) the extinction of fire, then it is essentially the quenching of the flames on the surface of the Moon[45]. The conception of lunar eclipse and the understanding of the fact that the Moon suffers privation of light (eclipse) are radically determined by the *explanans* the astronomer endorses, so that it is not possible to know *what* the lunar eclipse is except through demonstrative knowledge (*Posterior Analytics* II 8, 93b15-20), more precisely, through the discovery of the cause and formulation of the *explanans*. In other words, without discovering the cause and formulating the *explanans*, it is unclear (*adêlos*, see *Metaphysics* H 4, 1044b9-15) *what* the lunar eclipse is, whereas, after the discovery of the cause and the resulting acquisition of an explanation, *what* the lunar eclipse is becomes clear (*dêlon*, see *Posterior Analytics* II 8, 93b15-20)[46]. Both the *definiendum* (the expression "<lunar> eclipse") and the *explanandum* ("the Moon suffers privation of light" or "privation of light <from the Moon>") are reinterpreted in accordance with the discovery of the cause and formulation of the *explanans*. If I am right, then, for Aristotle, demonstration is, among other things, a process of causal based reinterpretation of the *explanandum* (consequently, also of the *definiendum*, since the pre-demonstrative *definiens* is the *explanandum* formulated as a naming expression), a process that cannot occur without bringing together the semantic enrichment of the linguistic formulations (either as a declarative sentence, such as "the Moon suffers privation of light", or as a naming expression, like "privation of light from the Moon") of the object under investigation, that is, the deciphering of the essential properties solely knowable through the discovery of the cause, which includes an unavoidable and radical generation of new truths and, therefore, expansion of knowledge[47].

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[45] Aristotle does not go to the point of explicitly formulating these three alternative *definientia* for the expression "lunar eclipse".

[46] For a slightly different interpretation of the reason for the *logos* of lunar eclipse being *adêlos* without the efficient cause, see Code (2015, p. 25): "Why is the account unclear without the efficient cause? At least part of the reason is simply that without the efficient cause such an account is *too general* to be something distinctive of just lunar eclipses. There are various ways in which something – even the moon – could be deprived of light. […] Aristotle's proposal is not that this is clarified by adding some more determinate specification of observable feature of the moon's light deprivation, or a fuller phenomenological description of what eclipses look like to observers. The proposal is rather that this (allegedly unclear) *logos* is made clear by accompanying it with a statement of the efficient cause that is responsible for the subject, the moon, having that property, or form-analogue". In my opinion, the *adêlos logos* of <lunar> eclipse (i.e. "privation of light <from the Moon>"), although too general, could still be distinctive of just lunar eclipses. However, even in such a case, this *logos* would be correctly described as unclear or too general without the efficient cause, because it is not clear to the astronomer how to interpret the phenomenal data that the *logos* expresses. In fact, without knowing the cause, the astronomer cannot be sure that the phenomenal data observed during lunar eclipses correspond to the extinguishing of the flames on the surface of the Moon, to the hiddenness of the flaming face of the Moon (from an observer on the Earth), or to the shadow of the Earth cast over the sunny surface of the Moon. Without knowing the cause, the astronomer can identify and even predict occurrences of a lunar eclipse, but cannot *understand* what exactly is happening to the Moon when it suffers an eclipse, i.e., the astronomer does not know *what* a (lunar) eclipse is.

[47] In some measure, the results for which I am arguing here were already paved by some interpreters. In fact, some endorse views that seem to be committed to the variation in the sense of the *explanandum* that I am suggesting. For example, Charles (2000, p. 45), by comparing the first with the third kind of definition among

those listed in *Posterior Analytics* II 10, points out a "semantic" difference between them: "the first definition is […] general in form, and fails uniquely to identify the type of noise in question. While it says that thunder is a type of noise in the clouds, it does not state which it is. Thus, the *definiens* as well as the *definienda* will be different in the two cases. Even if some of the same terms are used ("noise in the clouds") at Stage 1 they are used to make an indefinite claim about a type of noise (*tis*), while in the second they uniquely identify the phenomenon in question". It should be noted that the expression "noise in the clouds" is precisely the *explanandum* (see *Posterior Analytics* II 10, 94a 8-10), although formulated as a naming expression. Charles seems to think that the same terms (i.e. "noise in the clouds") might be used both in a vague sense (in Stage 1) and in a more precise sense (Stage 3). Ferejohn (2013, p. 144-145) seems to argue in a similar direction, speaking of a "phenomenal (or 'thin') conception of thunder", one that gives place to the scientific conception of thunder and is obtainable from a scientific demonstration. Angioni (2014, p. 319), discussing *Physics* I 1 (184a16-26), seems to recognize the role of explaining in relation to the formulation of new definitions (which I take to imply new senses for terms like "privation of light (eclipse)", "noise in the cloud (thunder)", "solidification of water (ice)" etc.): "Research in the natural science consists exactly in this inquiry into differentiations and exact definitions, and this explains why Aristotle describes it as a path from '*katholou*' towards '*kath' hekaston*'. According to this itinerary of research, scientific explanation does not consist in a mere inclusion of data in more and more general classes. This work of classification is a mere preparatory step to another kind of work: to discern specific features able (i) to explain why things have the generic features we first are acquainted with and (ii) to ground a definition more satisfactory than the preliminary one". Code (2015, p. 25), already mentioned in the footnote 46, recognizes that the expression "privation of light <from the Moon>", in *Met.* H4, is not clarified "[…] by adding some more determinate specification of observable feature of the moon's light deprivation, or a fuller phenomenological description of what eclipses look like to observers", which leads me to think that it is made clear throughout some *semantic* modification, promoted by the discovery and formulation of the *explanans*.

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