UNIVERSIDADE ESTADUAL DE CAMPINAS
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ONTOLOGICAL UNDERPINNINGS OF ARISTOTLE'S PHILOSOPHY OF SCIENCE

Fundamentos Ontológicos da Filosofia da Ciência de Aristóteles

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ESTE EXEMPLAR CORRESPONDE À VERSÃO
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A Comissão Julgadora dos trabalhos de Defesa de Tese de Doutorado, composta pelos Professores Doutores a seguir descritos, em sessão pública realizada em DATA, considerou o candidato Breno Andrade Zuppolini aprovado.

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A Ata de Defesa, assinada pelos membros da Comissão Examinadora, consta do processo de vida acadêmica do aluno.

To my parents, Marta and Alexandre, for
their love, patience, and support.

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First let me talk with this philosopher. —
What is the cause of thunder?

William Shakespeare, *King Lear* III. iv. 138-9

ABSTRACT

This dissertation focuses on the ontological underpinnings of Aristotle's philosophy of science. His notion of scientific knowledge is committed to a certain kind of foundationalism, which recognizes essences as ultimate explanatory factors. The philosopher distinguishes between two kinds of essence-bearers: subjects and attributes. Our analysis of this distinction involves a study of Aristotle's doctrine of ontological categories and his theory of predication. In addition, we specify the roles played by the essences of subjects and the essences of attributes in scientific explanations. As a result, Aristotle's foundationalism amounts to the view that reality is composed of finite chains of explanatory connections and entities whose essences are connected to one another in a hierarchical structure.

Keywords: Aristotle; science; essence; predication; foundationalism.

RESUMO

Esta tese dedica-se aos fundamentos ontológicos da filosofia da ciência de Aristóteles. Sua noção de conhecimento científico compromete-se com certo tipo de fundacionismo, que reconhece essências como fatores explanatórios últimos. O filósofo distingue dois tipos de portadores de essência: sujeitos e atributos. Nossa análise dessa distinção envolve um estudo da doutrina das categorias e da teoria da predicação de Aristóteles. Ademais, procuramos especificar os papéis desempenhados pelas essências dos sujeitos e pelas essências dos atributos em explicações científicas. Como resultado, temos que o fundacionismo de Aristóteles consiste na visão de que a realidade é composta de cadeias explanatórias finitas e entes cujas essências estão conectadas umas às outras em uma estrutura hierárquica.

Palavras-chave: Aristóteles; ciência; essência; predicação; fundacionismo.

ABBREVIATIONS

APo = Analytica Posteriora

APr = Analytica Priora

Cael. = de Caelo

Cat. = Categoriae

De An. = de Anima

EE = Ethica Eudemia

EN = Ethica Nicomachea

GA = de Generatione Animalium

GC = de Generatione et Corruptione

HA = Historia Animalium

IA = de Incessu Animalium

Insomn. = de Insomniis

Int. = de Interpretatione

Long. = de Longaevitate

MA = de Motu Animalium

MM = Magna Moralia

Metaph. = Metaphysica

Mete. = Meteorologica

PA = de Partibus Animalium

Ph. = Physica

Po. = Poetica

Pol. = Politica

Rh. = Rhetorica

SE = Sophistici Elenchi

Somn.Vig. = de Somno et Vigilia

Top. = Topica

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INTRODUCTION

We do not find anywhere in the *corpus aristotelicum* a systematic approach to the concept of knowledge in general. Perhaps such a general epistemology can be reconstructed in some way or another by comparing the different kinds of cognition Aristotle recognizes in many of his works.[1] It is true that one of his treatises, the *APo*, focuses on the notion of ἐπιστήμη, commonly translated as 'knowledge'. However, unlike Plato in the *Theaetetus*, Aristotle, in the *APo*, is not primarily concerned with knowledge generally speaking, with its conditions of possibility, sceptical challenges, or other topics we classify as typically epistemological.[2] Actually, the philosopher is interested in ἐπιστήμη ἁπλῶς – as defined in *APo* I 2, 71ᵇ 9-12 –, the superior kind of knowledge that is characteristic of expert scientists.[3] If the main object of the *APo* is scientific knowledge, we can affirm that the theory advanced in the treatise is better described as a philosophy of science than as a general epistemology.[4]

Aristotle recognizes two basic types of scientific knowledge. On one hand, there is 'demonstrative knowledge' (ἐπιστήμη ἀποδεικτική), which is provided by an argument called

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[1] For a useful discussion, see Bronstein (2016a, pp. 16-21).

[2] See Taylor (1990, p. 116); Ferejohn (1991, pp. 2-3). However, as we shall see, a sceptical challenge against Aristotle's notion of scientific knowledge (and not knowledge in general) is addressed in *APo* I 3 and *APo* I 19-22.

[3] See Bronstein (2016a, pp. 18-20). Burnyeat (1981) argues that this use of the expression 'ἐπιστήμη' corresponds to our notion of 'understanding', rather than the broader notion of 'knowledge.' Although I accept Burnyeat's main claims, I agree with Bronstein that it is important to emphasize that 'ἐπιστήμη' is a kind of knowledge (the kind of knowledge expert scientists possess). Thus, I prefer to translate 'ἐπιστήμη' as 'scientific knowledge'.

[4] Cf. Ferejohn (1991, p. 2-3), who argues that none of the nomenclatures fully applies to Aristotle's theory.

'demonstration' (ἀπόδειξις). A demonstration is a deductive reasoning in which the premises present the *cause* or the *explanation* (αἴτιον) of the fact expressed in the conclusion.[5] On the other hand, there is another kind of scientific knowledge called 'comprehension' – in Greek, 'νοῦς'. Νοῦς is the knowledge that scientists have of fundamental explanations, i.e. indemonstrable principles on which demonstrative knowledge is ultimately based.

The existence of two kinds of scientific knowledge is crucial to Aristotle. If every premise in a demonstration were itself known by demonstration, the philosopher would have to admit one of the following two scenarios:

(A)   The number of propositions in a demonstration is finite. However, if all scientific propositions are demonstrable, demonstrations have to proceed 'in a circle and reciprocally' (*APo* I 3, 72[b] 17-18), i.e. the demonstration of **p** includes among its premises propositions whose demonstration includes **p** among its premises.

(B)   There is no such thing as circular demonstrations. However, if all scientific propositions are demonstrable, every demonstration must involve infinitely many premises (*APo* I 3, 72[b] 7-10), i.e. **p** is demonstrated from different and more basic premises, whose demonstrations involve different and even more basic premises, and so on *ad infinitum*.

In *APo* I 3, Aristotle rejects both of these scenarios. Scenario (A) is denied on the grounds that circular 'demonstrations' are not properly explanatory. For him, the relation '…being explanatory of…' is asymmetrical: if a proposition **p₁** is explanatory of **p₂** (and **p₁** is a premise from which **p₂** is demonstrated), **p₂** is not explanatory of **p₁** (and therefore cannot be a premise from which **p₁** is demonstrated).[6] Scenario (B) is also rejected because an infinite set of premises cannot be surveyed with thought.[7] Aristotle avoids circularity, on one hand, and infinite regress, on the other, by rejecting the common assumption underlying (A) and (B), namely, that all scientific propositions are demonstrable. For him, demonstrative knowledge relies on noetic knowledge of indemonstrable premises.

Given this picture, it is easy to see how the theory advanced in the *APo* has been taken as a form of 'foundationalism'.[8] In the following chapters, I attempt to clarify the main aspects of Aristotle's theory of demonstration and try to specify in what sense it can be taken as a

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[5] I shall use the word 'cause' to translate Aristotle's notion of 'αἴτιον' with the consciousness that we should not conflate the concept Aristotle has in mind with the modern (humean) notion of cause.

[6] According to Aristotle, 'an explanation is prior to what it is explanatory of' (τὸ γὰρ αἴτιον πρότερον οὗ αἴτιον, *APo* II 16, 98[b] 17) and priority is an asymmetrical relation (*Cat.* 12, 14[a] 29-35; 14[b] 11-22; *Metaph.* V 11, 1019[a] 1-4; VII 10, 1034[b] 30-32; 1035[b] 6-7). See also *APo* I 3, 72[b] 25-73[a] 20; *APr* II 16.

[7] *APo* I 3, 72[b] 7-15; I 22, 82[b] 37- 83[a] 1; 83[b] 6-7, 83[b] 32 - 84[a] 6.

[8] See Irwin (1988, pp. 130-1); Ferejohn (1991, pp. 4-5; 2009, p. 66); Goldin (2013); Zuppolini (2014b; 2016).

foundationalist doctrine. My primary aim is to show how Aristotle's foundationalism is deeply rooted in metaphysical views involving concepts such as cause, essence, and predication.

In Chapter 1, I discuss in detail the common view that Aristotle endorses some form of foundationalism. Without disputing the nomenclature, I argue that his 'foundationalism' should not be taken as a rationalist theory of epistemic justification, as if the first principles of science could be known as such independently of their explanatory connections to other propositions. On the contrary, knowing first principles as such involves knowing them *as explanatory of* demonstrable facts. As a result, we can affirm (or so I shall argue) that noetic and demonstrative knowledge are in a sense interdependent cognitive states. In addition, the relation between νοῦς and ἐπιστήμη ἀποδεικτική elucidates in which way definitions are first principles for Aristotle. The philosopher distinguishes definitional sentences as mere accounts of meaning (or nominal definitions) from definitions as accounts of essence (or real definitions). Real definitions are 'accounts displaying the reason why' (*APo* II 10, 93^b 39), which, in virtue of their explanatory content, play the role of first principles in demonstrative sciences. In other words, Aristotle's 'foundationalism' consists in recognizing essences as ultimate explanations, which makes his essentialism one of the most important ontological underpinnings of his philosophy of science.[9]

Chapter 2 focuses on another topic closely related to what is discussed in Chapter 1: the interdependence between defining and explaining. I shall follow part of the secondary literature and argue that defining and explaining are interdependent scientific practices.[10] For Aristotle, we cannot know the essence of something independently of the explanatory role it plays in demonstrations. This means that the acquisition of definitions intrinsically involves the act of explaining demonstrable facts. According to Aristotle, real definitions are made clear through demonstrations (*APo* II 8, 93^b 17-18) and are described as demonstrations 'differing in arrangement' (*APo* II 10, 94^a 2). These definitions are isomorphic to demonstrative syllogisms: thunder is defined as a certain noise in the clouds caused by extinction of fire; we acquire this definition by explaining syllogistically that the kind of noise we call 'thunder' (major term) occurs in the clouds (minor term) in virtue of fire being extinguished (middle term).

At the end of this chapter, I address a long-standing question, recently revived in the literature.[11] In different passages of *APo* II, Aristotle affirms that the middle term captures the essence (or the causal part of the essence) of the major term[12]: extinction of fire (middle term) is the causal element in the definition of thunder (major term) and explains why it belongs to the

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[9] This first chapter is a modified version of Zuppolini (2016)

[10] The most prominent defence of this view is in Charles (2000). See also Kung (1977); Charles (2010b, pp. 268-328); Williams & Charles (2013); Peramatzis (2011, pp. 180-188; 2013); Koslicki (2012); Angioni (2014c; 2016).

[11] Ferejohn (2013, p. 149-155); Angioni (2014c, pp. 103-107); Bronstein (2015; 2016a, pp.48-50).

[12] See *APo* II 8, 93^b 6; 12; II 16, 98^b 21-24; II 17 99^a 21-22, 25-26.

clouds (minor term). However, demonstrable attributes are described by Aristotle as '*per se* accidents' (καθ᾽αὑτὰ συμβεβηκότα), which are defined as predicates belonging to a subject 'in itself' (καθ᾽αὑτὸ), but not as a part of its 'essence' (οὐσία).[13] Many interpreters think that, by characterizing demonstrable attributes as *per se* accidents, Aristotle wants to stress that science deals with properties that are peculiar to their subjects and belong to them in virtue of the subjects being what they are. In other words, demonstrable attributes are non-essential properties that follow from and are explained by the essence of their subjects. Thus, the reader of the *APo* is entitled to ask: is the middle term the definition of the major (attribute) or the minor term (subject)? I shall not present my solution to this problem until Chapter 5.

The debate about whether the explanation of a demonstrable fact is the essence of the attribute or the essence of the subject requires a fine-grained analysis of the distinction between subjects and attributes. In Chapter 3, I reconstruct a sophisticated and complex proof presented by Aristotle in *APo* I 19-22. An important part of his proof consists of a theory of predication involving the doctrine of ontological categories. Thus, a close examination of these chapters helps us understand the distinction between subjects and attributes and the constraints it imposes on scientific discourse. But there is a reason to consider the proof in its entirety. Its main purpose is to show how a demonstrative science is protected against the threat of infinite regress if it adopts the syllogistic as its underlying logic and regulates its use with certain ontological-semantical principles. If so, we can take Aristotle's argumentation in *APo* I 19-22 as a metaphysically loaded defence of his foundationalism.

The topic of predication is further examined in Chapter 4, in which I analyse the four senses of 'καθ᾽ αὑτὸ' ('in itself' or '*per se*') distinguished in *APo* I 4. Far from being just linguistic relations between terms (as it is usually thought), I argue that the four uses of 'in itself' presuppose a hierarchical organization of the different kinds of entities in a scientific domain, in which the ontological priority of subjects over attributes plays an important role. The first use of 'in itself' (*per se₁*) covers all essential predicates of all kinds of essence-bearers (subjects and attributes). The second (*per se₂*) presupposes the distinction between prior and posterior essence-bearers (subjects and attributes, respectively), the former being defined without mentioning the latter, but not the other way around. The third use (*per se₃*) applies precisely to the primary essence-bearers, which are what they are independently of being predicated of something different. Finally, the fourth sense of 'in itself' (*per se₄*) is used to identify the appropriate subjects of demonstrable attributes from an explanatory point of view. In addition, I discuss some of the most prominent views on the notion

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[13] *Metaph.* V 30, 1025ᵃ 10-34.

of '*per se* accident' available in the secondary literature and offer my own interpretation of this concept.[14]

In Chapter 5, I propose an interpretation of *APo* II 16-17. In these chapters, Aristotle claims that there cannot be more than one *explanans* for the same scientific *explanandum*. However, this seems to be true only for 'primary-universal' (πρῶτον καθόλου) demonstrations, in which the major term belongs to the minor 'in itself' and the middle term is coextensive with the extremes. If so, several *explananda* we would like to admit as truly scientific would be out of the scope of an Aristotelian science. The secondary literature has identified a second problem in II 16-17, which we previously discuss at the end of our Chapter 2 : the middle term of a demonstration is sometimes taken as the definition of the minor term (the subject), other times as the definition (or the causal part of the definition) of the major (the demonstrable attribute). I shall argue that Aristotle's solution to the first problem involves showing that certain problematic attributes, which appear to admit more than one explanation, actually fall into the privileged scenario of primary-universal demonstrations. In addition, his solution suggests a conciliatory way-out to the second problem (or so I shall argue): the existence of an attribute as a definable unity depends on its subject having the essence it has, which indicates that both the essence of subjects and the essence of demonstrable attributes can play explanatory roles in demonstrations.

Finally, in Chapter 6, I argue against the view that the essence of subjects constitutes an exception to the interdependence between defining and explaining. By analysing passages from *Metaph.* VII 17 and VIII 2-4, I try to show how the model applied to attributes and processes in *APo* II 8-10 works for subjects as well. The chapter includes a brief discussion of Aristotle's hylomorphism. After all, his theory of form and matter is what allows him to extend to subject-kinds the picture advanced in *APo* II 8-10. In addition, I shall argue that the interdependence between defining and explaining holds good even for subjects that are not analysable as compounds of form and matter: despite not being isomorphic to a demonstrative syllogism, the essence of an unanalysable subject cannot be known *as such* if it is not perceived as explanatory of the subject's demonstrable properties.

In all these six chapters, we can see Aristotle offering general principles that (he believes) can be used by expert scientists in their specific fields. However, those guidelines should apply to all scientific domains independently of their differences and peculiarities. My aim is to clarify how Aristotle's general metaphysics (which he believes to be true for all domains of reality) helps him to accomplish this task. Therefore, this dissertation can be regarded as an attempt to reconstruct the ontological framework associated with Aristotle's philosophy of science.

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[14] Some segments of this chapter are modified versions of arguments found in Zuppolini (forthcoming).

CHAPTER 1

ARISTOTLE'S FOUNDATIONALISM

1.1 – Scientific Knowledge: Demonstration, Comprehension, and Foundationalism

Aristotle begins the *APo* with the following general statement: 'all teaching and all learning of all intellectual kind proceed from pre-existing knowledge' (*APo* I 1, 71ᵃ 1-2).[15] The philosopher notes that, when intellectual learning is provided by an argument, either deductive or inductive, we learn the conclusion when we have previous knowledge of the premises (*APo* I 2, 71ᵃ 5-9). In the *APo*, Aristotle focuses on a preeminent kind of learning which produces what he calls 'demonstrative knowledge' (ἐπιστήμη ἀποδεικτική). Such knowledge is acquired by *demonstration* (ἀπόδειξις), a deductive argument in which the premises present the *explanatory factor* (αἴτιον) in virtue of which the conclusion is the case. A full-fledged demonstration provides understanding 'without qualification' (ἁπλῶς), which differs from the mere pretence of knowledge labelled as 'sophistic' (σοφιστικόν) or 'incidental' (κατὰ συμβεβηκός):

> [**T1**] Ἐπίστασθαι δὲ οἰόμεθ᾽ ἕκαστον ἁπλῶς, ἀλλὰ μὴ τὸν σοφιστικὸν τρόπον τὸν κατὰ συμβεβηκός, ὅταν τήν τ᾽ αἰτίαν οἰώμεθα γινώσκειν δι᾽ ἣν τὸ πρᾶγμά ἐστιν, ὅτι ἐκείνου αἰτία ἐστί, καὶ μὴ ἐνδέχεσθαι τοῦτ᾽ ἄλλως ἔχειν.

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[15] All quotations of the *APo* come from Barnes (1993). Eventual modifications are indicated.

> We think we understand something without qualification (and not in the sophistical way, incidentally) when we think we know of the cause because of which something holds that it is its cause, and also that it is not possible for it to be otherwise [*APo* I 2, 71^b 9-12; Barnes 1993, with changes].

Aristotle also affirms that demonstrative knowledge is one of the (apparently two)[16] types of 'understanding without qualification' (ἐπίστασθαι ἁπλῶς): 'whether there is another type of scientific knowledge we shall say later: here we assert that we do know things through demonstrations' (*APo* I 2, 71^b 16-17). Although Aristotle is primarily concerned with demonstrative knowledge in the *APo*, the other kind of ἐπιστήμη ἁπλῶς whose existence is implied in this passage is relevant to assessing the overall picture of his philosophy of science. As a result of intellectual learning, demonstrative knowledge is based on previous knowledge, which means that, if the ordered pair ⟨**Π**, **c**⟩ is a demonstration – where **Π** is a set of premises and **c** is the conclusion –, the knowledge of **c** is based on the knowledge of the members of **Π**, **p₁**, **p₂**, … , **pₙ**. However, if the knowledge of each **pᵢ** is itself demonstrative, there should be, for each **pᵢ**, a subset of **Π**, **Π'**, such that ⟨**Π'**, **pᵢ**⟩ would the demonstration of **pᵢ**. In that case, either each **pᵢ** would never be a member of **Π'** – that is to say, every premise would be demonstrated from different and more basic premises – or ⟨**Π**, **c**⟩ would involve circular explanations. In *APo* I 3, Aristotle takes both alternatives as problematic. In the first case, the set **Π** would be infinite and Aristotle believes that a demonstration with an unlimited set of premises is impossible simply because we could not survey it with thought.[17] The alternative, however, is not better, since Aristotle does not recognize any demonstrative value in circular proofs (see *APo* I 3, 72^b 25-73^a 20; *APr* II 16).

The two horns of this (apparent) dilemma relates to two epistemological views Aristotle rejects in *APo* I 3. One of them admits the possibility of scientific knowledge by accepting circular explanations as authentic demonstrations. The other view is sceptical about the possibility of demonstrative knowledge on the grounds that demonstrating would be a process that leads to infinite regress. Aristotle believes that both views rely on the false assumption that every type of knowledge is demonstrative and offers a solution that has been described as a form of 'foundationalism.'[18] If ⟨**Π**, **c**⟩ is a demonstration, the set **Π** is finite, there being a subset of **Π**, **Π'**, such that, whereas all the members of **Π'** are indemonstrable, all the other premises in **Π** (and consequently **c**) are directly or indirectly demonstrated from them.[19] In *APo* I 2, Aristotle had already anticipated his solution by affirming that all demonstrations proceed from 'items which are

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[16] The other kind of knowledge in question is called 'νοῦς.' For a convincing argument that the definition of ἐπιστήμη ἁπλῶς in T1 applies to noetic knowledge as well, see Bronstein (2016a, pp. 51-57). See also Bronstein (2012, p. 34).

[17] *APo* I 3, 72^b 7-15; I 22, 82^b 37- 83^a 1; 83^b 6-7, 83^b 32 - 84^a 6.

[18] See Irwin (1988, pp. 130-1); Ferejohn (1991, pp. 4-5; 2009, p. 66); Goldin (2013); Zuppolini (2014b; 2016).

[19] *APo* I 3, 72^b 18-25; I 19, 82^a 2-9; I 22, 83^b 24-84^b 2.

true and primitive and immediate and more familiar than and prior to and explanatory of the conclusion' (*APo* I 2, 71^{b} 19-22). Although these basic premises are indemonstrable (*APo* I 2, 71^{b} 26-7), we do have knowledge of them 'without qualification' by a cognitive state Aristotle calls 'comprehension' (νοῦς, *APo* II 19, 100^{b} 5-17).[20] Therefore, the nature of ἐπιστήμη ἁπλῶς is two-fold not without reason. Working with those two kinds of scientific knowledge (noetic and demonstrative) is what enables Aristotle to sustain his foundationalist project.

After these general considerations on the nature of knowledge and demonstration in *APo* I 1-3, Aristotle moves on to present a *an abstract model* or *paradigm* of demonstrative knowledge (with its own ontological framework, semantic principles, and formal features) whose feasibility is meant to show that the foundationalist enterprise is possible and worth pursuing.[21] Because it produces knowledge by means of arguments of a certain sort, demonstrative sciences should adopt an appropriate set of rules of inferences to underlie its argumentation. To play the role of underlying logic in his abstract model, Aristotle selects the formal system developed in *APr*, the Syllogistic.[22] Thus, in an Aristotelian demonstration ⟨**Π**, **c**⟩, each element of **Π** and **c** are phrased – or at least susceptible to being phrased – in one of the four syllogistic categorical sentences:

> Universal Affirmative: P holds of all S (henceforth, 'PaS')
> Particular Affirmative: P holds of some S ('PiS')
> Universal Negative: P holds of no S ('PeS')
> Particular Negative: P holds not of every S ('PoS')

In addition, an Aristotelian demonstration is made of one or more syllogistic inferences, in which a pair of categorical premises sharing a common term (the middle term) entails another categorical sentence with the remaining two terms (the major and the minor extremes); an inference in *Barbara*, for instance, could be represented as follows:

PaM, MaS	P holds of all M, M holds of all S
PaS	P holds of all S

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[20] It is worth noting that in *APo* II 19 (and also in I 3, 72^{b} 18-25) the term 'ἐπιστήμη' refers to a narrower notion that excludes the knowledge of first principles. In these passages, 'νοῦς' is described not as 'ἐπιστήμη' but as 'ἀρχὴ ἐπιστήμης.'

[21] Cf. Ferejohn (2013, p. 81) who describes his overall interpretation of the *APo* as showing that 'there is a major break between the opening three chapters (A 1-3) – where Aristotle develops a set of general pre-theoretical constraints on the possession of scientific knowledge – and the remainder of the book, beginning in chapter A 4, in which he sets out his own (syllogistic based) theory of demonstration designed specifically to satisfy these constraints.' See also Ferejohn (1991; 2013, p. 65). I would like to point out that I take the constraints formulated in *APo* I 1-3 as concerning *scientific knowledge* (and not knowledge generally speaking), with its characteristic explanatory content, understood in the strong and restrictive terms I am going to propose in rest of this chapter.

[22] For a defence of the view that the Syllogistic is not a logical theory, but an underlying logic, and that syllogisms are not conditionals, but arguments, see Smiley (1973); Corcoran (1974a; 1974c); Smith (1989); Ribeiro (2011, pp. 14-15); Ferreira (2012, pp. 65-68); Weinmann (2014, pp. 4-5). For the opposite view, see Łukasiewicz (1957); Patzig (1968).

Several interpreters objected to the presence of Aristotle's Syllogistic in his theory of demonstration by arguing that the logic of the *APr* is too limited to apply to actual scientific cases, which would explain why it was ignored by scientists of his time – including, according to some of these interpreters, Aristotle himself.[23] One may reply to these critics by pointing out shortcomings either in their interpretations of the Syllogistic or in their understanding of Aristotle's scientific practice.[24] However, there is a sense in which these criticisms are clearly out of place. Once we take the Syllogistic as part of a *model* or a *paradigm* meant to illustrate the nature of demonstrative knowledge in general, it becomes neither necessary nor desirable to assume that the *APo* require all scientists to adopt the Syllogistic as their underlying logic, as if knowledge 'without qualification' were not possible without this specific formal apparatus.[25] In fact, one may argue that Aristotle had good reasons to select a particular logical system for his model of science. In order to come to know **c** based on a set of premises **Π**, we need not only to know that the premises are true, but also to be familiar with the rules of inference that allow us to obtain **c** from **Π**. Therefore, elaborating and selecting a particular deductive system would be a helpful way of exemplifying what kind of knowledge and skills are involved in the process of learning 'by demonstration' (*APo* I 18, 81ª39-40).

It is far from clear, however, how exactly Aristotle thinks we can acquire knowledge through demonstrations. As we shall see in the next section, depending on how this process of learning is specified, Aristotle's solution to the dilemma of *APo* I 3 can be seriously misinterpreted, rendering his foundationalist model of science inconsistent and unattractive.

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[23] See, for instance, Barnes (1981); Leslz (1981); Harari (2004, pp. 87-116); McKirahan (1992, p. 150). I do not intend to deal with the problem of whether Aristotle created the syllogistic before or after the development of the core theses of his theory of demonstration. About the topic, see Solmsen (1929); Ross (1939); Barnes (1981); Smith (1982a); Smith (1982b).

[24] See Gotthelf (1987); Lennox (1987, pp. 118-119); Ribeiro (2011, pp. 23-31; 2014); Angioni (2014b); Zuppolini (2014b).

[25] See Ferejohn (1991; 2013, p. 65; p. 81). Even though the notion of syllogism is present in *APo* I 2 (71ᵇ 16-18; 72ª 15), I believe this chapter is primarily concerned with general requirements on the possession of scientific knowledge, which can be met by sciences that eventually adopt alternative underlying logics. Angioni (2012) argues that the requirements introduced in *APo* I 2, 71ᵇ 20-33 already presuppose the syllogistic structure of demonstrations. Previously, I have myself defended that at least the 'immediacy' criterion brings Aristotle's Syllogistic to the context of 71ᵇ 20-33. See my Zuppolini (2014b, pp. 187-188); see also Smith (1986; 2009, p. 53); McKirahan (1992, p. 25); Barnes (1993, p. 94). I no longer think that it is necessary to read the passage in this way, mainly because Aristotle clarifies the notion of 'immediacy' in terms of 'priority' in 72ª 7-8, not in terms of absence of syllogistic middle terms. Of course, in Aristotle's *model* of demonstrative science, 'immediacy' amounts to the absence of an explanatory middle term, which might explain why he uses the expression 'immediate syllogistic principle' in 71ª 14. However, this does not mean that, for Aristotle, only sciences that adopt the Syllogistic as their underlying logic can meet the requirements listed in 71ᵇ 20-33. Nevertheless, I shall argue in Chapter 5 that the Syllogistic is not a random choice of Aristotle: syllogistic inferences always involve three terms, which makes them adequate to capture causal relations, which Aristotle takes to be triadic – i.e. they involve a cause, an attribute *of which it is cause* (οὗ αἴτιον) and a subject *for which it is cause* (ᾧ αἴτιον). This is what Lucas Angioni calls 'the triadic structure' of scientific explanations. For a systematic discussion of this notion – to which I am very much indebted – see Angioni (2008, pp. 328ff.; 2012; 2013; 2014b; 2014c; 2016). For similar approaches, see Charles (2000, pp. 204-209); Ribeiro (2011, pp. 7-31; 2014).

1.2 – A Rationalist Interpretation of Aristotle's Foundationalism

According to the common contemporary view, someone learns something through an argument ⟨Π, c⟩ when, without previously knowing c to be true, she finds it to be true by (i) knowing in advance that the premises in Π are true and (ii) realizing that c is a logical consequence of Π. Naturally, this view has been imputed to Aristotle and his theory of demonstration:

> Aristotle presented a general truth-and-consequence conception of demonstration meant to apply to all demonstrations. According to him, a demonstration, which normally proves a conclusion not previously known to be true, is an extended argumentation beginning with premises known to be truths and containing a chain of reasoning showing by deductively evident steps that its conclusion is a consequence of its premises [Corcoran 2009, p. 1].

In the same vein, some interpreters believed that Aristotle's foundationalism implies that the indemonstrable principles of sciences are self-evident premises whose truth is known by non-inferential procedures and from which the scientist infers and therefore learns other propositions not previously known to be true.[26] This interpretation of Aristotle's foundationalism might seem congenial to the fact that, in his theory, demonstrations proceed from definitions:[27]

> **[T2]** ἔτι αἱ ἀρχαὶ τῶν ἀποδείξεων ὁρισμοί, ὧν ὅτι οὐκ ἔσονται ἀποδείξεις δέδεικται πρότερον – ἢ ἔσονται αἱ ἀρχαὶ ἀποδεικταὶ καὶ τῶν ἀρχῶν ἀρχαί, καὶ τοῦτ᾽ εἰς ἄπειρον βαδιεῖται, ἢ τὰ πρῶτα ὁρισμοὶ ἔσονται ἀναπόδεικτοι.

> Again, the principles of demonstrations are definitions, and it has been proved earlier that there will not be demonstrations of principles – either the principles will be demonstrable and there will be principles of principles, and this will continue *ad infinitum*, or else the primitives will be indemonstrable definitions [*APo* II 3, 90ᵇ 24-7; Barnes 1993].

Certain definitional statements (usually called 'nominal definitions') are meant to fix the meaning of the terms of scientific discourse. Such statements can be described as analytic and knowable *a priori*. Hence, their status as first principles would rely primarily on self-evidence. According to this view, the intuitive knowledge we have of propositions of this kind is what Aristotle calls 'νοῦς', from which ἐπιστήμη ἀποδεικτική is (deductively) derived. Since these are the only kinds of knowledge 'without qualification', it is easy to understand why Aristotle was once seen as 'the

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[26] See, for instance, Scholz (1975); Irwin (1988, pp. 130-131); Frede (1996).
[27] See also *APo* I 2, 72ᵃ 14-24; I 8, 75ᵇ 30-1; I 33, 89ᵃ 16-9; II 3, 90ᵇ 30-3; *APo* II 8, 93ᵇ 6-7, 12; II 17, 99ᵃ 3-5, 21-6.

paradigm of an extreme rationalist', who would recognise *a posteriori* truths as knowable (if at all) 'only in a debased sense of knowledge.'[28]

However, if this is the process of intellectual learning by which we acquire demonstrative knowledge, Aristotle's foundationalist project seems blatantly inconsistent. As we saw, if ⟨**Π, c**⟩ is a demonstration, the set of premises **Π** reveals the appropriate explanation of the conclusion **c**. However, the philosopher believes we cannot start pursuing the *explanans* without knowing in advance that the corresponding *explanandum* is true (see *APo* II 1-2). Thus, how could a demonstration ⟨**Π, c**⟩ enable us to learn **c** in the first place if knowing that **c** is true is a necessary condition for investigating the very explanation the set **Π** is expected to display?[29]

The apparent inadequacy of Aristotle's account seems to lie with his assumption that the *explanans* is presented by the premises of a demonstration, whereas the *explanandum* is found in the conclusion. In fact, this seems to violate our modern intuitions about how knowledge of causal or explanatory relations is acquired. For instance, modern philosophers of science such as Charles Peirce distinguish between three kinds of arguments:[30]

Deduction:

All the beans from this bag are white, These beans are from this bag
These beans are white

Induction:

These beans are from this bag, These beans are white
All the beans from this bag are white

Abduction:

All the beans from this bag are white, These beans are white
These beans are from this bag

In a deductive argument such as the one formulated above, the premises state a general rule (all the beans from this bag are white) and a case under the rule (these beans are from this bag), whereas the conclusion is obtained by applying the general rule to the particular case (these beans are white).[31] Inductive arguments, on the other hand, obtain a general rule (all the beans from this bag are white) from a number of cases of which certain facts are simultaneously true (these beans are

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[28] Frede (1996, pp. 157-158).
[29] Barnes (1969, p. 146); Burnyeat (1981, pp. 116-117). For a clarifying exposition of the problem, see Bronstein (2014, p. 13; 2016a, pp. 32-33).
[30] See Peirce (*Collected Papers*; 2. 622-623)
[31] See Peirce (*Collected Papers*; 2. 620).

from this bag, these beans are white). Finally, abduction is a kind of reasoning that could be described as 'the process of forming explanatory hypotheses'[32] or as 'inference to the best explanation.'[33] Suppose we find a handful of white beans on a table next to a bag of beans, knowing, in addition, that all the beans from this bag are white. In that case, we are inclined to infer that the beans lying on the table came from the bag simply because this conclusion, if true, would best explain why these beans are white. Thus, abductive inferences produce causal knowledge insofar as the conclusions are explanatory of one or more of their premises. In the *APo*, on the other hand, the premises are explanatory of the conclusion and not the other way around, which seems to invert the order in which arguments are supposed to produce knowledge of causal relations.

This picture explains why the interpretation advanced by Jonathan Barnes (1969) has been so influential. Barnes argued that the *APo* are not meant to describe how scientists acquire knowledge, nor does it intend to account for scientific research. Instead, 'the theory of demonstration offers a formal account of how an achieved body of knowledge should be presented and taught' (Barnes 1969, p. 147). This solution is attractive. Without violating our intuitions about how causal knowledge is acquired, it explains why it is possible to learn things 'by demonstration': demonstrative arguments do not reflect the order in which the expert scientist reaches his explanations, but the order in which she imparts these explanations to her pupils.

However, if demonstrating were essentially a pedagogic procedure, it would not be good one. Aristotle makes it clear that the premises of a demonstration are more familiar and prior to the conclusion precisely because they are explanatory of it (*APo* I 2, 71ᵇ 31-2). In this context, the explanatory priority of the premises corresponds to what Aristotle describes as priority 'by nature'. However, what is prior and more familiar 'by nature' (τῇ φύσει), says he, is not the same as what is prior and more familiar 'to us' (πρὸς ἡμᾶς, *APo* I 2, 71ᵇ 33- 72ᵃ 5). The premises of a demonstration are not more familiar and prior to the conclusion in the sense of being obviously true and more likely to be accepted by someone who is not yet an expert on the subject in question. They are prior and more familiar 'by nature' insofar as they display the *cause* of the fact expressed in the conclusion – see 'εἴπερ αἴτια' in *APo* I 2, 71ᵇ 31 –, a cause that not even the expert knows from the start, but grasps only after a complex procedure of inquiry. In other words, what counts as an αἴτιον for Aristotle is (causally) prior to the phenomenon it explains *independently* of the way the phenomenon was discovered in the first place.

To some extent, this is a problem of philosophical vocabulary. Foundationalism is usually depicted as a theory of how knowledge and true beliefs are justified, whereas Aristotelian

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[32] Peirce (*Collected Papers*; 5.172).
[33] Harman (1965).

explanations cannot be confounded with mere justification. Mere justifications provide answers to questions such as 'why do I believe that **p**?'. Aristotelian explanations, on the other hand, are meant to answer the question 'why is it the case that **p**?'[34] In order to justify my belief in a proposition **p**, all I need is to set out the reasons why I believe in **p**. On the other hand, for Aristotle, to present the αἴτιον of **p** is to identify a real-world item that is responsible for **p** being true (instead of being responsible for my belief that **p** is true).[35] Premises that are explanatory in this strong sense are certainly not self-evident or knowable *a priori*. Therefore, when interpreted according to the rationalist approach depicted above, Aristotle's foundationalism becomes incompatible with his own concept of explanation. If his solution to the dilemma of *APo* I 3 is to be labelled as a form of foundationalism at all, it seems preferable to specify what kind of foundationalism it is not in terms of justification, but in terms of causal explanations.

1.3 – Coming to Know First Principles: A Non-Rationalist Account

The acquisition of first principles is the topic of the very last chapter of the *APo*. In II 19, Aristotle identifies 'the state that knows' (ἡ γνωρίζουσα ἕξις, 99ᵇ 18) the principles with νοῦς, which is characterised as the most 'accurate' of our cognitive states (100ᵇ 5-14). One of Aristotle's aims in the chapter is to address the following puzzle:

> **[T3]** Ὅτι μὲν οὖν οὐκ ἐνδέχεται ἐπίστασθαι δι᾽ ἀποδείξεως μὴ γιγνώσκοντι τὰς πρώτας ἀρχὰς τὰς ἀμέσους, εἴρηται πρότερον. τῶν δ᾽ ἀμέσων τὴν γνῶσιν, [...] διαπορήσειεν ἄν τις [...] πότερον οὐκ ἐνοῦσαι αἱ ἕξεις ἐγγίνονται ἢ ἐνοῦσαι λελήθασιν. εἰ μὲν δὴ ἔχομεν αὐτάς, ἄτοπον· συμβαίνει γὰρ ἀκριβεστέρας ἔχοντας γνώσεις ἀποδείξεως λανθάνειν. εἰ δὲ λαμβάνομεν μὴ ἔχοντες πρότερον, πῶς ἂν γνωρίζοιμεν καὶ μανθάνοιμεν ἐκ μὴ προϋπαρχούσης γνώσεως; ἀδύνατον γάρ, ὥσπερ καὶ ἐπὶ τῆς ἀποδείξεως ἐλέγομεν.
>
> I have said earlier that you cannot understand anything through a demonstration unless you know the primitive immediate principles. As for knowledge of the immediates, one might wonder […] whether the states, not being present in us, come about in us or rather are present in us without being noticed. It is absurd to suppose that we possess such states; for then we should possess pieces of knowledge more accurate than demonstration without its being noticed. But if we get them without possessing them earlier, how could we come to acquire knowledge and to learn except from pre-existing knowledge? This is impossible, as I said in connection with demonstration [*APo* II 19, 99ᵇ 20-30; Barnes 1993, with changes].

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[34] See Goldin (2013, p. 200).
[35] See my Zuppolini (2014b, pp. 178-179; 2016). On the difference between justification and explanation, see Burnyeat (1981, p. 101); Goldin (2013, p. 200); Salmieri (2014, pp. 2-3). For other interpretations that claim or assume that this is the notion of explanation present in Aristotle's theory of demonstration, see Kosman (1973); Matthen (1981); Taylor (1990, p. 120); McKirahan (1992, pp. 209-31); Lesher (2001, p. 46); Charles (2000); Angioni (2007a; 2012; 2013; 2014b; 2014c; 2016); Bronstein (2012; 2014; 2015; 2016a).

Aristotle discusses two alternative hypotheses about the origin of our knowledge of first principles: either (i) it is already present in us without being noticed (ἐνοῦσαι λελήθασιν, 99ᵇ25-26) or (ii) it 'comes about' (ἐγγίνονται, 99ᵇ 25) in us somehow. It is worth stressing that Aristotle does *not* consider the possibility of first principles being available to us from the beginning, as if they were self-evident propositions we could know without any heuristic procedure being required. On the contrary, if they are known to us at all – as in alternative (i) – we are not completely aware of them (along the lines of Plato's theory of recollection).[36]

Aristotle rejects alternative (i) on the grounds that such an 'accurate' cognitive state – even more accurate than demonstrative knowledge (99ᵇ 27) – could not be present in us without us noticing them. As stated in hypothesis (ii), comprehension (νοῦς) must 'come about' in us, which in this context implies that first principles are acquired by a process of learning (μανθάνοιμεν, 99ᵇ 29). Since there cannot be learning except from pre-existing knowledge (99ᵇ 28-30) – as the very first sentence of the *APo* makes it clear (*APo* I 1, 71ᵃ 1-2) –, 'the state that knows' first principles is not a fundamental cognitive state in the sense of not being based on previous knowledge of any kind. This pre-existing knowledge, however, cannot be 'more valuable (…) in respect of accuracy' (99ᵇ 33-340) than νοῦς, since νοῦς is the most accurate of all cognitive states. Therefore, the task Aristotle takes on in *APo* II 19 is to indicate a state or capacity that, despite being less accurate than comprehension or demonstration, can at least initiate the process that leads us towards these superior forms of knowledge.[37]

Aristotle goes on to claim that this initial state is a 'connate discriminatory capacity' (δύναμιν σύμφυτον κριτικήν) known as 'perception' (αἴσθησιν, 99ᵇ 34-35). As an innate capacity, perception does not come from pre-existing knowledge nor is it a result of intellectual learning (μάθησις διανοητική). Therefore, the principle stated in the opening lines of the *APo* no longer threatens Aristotle's theory with infinite regress, since it does not apply to the capacity that initiates scientific inquiry. However, a feature common to all animals such as perception (99ᵇ 34) is certainly not enough to give rise to a sophisticated form of knowledge such as νοῦς, which means the acquisition of first principles requires co-operation of other capacities. First, Aristotle recognises 'memory' (μνήμη) as indispensable to the process, since the information gathered by perception must be retained in our souls in some way (100ᵃ 3-4). Second, several memories of the same thing

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[36] Some interpreters take hypothesis (i) as referring to Platonic innatism. See Barnes (1993, p. 261); Bronstein (2012, pp. 38-39; 2016a, p. 234; 2016b).

[37] This description of Aristotle's aim in *APo* II 19 follows in general lines the interpretation advanced by Bronstein (2012; 2016a, pp. 225-247), who argues convincingly that the philosopher does not intend in this chapter to specify all the steps involved in the acquisition of first principles, but to defend that our knowledge of them originates in perception. Cf. Kahn (1981). However, my interpretation is significantly different from his when it comes to the role of induction in the acquisition of first principles, as will become clear soon.

must be collected and compared with one another, which is made possible by a capacity Aristotle calls 'experience' (ἐμπειρία, 100ᵃ 4-6).[38] Experience, in turn, allows us to grasp what Aristotle calls 'the entire universal' (παντὸς τοῦ καθόλου, 100ᵃ 6-7).[39] At some point, this process ends up with the acquisition of νοῦς (100ᵇ 12-14) – or, as it is called in this passage, a 'principle of knowledge' (ἀρχὴ ἐπιστήμης, 100ᵃ 8; cf. 100ᵇ 12-14).

We might think that, by tracing the acquisition of first principles back to perception, Aristotle prevents us from understanding his theory of demonstration along the lines of the rationalist interpretation sketched in the previous section. However, the capacities discussed in 99ᵇ34-100ᵇ5 can be understood as parts of a process of concept-formation.[40] If so, the proponent of the rationalist interpretation might argue that the first principles we grasp by the end of this process are nothing more than propositions specifying the meaning of conceptual terms to be used in scientific discourse.

This reasoning is a *non sequitur*. From the fact that perception, memory and experience might be relevant to concept-formation it does not follow that the first principles of science are *a priori* self-evident propositions or that νοῦς is nothing more than an intuitive grasp of the meaning of conceptual terms.[41] In this chapter, Aristotle is primarily engaged in the task of identifying an innate capacity that is not based on pre-existing knowledge and therefore can serve as a starting point in our journey towards higher forms of cognition. As has been argued, there might well be further steps between the last stages described in 99ᵇ34-100ᵇ5 and the noetic knowledge of first principles, a gap Aristotle did not attempt to fill in *APo* II 19.[42] Therefore, it is not safe to conclude, only based on *APo* II 19, that the grasp of first principles is nothing more than a process of concept-formation.

Moreover, Aristotle claims that induction (ἐπαγωγή) is the kind of inference underlying the process by which we get from perception to the grasp of 'the entire universal' (100ᵇ 4-5; with 100ᵃ 6-7). Therefore, it plays an important role in the acquisition of the first principles of science (τὰ πρῶτα, 100ᵇ 3-4).[43] It is certainly true that inductive reasoning is part of the process of

[38] See *Metaph.* I 1, 980ᵇ 28-982ᵃ 1. Cf. Ferejohn (2009, p. 69), who characterises experience as 'the ability to classify retained percepts into general kinds.' For a detailed discussion of this notion, see Hasper & Yurdin (2014).

[39] I shall set aside the question of whether 'the grasp of the universal' is intrinsic to experience (see Ross 1949, p. 674; Barnes 1993, p. 264) or a further, independent step in the acquisition of first principles (see McKirahan 1992, p. 243; Bronstein 2012, pp. 44-46; 2016a, pp. 237-240).

[40] See Barnes (1993, pp. 264-265); Ross (1949, pp. 675-676). Cf. Kahn (1981, pp. 391-395); McKirahan (1992, p. 246); Charles (2000, p. 264, n. 37); Bronstein (2012, p. 58, n. 67; 2016a, p. 246, n. 63).

[41] Lesher (1973, p. 61).

[42] See Kahn (1981, pp. 396-397); Bronstein (2012; 2016a, pp. 225-247).

[43] In order to avoid the consequence that induction is all it takes to know the first principles, Bronstein (2012, pp. 53-54; 2016a, p. 242) argues that 'τὰ πρῶτα' in 100ᵇ 4 denotes something else – in his words, 'first universals' and 'preliminary accounts'. However, in *APo* II 19, 100ᵇ 3-4, the dative 'ἐπαγωγῇ' does not necessarily mean that induction is sufficient for coming to know the items Aristotle calls 'τὰ πρῶτα.' Therefore, it is possible to interpret 'τὰ πρῶτα' as

concept-formation. However, this is not the only, nor the most important role it plays in scientific inquiry.[44] Aristotle seems to have recognised this fact in *APr* II 23, where he offers a sophisticated account of the kinds of reasoning involved in the discovery of scientific explanations. Contrary to expectations, his account is significantly close to the one proposed by contemporary philosophers of science:

> **[T4]** Ἐπαγωγὴ μὲν οὖν ἐστι καὶ ὁ ἐξ ἐπαγωγῆς συλλογισμὸς τὸ διὰ τοῦ ἑτέρου θάτερον ἄκρον τῷ μέσῳ συλλογίσασθαι, οἷον εἰ τῶν Α Γ μέσον τὸ Β, διὰ τοῦ Γ δεῖξαι τὸ Α τῷ Β ὑπάρχον· οὕτω γὰρ ποιούμεθα τὰς ἐπαγωγάς. οἷον ἔστω τὸ Α μακρόβιον, τὸ δ᾽ ἐφ᾽ ᾧ Β τὸ χολὴν μὴ ἔχον, ἐφ᾽ ᾧ δὲ Γ τὸ καθ᾽ ἕκαστον μακρόβιον, οἷον ἄνθρωπος καὶ ἵππος καὶ ἡμίονος. τῷ δὴ Γ ὅλῳ ὑπάρχει τὸ Α (πᾶν γὰρ τὸ Γ μακρόβιον)· ἀλλὰ καὶ τὸ Β, τὸ μὴ ἔχειν χολήν, παντὶ ὑπάρχει τῷ Γ. εἰ οὖν ἀντιστρέφει τὸ Γ τῷ Β καὶ μὴ ὑπερτείνει τὸ μέσον, ἀνάγκη τὸ Α τῷ Β ὑπάρχειν. δέδεικται γὰρ πρότερον ὅτι ἂν δύο ἄττα τῷ αὐτῷ ὑπάρχῃ καὶ πρὸς θάτερον αὐτῶν ἀντιστρέφῃ τὸ ἄκρον, ὅτι τῷ ἀντιστρέφοντι καὶ θάτερον ὑπάρξει τῶν κατηγορουμένων. δεῖ δὲ νοεῖν τὸ Γ τὸ ἐξ ἁπάντων τῶν καθ᾽ ἕκαστον συγκείμενον· ἡ γὰρ ἐπαγωγὴ διὰ πάντων.

> Induction, then – that is, a deduction from induction – is deducing one extreme to belong to the middle through the other extreme, for example, if B is the middle for A and C, proving A to belong to B by means of C (for this is how we produce inductions). For instance, let A be long-lived, B stand for not having bile, and C stand for a particular long-lived thing, as a man, a horse, or a mule. Now, A belongs to the whole C (for every C is long-lived); but B (not having bile) belongs to every C. If, then, C converts with B and the middle term does not reach beyond the extreme, then it is necessary for A to belong to B: for it has been proved earlier that if two terms belong to the same thing and the extreme converts with one of them, then the other of the predicates will also belong to the term that converts with it. (But one must understand C as composed of every one of the particulars: for induction is through them all.) [*APr* II 23, 68[b] 15-29; Smith 1989, with changes].

In this passage, Aristotle is primarily concerned not with 'induction' (ἐπαγωγή) properly speaking but with an argument derived from it – here called 'deduction from induction' (ὁ ἐξ ἐπαγωγῆς συλλογισμός). Let us examine Aristotle's example.

Scientists investigate certain biological phenomena by having perceptual contact with certain animals (αἴσθησις), retaining images of them (μνήμη) and realizing that these animals instantiate certain properties with regularity (ἐμπειρία). Let us suppose that, in this process, the biologist finds out a co-relation between longevity and absence of bile in animals like humans,

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referring to the first principles of science without committing Aristotle to the view that induction is sufficient for grasping them.

[44] I therefore disagree with Kahn (1981, p. 396) and Bronstein (2012; 2016a, p. 243), who limit the use of inductive inferences to the acquisition of nominal definitions.

horses and mules. Eventually, an inductive procedure will indicate that *all* animals of a certain kind are long-lived whenever their bodies do not contain a significant quantity of bile:

Syllogism I:[45]

Longevity holds of *humans, horses etc., Being a K* holds of *humans, horses etc.*
Longevity holds of all *Ks*

Syllogism II:

Absence of bile holds of *humans, horses etc., Being a K* holds of *humans, horses etc.*
Absence of bile holds of all *Ks*

Relying on this result, the inquirer proceeds to an inference that could be described as an 'inverted demonstration', where the explanatory term is not the middle, but the major extreme:[46]

Syllogism III:

Longevity holds of all *Ks, Being bileless* holds of all *Ks*
Longevity holds of all *bileless animals*

In fact, the co-occurrence of longevity and absence of bile made Aristotle believe that, in certain animals, the latter is the explanation of the former.[47] Thus, in Syllogism III, the *explanans* appears in the conclusion while the *explanandum* occurs in the major premise – an inference a modern reader could classify as abductive. However, while the so-called 'inferences to the best explanation' are non-deductive, Aristotle believes that, if the induction that precedes it is sufficiently comprehensive, we can obtain a *deduction* to the best explanation. Lines 68ᵇ 24-27 refer back to *APr* II 22, 68ᵃ 21-25, where Aristotle has shown that if two terms A and B hold of all C, and C also holds of all B, then A necessarily holds of all B. Therefore, if the induction shows us that *all and only* the members of the relevant kind are bileless – and perhaps this is what Aristotle means by the enigmatic phrase 'the entire universal' in *APo* II 19 (παντὸς τοῦ καθόλου, 100ᵃ 6-7) –, we are warranted to convert the previous minor premise and obtain 'a deduction from induction' concluding that all bileless animals are long-lived:

Syllogism IV:

Longevity holds of all *Ks, Being a K* holds of all *bileless animals*
Longevity holds of all *bileless animals*

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[45] I am calling Syllogism I, II, and III 'syllogisms' just for the sake of exposition. Technically speaking, these arguments are not Aristotelian syllogisms, since Aristotle uses the term 'συλλογισμός' only for valid arguments in syllogistic form.
[46] The terms called 'middle' and 'extreme' in T4 do not match the roles they play in the argument discussed in the passage, which means that these expressions are used as rigid designators of the middle term and the extremes *of a demonstrative syllogism*. See Ross (1949, pp. 484-485).
[47] *PA* IV 2, 676ᵃ 30-677ᵇ 10.

Therefore, the steps involved in the discovery of explanations could be represented by the following scheme, where P is the predicate whose occurrence we seek to explain, M is the putative explanation and S is a universal kind comprising all instances of P, while $s^1, s^2, \ldots, s^n$ are subspecies of S:

Induction:

$$\frac{\text{P holds of } s^1, s^2 \ldots s^n, \text{ S holds of } s^1, s^2 \ldots s^n}{\text{P holds of all S}}$$

$$\frac{\text{M holds of } s^1, s^2 \ldots s^n, \text{ S holds of } s^1, s^2 \ldots s^n}{\text{M holds of all (and only) S}}$$

Abduction:

$$\frac{\text{P holds of all S, M holds of all S}}{\text{P holds of all M}}$$

Deduction from induction (converting the minor premise):

$$\frac{\text{P holds of all S, S holds of all M}}{\text{P holds of all M}}$$

Thus, in *APr* II 23, Aristotle offers an account of the acquisition of explanations which is (to a certain extent) close to the one advanced by modern philosophers of science. However, none of the steps discussed in the chapter contain 'ἀποδείξεις' in the strict sense of the term, in which the explanation occurs as the middle term:

Demonstration:

$$\frac{\text{P holds of all M, M holds of all S}}{\text{P holds of all S}}$$

Thus, the chapter leaves us without an answer to the question of how exactly can scientists learn by demonstration.

Interpreters such as Kosman (1973, p. 383) and McKirahan (1992, p. 243) distinguish between knowing an explanation and knowing an explanation *as such*. Based on this distinction, David Bronstein (2014; 2016a, pp. 39-40) has recently argued that there is a sense in which it is possible to learn by demonstration: if p_1 is explained by p_2, demonstration is the reasoning by which a scientist learns that p_2 is actually explanatory of p_1 (and not simply that p_2 is the case).[48] Let me

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[48] 'Learning by demonstration, I suggest, does not consist in deducing a new conclusion from known premises. Rather, it consists in discovering a previously unknown explanatory connection among facts the scientist already knows but not scientifically. Prior to learning, she knows x and y, where y is the explanation of x and x is explained by y, but she does not know x or y as such. She learns by demonstration when she apprehends y as explanatory of x, or—what is

endorse Bronstein's interpretation in the following terms. Inductive and abductive arguments merely make it reasonable to accept their conclusions as true, since what they infer is not a necessary consequence of their premises. On the other hand, the argument Aristotle calls 'deduction from induction', despite having premises that do necessitate the conclusion, does nothing more than establishing *that* the *explanans is true*, which is quite different from establishing that it *is the adequate explanation* of the *explanandum* in question. Knowing that all bileless animals are long-lived is different from knowing that this is the reason why horses and mules are long-lived. For Aristotle, only the second case is qualified as scientific knowledge and only demonstrations are able to provide it. A true expert scientist not only assents to a set of true propositions, but also organizes it in terms of explanatory priority. When she demonstrates a given proposition taken as *explanandum*, the scientist not only knows that the correspondent *explanans* is true, but also (and more importantly) makes scientific discourse reproduce the causal order of reality by choosing as premises propositions that are explanatorily prior to the respective conclusions. Hence, the syllogistic inference that would count as a good explanation would run as follows:

Syllogism V:

> *Longevity* holds of all *bileless animals, Being bileless* holds of all *Ks*
> *Longevity* holds of all *Ks*

The question of how exactly we are able to recognize causal connections in the world does not seem to have bothered Aristotle (in the same way as it has bothered Hume, for instance). As a result, he never explains in a clear way (as far as I know) how the scientist realizes that a proposition p_1 is explanatory of p_2. However, if my interpretation of *APr* II 23 is correct, we can at least affirm that this recognition occurs at some point between Syllogism IV and Syllogism V. If it happens *after* Syllogism IV, by the time the scientist recognizes p_1 as explanatory of p_2, she already knows that p_1 and p_2 are true. Therefore, what she learns 'by demonstration' cannot be the truth-value of problematic propositions. One the other hand, if the recognition of causal relations happens *before* Syllogism V, one might object that demonstration is not the reasoning by which the scientist learns that something is causally prior to another, but just a way of exposing this causal priority in scientific discourse. If so, there is nothing the expert scientist *really* learns 'by demonstration'. How then are we supposed to understand Aristotle's use of the expression 'learning by demonstration'? Let me suggest the following solution. The term 'demonstration' is ambiguous: in one sense of the term, 'demonstration' is the name of a reasoning (a proof-search procedure, one could say) in which a scientist tries to identify propositions (already known to be

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the same thing—x as explained by y. As a result of her learning, she now has scientific knowledge of x, which she previously knew only non-scientifically' (Bronstein 2014, p. 14).

true) from which a given conclusion (also known to be true) can be deduced and explained; in another sense, 'demonstration' is just the name of the syllogistically structured sequence of sentences that results from this procedure.[49] In the first sense, Aristotle could say that expert scientists learn 'by demonstration' without contradicting his claim that knowing that the *explanandum* is true is a necessary condition for investigating the *explanans*. The acquisition of demonstrative knowledge involves overcoming the *ordo cognoscendi* and making scientific discourse reproduce the *ordo essendi*; to demonstrate (in the first sense of 'demonstration') is to realize that and how this is possible.

Finally, it is worth noting that even though Aristotle requires the *explanandum* to be a logical consequence of the *explanans*, his theory remains quite different from the deductive-nomological models of explanation. For him, what makes a scientific proposition prior to another is something more than their difference in generality or the inferential connections between them (*APo* I 13, 78ᵃ 22-ᵇ3; II 16, 98ᵇ 16-24). As we can see, demonstrations include as premises the same sentences we would find in abductive arguments or ἐξ ἐπαγωγῆς συλλογισμοί, but the inference goes in the opposite direction. The inferential steps discussed in *APr* II 23 enable the scientist to grasp a set of true propositions, whereas at the demonstrative stage this body of truths is organized in terms of causal priority – that is, priority 'by nature.' In other words, a demonstration of a conclusion **c** allows us to know not only (i) that **c** can be logically derived from a set of true premises **Π** but also (ii) that **Π** presents the set of factors responsible for **c** being true (which are prior to **c** 'by nature'), instead of the factors which make us believe that **c** is true (which are prior to **c** only 'relative to us').[50]

What about our knowledge of first principles? Some authors have pointed out that to understand first principles – that is, to have νοῦς of them – is to understand them *insofar as they are principles*.[51] As we have been arguing, first principles are nothing more than ultimate explanations. If inductions or 'deductions from inductions' do not make us know explanations *as explanations*, the same should apply to first principles *as first principles*. But what does it mean to know a principle *as*

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[49] Bronstein (2016a, p. 41) seems to reply to this objection with a similar distinction between two senses of 'demonstration' – although it is not completely clear to me whether the senses of 'demonstration' he briefly discusses are the same two senses I have tried to discriminate.

[50] For the differences between Aristotle's and the 'covering law' theory of scientific explanation, see McKirahan (1992, pp. 230-231). See also Brody (1972) for the advantages of the former over the latter.

[51] Kosman (1973, p. 389) argues: '[…] the noetic grasp we have of them [first principles] as principles concerns our ability to use them in explaining and making intelligible the world of phenomena. Νοῦς therefore is a feature of our understanding of all explanatory principles or premises […] just insofar as we understand them in the act of explaining by them, i.e. just insofar as we understand them *qua* principles and not *qua explicanda* [emphasis in original].' See also McKirahan (1992, pp. 243-244).

principle? Based on our discussion so far, we can define an Aristotelian first principle in the following terms:

Def. (First Principle): p is a first principle iff.:

(i) there is an Aristotelian demonstration $\langle \mathbf{\Pi}, \mathbf{c} \rangle$ such that **p** belongs in $\mathbf{\Pi}$

(ii) there is no set $\mathbf{\Psi}$ such that $\langle \mathbf{\Psi}, \mathbf{p} \rangle$ is an Aristotelian demonstration of **p**

According to this definition, to know a principle **p** *as a first principle* is to know that **p** satisfies conditions (i) and (ii). Whereas condition (ii) accounts for the indemonstrability of first principles, condition (i) states that a principle is always a principle *of* something. As we know, in *APo* I 2, 71ᵇ 19-22, Aristotle lists six features of demonstrative principles, of which three are relative to a conclusion: 'more familiar than', 'prior to' and 'explanatory of.'[52] Therefore, to grasp a first principle *as such* is to understand it *as* an indemonstrable premise from which one or more conclusions are demonstrated.

If this account is correct, νοῦς and ἐπιστήμη ἀποδεικτική can be considered interdependent in a certain way. Demonstrative knowledge in the strict sense involves knowing not only the proximate causes of a given phenomenon, but the ultimate ones as well. In other words, if $\langle \mathbf{\Pi}, \mathbf{c} \rangle$ is a full-fledged demonstration, there must be a subset of $\mathbf{\Pi}$ containing only indemonstrable premises, of which we have not ἐπιστήμη ἀποδεικτική but νοῦς. Therefore, ἐπιστήμη ἀποδεικτική is dependent on νοῦς insofar as full-fledged demonstrative knowledge is impossible without the comprehension of first principles. Nevertheless, a proposition *cannot* be considered a first principle of science *independently* of their explanatory roles in demonstrations. Therefore, if νοῦς is the knowledge of first principles *as first principles*, its acquisition depends on figuring out their position in the body of science as a whole, which involves the practice of demonstrating (or attempting to demonstrate) other, less basic propositions from them.[53] This

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[52] See McKirahan (1992, p. 243). Cf. Ross (1949, p. 509); Barnes (1993, p. 93). Ferejohn (2009, pp. 78-79) criticises McKirahan for being 'apparently impressed by Aristotle's use of comparatives in *APo* I 2, 71ᵇ 19-22.' Alternatively, he takes the three 'relational' conditions as reducible to a single 'absolute' condition: 'intelligibility in nature.' However, the notion of 'intelligibility in nature' seems more obscure than the conditions it is supposed to clarify. More significantly, Aristotle explicitly takes the condition 'being explanatory of…' as the fundamental one (*APo* I 2, 71ᵇ 29-33). The fact that these three requirements are relational does not imply that 'there are no objective and context-independent features that make somethings acceptable as principles and other things not.' Since Aristotle is *not* concerned with mere justification (as Ferejohn supposes), what makes something a principle in his theory is something objective: the causal order of the reality (see Hankinson 1998, p. 161). In other words, the principles are relational in the sense of being prior *to other propositions*, but objective in the sense of being prior 'in nature' and not 'relative to us.' For an approach that expands this 'relational' aspect of the notion of principle to other requirements in *APo* I 2, 71ᵇ 19-22, and to the concept of 'necessary principle', see Angioni (2012) and Angioni (2016) respectively.

[53] Aristotle emphasizes the holistic character of scientific knowledge in *APr* I 30: 'Consequently, if the facts concerning any subject have been grasped, we are already prepared to bring the demonstrations readily to light. For if nothing that truly belongs to the subjects has been left out of the collection of facts, then concerning every fact, if a demonstration for it exists, we will be able to find that demonstration and demonstrate it, while if it does not naturally have a demonstration, we will be able to make that evident [*APr* I 30, 46ᵃ 22-27; Smith 1989].'

result is in accordance with part of the secondary literature, which claims that ἐπιστήμη ἁπλῶς (both noetic and demonstrative) involves a holistic outlook of a given body of truths. Interpreters such as Kosman (1973) and Myles Burnyeat (1981) have argued that to understand (ἐπίστασθαι) a proposition p_i is to determine its place in a complex web of interrelated propositions $p_1, p_2, \ldots, p_n$ organized in terms of explanatory priority, either as a first principle (noetic understanding) or as a theorem (demonstrative understanding).[54] Along the same lines, McKirahan (1992, pp. 243-244) affirms: 'to grasp something as a principle is to understand how the things of which it is a principle depend on it. […] Thus, knowing principles entails appropriate knowledge of nonprinciples, and this amounts to possessing the whole demonstrative science.'

Let me now address some objections that might be raised against my proposal. I have claimed that to have νοῦς of first principles is to know them *as first principles*, which involves understanding them as satisfying all the six requirements mentioned in *APo* I 2, 71^b 19-22, including the relational ones: being 'more familiar than…', 'prior to…' and 'explanatory of…'. David Bronstein (2016a, pp. 62-63) has argued that if this is so, νοῦς and ἐπιστήμη ἀποδεικτική turn out to be one and the same cognitive state. If ⟨{p_1, p_2}, c⟩ is a demonstration, having demonstrative knowledge of c is to know c *as explained by* premises p_1 and p_2. On the other hand, to know that p_1 and p_2 satisfy the relational criteria is to know them *as explanatory of* c. However, 'knowing c as explained by p_1 and p_2' and 'knowing p_1 and p_2 as explanatory of c' are, according to him, 'two descriptions of the same cognitive state' (Bronstein 2016a, p. 62).

However, my claim is that having νοῦς of p_1 and p_2 involves determining their places in a given body of interrelated propositions and realizing that: (i) there are no propositions within it from which p_1 or p_2 can be demonstrated; (ii) there are one or more propositions that can be demonstrated from p_1, as well as there are one or more propositions that can be demonstrated from p_2 – leaving it open whether p_1 or p_2 can be used to demonstrate the same proposition.[55] Thus, νοῦς depends on there being demonstrative knowledge of one proposition or another. That being said, we can reply to this first objection as follows. If p_1 and p_2 are the first principles from which c is demonstrated, having demonstrative knowledge of c requires having noetic knowledge of p_1 and p_2. Nevertheless, although noetic knowledge of p_1 and p_2 requires a comprehensive

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[54] Ferejohn (2009, p. 75) objects that interpretations like Kosman's associate Aristotle with coherentism, in opposition to the foundationalist view advanced in the *APo*. In the same vein, one could say that our interpretation also commits Aristotle to some sort of coherentism. However, we would be ascribing a coherentist doctrine to Aristotle only if we were saying that organizing scientific propositions in a coherent body is *the method* by which scientists *get to know* explanatory relations. This is *not* what I am proposing – and, if I understand his interpretation correctly, neither is Kosman. What requires a holistic understanding of the body of scientific truths is *not* the recognition of a particular explanatory relation between two propositions, but the recognition of *first principles as such* – after all, figuring out that p is a principle involves realizing that there is no other proposition from which p can be demonstrated.

[55] Certainly, clause (ii) does not require a demonstrative knowledge established previously and independently of νοῦς. Therefore, my view does not imply that there is one piece of demonstrative knowledge which is prior to νοῦς *in time*.

understanding of a given body of truths (and the explanatory role of p_1 and p_2 within it), it *does not* require knowing p_1 and p_2 as explanatory of a given conclusion **c** *specifically*. Therefore, even if the expressions 'knowing p_1 and p_2 as explanatory of **c**' and 'knowing **c** as explained by p_1 and p_2' describe the same piece of knowledge – a claim which is by itself controversial – 'knowing p_1 and p_2 as explanatory of **c**' in which '**c**' stands for a determinate conclusion is not a good description of the kind of holistic cognition Aristotle calls 'νοῦς.'

In fact, if the content of noetic knowledge of p_1 and p_2 could not be specified without mentioning a specific conclusion such as **c**, it would be difficult to sustain that an expert scientist could learn by demonstration in the way we agreed she could. After all, if having νοῦς of p_1 and p_2 already involves knowing p_1 and p_2 *as explanatory of* **c**, the scientist will learn nothing when she tries to demonstrate **c** from p_1 and p_2.[56] On the other hand, if coming to know p_1 and p_2 as principles involves realizing that there are true propositions that can be demonstrated from them (which are not necessarily **c**), there is still room for discovering new *explananda* (possibly **c**) and trying to trace them back to the first principles. Let us consider, for instance, an expert biologist who discovered (through the inferences and capacities described in *APo* II 23 and *APo* II 19) that absence of bile causes animals such as horses, mules and camels to be long-lived. Let us also say that it has already been established that all these species are essentially blooded animals (which involves knowing that some of their properties are explained by their being blooded). If the biologist tries to explain their longevity from first principles, she will eventually find out that absence of bile is the cause of their being long-lived because the liver (of which bile is a residue) is vital and necessary to blooded animals. Thus, she will have learned by demonstration that certain blooded animals are long-lived having previous noetic knowledge that their essence involves their being blooded.[57] This example illustrates how an account of scientific knowledge in terms of 'interrelatedness' does not require a scientist to know *absolutely all* the facts in the domain in order to have ἐπιστήμη ἁπλῶς. The acquisition of scientific expertise is not an all-or-nothing situation. As long as the scientist knows a set of indemonstrable propositions *as such* – knowledge that involves recognizing their explanatory connections with at least some demonstrable facts–, there is still room for discovering new facts and explaining them from these immediate principles.

However, even if there is a way of distinguishing one cognitive state from the other, a second objection could be raised. In *APo* II 19, Aristotle claims that νοῦς is 'more accurate' (ἀκριβέστερον) than demonstrative knowledge. One might argue that we cannot explain this claim

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[56] As Bronstein (2016a, p. 65) himself notes.
[57] See *PA* IV 2, 677ª-ᵇ10. In *PA* IV 5, 678ª 33-34. Aristotle affirms: 'that some animals are blooded while some are bloodless will belong in the account defining their substantial being' (translation by Lennox 2001). If this pattern describes Aristotle in his biological treatises, it might count as further evidence for my interpretation the fact that it is in accordance with his scientific practice.

if we take these two cognitive states as interdependent. On the other hand, the rationalist interpretation would take this claim in purely subjective terms: the first principles are self-evident and accepted as true without any justification, whereas the respective conclusions become evident to us only through the evidence of the principles. Thus, the rationalist interpretation is able to explain how the 'accuracy' of demonstrative knowledge depends on the 'accuracy' of νοῦς but not vice-versa.

First, the claim that νοῦς is the most 'accurate' type of knowledge does not need to be understood in subjective or psychological terms, as if the content of noetic knowledge were somehow 'more evident' than the content of other cognitive states. As we have seen, Aristotle describes the premises of a demonstration as being 'more familiar' or 'more intelligible' (γνωριμωτέρα) than the conclusion. At first sight, this vocabulary might suggest that our mental attitudes towards these premises are at stake. Nevertheless, the feature of demonstrative premises Aristotle wants to stress is fully objective: by 'more familiar' he means not 'more familiar to us' (a subjective notion) but 'more familiar by nature', which amounts to the objective notion of causal or explanatory priority (*APo* I 2, 71$^\mathrm{b}$ 31). Lesher (2010), for instance, has convincingly argued that 'clarity' (σαφήνεια) is not necessarily a psychological notion, the same being true for the notion of 'accuracy' (τὸ ἀκριβές). He points out that in several contexts Aristotle uses the term 'σαφές' and correlate expressions to refer to 'the attainment of full scientific knowledge.'[58] Barnes (1993, p.189) also argues that 'ἀκριβές' can be used to describe whatever is of 'good epistemic quality', not necessarily what is certain or evident. According to Liddell/Scott/Jones, the word is used to qualify what is 'consummate' or 'in perfect condition'. Along the same lines, Zabarella had already noted that 'ἀκρίβεια' means not only certainty, but completeness or perfection.[59] Now, as I have argued, if $\langle \{\mathbf{p_1}, \mathbf{p_2}\}, \mathbf{c} \rangle$ is the demonstration of $\mathbf{c}$, one cannot have demonstrative knowledge of $\mathbf{c}$ without having noetic knowledge of $\mathbf{p_1}$ and $\mathbf{p_2}$. However, having νοῦς of $\mathbf{p_1}$ and $\mathbf{p_2}$ does *not* require demonstrative knowledge of $\mathbf{c}$ specifically. Therefore, the content of noetic knowledge (e.g. knowing $\mathbf{p_1}$ and $\mathbf{p_2}$ as *principles*) is more comprehensive and complete in comparison with the more specific content of the correspondent piece of demonstrative knowledge (e.g. knowing $\mathbf{c}$ as explained by $\mathbf{p_1}$ and $\mathbf{p_2}$)[60] – and this could be what Aristotle had in mind when he claimed that νοῦς is the most 'accurate' of all cognitive states.

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[58] Lesher (2010, pp. 148-156).
[59] '[...] *akribeiam*, quae non solam certitudinem significat, sed cum perfection [Zabarella 1582, 168B].'
[60] This use of 'ἐπιστήμη ἀποδεικτική' corresponds to the second sense of the term discussed by Salmeri (2014, p. 2): '"*epistēmē*"(and "*epistasthai*") can refer to a certain estimable cognitive state: the state in which the possessor of a science stands toward each of its theorems, in virtue of a demonstration of the theorem from the appropriate principles.'

Thus, we have strong reasons to believe that, for Aristotle, noetic and demonstrative knowledge are, in a way, interdependent cognitive dispositions. This account of the relation between νοῦς and ἐπιστήμη ἀποδεικτική also helps us elucidate in which way definitions are first principles. In *APo* II 10, the philosopher distinguishes definitional sentences that are mere accounts of meaning (93ᵇ 19-37) – or 'nominal definitions' – from definitions as accounts of essence – or 'real definitions' (93ᵇ 38-94ᵃ 7). According to Aristotle, a definition of the second kind is 'an account which displays the reason why' (λόγος ὁ δηλῶν διὰ τί ἔστιν, 93ᵇ 39). We know first principles are not self-evident propositions from which problematic beliefs can be justified, but causal explanations acquired after a complex process of inquiry (involving perception, memory, experience, induction etc.). Therefore, in virtue of their causal or explanatory content, real (and not merely nominal) definitions are the propositions playing the role of first principles in Aristotle's theory. In *APo* II 8-10, it becomes clear that causal definitions of this sort are not grasped independently of the practice of demonstrating. They are made clear by syllogistic demonstrations (δῆλον μέντοι διὰ συλλογισμοῦ καὶ δι᾽ ἀποδείξεως, *APo* II 8, 93ᵇ 17-18) and described as demonstrations 'differing in arrangement' (τῇ θέσει διαφέρων, *APo* II 10, 94ᵃ 2). This interdependence between definition and demonstration is in accordance with our account of the relation between νοῦς and ἐπιστήμη ἀποδεικτική. As has been claimed, this is not just a peculiarity of Aristotle's methods for explaining phenomena and grasping definitions. The *epistemic* interdependence between defining and explaining – and between comprehension and demonstrative knowledge – is grounded in a *metaphysical* interdependence between the notion of essence and the notion of cause (or primary cause).[61] In the next chapter, I shall discuss the connections between definition and demonstration, essence and causation. Not only in Chapter 2 but also in the following chapters, I will be particularly concerned with the ontological distinction between subjects and attributes, their differences as essence-bearers, and the influence of this distinction in Aristotle's model of demonstrative science.

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[61] Kung (1977, pp. 168-172); Charles (2000; 2010b, pp. 268-328); Williams & Charles (2013); Peramatzis (2011, pp. 180-188; 2013); Angioni (2012; 2014b; 2014c; 2016); Koslicki (2012).

CHAPTER 2

CAUSE, ESSENCE, AND ESSENCE-BEARERS

2.1 – The Four Objects of Inquiry and Knowledge: Fact, Cause, Existence, and Essence

At the beginning of *APo* II, Aristotle affirms that the things we seek (τὰ ζητούμενά) are equal in number to those we know (ἐπιστάμεθα) (*APo* II 1, 89^b 23-4):

(1) 'the fact' (τὸ ὅτι)

(2) 'the reason why' (τὸ διότι)

(3) 'if something is' (εἰ ἔστι)

(4) 'what something is' (τί ἐστιν)

Each of these four objects of inquiry and knowledge corresponds to one question:

> **[T5]** ὅταν μὲν γὰρ πότερον τόδε ἢ τόδε ζητῶμεν, εἰς ἀριθμὸν θέντες, οἷον πότερον ἐκλείπει ὁ ἥλιος ἢ οὔ, τὸ ὅτι ζητοῦμεν. σημεῖον δὲ τούτου· εὑρόντες γὰρ ὅτι ἐκλείπει πεπαύμεθα· καὶ ἐὰν ἐξ ἀρχῆς εἰδῶμεν ὅτι ἐκλείπει, οὐ ζητοῦμεν πότερον. ὅταν δὲ εἰδῶμεν τὸ ὅτι, τὸ διότι ζητοῦμεν, οἷον εἰδότες ὅτι ἐκλείπει καὶ ὅτι κινεῖται ἡ γῆ, τὸ διότι ἐκλείπει ἢ διότι κινεῖται ζητοῦμεν. ταῦτα μὲν οὖν οὕτως, ἔνια δ᾽ ἄλλον τρόπον ζητοῦμεν, οἷον εἰ ἔστιν ἢ μὴ ἔστι κένταυρος ἢ θεός· τὸ δ᾽ εἰ ἔστιν ἢ μὴ ἁπλῶς λέγω, ἀλλ᾽ οὐκ εἰ λευκὸς ἢ μή. γνόντες δὲ ὅτι ἔστι, τί ἐστι ζητοῦμεν, οἷον τί οὖν ἐστι θεός, ἢ τί ἐστιν ἄνθρωπος;

When we seek whether this our that is the case, setting down a plurality of terms (e.g. whether the sun is eclipsed or not), we are seeking the fact. Evidence for this: on finding that it is eclipsed, we stop; and if from the beginning we know that it is eclipsed, we do not seek whether it is. When we know the fact we seek the reason why (e.g. knowing that it is eclipsed or that the earth moves, we seek the reason why it is eclipsed or why it moves). These things we seek in this way; but certain items we seek in another way – e.g. if a centaur or a god is or is not. (I mean if one is or is not 'without qualification' and not if one is white or not.) And having come to know that it is, we seek what it is (e.g.: Then what is a god? or What is a man?) [*APo* II 1, 89ᵇ 25-35; Barnes 1993, with changes].

The philosopher groups these questions into two pairs based on a typical Aristotelian division between subjects and attributes.[62] The first couple of questions concern the presence of an attribute in a given subject:

(Q1) Does the attribute P belong to the subject S?

(Q2) Why does P belong to S?

Questions Q1 and Q2 ask whether and why a given subject S is 'something or not something' (εἰ γάρ ἐστι τὶ ἢ μὴ ἔστι τί, 90ᵃ 3-4), is 'partially' (ἐπὶ μέρους, 89ᵇ39; 90ᵃ2) or is 'one of the items which hold of it in itself or incidentally' (τι τῶν καθ᾽ αὑτὸ ἢ κατὰ συμβεβηκός, 90ᵃ 11): 'Is the earth moving?' or 'Why is the sun eclipsed'?'. Aristotle also notes that Q1 is prior to Q2 in the order of inquiry, since we can only ask *why* S is P when we already know *that* it is P.

On the other hand, the other two questions address the subjects themselves:

(Q3) Does S exist?

(Q4) What is S?

Question Q3 does not ask whether a subject S is or is not something, but whether S is 'without qualification' (ἁπλῶς, 89ᵇ 39; 90ᵃ 4) – i.e. whether it exists[63] –, whereas Q4 asks about its nature or essence. Questions Q3 and Q4 no longer concern attributes, but the 'substance' (τὴν οὐσίαν, 90ᵃ10) and the 'underlying subject' (τὸ ὑποκείμενον, 90ᵃ 12) to which they belong: 'Is there such a thing as a centaur?' or 'What is a god?'. Question Q3 is also epistemologically prior to Q4: in order to know *what* a subject S is, says Aristotle, we need to know in advance *that* S 'is' or 'exists'.

As one would expect given the definition of knowledge in **T1** (*APo* I 2, 71ᵇ 9-12), Aristotle argues that looking for an answer to these four questions is equivalent to seeking for a

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[62] This reading is a traditional one, with the support of modern interpreters such as Ross (1949, pp. 609-10), Tredennick (1960, p. 11), Mansion (1976, p. 63), Barnes (1993, pp. 203-4), and Bronstein (2016a, pp. 89-107).

[63] For a different account, see Gomez-Lobo (1980). However, the examples 'god' and 'centaur', whose existence is controversial, strongly suggests the existential meaning of the verb 'to' be.'

cause (*APo* II 2, 90ᵃ 6-7). However, the 'cause' (τὸ αἴτιον) is now identified with the 'middle term' (τὸ μέσον):

[T6] ζητοῦμεν δέ, ὅταν μὲν ζητῶμεν τὸ ὅτι ἢ τὸ εἰ ἔστιν ἁπλῶς, ἆρ᾽ ἔστι μέσον αὐτοῦ ἢ οὐκ ἔστιν· ὅταν δὲ γνόντες ἢ τὸ ὅτι ἢ εἰ ἔστιν, ἢ τὸ ἐπὶ μέρους ἢ τὸ ἁπλῶς, πάλιν τὸ διὰ τί ζητῶμεν ἢ τὸ τί ἐστι, τότε ζητοῦμεν τί τὸ μέσον.

When we seek the fact or if something is without qualification, we are seeking whether or not there is a middle term for it; and when, having come to know either the fact or if it is – either partially or without qualification –, we seek the reason why or what it is, we are seeking what the middle term is [*APo* II 2, 89ᵇ37-90ᵃ1; Barnes 1993, with changes].

The expression 'τὸ μέσον' comes from the vocabulary of the *APr*, which suggests that the four questions listed in *APo* II 2 are limited to syllogistic propositions – hence, they are formulated within the framework of Aristotle's model of demonstrative science.[64] One of Aristotle's claims here is that Q1 and Q3 are reduced to a question about the existence of a middle term:

(Q1*/Q3*) Is there a middle term?

On the other hand, we answer the questions Q2 and Q4 when we find out what that middle term is:

(Q2*/Q4*) What is the middle term?

In a context where the μέσον is identified with the αἴτιον, asking about the existence of a middle term for a given categorical sentence is asking whether this sentence is likely to be scientifically explained.[65] At this point, the inquirer is not looking for a middle term that simply establishes the truth of the conclusion, but 'the actual ground in reality of the fact to be explained.'[66] Inquiring into the existence of such ground is to examine whether the phenomenon in question presents the kind of regularity and consistency that suggests the presence of an underlying causal structure.[67] Asking what that middle term is, on the other hand, is asking what that actual ground is after all. Therefore, first we have:

(Q1*/Q3*) Is there an M such that PaM, MaS ⊢ PaS & M is the reason why PaS?[68]

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[64] Barnes (1993, p. 203).
[65] Barnes (1993, p. 205).
[66] Ross (1949, p. 611).
[67] Charles (2000, p. 71).
[68] Our formulation of Q1* is motivated by the fact that, according to Aristotle, scientific explanations are preferably structured in *Barbara* (see *APo* I 14, 79ᵃ 24-29; II 8, 93ᵃ 3-9). Still, our interpretation is compatible with other syllogistic moods.

Once we know that PaS is scientifically explainable – i.e. once we have an affirmative answer to Q1* –, we are able ask:

(Q2*/Q4*) What is M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

It is important to note that an affirmative answer to Q1 is compatible with a negative answer to Q1* if 'PaS' is indemonstrable. Therefore, Aristotle is assuming that Q1 and Q2 in *APo* II 1-2 are restricted to demonstrable propositions, which excludes tautologies and definitions.[69]

At this juncture, it could be argued that limiting Q3 and Q4 to subjects was an unfortunate move. Apparently, nothing prevents us from asking what an eclipse is or whether there is such a thing as an eclipse, which means Aristotle should have included the following two questions in his account:

(Q3.1) Does P exist?
(Q4.1) What is P?

However, Aristotle does not say that we cannot ask questions of existence and essence about attributes. Actually, his claim is that, for the purpose of scientific investigation, those questions are equivalent to, and in fact better phrased in the form of, Q1 and Q2:[70]

> **[T7]** ἐν ἅπασι γὰρ τούτοις φανερόν ἐστιν ὅτι τὸ αὐτό ἐστι τὸ τί ἐστι καὶ διὰ τί ἔστιν. τί ἐστιν ἔκλειψις; στέρησις φωτὸς ἀπὸ σελήνης ὑπὸ γῆς ἀντιφράξεως. διὰ τί ἔστιν ἔκλειψις, ἢ διὰ τί ἐκλείπει ἡ σελήνη; διὰ τὸ ἀπολείπειν τὸ φῶς ἀντιφραττούσης τῆς γῆς.
>
> In all these cases it is clear that what it is and why it is are the same. What it is an eclipse? Privation of light from the moon by the screening of the earth. Why is there an eclipse? Or Why is the moon eclipsed? Because the light leaves it when the earth screens it [*APo* II 2, 90ᵃ 14-18; Barnes 1993].

According to Aristotle, an attribute is said to 'exist' insofar as it is predicated of a subject. Knowing the existence of the lunar eclipse is the same as knowing that it is predicated of the moon. On the other hand, there is a correspondence between the definition of an attribute and the explanation of its occurrence in the relevant subject. For instance, the lunar eclipse is defined as follows:

Def. (Lunar eclipse):
Lunar eclipse is(df.)*the privation of light from the moon in virtue of it being screened from the sun by the earth.*

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69 See Barnes (1993, p. 205); Gomez-Lobo (1980, p.73, n.10).
70 This could explain why 'night' (νύξ) appears as an example of Q3 in *APo* II 2, 90ᵃ 5.

On the other hand, we explain why *lunar eclipse* belongs to the *moon* through the middle term *being screened by the earth* (*APo* II 8, 93ᵃ 29-ᵇ14):

Syllogism VI:

> *Eclipse* (or *privation of light*) holds of *earth-screening, Earth-screening* holds of *the moon*
> *Eclipse* (or *privation of light*) holds of *the moon*[71]

Such isomorphism between definition and demonstration is what probably made Aristotle think that formulating Q3.1 e Q4.1 in *APo* II 1-2 was unnecessary, since the following equivalencies hold good:

(Q1) Does P holds of S? ≡ (Q3.1) Does P exist?

(Q2) Why does P holds of S? ≡ (Q4.1) What is P?

One may think that such correspondence is just the result of a successful inquiry. If there is an equivalence between the questions 'why is the moon eclipsed?' and 'what is eclipse?', a successful attempt to define eclipse will have its result somehow corroborated by a successful demonstration of the fact that the moon is eclipsed. For Aristotle, however, the correspondence between definitions and demonstrations should not be taken just as a mutual corroboration between the results of two independent practices. On the contrary, defining and explaining are interdependent scientific tasks, as we shall see in the next section.

2.2 – Interdependence between Defining and Explaining

As we have seen, as long as the *APo* is understood as advancing not a theory on epistemic justification, but a theory on causal explanations (and on how these explanations are grasped and displayed in scientific discourse), Aristotle can be correctly described as a foundationalist philosopher of science. His foundationalism lies in the fact that an Aristotelian demonstration ⟨**Π**, **c**⟩ always contains a subset of indemonstrable premises **Π'** from which all the demonstrable premises in **Π** (and consequently **c**) are demonstrated. The set **Π'** includes definitions, i.e. propositions specifying essences or essential features. Therefore, Aristotle's foundationalism would not be viable if there were demonstrations of the form ⟨**Π**, **c**⟩ in which **c** is a definitional proposition. In other words, definitions should be principles of demonstrations, but not themselves demonstrated.

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[71] Aristotle uses as the major term sometimes the *definiendum* (e.g. '*thunder*' or '*eclipse*'; *APo* II 8, 93ᵃ 35-ᵇ6; ᵇ8-9), sometimes a brief and preliminary elucidation of what the *definiendum* is (e.g. '*noise*' or '*privation of light*', 93ᵇ 11-12).

Given the importance of the matter, in *APo* II, Aristotle engages in a long discussion about whether or not definitions can be demonstrated. His final answer is negative. Although it is possible to elaborate sound syllogisms whose conclusions are definitional sentences, such arguments are merely 'logical' (λογικὸς), without real explanatory force (*APo* II 8, 93ᵃ 9-15). However, Aristotle raises and discusses several puzzles in *APo* II 3-7, of which one is of particular interest to us: 'you might puzzle over whether you can know the same thing in the same respect both by a definition and by a demonstration, or whether this is impossible' (*APo* II 3, 99ᵇ 1-3). This puzzle is not solved until *APo* II 8. According to Aristotle, although real definitions (i.e. accounts of essences) cannot occur as conclusions of demonstrations, they are 'made clear by syllogism and demonstration' (δῆλον μέντοι διὰ συλλογισμοῦ καὶ δι᾽ ἀποδείξεως, *APo* II 8, 93ᵇ 17-18), being similar to demonstrations, but 'differing in arrangement' (τῇ θέσει διαφέρων, *APo* II 10, 94ᵃ 2). In the following, I shall spell out how Aristotle reaches this result.

After denying that conclusions of demonstrations can be definitional sentences (*APo* II 8, 93ᵃ 9-15), Aristotle announces his aim in *APo* II 8: 'let us say in what way a demonstration [of what something is] is possible, starting again from the beginning' (93ᵃ 15-16). 'Starting again from the beginning' (πάλιν ἐξ ἀρχῆς), in this context, refers back to the four questions discussed in *APo* II 1-2, which Aristotle resumes in *APo* II 8:

> **[T8]** ὥσπερ γὰρ τὸ διότι ζητοῦμεν ἔχοντες τὸ ὅτι […], δῆλον ὅτι ὁμοίως καὶ τὸ τί ἦν εἶναι οὐκ ἄνευ τοῦ ὅτι ἔστιν· ἀδύνατον γὰρ εἰδέναι τί ἐστιν, ἀγνοοῦντας εἰ ἔστιν.
>
> Just as we seek the reason why when we grasp the fact […], in the same way we plainly cannot grasp what it is to be something without grasping that it exists; for we cannot know what something is when we do not know whether it exists [*APo* II 8, 93ᵃ 16-20; Barnes 1993].

As we know, questions of the form

(Q1) Does P belong to S?/(Q3.1) Does P exist?

are epistemologically prior to questions of the form

(Q2) Why does P belong to S?/(Q4.1) What is P?

That is to say, we cannot start investigating what something is before we know that it exists. However, as several interpreters have noted[72], the priority of Q3 and Q3.1 over Q4 and Q4.1 gives

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[72] See Bolton (1976); Ackrill (1981, pp. 364-366); Bayer (1995, p. 246); Charles (2000, p. 76); Bronstein (2010; 2016a, pp. 84-88, pp. 93-94).

rise to an epistemological problem close to the one discussed in Plato's dialogue *Menon*.[73] I shall call it the 'Inquiry Problem':

The Inquiry Problem: If I do not know that x exists, I cannot start investigating what x is (according to *APo* II 1-2). On the other hand, if I do not know what x is, how could I inquire whether x exists or not?

This question is motivated by the following assumption: if the essence of x is unknown to me, I do not have the means to identify eventual instances of x, and hence cannot investigate whether x exists. In *APo* II 8, Aristotle offers his solution to the Inquiry Problem by undermining the assumption that motivates it. He writes as follows:

> **[T9]** τὸ δ᾽ εἰ ἔστιν ὁτὲ μὲν κατὰ συμβεβηκὸς ἔχομεν, ὁτὲ δ᾽ ἔχοντές τι αὐτοῦ τοῦ πράγματος, οἷον βροντήν, ὅτι ψόφος τις νεφῶν, καὶ ἔκλειψιν, ὅτι στέρησίς τις φωτός, καὶ ἄνθρωπον, ὅτι ζῷόν τι, καὶ ψυχήν, ὅτι αὐτὸ αὑτὸ κινοῦν.
>
> But as to whether it exists, sometimes we grasp this incidentally, and sometimes by grasping something of the object itself – e.g. of thunder, that it is a sort of noise in the clouds; of an eclipse, that it is a sort of privation of light; of man, that he is a sort of animal; of soul, that it is something which moves itself [*APo* II 8, 93ᵃ 21-24; Barnes 1993].

If I intend to know what a lunar eclipse is, I need at least some information with which I could start off my inquiry. In one scenario, what I know about eclipse holds of it 'incidentally' (κατὰ συμβεβηκὸς). Here, Aristotle probably has in mind the notion of συμβεβηκὸς defined in *Top*. I 5, 102ᵇ 6-7, i.e. a predicate that 'can belong or not belong to one and the same thing.' If everything I know about eclipse is contingently connected to it, I would not be able to recognize its instances with the kind of consistency that scientific investigation requires.

At this point, it is worth stressing that, according to the doctrine of *APo* II 1-2, questions of the form

(Q1) Does P belong to S?/(Q3.1) Does P exist?

are equivalent to a question about the existence of a cause or middle term:

(Q1*/Q3*) Is there an M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

Therefore, inquiring whether the lunar eclipse 'exists' is not just a matter of investigating whether or not it happens to the moon, but of realizing that it occurs frequently and regularly enough to

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[73] 'How will you look for it, Socrates, when you do not know at all what it is? How will you aim to search for something you do not know at all? If you should meet with it, how will you know that this is the thing that you did not know?' [*Meno*, 80d-e; G.M.A Grube in Cooper 1997].

suggest the presence of an underlying cause – a cause that could be used not only to explain why the moon is regularly eclipsed, but also to formulate a causal definition of eclipse. Therefore, Q2 should be interpreted not as asking whether (e.g.) eclipse *exists* without further qualification, but whether it exists *as a definable unity* or a *genuine kind*.[74] If all I know about the lunar eclipse is something that may or may not belong to it, I could always mistake its instances for something else. Even if I eventually recognise as a case of eclipse something that actually happens to be one of its instances, I would not have an answer to Q3.1 'except incidentally' (ἀλλ᾽ ἢ κατὰ συμβεβηκός, *APo* II 10, 93ᵇ 35). In other words, I would never be able to determine whether all the cases to which I apply the word 'eclipse' are actually instances of the same, unified phenomenon.

Our inquiry is more promising, says Aristotle, if we 'grasp something of the object itself' (τι αὐτοῦ τοῦ πράγματος), as when we know of thunder that it is a sort of noise in the clouds, or of eclipse that it is a sort of privation of light from the moon. These vague descriptions seem to be preliminary accounts of the words 'thunder' and 'eclipse' without which no one could use them with linguistic competence. In *APo* II 10, this step of the inquiry is identified with knowing the meaning of words – i.e. knowing their 'nominal definitions'[75] –, without knowing yet that they refer to genuine existing kinds:[76]

> **[T10]** Ὁρισμὸς δ᾽ ἐπειδὴ λέγεται εἶναι λόγος τοῦ τί ἐστι, φανερὸν ὅτι ὁ μέν τις ἔσται λόγος τοῦ τί σημαίνει τὸ ὄνομα ἢ λόγος ἕτερος ὀνοματώδης, οἷον τί σημαίνει τρίγωνον. ὅπερ ἔχοντες ὅτι ἔστι, ζητοῦμεν διὰ τί ἔστιν·
>
> Since a definition is said to be an account of what something is, it is clear that one type will be an account of what its name, or some other name-like account, means – e.g. what 'triangle' means. When we grasp that this exists, we seek why it is [*APo* II 10, 93ᵇ 29-32; Barnes 1993, with changes].

Based on this passage (and its connection to *APo* II 8), David Charles (2000, pp. 23-76) argued that, according to Aristotle, the inquiry of essences can be divided into three stages:

Stage 1: One knows an account of what a name (or a name-like expression)[77] signifies, without knowing whether the name denotes a genuine existing kind.

Stage 2: One knows that the thing denoted by the name (or the name-like expression) exists (as a genuine kind).

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[74] See Upton (1991, pp. 322-323); Charles (2000, pp.40-41; p.203); Bronstein (2010, pp.109-110; p. 112; 2016a, pp. 104-107).

[75] See Ross (1949 p. 635); Demoss & Devereux (1988, p. 136); Barnes (1993, p. 222).

[76] See Charles (2000, pp. 24-24). For a different view, see Bolton (1976, pp. 522-526).

[77] I am following Ross (1949, p. 635) and taking λόγος ἕτερος ὀνοματώδης᾽ as referring to complex nominal phrases to be contrasted with simple names.

Stage 3: One knows the essence (i.e. the cause) of the thing denoted by the name (or name-like expression).

At stage 1, the scientist has the kind of basic information about (e.g.) eclipses that regulates the (standard) use of the word 'eclipse' in ordinary discourse: if there is such a thing as a lunar eclipse, it will be a certain privation of light from the moon. As Charles (2000, p. 35) puts it, the scientist can use this preliminary information as a sort of 'springboard' to move from Stage 1 to Stage 2. By knowing that (e.g.) thunder is a certain noise in the clouds, one might perform induction-based inferences – like Syllogisms I to IV, discussed in Chapter 1 – to gather more information about the phenomenon: for instance, that it happens under certain meteorological conditions, that it follows lightning, etc. Thus, the indefinite pronouns 'τις' and 'τι' in *APo* II 8, 93ᵃ 22-24 stand for 'place-holders' to be filled in with the kind of information needed to move from Stage 1 to Stage 2 – i.e. that the phenomenon under investigation presents (in a regular basis) distinguishing features that suggest we are not dealing with a chance event. If so, there must be an underlying cause to be grasped at Stage 3.

Aristotle gives a helpful example of how one may move from Stage 1 to Stage 2 without yet knowing the cause (i.e. the essence) of the phenomenon at stake.

> **[T11]** ὅταν δ᾽ εὕρωμεν, ἅμα τὸ ὅτι καὶ τὸ διότι ἴσμεν, ἂν δι᾽ ἀμέσων ᾖ· εἰ δὲ μή, τὸ ὅτι, τὸ διότι δ᾽ οὔ. σελήνη Γ, ἔκλειψις Α, τὸ πανσελήνου σκιὰν μὴ δύνασθαι ποιεῖν μηδενὸς ἡμῶν μεταξὺ ὄντος φανεροῦ, ἐφ᾽ οὗ Β. εἰ τοίνυν τῷ Γ ὑπάρχει τὸ Β τὸ μὴ δύνασθαι ποιεῖν σκιὰν μηδενὸς μεταξὺ ἡμῶν ὄντος, τούτῳ δὲ τὸ Α τὸ ἐκλελοιπέναι, ὅτι μὲν ἐκλείπει δῆλον, διότι δ᾽ οὔπω, καὶ ὅτι μὲν ἔστιν ἔκλειψις ἴσμεν, τί δ᾽ ἐστὶν οὐκ ἴσμεν.
>
> When we discover it [i.e. the account of eclipse], we know at the same time the fact and the reason why – if we proceed through immediates.[78] Otherwise, we know the fact but not the reason why: moon *C*, eclipse *A*, not being able to produce a shadow during full moon although nothing visible is between us and it *B*. If *B*, not being able to produce a shadow during full moon although nothing visible is between us and it, holds of *C*, and *A*, being eclipsed, holds of *B*, then it is plain *that* it is eclipsed but not yet *why*; and we know *that* there is an eclipse but we do not know *what* it is [*APo* II 8, 93ᵃ 35-ᵇ2; Barnes 1993, with changes].

Suppose a scientist at Stage 1 knows that eclipse is some sort of loss of light from the moon. As she proceeds with her investigation, she realises that it is not any kind of privation of light from the moon that can be correctly called 'eclipse'. If, in a cloudy night, the moon becomes unable to cast shadows, she will probably take into account that the clouds might be blocking the light from the moon and would avoid concluding that an eclipse is taking place. If, however, a full moon

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[78] Reading 'δι᾽ ἀμέσων' with Ross (1949) instead of 'διὰ μέσων', like most MSS.

becomes unable to produce shadows even if there is nothing intermediate that could be blocking its light, the following syllogism could be formulated:

Syllogism VII:

Eclipse holds of *inability to cast shadows etc.*, *Inability to cast shadows etc.* holds of *the moon*
Eclipse holds of *the moon*

Syllogism VII establishes *that* the moon is eclipsed – and establishes it in a way that its conclusion is now seen as a legitimate *explanandum*. Now, we can investigate *why* this is the case, and hence move from Stage 2 to Stage 3:

> **[T12]** δήλου δ᾽ ὄντος ὅτι τὸ Α τῷ Γ ὑπάρχει, ἀλλὰ διὰ τί ὑπάρχει, τὸ ζητεῖν τὸ Β τί ἐστι, πότερον ἀντίφραξις ἢ στροφὴ τῆς σελήνης ἢ ἀπόσβεσις. τοῦτο δ᾽ ἐστὶν ὁ λόγος τοῦ ἑτέρου ἄκρου, οἷον ἐν τούτοις τοῦ Α· ἔστι γὰρ ἡ ἔκλειψις ἀντίφραξις ὑπὸ γῆς.
>
> When it is plain that *A* holds of *C*, then to seek why it holds is to seek what *B* is – whether screening or rotation of the moon or extinction. And this is the account of the one extreme, i.e. in this case of *A*; for an eclipse is a screening by the earth [*APo* II 8, 93ᵇ 3-7; Barnes 1993].

At Stage 3, then, the scientist finally discovers the cause of eclipse, which is signified by the middle term of our Syllogism VI:

Syllogism VI:

Eclipse (or *privation of light*) holds of *earth-screening*, *Earth-screening* holds of *the moon*
Eclipse (or *privation of light*) holds of *the moon*

Here, the middle term is said to be the definition of the major term 'eclipse' (ὁ λόγος τοῦ ἑτέρου ἄκρου). Strictly speaking, the middle term is the *causal* part of the definition, which was missing in the preliminary account used at Stage 1. Thus, a Stage 3-definition of eclipse would be isomorphic to Syllogism VI:

Def. (Lunar eclipse):

Lunar eclipse is₍df₎ *the privation of light from the moon in virtue of it being screened from the sun by the earth.*

Even if Syllogism VI is not a demonstration of the definition – in the sense of having the *definiendum* as the minor term and the *definiens* as the major –, it *displays* or *reveals* the essence of eclipse. Therefore, Aristotle can conclude his reasoning as follows:

> **[T13]** Ὡς μὲν τοίνυν λαμβάνεται τὸ τί ἐστι καὶ γίνεται γνώριμον, εἴρηται, ὥστε συλλογισμὸς μὲν τοῦ τί ἐστιν οὐ γίνεται οὐδ᾽ ἀπόδειξις, δῆλον μέντοι διὰ συλλογισμοῦ καὶ δι᾽ ἀποδείξεως· ὥστ᾽ οὔτ᾽ ἄνευ ἀποδείξεως ἔστι γνῶναι τὸ τί ἐστιν.

> We have said how what something is is taken and becomes familiar. Although there are no syllogisms and no demonstrations of what something is, nevertheless what something is is made plain through syllogisms and through demonstrations. Hence without a demonstration you cannot get to know what something is [*APo* II 8, 93ᵇ 15-18; Barnes 1993].

The isomorphism between the definition of eclipse and Syllogism VI is not just a coincidence of results of two independent scientific practices: defining and explaining. On the contrary, we cannot know the essence of something independently of the explanatory role it plays in a demonstration: οὔτ᾽ ἄνευ ἀποδείξεως ἔστι γνῶναι τὸ τί ἐστιν (93ᵇ 19-18). In other words, the way we acquire knowledge of definitions intrinsically involves the act of explaining a phenomenon by demonstration.[79] This result is in accordance with the claim we advanced in Chapter 1. Νοῦς is the cognitive state that knows definitions. Since demonstrations are based on definitions, ἐπιστήμη ἀποδεικτική is dependent on νοῦς. However, if we cannot get to know a definition independently of the act of demonstrating, one cannot have νοῦς without having ἐπιστήμη ἀποδεικτική. The interdependence of the two kinds of understanding 'without qualification' just mirrors the interdependence between defining and explaining.

2.3 – The Essence of Subjects *vs.* The Essence of Attributes: Two Models of Definition-Based Explanation

Pairing up Q1 and Q2 with Q1* and Q2* seems unproblematic. The presence of an attribute in a subject can easily be phrased in a categorical sentence liable to occur as the conclusion of a syllogistic inference. Thus, it is easy to understand why Aristotle takes questions such as

(Q1) Does P belong to S?/(Q3.1) Does P exist?
(Q2) Why dos P belong to S?/(Q4.1) What is P?

as equivalent to questions about a middle term:

(Q1*) Is there an M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

(Q2*) What is M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

However, Aristotle makes it clear that a middle term is sought not only in questions about attributes, but also in questions about subjects (*APo* II 2, 89ᵇ37-90ᵃ5). Therefore, questions like

(Q3) Does S exist?

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[79] See Kung (1977, pp. 168-172); Charles (2000; 2010b, pp. 268-328); Williams & Charles (2013); Peramatzis (2011, pp. 180-188; 2013); Koslicki (2012); Angioni (2014c; 2016).

(Q4) What is S?

would also be reduced to questions about the existence and identity of middle terms. However, several interpreters have noted that, at first sight, it does not seem natural to talk of middle terms when we are asking whether a given subject is 'without qualification':

> How can εἰ ἔστι and τί ἐστιν applied to a substance be supposed to be concerned with a middle term? A substance does not inhere in anything; there are no two terms between which a middle term is to be found. A. [Aristotle] gives no example of what he means by the μέσον in such a case, and in this chapter the application of the questions εἰ ἔστι and τί ἐστιν to substances is overshadowed by its application to attributes and events, which is amply illustrated (90ᵃ 15-23) [Ross 1949, pp. 611-2].

> It seems clear from Aristotle's first examples that his questions are (1) Is X Y? (2) Why is X Y? (3) Does X exist? What is X? – X being a substance (centaur, god, man). But when he goes on to say that in every case we are looking for a middle term or cause, doubts arise; because it is not obviously true that when we ask whether a substance exists, or what is it, we are inquiring for its cause [Tredennick 1960, p. 11].

> Once we know that (ὅτι) C is A, we know that there is a middle term holding the extreme terms together. When we ask why (διὰ τί) C is A, we ask what is the μέσον. If it is B, then we know that C is A because (διότι) C is B and B is A. But how can there be a middle term between a single term and the predicate 'exists'? [Gomez-Lobo 1980, p. 73].

This difficulty comes from the general view that the existence of subjects, unlike that of attributes, cannot be reduced to their presence in a more basic entity. Thus, one could say that Q3 and Q4 cannot be translated into subject-predicate sentences (as Q3.1 and Q4.1 can), which makes it difficult to understand why Aristotle takes them as tantamount to questions about a middle term. After reading *APo* II 1-2, we have the impression that it would be more congenial to Aristotle's theory if Q3 and Q4 were not answered by means of syllogistic demonstrations, letting subjects and their essences fall exclusively within the competence of νοῦς. If so, in the case of subjects at least, defining and explaining would not be interdependent practices.

One could argue that it makes perfect sense to take Q3 and Q4 as questions about a middle term if we understand existence as a first order predicate. In that case, the existence of a subject would be verified insofar as there would be a middle term proving that the predicable 'existing' belongs to it. The cause signified by this middle term, on the other hand, would be the essence of the subject, providing in this way an answer to Q4. However, a few considerations about Aristotle's theory of demonstration shall make it clear that a predicate such as 'being' or 'existing' could hardly occur as the major term in a typical Aristotelian demonstration.

Aristotle describes demonstrable attributes as '*per se* accidents' (καθ᾽αὑτὰ συμβεβηκότα)[80], i.e. as predicates belonging to a subject 'in itself' (καθ᾽αὑτὸ), but not as a part of its 'essence' (οὐσία).[81] Aristotle intends to account for the fact that science is above all concerned with attributes that, unlike existence, are proper to their subjects and hold of them by necessity. Nevertheless, their presence in the relevant subject is not a trivial fact about it, knowable *a priori* through the analysis of what it is to be that subject. As several interpreters have noted, for Aristotle, necessary predicates are either part of the essence of the subject or follow from its essence.[82] Since it is not a part of the essence of its subject, a *per se* accident is a necessary consequence of and is explained by the subject's essence.

It is at least unlikely that this picture could apply to a predicate such as 'existing.' However, this approach not only fails to solve the inconsistency found in *APo* II 1-2, but also brings into focus another (potential) problem in Aristotle's theory: the philosopher appears to sustain two different (and perhaps incompatible) models of explanation. Since definitions are crucial to Aristotle's foundationalist project, it is mandatory for us to determine what role they play in syllogistic demonstrations. This task involves addressing a long-standing and important question, for many years neglected and recently revived in the secondary literature.[83] Definitions are principles of demonstrations insofar as the middle term is the λόγος of the extreme and therefore signifies an essence of a certain kind. However, is the middle term the λόγος (i.e. the definitional account) of the major or the minor term? The answer depends on whether, for Aristotle, the cause of a subject S being P is the essence of the attribute P or of the subject S.

As we have seen, in the second book of the *APo*, Aristotle is overtly committed to what I shall call the 'A-Model': the reason why 'PaS' is true is the essence (or the causal part of the essence of) *of the attribute* P.[84] In that case, a syllogistic explanation will have the following form:

$$\underline{\text{PaDef.(P), Def.(P)aS}}$$
$$\text{PaS}$$

in which 'Def.(P)' stands for the definition of P (or the causal part of its definition). Let us say, for instance, that the syllogism explaining the occurrence of thunders runs as follows (*APo* II 8, 93^b 7-14):

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[80] See *APo* I 6, 75^a 18-19; I 7, 75^b 42-^{b}2; I 10, 76^b 11-15; *Ph.* II 2, 193^b 22-30; *Metaph.* III 1, 997^a 19-25. For other occurrences of the notion, see Bonitz 713^{b}43-71^{a}3.

[81] *Metaph.* V 30, 1025^a 10-34.

[82] Loux (1991, p. 73); Barnes (1993, p. 120); Charles (2000, p. 203); Malink (2013, pp. 124-126); Bronstein (2015, pp. 724-725); Shields (2016, pp. 84-85).

[83] Ferejohn (2013); Angioni (2016, pp. 103-107); Bronstein (2015; 2016a, 48-50). See also my Zuppolini (2014a, pp. 103-145).

[84] *APo* II 2, 89^b 36 - 90^a 14; 90^a 31-35; II 8, 93^{a}31-33; *APo* II 16, 98^b 21-24; II 17 99^a 21-22, 25-26

Syllogism VIII:

Thunder (or *such-and-such noise*) holds of *extinction of fire, Extinction of fire* holds of *clouds*
Thunder (or *such-and-such noise*) holds of *clouds*

In that case, the complete (causal) definition of thunder would be isomorphic to Syllogism VIII:

Def.(Thunder):

Thunder is₍df.₎ *noise of fire being extinguished in the clouds* (*APo* II 10, 94ᵃ 5-6).

However, according to the traditional account of *per se* accidents, a demonstrable attribute P is a necessary property of its subject S, which follows from, and is explained by the subject's essence. If so, Aristotle would also be committed to what I shall call the 'S-Model': the reason why a demonstrable proposition 'PaS' is true is the essence *of the subject* S.[85] According to this model, a syllogistic explanation will be structured as follows:

PaDef.(S), Def.(S)aS
PaS

in which 'Def.(S)' stands for the definition of S.

Some passages (especially in *APo* I) can be interpreted as being in accordance with the S-Model. Here is one of them:

> **[T14]** Ἕκαστον δ᾽ ἐπιστάμεθα μὴ κατὰ συμβεβηκός, ὅταν κατ᾽ ἐκεῖνο γινώσκωμεν καθ᾽ ὃ ὑπάρχει, ἐκ τῶν ἀρχῶν τῶν ἐκείνου ᾗ ἐκεῖνο, οἷον τὸ δυσὶν ὀρθαῖς ἴσας ἔχειν, ᾧ ὑπάρχει καθ᾽ αὐτὸ τὸ εἰρημένον, ἐκ τῶν ἀρχῶν τῶν τούτου.
>
> We understand something [S being P] non-incidentally when we know it in virtue of that in virtue of which it holds and from what are its principles as such [M]. E.g. we understand that having angles equal to two right angles [P] holds of something [S] when we know it from the principles [M] of that of which it holds in itself [S *qua* S] [*APo* I 9, 76ᵃ 4-7; Barnes 1993, with changes].

Aristotle might be taken to affirm that an attribute P belongs to a subject S *in itself* (καθ᾽ αὐτὸ) when S is P in virtue of a cause M that is among the constitutive principles of S *as* S (τῶν ἀρχῶν τῶν ἐκείνου ᾗ ἐκεῖνο; ᾧ ὑπάρχει καθ᾽ αὐτὸ τὸ εἰρημένον, ἐκ τῶν ἀρχῶν τῶν τούτου). The jargon used in this passage suggests that being a principle of S is equivalent to being one of its essential features.[86]

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[85] The S-Model and the A-Model correspond to David Bronstein's Model 1 and Model 2, respectively (see Bronstein 2016a, pp. 48-50).

[86] Although this passage is highly controversial, I think it is useful for introducing this debate given the fact that Aristotle's use of the expression 'καθ᾽ αὐτὸ' is usually taken to favour the S-Model, since 'αὐτὸ' refers to the subject of *per se* predications, as I am going to argue below. For a different understanding, see Angioni (2014c; 2016), who takes the 'in itself' formula and similar expressions to refer to the *explanandum* as such. For other readings of T14, see Ross (1949, p. 537); Barnes (1993, p. 135); Angioni (2014c; 2016, p. 93).

Here, the expression 'ᾗ ἐκεῖνο' in 76ᵃ 6 is replaced by the well-known formula 'καθ᾽ αὑτὸ' in 76ᵃ 7. The shift shall not surprise the reader:

> **[T15]** τὸ καθ᾽ αὑτὸ δὲ καὶ ᾗ αὑτὸ ταὐτόν, οἷον καθ᾽ αὑτὴν τῇ γραμμῇ ὑπάρχει στιγμὴ καὶ τὸ εὐθύ (καὶ γὰρ ᾗ γραμμή), καὶ τῷ τριγώνῳ ᾗ τρίγωνον δύο ὀρθαί (καὶ γὰρ καθ᾽ αὑτὸ τὸ τρίγωνον δύο ὀρθαῖς ἴσον).
>
> To hold of something in itself and to hold of it as such are the same thing: e.g. point and straight hold of line in itself – for they hold of it as line; and two right angles hold of triangle as triangle – for the triangle is in itself equal to two right angles [*APo* I 4, 73ᵇ 28-32; Barnes 1993, with changes].

The passage above shows that, in the formula 'S is καθ᾽ αὑτὸ P', 'αὑτὸ' refers anaphorically to the subject S. First, the pronoun is in the same gender and number as the subject-terms of the predications cited as examples, 'αὑτὴν' with 'γραμμή' and 'αὑτὸ' with 'τρίγωνον'. Second, the pronoun 'αὑτὸ' in the expression 'ᾗ αὑτὸ' is replaced in both cases by the respective subject-terms, 'γραμμή' and 'τρίγωνον'. Nevertheless, as we can see in the preceding quotation (*APo* I 9, 76ᵃ 4-7), the pronoun 'αὑτὸ' in 'S is καθ᾽ αὑτὸ P' may refer anaphorically to the subject S, *but not tautologically*. Rather, we may say that it refers back to S by introducing another item that is, in the relevant way, the 'same as' S (αὑτὸ) – that is, the essence of S. If this reading is correct, the reason why triangles have 2R is not something different from what it is to be a triangle, i.e. the essence of triangle. Hence, the corresponding demonstration would run as follows:

Syllogism IX

> 2R holds of all *three-sided closed plane figures*, *three-sided closed plane figure* holds of all *triangles*
> ——————————————————————————————————————
> 2R holds of all *triangles*

Other passages in the *Analytics* favour the S-Model. In *APo* II 16, 98ᵃ35-ᵇ4, Aristotle affirms that broad-leaved plants such as vines and fig-trees shed their leaves precisely because they are broad-leaved (τὸ πλατέα ἔχειν τὰ φύλλα).[87] In *APr* I 35, 48ᵃ 33-36, 2R is said to hold of triangle 'in itself' (καθ᾽ αὑτὸ) because anything that has 2R has it 'in virtue of' (διά) triangle, whereas triangle has 2R 'not in virtue of something different' (οὐκέτι δι᾽ἄλλο).[88] In other passages, the same general idea is formulated with a 'κατὰ' or a (explanatory) 'ὅτι' instead of 'διά' (*APo* I 5, 74ᵇ 2-4; I 24, 85ᵇ 5-13).[89] Passages from outside the *Analytics* also suggest something along the lines of the S-Model:

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[87] See Ferejohn (2013, p. 104).

[88] In *APr* I 35, Aristotle addresses the mistake of taking a primary *demonstrandum* – in which we have the appropriate subject-term from an explanatory point of view – as an immediate proposition. Although there is not a kind-term that is, in respect of the property 2R, explanatorily prior to 'triangle', a complex expression (maybe the definition of triangle) could be used as a middle term to explain why all triangles have 2R.

[89] For an interpretation that also takes the occurrences of 'ὅτι' in the first half of *APo* I 24 as explanatory, see Angioni (2016, pp. 96-100).

[T16] ἔστι γὰρ οἷον ἀρχὴ τῶν ζῴων. ἐπιζητοῦμεν δὲ θεωρῆσαι καὶ γνῶναι τήν τε φύσιν αὐτῆς καὶ τὴν οὐσίαν, εἶθ᾽ ὅσα συμβέβηκε περὶ αὐτήν· ὧν τὰ μὲν ἴδια πάθη τῆς ψυχῆς εἶναι δοκεῖ, τὰ δὲ δι᾽ ἐκείνην καὶ τοῖς ζῴοις ὑπάρχειν.

For the soul is a sort of first principle of animals. We aim to consider and ascertain its nature and essence, and then its properties, of which some seem to be affections peculiar to the soul itself, while others belong to animals as well because of the soul [*De An.* I 1, 402ᵃ 6-10; Shields 2016].

[T17] οὐκ ἔχουσι δ᾽ ἀπηρτημένα κῶλα οἱ ἰχθύες διὰ τὸ νευστικὴν εἶναι τὴν φύσιν αὐτῶν κατὰ τὸν τῆς οὐσίας λόγον, ἐπεὶ οὔτε περίεργον οὐδὲν οὔτε μάτην ἡ φύσις ποιεῖ. ἐπεὶ δ᾽ ἔναιμά ἐστι κατὰ τὴν οὐσίαν, διὰ μὲν τὸ νευστικὰ εἶναι πτερύγια ἔχει, διὰ δὲ τὸ μὴ πεζεύειν οὐκ ἔχει πόδας.

The fish do not have distinct limbs, owing to the fact that the nature of fish, according to the account of their essence, is to be able to swim, and since nature makes nothing either superfluous or pointless. And since they are blooded in virtue of their essence, it is on account of being swimmers that they have fins, and on account of not being land-dwellers that they do not have feet [*PA* IV 13, 695ᵇ 17-22; Lennox 2001, with changes].

[T18] δίπουν δ᾽ ἐξ ἀνάγκης ἐστίν· τῶν γὰρ ἐναίμων ἡ τοῦ ὄρνιθος οὐσία, ἅμα δὲ καὶ πτερυγωτός, τὰ δ᾽ ἔναιμα οὐ κινεῖται πλείοσιν ἢ τέτταρσι σημείοις.

They are two-footed of necessity; for the essence of the bird is that of the blooded animals, but at the same time that of the winged animals, and blooded animals do not move by more than four points [*PA* IV 693ᵇ 5-8; Lennox 2001, with changes].[90]

Therefore, we have textual evidence (from the *Analytics* and from other works in the *corpus*) favouring both the A-Model and the S-Model. Thus, a satisfactory account of Aristotle's theory of demonstration must address the question of whether he endorses the A-Model, the S-Model, or a combination of both (if they are compatible in the first place). However, this question cannot be properly answered unless the distinction between subjects and attributes is clearly drawn. Although Aristotle takes this distinction as a *datum* in *APo* II 1-2, several issues remain obscure:

(A) What are the criteria for distinguishing between subjects and attributes? How does the metaphysical distinction between subjects and attributes relate to the linguistic or logical distinction between subject- and predicate-terms?

(B) How do subjects relate to their attributes from a metaphysical point of view? Does this metaphysical relation affect the roles they play in scientific explanations?

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[90] See also *Ph.* IV 4, 211ᵃ 7-11; *PA* IV 5, 678ᵃ 26-34; IV 6, 682ᵃ 35-ᵇ32; IV 8, 684ᵃ 32-ᵇ1.

(C) Is there a place for definitions of subjects in demonstrative sciences? Can their definitions be used to explain their demonstrable attributes? Can their definitions be used to explain their existence in syllogistic arguments?

In the next chapters, I intend to approach these three topics by analysing some of the metaphysical views that underlie Aristotle's philosophy of science. We shall see that this ontological framework accomplishes three basic tasks: (i) it imposes certain semantic rules for scientific discourse; (ii) it plays a crucial role in Aristotle's conception of causation and scientific explanation; (iii) it provides particular sciences with a set of criteria for linking together and organizing their propositions in terms of explanatory priority.

CHAPTER 3

A METAPHYSICAL DEFENCE AGAINST INFINITE REGRESS

3.1 – Aristotelian Foundationalism Challenged and a Metaphysically Loaded Response

We have seen that the metaphysical distinction between subjects and attributes is a crucial part of Aristotle's model of demonstrative science. However, the philosopher was accused of selecting an underlying logic that overlooks this very distinction. Peter Geach (1972, p. 44) argued: 'Aristotle, like Adam, began right, but soon wandered into a wrong path, with disastrous consequences for his posterity.' In order to promote his Syllogistic, says the author, Aristotle rejected a healthy theory of predication – already sketched by Plato in the *Sophist* and explored by Aristotle himself in the *De interpretatione* – which could have anticipated notions and theses that would be achieved only by Frege and Russell.[91] Following Plato, Aristotle argued that the simplest propositions available are composed of two basic elements, a 'verb' (ῥῆμα) and a 'name' (ὄνομα). Names and verbs have distinct and mutually exclusive logical roles. A verb is always 'a sign of things said of something else' (*Int.* 3, 16ᵇ 7-8.), like 'thinks' or 'runs', whereas a name, like 'Socrates' or 'Secretariat', refers to the object to which the verb is applied. Together, name and verb compose

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[91] See also Harari (2004, pp. 81-82).

meaningful propositions such as 'Socrates thinks' or 'Secretariat runs', which does not happen when we have a sequence of names ('Socrates Secretariat') or of verbs ('thinks runs'). In addition, Aristotle says that 'there is no difference between saying that a man walks and saying that a man is walking' (*Int.* 12, 21^b 9-10). Thus, the logical asymmetry that holds between subject and predicate is present in sentences with a bipartite syntax of the form 'S Ps' ('Secretariat runs') as well as in sentences with a tripartite structure such as 'S is P' ('Secretariat is running').[92]

However, at first sight, there seems to be no asymmetry between subject and predicate in the logic of the *APr*, since all the terms involved in a syllogistic reasoning must be able to play both logical roles. As Geach points out, a combinatory analysis shows us that, in all syllogistic figures, at least one of the three terms (the major, the middle and the minor) must occur as subject in one of the propositions and as predicate in another – in the first figure, the middle term is the subject of the major premise and the predicate of the minor; in the second figure, the major term is the subject of the major premise and the predicate of the conclusion; in the third figure, the minor term is the predicate of the minor premise and the subject of the conclusion. Additionally, the Syllogistic contains a set of conversion rules that change the logical role of the terms of the proposition to which they apply.[93] Russell (1961, pp. 195-198) had already criticised the same aspect of Aristotle's Logic, arguing that such shift in the logical role of a term within the same argument makes room for a large-scale production of equivocation fallacies.[94] Following Russell's criticisms, Peter Geach (1972, pp.51-54) claimed that abandoning the distinction between name and verb initiated a gradual deterioration of Logic, with harmful consequences for its development.

In the same vein, one could claim that Aristotle's model of demonstrative science embraces an underlying logic that is insensitive to the distinction between subjects and attributes, whose importance to his theory is made clear in *APo* II 1-2, as we have seen. Nevertheless, the *APo* compensate the loss of logical asymmetry between subject and predicate in syllogistic propositions with a set of (metaphysically loaded) theses on predication. These theses are part of a sophisticated argument presented in *APo* I 19-22, which we shall analyse in the present chapter.[95]

In *APo* I 3, as we have seen in Chapter 1, Aristotle describes a group of sceptics who believe that scientific knowledge is not possible since it would require demonstrations to go on *ad*

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[92] Barnes (2007, p.111) notes: 'There is no reason to question the equivalence which Aristotle and his followers proclaim – although it is perhaps worth insisting that the claim does not concern the English continuous present (for which, of course, it would be quite false) but rather a certain Greek paraphrastic idiom. So (the Greek form for) "sang" means the same as (the Greek form for) "was singing"; and in general "VERBs" means the same as "is VERBing".'

[93] The conversions are the following: AaB ⊢ BiA; AiB ⊢ BiA; AeB ⊢ BeA.

[94] See also Harari (2004, p. 92).

[95] I presented a full reconstruction of Aristotle's proof in Zuppolini (2014a), in which some of the claims I advance in this chapter can be found. Nevertheless, the interpretation presented there is significantly different from the one I am proposing now.

infinitum. In *APo* I 19-22, the philosopher presents a very complex argument meant to show that his model of demonstrative science is not vulnerable to this kind of sceptical attack. In other words, the argument is meant to establish that all Aristotelian demonstrations of the form ⟨**Π**, **c**⟩ contain a limited number of inferential steps, the set **Π** being finite.[96]

Aristotle begins his proof by questioning the possibility of there being infinite series of predications. These series can be of two kinds, the first of them being specified as follows:

> **[T19]** Ἔστω δὴ τὸ Γ τοιοῦτον ὃ αὐτὸ μὲν μηκέτι ὑπάρχει ἄλλῳ, τούτῳ δὲ τὸ Β πρώτῳ, καὶ οὐκ ἔστιν ἄλλο μεταξύ. καὶ πάλιν τὸ Ε τῷ Ζ ὡσαύτως, καὶ τοῦτο τῷ Β. ἆρ᾽ οὖν τοῦτο ἀνάγκη στῆναι, ἢ ἐνδέχεται εἰς ἄπειρον ἰέναι;
>
> Then let *C* be such that it itself no longer holds of anything else and *B* holds of it primitively (i.e. there is nothing else between them). Again, let *E* hold of *F* in the same way, and *F* of *B*. Now must this come to a stop, or is it possible for it to go on *ad infinitum*? [*APo* I 19, 81ᵇ 30-33; Barnes 1993]

Later on, in 81ᵇ 39-40, the philosopher describes this series as going 'upwards' (ἐπὶ τὸ ἄνω): such a series – which I shall call 'U-series' – begins with a 'fixed' subject and the predicate of each categorical sentence occurs as subject in the next predication:

Infinite Upwards Series (U-series): M^1aS, M^2aM^1, M^3aM^2, ... , such that $\forall n(M^{n+1}aM^n)$

The other kind of predicative series runs as follows:

> **[T20]** καὶ πάλιν εἰ τοῦ μὲν Α μηδὲν κατηγορεῖται καθ᾽ αὑτό, τὸ δὲ Α πρώτῳ Θ ὑπάρχει πρώτῳ, μεταξὺ δὲ μηδενὶ προτέρῳ, καὶ τὸ Θ τῷ Η, καὶ τοῦτο τῷ Β, ἆρα καὶ τοῦτο ἵστασθαι ἀνάγκη, ἢ καὶ τοῦτ᾽ ἐνδέχεται εἰς ἄπειρον ἰέναι;
>
> Again, if nothing is predicated of *A* in itself and *A* holds of *H* primitively and of nothing prior in between, and *H* holds of *G* and this of *B*, must *this* come to a stop, or is it possible for *this* to go on *ad infinitum*? [*APo* I 19, 81ᵇ 33-37; Barnes 1993]

This second series goes the opposite direction: it starts from a given predicate and the subject of each predication becomes the predicate in the next sentence. In 82ᵃ 1-2, Aristotle refers to this sequence of predications as going 'downwards' (ἐπὶ τὸ κάτω) – thus, I shall call it 'D-series':

Infinite Downwards Series (D-series): PaM^1, $M^1a\,M^2$, M^2aM^3, ... , such that $\forall n(M^naM^{n+1})$

To these first two questions, Aristotle adds a third one:

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[96] This has been called Aristotle's 'compactness proof.' See Lear (1980, pp. 15-34), who admits that Aristotle's concern is not exactly the same as the one we understand nowadays as the compactness problem. On this, see Scanlan (1983).

[T21] Ἔτι τὰ μεταξὺ ἆρ᾽ ἐνδέχεται ἄπειρα εἶναι ὡρισμένων τῶν ἄκρων; λέγω δ᾽ οἷον εἰ τὸ Α τῷ Γ ὑπάρχει, μέσον δ᾽ αὐτῶν τὸ Β, τοῦ δὲ Β καὶ τοῦ Α ἕτερα, τούτων δ᾽ ἄλλα, ἆρα καὶ ταῦτα εἰς ἄπειρον ἐνδέχεται ἰέναι, ἢ ἀδύνατον; ἔστι δὲ τοῦτο σκοπεῖν ταὐτὸ καὶ εἰ αἱ ἀποδείξεις εἰς ἄπειρον ἔρχονται, καὶ εἰ ἔστιν ἀπόδειξις ἅπαντος, ἢ πρὸς ἄλληλα περαίνεται.

Again, is it possible for the terms in between to be infinite if the extremes are determined? I mean e.g. if the *A* holds of *C*, and *B* is a middle term for them, and for *B* and *A* there are different middle terms, and for these others, is it possible or impossible for *these* to go on *ad infinitum*? This is the same as to inquire whether demonstrations can proceed *ad infinitum* and whether there can be demonstrations of everything, or whether terms are bounded by one another [*APo* I 19, 82ᵃ 2-8; Barnes 1993].

At first sight, one might read the first two lines of this passage as referring to the two limits S and P (τὰ ἄκρα) and the intermediate terms M's (τὰ μεταξὺ) in U- or D-series. However, what characterises these series seems to be the fact that each of them has only one boundary – an ultimate subject S and an ultimate predicate P respectively. Actually, the occurrence of 'μέσον' in 82ᵃ4 suggests that Aristotle has in mind a categorical proposition that requires an infinite number of middle terms in order to be demonstrated. By asking about the possibility of there being infinite middle terms between two (extreme) terms, Aristotle is again addressing the sceptical objection raised in *APo* I 3. In fact, what he will try to prove in *APo* 19-22 is precisely that demonstrations cannot be extended *ad infinitum*. On the other hand, if 'τῶν ἄκρων' and 'τὰ μεταξὺ' refer to the terms of the conclusion and to the middle terms of a demonstration, respectively, the connection between this third question and the other two becomes far from obvious.

It is worth stressing that the three questions are raised in a context in which the Syllogistic is always present in the background as a fundamental presupposition of Aristotle's argumentation, a point interpreters often neglect. In the first paragraph of *APo* I 19, 81ᵇ 10-29, Aristotle reminds his readers of some of the features of syllogistic reasoning, making comments he would not bother to make if they were not to be taken into account in the next paragraphs. In fact, the first paragraph of *APo* I 19 and the following chapters make it clear that the first two questions are, more precisely, about whether infinite series of universal affirmative predications can occur *in syllogistic demonstrations*.

Aristotle's point can be illustrated as follows. If a demonstration could go *ad infinitum*, at least one of its branches would contain infinitely many steps. Thus, the two questions raised in *APo* I 19 can be taken as exploring two *minimum scenarios* in which an infinite demonstration would be possible. Suppose, for instance, that an infinite sequence of inferences in *Barbara* would be necessary to demonstrate a given universal affirmative sentence 'PaS'. In the first minimum scenario, the minor premise of each syllogistic inference in the demonstration would be

indemonstrable, which means, in Aristotle's vocabulary, that each predicate of each of these minor premises would belong to their respective subjects 'primitively' – see 'πρώτῳ', 'οὐκ ἔστιν ἄλλο μεταξύ' (81^{b}31) and 'ὡσαύτως' (81^{b}32). In this situation, a U-series would be generated from the bottom minor term:[97]

$$\frac{PaM^{\omega} \qquad\qquad \mathbf{M^{\omega}aM^{\omega-1}}}{PaM^{\omega-1}}$$

$$(...)$$

$$\frac{PaM^3 \qquad\qquad \mathbf{M^3aM^2}}{\dfrac{PaM^2 \qquad\qquad \mathbf{M^2aM^1}}{\dfrac{PaM^1 \qquad\qquad \mathbf{M^1aS}}{PaS}}}$$

In another scenario, the demonstration would proceed *ad infinitum* through its other branch. In this case, the major premises would be such that the predicate holds of the subject 'primitively' – see again 'πρώτῳ' and 'μεταξὺ δὲ μηδενὶ προτέρῳ' (81^{b}35). Thus, a D-series would emerge from the bottom major term:

$$\frac{\mathbf{M^{\omega-1}aM^{\omega}} \qquad\qquad M^{\omega}aS}{M^{\omega-1}aS}$$

$$(...)$$

$$\frac{\mathbf{M^2aM^3} \qquad\qquad M^3aS}{\dfrac{\mathbf{M^1aM^2} \qquad\qquad M^2aS}{\dfrac{\mathbf{PaM^1} \qquad\qquad M^1aS}{PaS}}}$$

Of course, U- and D-series do not emerge necessarily from the bottom minor and major terms (the subject and the predicate of the conclusion). The picture we find in these two minimum scenarios can also be found in any other demonstrable premise in the proof, so that these series might well begin with the minor or major term of any of the syllogistic inferences within it.

It can be proved that, if at least one of the branches of a demonstration, in any combination of syllogistic moods, contains infinitely many steps, an infinite sequence of universal affirmative sentences will be generated – either a U- or a D-series. Although Aristotle himself does not present a sound argument for it, the chapters *APo* I 20-21 seem to offer at least a proof sketch that, if properly followed, will make it clear that no demonstrations can be extended *ad infinitum* without containing infinite series of predications.[98] Therefore, with the first paragraph of *APo* I 19

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[97] Reading from the bottom (the conclusion) to the top of the deductive tree.

[98] It is highly implausible that Aristotle would make the whole argument of *APo* I 19-22 rely on a premise that is far from trivial without bothering to verify it himself. Lear (1980, pp.25-30) claims that Aristotle's argument is invalid and

(81^{b} 10-29) providing the appropriate context, the three questions raised in the chapter can be rephrased in the following terms:

I) If ⟨**Π**, **c**⟩ is an Aristotelian demonstration, can there be a U-series – let it be **Φ** – such that **Φ ⊆ Π**? (**T19**, *APo* I 19, 81^{b} 30-33)

II) If ⟨**Π**, **c**⟩ is an Aristotelian demonstration, can there be a D-series – let it be **Ψ** – such that **Ψ ⊆ Π**? (**T20**, *APo* I 19, 81^{b} 33-37)

III) Can there be an Aristotelian demonstration ⟨**Π**, **c**⟩ with infinitely many inferential steps, the set **Π** being infinite? (**T21**, *APo* I 19, 82^{a} 2-8)

Under these formulations, the connection between the three questions is clear. As we have seen, the possibility of there being an infinite chain of syllogistic inferences in a demonstration entails an affirmative answer to at least one of the first two questions. Thus, Aristotle argues that the answer to both of them is negative, which allows him to give a negative answer to the third question as well.

The arguments for negative answers to questions **I** and **II** are found in *APo* I 22. In this chapter, Aristotle formulates a set of constraints limiting the logical roles of certain terms in demonstrative syllogisms. These constraints are at the core of Aristotle's defence of his foundationalist project against the sceptics of *APo* I 3. On the other hand, they also provide an answer to criticisms (mentioned at the beginning of this chapter) made against the Syllogistic: at least in scientific contexts, the terms involved in syllogistic inferences cannot play the roles of predicate and subject regardless of their semantic contents.

These constraints rely on a set of strong metaphysical theses including the doctrine of ontological categories. One could ask why Aristotle's argument follows a *metaphysical* approach if he intends to deny the occurrence of infinite series of predicative *sentences*, a purpose that is better described as having a *formal* or *linguistic* character. At this point, it is helpful to bring in a distinction, set out in the literature, between 'linguistic' and 'metaphysical' predications.[99] What I shall call 'linguistic predication' is an item of a given language and has a syntactical structure of the form 'S is P' – or 'S Ps' or equivalents –, where 'S' and 'P' are called 'subject' and 'predicate' for no other reason than the grammatical roles they perform in the sentence in which they occur. Metaphysical predication, on the other hand, is not a linguistic item, but the state of affairs that determines the truth-value of linguistic predications. The subject of a metaphysical predication S (and not 'S') is

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offers his own proof of this result. For evidences that Aristotle came up with a sound strategy on his own, see Crager (2013, pp. 38-62; 2015, pp. 100-124).

[99] Bogen & McGuire *(*1985, pp. 1-2); Code (1985); Lewis (1985; 1991).

no longer a term or expression, but an object to which a given attribute P (and not 'P') belongs. In the following, I shall call subjects and predicates of linguistic predications 'grammatical subjects' and 'grammatical predicates', whereas the subjects and predicates of metaphysical predications will be called 'metaphysical subjects' and 'metaphysical predicates'.

Aristotle's proof is based on the distinction between two kinds of predicative relation. At the very beginning of *APo* I 22, he discusses essence-specifying sentences, when there is a definitional connection between the (grammatical) subject and the (grammatical) predicate (see *APo* I 22, 83^b 5-8). He argues that there cannot be infinite series of predications of this kind because the essence of a given (metaphysical) subject cannot be composed of infinitely many (metaphysical) predicates:

> [T22] Ἐπὶ μὲν οὖν τῶν ἐν τῷ τί ἐστι κατηγορουμένων δῆλον· εἰ γὰρ ἔστιν ὁρίσασθαι ἢ εἰ γνωστὸν τὸ τί ἦν εἶναι, τὰ δ᾽ ἄπειρα μὴ ἔστι διελθεῖν, ἀνάγκη πεπεράνθαι τὰ ἐν τῷ τί ἐστι κατηγορούμενα.
>
> For items predicated in what something is, the case is plain: if it is possible to define anything, or if what it is to be something can be known, and if you cannot survey infinitely many items, then the items predicated in what something is must be finite [*APo* I 22, 82^b 37-83^a 1; Barnes 1993].

After these brief words, Aristotle goes on to examine sentences in which the grammatical predicate is not mentioned in the definition of its grammatical subject; the corresponding metaphysical predicate, in turn, would not be part of the essence of the respective metaphysical subject:[100]

> [T23] ἔστι γὰρ εἰπεῖν ἀληθῶς τὸ λευκὸν βαδίζειν καὶ τὸ μέγα ἐκεῖνο ξύλον εἶναι, καὶ πάλιν τὸ ξύλον μέγα εἶναι καὶ τὸν ἄνθρωπον βαδίζειν. ἕτερον δή ἐστι τὸ οὕτως εἰπεῖν καὶ τὸ ἐκείνως. ὅταν μὲν γὰρ τὸ λευκὸν εἶναι φῶ ξύλον, τότε λέγω ὅτι ᾧ συμβέβηκε λευκῷ εἶναι ξύλον ἐστίν, ἀλλ᾽ οὐχ ὡς τὸ ὑποκείμενον τῷ ξύλῳ τὸ λευκόν ἐστι· καὶ γὰρ οὔτε λευκὸν ὂν οὔθ᾽ ὅπερ λευκόν τι ἐγένετο ξύλον, ὥστ᾽ οὐκ ἔστιν ἀλλ᾽ ἢ κατὰ συμβεβηκός. ὅταν δὲ τὸ ξύλον λευκὸν εἶναι φῶ, οὐχ ὅτι ἕτερόν τί ἐστι λευκόν, ἐκείνῳ δὲ συμβέβηκε ξύλῳ εἶναι, οἷον ὅταν τὸ μουσικὸν λευκὸν εἶναι φῶ (τότε γὰρ ὅτι ὁ ἄνθρωπος λευκός ἐστιν, ᾧ συμβέβηκεν εἶναι μουσικῷ, λέγω), ἀλλὰ τὸ ξύλον ἐστὶ τὸ ὑποκείμενον, ὅπερ καὶ ἐγένετο, οὐχ ἕτερόν τι ὂν ἢ ὅπερ ξύλον ἢ ξύλον τί.
>
> You can say truly that the white thing is walking, and that that large thing is a log, and again that the log is large and the man is walking. When you speak in these two ways you make different sorts of statement. When I assert that the white thing is a log, I say that something which is

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[100] For a similar division of the chapter, see Philoponus (235.10-236.23); Barnes (1993, p. 175); Angioni (2007b, pp. 108-109). Someone may think that 'καθόλου δὲ ὧδε λέγομεν' in 83^{a}1 indicates that the rules formulated in 83^{a}1-23 apply both to essential and non-essential predications. Even if this sentence is read as recognizing the need to deal with both kinds of predication (essential and non-essential), this does not entail that *one single* argument for both kinds must be provided. Neither is it necessary to read 'οὕτω γὰρ αἱ ἀποδείξεις ἀποδεικνύουσιν' in 83^{a}20-21 as implying the same result, since 'οὕτω' may very well be read as meaning 'without containing (non-essential) unnatural predications.'

incidentally white is a log, and not that the white thing is the underlying subject for the log. For it is not the case that, being white or just what is some particular white, it came to be a log – hence it is not a log except incidentally. But when I say that the log is white, I do not say that something different is white and that that is incidentally a log, as when I say that the musical thing is white (I am then saying that the man, who is incidentally musical, is white). Rather, the log is the underlying subject which came to be [white] not in virtue of being something different from what is a log or a particular log [*APo* I 22, 83ᵃ 1-14; Barnes 1993, with changes].

Here, Aristotle draws a distinction between two sorts of non-definitional predicative sentences, which I shall call 'natural' and 'unnatural' predications.[101] A natural (linguistic) predication like 'the log is white' and 'the man is walking' is such that the grammatical subject denotes the metaphysical subject of the associated metaphysical predication appropriately. On the other hand, unnatural (linguistic) predications such as 'the white thing is walking' and 'that large thing is a log' have as their grammatical subjects terms that fail to refer to the corresponding metaphysical subjects in a proper way.

Aristotle makes it clear that we can state truths about the world with unnatural predications. Such sentences are very common in ordinary discourse and, in most cases, they turn out to be perfectly intelligible. Scientific discourse, however, should avoid sentences of this kind and be limited to natural predications (see *APo* I 22, 83ᵃ 20-21). In the sentence 'the log is white', the grammatical subject '(the) log' is an appropriate denoting phrase[102] because the corresponding metaphysical subject is white 'without being something different from just what is a log or a particular log' (οὐχ ἕτερόν τι ὂν ἢ ὅπερ ξύλον ἢ ξύλον τί, *APo* I 22, 83ᵃ 13-14). Terms that capture *just what* a given metaphysical subject *is* (ὅπερ ἔστι) are said to 'signify substance' (οὐσίαν σημαίνει, *APo* I 22, 83ᵃ 24-25). This is congenial to Aristotle's well-known thesis that substances are the metaphysical subjects *par excellence*, which makes them the primary realities on which everything else ontologically depends.[103] Thus, science should avoid unnatural predications because scientific propositions are supposed to describe and explain the world as it is, which involves referring to the basic metaphysical subjects as what they are, namely, substances.[104]

Therefore, the argument in *APo* I 22 is underpinned by a metaphysical theory that identifies substances – humans, horses, logs and so on – as the primary subjects based on which

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[101] See Philoponus 235.17-23; Barnes (1993, pp. 114; 175).

[102] We are using the expression 'denoting phrase' as it is defined in Russell (1905). For a comparison between Aristotle's and Russell's theories of descriptions see Williams (1985).

[103] We shall discuss in more detail the notion of ontological dependence in Chapter 4.

[104] For a similar view, see Barnes (1993, p. 176); Angioni (2006, pp.114-117); Angioni (2007b). Of course, this semantic principle needs to be qualified. As we are going to see below, depending on the science in question, the basic subjects in a scientific domain will not be, strictly speaking, *substances*, but still have their essence specified independently of mentioning more basic subjects to which they belong.

reality is metaphysically structured. In order to understand the claims of the chapter, interpreters usually resort to the *Categories*. In the next section, we shall analyse the main theses of this treatise before we continue to examine Aristotle's proof in *APo* I 22.

3.2 – The *Categories*: Inherence and Said-of Relations

We have seen that the argument in *APo* I 22 relies on the distinction between essential and non-essential predications. In *Cat.* 2, 1ª 20-ᵇ9, Aristotle uses a technical vocabulary to draw a similar distinction: linguistic predications of the form 'S is P' are split into two groups depending on the metaphysical relation that holds between the entity introduced by 'S' and the one introduced by 'P'. A sentence like 'Socrates is white' is analysed as expressing, between the (metaphysical) subject Socrates and the (metaphysical) predicate whiteness, a relation Aristotle describes with the expression 'ἐν ὑποκειμένῳ εἶναι'. We shall call it the '*inherence* relation':

Inherence Relation: 'Socrates is white' is true iff. whiteness is *in the subject* Socrates.

On the other hand, a sentence like 'Socrates is a man' signifies a predicative connection that Aristotle describes by the phrase 'καθ᾽ ὑποκειμένου λέγεσθαι.' In spite of Aristotle's misleading vocabulary, this kind of predication is metaphysical rather than linguistic.[105] We shall call it the '*said-of* relation':

Said-of Relation: 'Socrates is a man' is true iff. man is *said of the subject* Socrates.

Aristotle does not elaborate clear definitions of these predicative connections, but their basic features are well known. In *said-of* relations, the (metaphysical) predicate is part of the essence or nature of the (metaphysical) subject, consisting in its species or genus.[106] If it signifies a relation of this type, the sentence 'S is P' is a good answer to the question 'what is S?' and should be interpreted as expressing a 'definitional truth' (Ferejohn 1991, p. 82). In *inherence* relations, on the other hand, the (metaphysical) predicate is not a part of the essence of the (metaphysical) subject, but an 'incidental' attribute (συμβεβηκός). Thus, if it expresses an *inherence* relation, the (linguistic) predication 'S is P' would not be an answer to the question 'what is S?', but to other questions like 'of what quality is S?', 'of what quantity is S?, 'where is S?' and so on.

In *Cat.* 2, Aristotle classifies 'beings' (τῶν ὄντων, 1ª 20) using as a criterion the roles they play in *said-of* and *inherence* relations:

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[105] See 'τῶν ὄντων' in 1ª 20. See Ackrill (1963, p. 75) and, for another reading, Moravcsick (1967). Cf. Ferejohn (1991, pp. 78-79). On the distinction between *inherence* and *said-of* relations, see Chen (1957).
[106] See Ackrill (1963, pp.74-75).

[T24] τῶν ὄντων τὰ μέν καθ᾽ὑποκειμένου τινὸς λέγεται, ἐν ὑποκειμένῳ δὲ οὐδενί ἐστιν, οἷον ἄνθρωπος καθ᾽ ὑποκειμένου μέν λέγεται τοῦ τινὸς ἀνθρώπου, ἐν ὑποκειμένῳ δὲ οὐδενί ἐστιν· τὰ δὲ ἐν ὑποκειμένῳ μέν ἐστι, καθ᾽ ὑποκειμένου δὲ οὐδενὸς λέγεται [...] οἷον ἡ τὶς γραμματικὴ ἐν ὑποκειμένῳ μέν ἐστι τῇ ψυχῇ, καθ᾽ ὑποκειμένου δὲ οὐδενὸς λέγεται, καὶ τὸ τὶ λευκὸν ἐν ὑποκειμένῳ μέν ἐστι τῷ σώματι – ἅπαν γὰρ χρῶμα ἐν σώματι –, καθ᾽ ὑποκειμένου δὲ οὐδενὸς λέγεται. τὰ δὲ καθ᾽ ὑποκειμένου τε λέγεται καὶ ἐν ὑποκειμένῳ ἐστίν, οἷον ἡ ἐπιστήμη ἐν ὑποκειμένῳ μέν ἐστι τῇ ψυχῇ, καθ᾽ ὑποκειμένου δὲ λέγεται τῆς γραμματικῆς· τὰ δὲ οὔτε ἐν ὑποκειμένῳ ἐστὶν οὔτε καθ᾽ ὑποκειμένου λέγεται, οἷον ὁ τὶς ἄνθρωπος ἢ ὁ τὶς ἵππος - οὐδὲν γὰρ τῶν τοιούτων οὔτε ἐν ὑποκειμένῳ ἐστὶν οὔτε καθ᾽ ὑποκειμένου λέγεται.

Of things that are: [1] some are said of a subject but are not in any subject. For example, man is said of a subject, the individual man, but is not in any subject. [2] Some are in a subject but are not said of any subject. […] For example, the individual knowledge-of-grammar is in a subject, the soul, but is not said of any subject; and the individual white is in a subject, the body (for all colour is in a body), but is not said of any subject. [3] Some are both said of a subject and in a subject. For example, knowledge is in a subject, the soul, and is also said of a subject, knowledge-of-grammar. [4] Some are neither in a subject nor said of a subject, for example the individual man or individual horse – for nothing of this sort is either in a subject or said of a subject [*Cat.* 2, 1ª 20-ᵇ9; Ackrill 1963].

The types of being classified in this passage have the following distinctive features:

1- Beings that are *said of a subject*, but are **not** *in a subject*.

2- Beings that are **not** *said of a subject*, but are *in a subject*.

3- Beings that are *said of a subject* and are *in a subject*.

4- Beings that are **not** *said of a subject*, **nor** are they *in a subject*.

Items of the first type are the genera and species in the category of substance – Aristotle calls them 'secondary substances' (δεύτεραι οὐσίαι) –, which are *said of* substances without *being in* them or in any other subject – as man (1ª 21) or animal (2ª 19) taken universally. Entities of the second type are *in* certain subjects, but are never *said of* anything, which means they are never an essential attribute of the subject to which they belong. These are particulars in categories other than substance – for instance, a particular knowledge of grammar (1ª 25-6) or a particular white (1ª 27). The third type of being includes universals belonging in non-substantial categories – as, for example, knowledge (1ᵇ 1), which is *in* the soul and is *said of* a particular knowledge of grammar. Finally, entities of the fourth type are individuals in the category of substance – as, for instance, a particular human being (1ᵇ 4), like Socrates or Churchill, or a particular horse (1ᵇ 4-5), like Bucephalus or Secretariat. These are called 'primary substances' (πρῶται οὐσίαι). Although the *Categories* are not clear about what kind of things can be taken as primary substances, Aristotle's examples made some interpreters describe them as 'concrete individual living things' (Ferejohn

1991, p. 81) and 'familiar concrete particulars of common sense' (Loux 1991, p. 23). In any case, the most distinguishable characteristic of primary substances is the fact that they never play the role of predicate in neither of these two predicative relations.

It is true that Aristotle does not give us an elaborate account of these four kinds of beings just by identifying their roles in *inherence* and *said-of* relations. Nevertheless, the four-fold division in *Cat.* 2 involves two important principles of Aristotle's ontology. First, primary substances are never the predicate in neither of these predicative relations, while all the other beings occur as predicate in at least one of them. Second, every metaphysical predicate bears a predicative relation with a primary substance (*Cat.* 5, 2^b 3-6). Therefore, beings of the fourth type are taken as the most fundamental realities (i.e. the primary 'beings' or 'substances') because the other entities only take part in reality insofar as they are predicated of them. At least according to the view Aristotle advances in the *Categories*, what makes entities like courage and whiteness depend on a certain collection of individuals like Socrates and Secretariat is the fact that the former can only be part of reality as long as there are individuals like the latter of which they are (metaphysically) predicated, but which are not themselves (metaphysically) predicated of (and hence are not ontologically dependent on) anything else.[107]

The dependent items of types 2 and 3 can be classified into further different kinds of being, which, together with substance (types 1 and 4), make up the list of Aristotelian categories: 'of things said without any combination, each signifies substance or quantity or quality or a relative or place or time or being-in-a-position or having or doing or being affected.'[108] In a famous passage of his commentary, Ackrill (1963, pp. 78-81) argued that Aristotle might have followed two alternative strategies for arriving at this list. The first strategy consists in distinguishing different kinds of question that can be asked about a given substance x: 'what is x?, 'of what quality is x?', 'where is x?' and so on – in fact, Aristotle uses single-word interrogative pronouns to designate some of the categories (πόσον, ποιὸν, ποὺ, ποτὲ etc.). We shall then notice that each of these questions admits only a limited range of appropriate answers and therefore corresponds to one of the categories into which beings can be classified (substance, quality, place etc.). Thus, if 'x is in the Lyceum', for instance, is an appropriate answer to the question 'where is x?', then the metaphysical predicate *being in the Lyceum* belongs in the category of place (ποὺ). It is worth noting that this strategy already presupposes an intuitive way of distinguishing substances (the concrete particulars of common sense) from incidental beings.[109] If the object in question is, for instance, a number or

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[107] At least, this seems to be the kind of ontological dependence that is in question in the *Categories*. We shall discuss in detail below (see Chapter 4) the problems involved in formulating ontological dependence in these terms and consider other kinds of ontological dependence and their impact in Aristotle's philosophy of science.

[108] *Cat.* 4, 1^b 25-27. Ackrill (1963) with changes.

[109] Ferejohn (1991, p. 85).

a Platonic form, questions like 'where?' and 'when?' would not make sense, which would render the list of categories incomplete.

The second method suggested by Ackrill consists not in asking several questions about a given substance, but in asking the 'what is x?' question about any entity whatsoever, a strategy which seems to be operating in *Top.* I 9:

> **[T25]** δῆλον δ᾽ ἐξ αὐτῶν ὅτι ὁ τὸ τί ἐστι σημαίνων ὁτὲ μὲν οὐσίαν σημαίνει, ὁτὲ δὲ πόσον, ὁτὲ δὲ ποιόν, ὁτὲ δὲ τῶν ἄλλων τινὰ κατηγοριῶν. ὅταν μὲν γὰρ ἐκκειμένου ἀνθρώπου φῇ τὸ ἐκκείμενον ἄνθρωπον εἶναι ἢ ζῷον, τί ἐστι λέγει καὶ οὐσίαν σημαίνει· ὅταν δὲ χρώματος λευκοῦ ἐκκειμένου φῇ τὸ ἐκκείμενον λευκὸν εἶναι ἢ χρῶμα, τί ἐστι λέγει καὶ ποιὸν σημαίνει. ὁμοίως δὲ καὶ ἐὰν πηχυαίου μεγέθους ἐκκειμένου φῇ τὸ ἐκκείμενον πηχυαῖον εἶναι μέγεθος, τί ἐστι λέγει καὶ πόσον σημαίνει. ὁμοίως δὲ καὶ ἐπὶ τῶν ἄλλων.
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> It is clear at once that an expression signifying the what-it-is will sometimes signify a substance, sometimes a quantity, sometimes a quality, and sometimes one of the other categories. For, supposing the example under consideration is a man, if it says that the example is a human or an animal, then it says what it is and signifies a substance. On the other hand, supposing the example under consideration is a white colour, if it says that the subject is a white or a colour, then it says what it is and signifies a quality. Similarly, supposing that the example under consideration is a foot-long length, if it says that the example is a foot-long length, then it says what it is and signifies a quantity. And likewise with the other categories [*Top.* I 9, 103^{b}27-35; Smith 1997].

The species or the genus (or higher genus) of Socrates and courage would be appropriate answers to the questions 'what Socrates is?' and 'what is courage?'. If we repeat the same question in respect of the species or genus mentioned in these first answers, and continue thus, we will eventually end up with conceptually simple terms naming one of the categories – substance, quality, quantity etc. –, which would be *summa genera* to which the 'what is x?' question would not apply. Ackrill (1963, p. 80) argues that, since there is no overlap between the ranges of possible answers to the questions of the first strategy, no item analysed in the second strategy could fall under more than one highest genus if defined by genus and differentia, which explains why these two methods are supposed to produce the same results.

It is hard to know whether Aristotle actually adopted these strategies and to which extent they are effective. However, they can still help us understand some important features of *inherence* and *said-of* relations. In the first strategy, a set of questions about a given substance is formulated, one of which is answered by a sentence signifying a *said-of* predication (the 'what is x?' question), whereas all the others are answered by sentences expressing *inherence* relations. We have also seen that questions corresponding to non-substantial categories are meaningless unless they

ask something about an item in the category of substance. All these facts already point to an important metaphysical principle in the *Categories*:

MP 1: if P is *in the subject* S, then S and P belong in different categories and S is a substance.[110]

On the other hand, as Ackrill's second strategy and *Top.* I 9 make it clear, the 'what is x?' question applies not only to substances, but to items in other categories as well. And again, the same being cannot belong in more than one branch of the porphyrian tree, and all the elements in the same branch fall under one and the same *summum genus*. This gives us another metaphysical principle:

MP 2: If P is *said of the subject* S, then S and P belong in the same category.

Something along the lines of MP1 and MP2 seems to underlie Aristotle's argumentation in *APo* I 22. First, a thesis similar to MP1 underpins the distinction between natural and unnatural predications. For Aristotle, science is supposed to portray reality as it is in a very precise sense: linguistic predications in scientific discourse must correspond to the metaphysical predications they intend to signify. In a non-essential predication between an attribute P and a subject S – that is to say, when P is *in the subject* S –, S will be an item in the category of substance, whereas P will belong in a non-substantial category. Therefore, the corresponding sentence 'S is P' would be a natural predication only if the grammatical subject 'S' is a substance-term like 'log' or 'man', since otherwise it would not refer to S as what S precisely is. In a linguistic predication like 'the musical [thing] is white' – τὸ μουσικὸν λευκὸν [ἐστὶν], 83ᵃ10 –, we do not have 'one thing predicated of one thing' (ἓν καθ᾽ ἑνός, *APo* I 22, 83ᵃ 22-23), but a complex sentence with two coincidental attributes (*being musical* and *being white*) being predicated of the same underlying subject. As Aristotle points out, what we mean by a sentence like 'the musical [thing] is white' is 'that the man, who is incidentally musical, is white' (ὁ ἄνθρωπος λευκός ἐστιν, ᾧ συμβέβηκεν εἶναι μουσικῷ, *APo* I 22, 83ᵃ 11-12). Still, items in non-substantial categories can also be subject of metaphysical predication. As long as P is part of the essence of a subject S – that is, P is *said of* S –, S may well be in a non-substantial category. In that case, according to MP 2, P will belong in the same category as S and none of them will 'signify substance.' In summary: if the sentence 'S is P' signifies a non-essential predication, S is in the category of substance while P is in a non-substantial category. Alternatively, if 'S is P' expresses an essential predication, S is either in the category of substance or in a non-substantial category, the predicate P being, in both cases, in the same category as S. Thus, the distinction between homocategorical and heterocategorical predications in the *Categories*

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[110] Furth (1988, p. 14); Ferejohn (1991, p. 82).

mirrors Aristotle's strategical distinction between essential and non-essential predicates in *APo* I 22.[111]

3.3 – A Defence against Infinite Regress: The Traditional Interpretation

Several interpreters believe that the theoretical background of the *Categories* enables Aristotle to justify negative answers to questions **I** and **II** (see **T19** and **T20** above). In the ontology of the *Categories*, all kinds of being can occur in metaphysical predications both as subjects and as predicates, with the exception of particular substances (type 4 entities in our analysis of **T24**) and *summa genera* (the conceptually simple items that come up at the end of Ackrill's second strategy). Thus, a 'downwards' sequence of predications of the form {PaM^0, M^{0}a M^1, M^{1}aM^2, ... } would always end up with a sentence like 'M^{i}aS' in which 'S' names a particular substance and therefore cannot occur as grammatical predicate in another predication. In conformity with *Top.* I 9 and Ackrill's second strategy, these interpreters also believe that every 'upwards' sequence like {M^{0}aS, M^{1}aM^0, M^{2}aM^1, ... } would be interrupted by a predication of the form 'PaM^i' in which 'P' signifies a *summum genus* (substance, quality, quantity etc.) and would not be qualified to occur as subject in another predicative statement.[112] Let us call this reading the 'Traditional Interpretation' of *APo* I 19-22.

This interpretation is in accordance with what Aristotle says in *APr* I 27:

> **[T26]** Ἁπάντων δὴ τῶν ὄντων τὰ μέν ἐστι τοιαῦτα ὥστε κατὰ μηδενὸς ἄλλου κατηγορεῖσθαι ἀληθῶς καθόλου (οἷον Κλέων καὶ Καλλίας καὶ τὸ καθ᾽ ἕκαστον καὶ αἰσθητόν), κατὰ δὲ τούτων ἄλλα (καὶ γὰρ ἄνθρωπος καὶ ζῷον ἑκάτερος τούτων ἐστί)· τὰ δ᾽ αὐτὰ μὲν κατ᾽ ἄλλων κατηγορεῖται, κατὰ δὲ τούτων ἄλλα πρότερον οὐ κατηγορεῖται· τὰ δὲ καὶ αὐτὰ ἄλλων καὶ αὐτῶν ἕτερα, οἷον ἄνθρωπος Καλλίου καὶ ἀνθρώπου ζῷον.
>
> Now of all the things there are, some are such that they cannot be predicated truly and universally of anything else (for instance, Cleon or Calllias, that is, what is individual and perceptible), but other things may be predicated of them (for each of these is both a man and an animal). Some things are themselves predicated of others, but nothing else is prior and predicated of them. And some things are both predicated themselves of others and others of them, as man is predicated of Callias and animal of man [*APr* I 27, 43ª25-32; Striker 2009].

Here, Aristotle divides things into three groups: those that are not predicated of anything else, but of which some things can be predicated; those that are predicated of other things but of which

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[111] See Philoponus (236.5-8), who believes that Aristotle relies on MP 1 and MP 2 in *APo* I 22.

[112] Philoponus 233.28-29, 244.28-32, 247.17-22; 250.21-251.9; Demos (1944, pp. 257-258); Ross (1949, pp. 578-579); Hamlyn (1961, p.119); Loux (1991, p. 23); Bronstein (2016a, pp. 41-42)

nothing can be predicated; and finally those that can be both predicated of other things and other things of them. The first class is exemplified by particular and perceptible objects such as Callias or Socrates (*APr* I 27, 43ᵃ 32-36), while the third class covers intermediary items such as man, which are predicated of things like Callias and of which things like animal are predicated. Aristotle does not give an example of the second class, but just announces that he will argue 'later' (πάλιν ἐροῦμεν) that 'one also comes to a halt if one goes upwards' (*APr* I 27, 43ᵃ 36-37). The occurrence of the phrase 'ἐπὶ τὸ ἄνω' here does suggest that this passage refers to *APo* I 19-22 and it is easy to see why anyone advocating the Traditional Interpretation of these chapters would like to take the *summa genera* as examples of the second class listed in **T26**.[113]

Indeed, Aristotle seems to accept in his ontology items that function as boundaries in the complex structure of predicative connections of which reality is made. However, there is no reliable evidence that this aspect of his metaphysical theory is crucial (or even relevant) to his argument in *APo* I 19-22. In addition to the lack of textual evidence, there are also three positive reasons to reject the Tradition Interpretation:

(i) First of all, this reading makes names and descriptions of particular substances the basic subject-terms of scientific discourse. However, Aristotle seems hostile to the presence singular terms in demonstrative sciences. In the *Categories*, a universal kind K is said to be ontologically dependent on its particular members in the sense that it could not exist if there were no individuals of which K could be predicated. Therefore, particular substances are said to be 'primary', while their species and genera only get the status of 'secondary' substances. Nevertheless, the type of dependence between attributes and subjects that demonstrations are supposed to account for is not *existential*, but *explanatory*. For Aristotle, the knowledge that the triangle has 2R is in some way prior to the knowledge that 'a given figure in a semi-circle'[114] or the isosceles triangle[115] have the same property, since 2R belongs to them *as triangles*. Thus, particular objects x, y, z (…) have the demonstrable properties they have *qua* members of a universal kind K, i.e. *in virtue of* being members of K – even if the existence of K depends on the existence of its particular members. As we shall see in the next chapters, one fundamental task of demonstrative sciences is to identify the relevant kinds on which a given property relies from an explanatory point of view. For that reason, the corresponding (universal) kind-terms will be the basic subjects in demonstrative sciences, not names and descriptions of particular substances.[116]

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[113] For a careful discussion of T26, and the presence of singular terms and *summa genera* in Aristotle's syllogistic, see Almeida (2013).
[114] *APo* I 1, 71ᵃ 19-21.
[115] *APo* I 4, 73ᵃ 28-34; 73ᵇ 25 *APo* I 24, 85ᵇ 5-7 *APo* I 9, 76ᵃ 4-9.
[116] See my Zuppolini (2014c, pp. 15-17).

(ii) On the other hand, being a substance, a quality or a quantity does not seem to be the kind of feature Aristotle would take as a demonstrable attribute. In ideal cases, a demonstrable attribute is peculiar to its subject and belongs to it in virtue of the subject being the specific subject it is.[117] This could hardly be the case of highly abstract and generic predicates such as *summa genera*. Although they are relevant to metaphysical speculation, these concepts seem to be associated with classificatory practices rather than scientific explanation. It is hard to see how a scientist could tell a clear-cut causal story explaining why they are connected to a specific subject and not another – as a geometer is able to explain why 2R belongs to the triangle and no other figure. If there is such causal story to be told, it is certainly not the kind of explanation departmental sciences are supposed to provide.

(iii) There is a third and final reason to reject the Traditional Interpretation of *APo* I 19-22. As we have noted, the aim of Aristotle's argumentation in these chapters is to provide an answer to a group of sceptics described in *APo* I 3, who believe that scientific knowledge is not possible because demonstrations would proceed *ad infinitum*. As we know, this sceptical objection relies on the false assumption that every proposition in demonstrative sciences is known by demonstration. Without this assumption, it is possible to insist on a foundationalist solution and hold that every demonstration is ultimately based on propositions which do not need to be demonstrated from explanatorily prior premises in order to be known. However, in addition to the abstract epistemological discussion in *APo* I 3, Aristotle found it necessary to make sure his own model of demonstrative science was safe from infinite regress, a task he tried to accomplish in *APo* I 19-22. Since syllogistic demonstrations with an infinite set of premises would contain infinite series of predications, Aristotle believed that showing the impossibility of infinite predicative series was tantamount to proving that no demonstration in his model could proceed *ad infinitum*. However, the sceptic from *APo* I 3 might well argue that the connection between infinite chains of predications and infinite regress is a peculiarity of Aristotle's metaphysics and its underlying logic, whereas his challenge concerns the existence of ultimate explanations. Therefore, unless we are able to show a relation between Aristotle's theses on predication and the existence of explanatorily basic premises, the philosopher (at least in *APo* I 19-22) would have failed to protect his model against infinite regress. Certainly, the Traditional Interpretation does not explain the connection between particular substances and *summa genera* being boundaries of predicative chains, on one hand, and the existence of ultimate explanations, on the other.

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[117] See *APo* I 4 73ᵇ32-74ᵃ3; I 5, 74ᵃ16-ᵇ4; I 24, 85ᵇ4-15; 85ᵇ23-27; 85ᵇ38-86ᵃ3. This aspect of Aristotle's theory will be clarified in the next chapter.

3.4 – A Defence against Infinite Regress: An Alternative Interpretation

As I have argued, the three questions raised in *APo* I 19 concern the occurrence of predicative series within syllogistically structured demonstrations:

I) If $\langle\mathbf{\Pi}, \mathbf{c}\rangle$ is an Aristotelian demonstration, can there be a U-series – let it be $\mathbf{\Phi}$ – such that $\mathbf{\Phi} \subseteq \mathbf{\Pi}$? (**T19**, *APo* I 19, 81^b 30-33)

II) If $\langle\mathbf{\Pi}, \mathbf{c}\rangle$ is an Aristotelian demonstration, can there be a D-series – let it be $\mathbf{\Psi}$ – such that $\mathbf{\Psi} \subseteq \mathbf{\Pi}$? (**T20**, *APo* I 19, 81^b 33-7)

III) Can there be an Aristotelian demonstration $\langle\mathbf{\Pi}, \mathbf{c}\rangle$ with infinitely many inferential steps, the set $\mathbf{\Pi}$ being infinite? (**T21**, *APo* I 19, 82^a 2-8)

Aristotle formulates question **III** with a typical syllogistic vocabulary: can there be an infinite set of middle terms $\{M^1, M^2, M^3, ... , M^\omega\}$ between two extremes P and S? Let us follow the scenario described in **T19** and suppose the following sequence of inferences in *Barbara*, in which the minor premises are 'immediate', whereas the major premises are always demonstrated from more basic propositions:

$$\frac{PaM^\omega \qquad\qquad \mathbf{M^\omega aM^{\omega-1}}}{PaM^{\omega-1}}$$

$$(...)$$

$$\frac{PaM^3 \qquad\qquad \mathbf{M^3aM^2}}{\dfrac{PaM^2 \qquad\qquad \mathbf{M^2aM^1}}{\dfrac{PaM^1 \qquad\qquad \mathbf{M^1aS}}{PaS}}}$$

In this context, asking whether the demonstration could proceed *ad infinitum* is equivalent to asking whether a U-series could be formed from the minor term S.[118] This question, however, is the same as asking whether there is a middle term M^i which is 'immediately' or 'indemonstrably' connected to P. Here, question **III** is equivalent to the following question:[119]

III.1) Is it the case that $\forall i \exists j((PaM^j, M^iaM^i \vdash PaM^i)$ & M^j is the reason why $PaM^i)$?

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[118] Of course, in a different context, with a different combination of syllogistic moods, a U-series may emerge (e.g.) from the bottom major term instead of the bottom minor term (see the sequence of *Camestres* in *APo* I 21, 82^{b}13-21), as well as a D-series may begin with (e.g.) the bottom minor term instead of the bottom major term (see the sequence of *Bocardo* in 82^b 22-28). It is worth noting that the same reasoning applies to all demonstrable premises within the chain, which means a U-series or a D-series may emerge from any minor or major term in the demonstration.

[119] See my Zuppolini (2014a, p. 48). Cf. Lear (1980, p. 22).

Suppose now a sequence of syllogisms in *Barbara* in which the minor premises are demonstrable, while the major premises are immediate – like the scenario suggested in **T20**:

$$\frac{\mathbf{M^{\omega-1}aM^{\omega}} \qquad\qquad M^{\omega}aS}{M^{\omega-1}aS}$$

(...)

$$\frac{\mathbf{M^2aM^3} \qquad\qquad M^3aS}{M^2aS}$$
$$\frac{\mathbf{M^1aM^2} \qquad\qquad M^2aS}{M^1aS}$$
$$\frac{\mathbf{PaM^1} \qquad\qquad M^1aS}{PaS}$$

Asking whether this demonstration have infinitely many steps is the same as asking whether a D-series could emerge from the major term P. Such question, however, is equivalent to asking whether there is no middle term M^i to which the bottom minor term S is 'immediately' connected:

III.2) Is it the case that $\forall i \exists j ((M^i a M^j, M^j a S \vdash M^i a S)$ & M^j is the reason why $M^i a S)$?

If this interpretation of *APo* I 19 is correct, Aristotle is *not* raising an abstract metaphysical question about the existence of ultimate subjects (such as particular substances) and ultimate predicates (such as *summa genera*). On the contrary, he is interested in denying that U- or D-series could be part of a demonstration proving the relation between two 'fixed' or 'determined' extremes (ὡρισμένων τῶν ἄκρων) – i.e. any major and minor terms in the syllogistic chain, and not necessarily names and descriptions of particular substances or general terms naming ontological categories. But how does Aristotle establish this result? What are the premises of his argument?

As we have seen, the ontology of the *Categories* contains the following metaphysical principles:

MP 1: if P is *in the subject* S, then S and P belong in different categories and S is a substance.

MP 2: If P is *said of the subject* S, then S and P belong in the same category.

These two principles (or some close version of them) seem to motivate the distinction between natural and unnatural predications in *APo* I 22. A categorical sentence 'PaS' – 'every S is P' – is a natural predication when the grammatical subject 'S' refers to the metaphysical subject S by signifying just what S is (ὅπερ ἐστιν). In contemporary terms, we would say that 'S' is a sortal or individuative term, whose distinguishing feature is what Quine calls 'divided reference.'[120] By specifying what the denoted objects essentially are, such terms provide us with a criterion for counting these objects as discrete entities, which makes them suitable to be attached to

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[120] Quine (1960, pp. 90-95).

quantificational expressions such as 'every S' or 'some S'. In other words, these terms signify οὐσίαν[121] (and not πόσον, ποιὸν etc.), i.e. they specify the essence of the basic subjects of a given domain, which are substances or substance-like entities on which all the other entities in the domain depend.[122]

Part of Aristotle's argumentation in *APo* I 22 consists in a discussion of the constraints MP 1 and MP 2 impose on scientific discourse. Let us call 'E-sentences' all essence-specifying predications (i.e. linguistic predications signifying *said-of* relations), while 'A-sentences' will refer to 'accidental' predications (i.e. linguistic predications signifying *inherence* relations). Thus, the linguistic correlates of MP 1 and MP 2 could be formulated as follows:

LP 1: If 'AaB' is an A-sentence, then 'A' *signifies* a non-substantial entity & 'B' *signifies* substance.

LP 2: If 'AaB' is an E-sentence, then 'A' and 'B' *signify* entities in the same category.

The fact that a subject-term 'signifies substance' tells us something about the roles it can perform in U- and D-series:

> **[T27]** Ἔτι τὰ μὲν οὐσίαν σημαίνοντα ὅπερ ἐκεῖνο ἢ ὅπερ ἐκεῖνό τι σημαίνει καθ᾽ οὗ κατηγορεῖται· ὅσα δὲ μὴ οὐσίαν σημαίνει, ἀλλὰ κατ᾽ ἄλλου ὑποκειμένου λέγεται ὃ μὴ ἔστι μήτε ὅπερ ἐκεῖνο μήτε ὅπερ ἐκεῖνό τι, συμβεβηκότα, οἷον κατὰ τοῦ ἀνθρώπου τὸ λευκόν. οὐ γάρ ἐστιν ὁ ἄνθρωπος οὔτε ὅπερ λευκὸν οὔτε ὅπερ λευκόν τι, ἀλλὰ ζῷον ἴσως· ὅπερ γὰρ ζῷόν ἐστιν ὁ ἄνθρωπος. ὅσα δὲ μὴ οὐσίαν σημαίνει, δεῖ κατά τινος ὑποκειμένου κατηγορεῖσθαι, καὶ μὴ εἶναί τι λευκὸν ὃ οὐχ ἕτερόν τι ὂν λευκόν ἐστιν.
>
> Again, terms which mean substance mean, of what they are predicated of, just what is that thing or just what is a particular sort of it. Terms which do not mean substance but are said of some other underlying subject which is neither just what is that thing nor just what is a particular sort of it, are incidental. E.g. white of a man: a man is neither just what is white nor just what is some particular white – rather, presumably, animal: a man is just what is an animal [*APo* I 22, 83ᵃ 24-30; Barnes 1993, with changes].

The sentence 'every man is musical' is a natural predication because the logical predicate used in the denoting phrase 'every man' specifies what the denoted objects (Socrates, Callias, Coriscus etc.) essentially are (ὅπερ ἔστι). The reason is that 'man' stands for a metaphysical item that is essentially

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[121] *APo* I 22, 83ᵃ 24-25. See Furth (1988, p. 30); Loux (1991, p. 132) and my Zuppolini (2014c, pp. 30-37).

[122] The qualification 'substance-like' is meant to account for basic subjects in mathematical sciences (such as line, surface, figure etc.), which are studied independently of the material elements in which they inhere in the real world. My point is that attributes such as *straight* is ontologically dependent on *lines*, even if lines are not substances in the strict sense of the term. What we mean by 'substance-like entities' is what Ross (1949, p. 633) describes as 'entities which are not substances but exist only as attributes of subjects, viz. those which a particular science considers *as if* they had independent existence and treats as its own subjects' [emphasis in original].

predicated of everything of which it is predicated – like type 1 entities in the four-fold division of *Cat.* 2 (see **T24**). Therefore, Aristotle is allowed to use the following premise in his argument:

P1: If 'AaB' is an A-sentence & 'BaC' is a scientific predication, 'BaC' is an E-sentence.[123]

On the other hand, the adjective term 'white', for instance, does not specify what white objects essentially are, which means it is not qualified to occur as subject in A-sentences, but only in E-sentences:

P2: If 'AaB' is an A-sentence & 'CaA' is a scientific predication, 'CaA' is an E-sentence.

A third premise can be obtained from this passage. Aristotle affirms that a term such as 'white' does not 'signify substance' insofar as it fails to specify what (e.g.) a white man essentially is (ὅπερ ἔστι). Here, Aristotle relies on a sort of test to determine whether a word signifies substance or not. If 'white' signified substance, a white man, for instance, would be *just what* white *is* (ὅπερ λευκὸν ἐστιν), i.e. a colour of a certain kind. Since this is not the case, 'white' does not signify substance. 'Animal', on the other hand, signifies substance insofar as every animal, man included, is *just what* animal *is* (ὅπερ ζῷον ἐστιν).[124] This test reminds us of what is said in *Cat.* 3, 1^b 10-16, where Aristotle endorses another metaphysical principle:

MP 3: If P is *said of the subject* S & S is *said of the subject* S', then P is *said of the subject* S'.

If *said-of* relations are transitive, as stated in MP 3, Aristotle can include the following premise in his argument:

P3: If 'AaB' is an E-sentence & 'BaC' is an E-sentence, then 'AaC' is an E-sentence.

Finally, as we know, Aristotle repeatedly denies the possibility of one single subject having infinitely many essential predicates.[125] If so, he also accepts the following premise:

P4: There cannot be infinitely many E-sentences 'A^{1}aB', 'A^{2}aB', …, 'A^{n}aB.'

I shall now argue that the metaphysical framework of the *Categories* together with P1, P2, P3 and P4 can be used to prove that U-series and D-series cannot occur within syllogistic demonstrations. Unlike the Traditional Interpretation, our proposal does not involve including names and descriptions of particular substances and *summa genera* in scientific demonstrations.

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[123] Let us say that 'AaB' is a scientific predication if and only if 'AaB' is true & 'AaB' is not an unnatural predication.
[124] See Philoponus (240.14-24); Angioni (2006, pp. 124-125) and my Zuppolini (2014a, p. 96).
[125] *APo* I 22, 82^b 37-83^a 1; 83^b 8; 13-16; 26-27.'

Let us first analyse the following predicative series, going 'upwards' from a subject S:

$$\Phi = \{M^1aS, M^2aM^1, M^3aM^2, \ldots, \text{ such that } \forall n(M^{n+1}aM^n)\}$$

The first predication of the series, 'M^{1}aS', is either an E-sentence or an A-sentence, i.e. either M^1 is part of the essence of S or not. I shall now analyse each of these two alternatives.

Suppose first that 'M^{1}aS' is an E-sentence. Now, we have to ask whether the other predications in the series are also E-sentences or whether an A-sentence comes up at some point. Let us say, for the sake of argument, that all the other predications in Φ are E-sentences as well. If 'M^{1}aS' and 'M^{2}aM^1' are E-sentences, 'M^{2}aS' is also an E-sentence (by P3). For the same reason, if 'M^{2}aS' and 'M^{3}aM^2' are E-sentences, 'M^{3}aS' is also an E-sentence, the same being true for every M^i in Φ. Thus, if the series Φ were infinite, there would be infinitely many E-sentences, each of which attributing a different essential predicate to S.

$$\Phi = \{M^1aS, M^2aM^1, M^3aM^2, \ldots\}$$

M^{2}aS

M^{3}aS

(…)

According to P4, this result is impossible, which means Φ could not be infinite in this way. Therefore, Φ must contain at least one A-sentence. Let us say that the first A-sentence in Φ is 'M^{2}aM^1'. In that case, the next sentence 'M^{3}aM^2' would have to be an E-sentence, since a predicate in an A-sentence does not 'signify substance' and therefore cannot be itself subject in another A-sentence (P2). If 'M^{3}aM^2' is an E-sentence, 'M^{4}aM^3' would also be an E-sentence, since 'M^3', as an essential predicate of 'M^2', does not signify substance either (see LP 2), and hence cannot be subject in an A-sentence (see LP 1). Thus, if Φ were infinite, there would be infinitely many E-sentences starting from 'M^{3}aM^2', from which infinitely many E-sentences with 'M^2' as subject would follow (P3). Since this result is impossible (P4), we must conclude again that Φ is finite. Therefore, if 'M^{1}aS' is an E-sentence, the series of predications Φ cannot be infinite.

Even if we assume (alternatively) that 'M^{1}aS' is an A-sentence, Φ could not be infinite either. If 'M^{1}aS' is an A-sentence, the next sentence in the series, 'M^{2}aM^1', would have to be an E-sentence (P2). In that case, however, the next proposition 'M^{3}aM^2' and all the other predications in Φ will also be E-sentences, since none of the M^{i}s would signify substance (LP 2 and P2). If so,

there would be infinitely many E-sentences with 'M¹' as subject-term (by P3), which is impossible according to P4. Since the first predication in **Φ** is either an E-sentence or an A-sentence, it follows that U-series cannot occur in syllogistic demonstrations. Therefore, Aristotle has the theoretical resources to justify a negative answer to question **I** without postulating the presence of *summa genera* in scientific demonstrations.

However, a negative answer to question **III** requires a negative answer not only to question **I** but also to question **II**. In other words, a demonstration ⟨**Π**, **c**⟩ could still have infinitely many steps if nothing prevented D-series from occurring in **Π**. We must then analyse a predicative series going 'downwards' from a predicate P:

$$\Psi = \{PaM^1, M^1a\,M^2, M^2aM^3, \dots, \text{ such that } \forall n(M^naM^{n+1})\}$$

The first predication of the series, 'PaM¹', will be either an E-sentence or an A-sentence. Let us assume first that 'PaM¹' is an E-sentence. Suppose, in addition, that all the other predications in **Ψ** are also E-sentences. Under this supposition, one could think that it is possible to argue as we did in the case of U-series, and use P3 to show that, if **Ψ** is infinite, there will be infinitely many E-sentences with one of the terms in **Ψ** as subject (which would be impossible according to P4). However, this line of reasoning does not work for D-series: for any M^i in **Ψ** there will be *finitely* many sentences from '$M^{i-1}aM^i$' back to 'PaM¹', as we can see in the following diagram:[126]

$$\Psi = \{PaM^1, M^1a\,M^2, M^2aM^3, \dots\}$$

$$M^1aM^3$$

$$PaM^3$$

$$\times$$
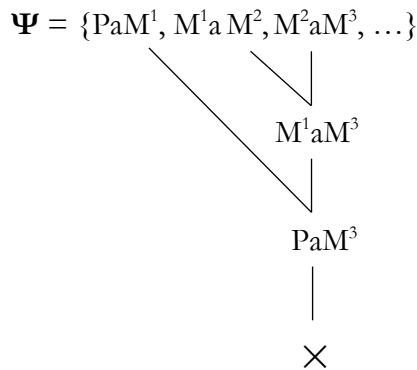
Nevertheless, it can be shown that, if **Ψ** were infinite, there would be infinitely many essential predicates belonging to the same subject, even if this subject is not mentioned in **Ψ**. If **Ψ** contains only E-sentences, it would be limited to a single category – either substance or a non-substantial category (LP 2). Let us say that every term in **Ψ** signifies a non-substantial category – e.g. 'sensible quality', 'colour', 'white' etc. According to Aristotle's ontology, each of these terms would be predicated of a type 2 entity (as defined in *Cat.* 2) – e.g. a particular sort of white. Therefore, if **Ψ** were infinite, it would be possible to derive from it infinitely many E-sentences

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[126] Barnes (1993, p. 180) makes a similar point about 84ᵃ7-28.

with (e.g.) 'seashell white' as subject-term (even if 'seashell white' does not occur in **Ψ**): *'sensible quality* holds of *seashell white'*, *'colour* holds of *seashell white'*, *'white* holds of *seashell white'* etc. Similarly, if all terms in **Ψ** are restricted to the category of substance – e.g. 'living being', 'animal', 'man' etc. –, each of them would be predicated of a type 4 entity – e.g. a particular man. Therefore, infinitely many E-sentences with (e.g.) 'Socrates' as subject-term would follow from **Ψ** (even if 'Socrates' does not occur in **Ψ**): *'living being* holds of *Socrates'*, *'animal* holds of *Socrates'*, *'man* holds of *Socrates'* etc. Since none of these results is possible (by P4), **Ψ** cannot be infinite if it is composed only of E-sentences.

Suppose then that an A-sentence comes up at some point – let it be 'M^{1}a M^2'. In that case, the next predication 'M^{2}aM^3' is necessarily an E-sentence: as subject of an A-sentence, 'M^2' signifies substance and therefore can only be predicate in E-sentences (according to P1). Given LP 2, the same is true for any 'M^i' in **Ψ** provided that $i \geq 2$. Again, if it were infinite, **Ψ** would contain infinitely many substantial predicates – e.g. 'living being', 'animal', 'man' etc. –, from which infinitely many E-sentences about any particular substance in the domain could be obtained: *'living being* holds of *Socrates'*, *'animal* holds of *Socrates'*, *'man* holds of *Socrates'* etc. In any case, it follows that **Ψ** is finite if its first predication is an E-sentence.

For similar reasons, the same result follows from the assumption that 'PaM^1' is an A-sentence. In that case, the next predication 'M^{1}a M^2' is necessarily an E-sentence, given P1. In fact, if **Ψ** begins with an A-sentence, every 'M^i', starting from 'M^1', would signify substance. Once again, **Ψ** would contain infinitely many substantial predicates, all of which are predicated of any of the particular substances in the domain – even if none of them is individually mentioned in **Ψ**. Since 'PaM^1' is either an A-sentence or an E-sentence, **Ψ** is necessarily finite. Therefore, no demonstration contains D-series, a conclusion which is possible to reach without including names and descriptions of particular substances in scientific demonstrations.

We have identified premises from which Aristotle could have justified negative answers to questions **I** and **II**. In *APo* I 22, 83^b 17-30, the philosopher not only endorses those premises, but actually obtains from them the conclusion he was trying to prove – albeit in a convoluted and excessively concise way, we must admit. In this passage, Aristotle summarizes his argument and reaffirms at least three of the four premises we formulated above:

> **[T28]** Ὑπόκειται δὴ ἓν καθ᾽ ἑνὸς κατηγορεῖσθαι, αὐτὰ δὲ αὑτῶν, ὅσα μὴ τί ἐστι, μὴ κατηγορεῖσθαι. συμβεβηκότα γάρ ἐστι πάντα, ἀλλὰ τὰ μὲν καθ᾽ αὑτά, τὰ δὲ καθ᾽ ἕτερον τρόπον· ταῦτα δὲ πάντα καθ᾽ ὑποκειμένου τινὸς κατηγορεῖσθαί φαμεν, τὸ δὲ συμβεβηκὸς οὐκ εἶναι ὑποκείμενόν τι.

> We have supposed that one thing is predicated of one thing, and that items are not predicated of themselves when they do not signify what something is. For these are all incidental (though some hold of things in themselves

and some in another way), and we say that all of them are predicated of an underlying subject, and that what is incidental is not an underlying subject [*APo* I 22, 83ᵇ 17-22; Barnes 1993, with changes].

 [T29] καθ᾽ ὧν μὲν γὰρ λέγεται τὰ συμβεβηκότα, ὅσα ἐν τῇ οὐσίᾳ ἑκάστου, ταῦτα δὲ οὐκ ἄπειρα.

The incidentals are said of items in the substance of each thing, and these latter are not infinite [*APo* I 22, 83ᵇ 26-27; Barnes 1993].

In **T28**, Aristotle endorses P2: items in non-substantial categories cannot be predicated of one another unless the predicate is part of the 'what-it-is' (the essence) of the subject (αὐτὰ δὲ αὑτῶν, ὅσα μὴ τί ἐστι, μὴ κατηγορεῖσθαι). In **T29**, the philosopher reaffirms P1 (καθ᾽ ὧν μὲν γὰρ λέγεται τὰ συμβεβηκότα, ὅσα ἐν τῇ οὐσίᾳ ἑκάστου) and P4 (ταῦτα [= ὅσα ἐν τῇ οὐσίᾳ ἑκάστου] δὲ οὐκ ἄπειρα). Probably assuming P3, which had already been stated in 83ᵃ 24-30 (quoted above), Aristotle concludes his argument and denies that U- and D-series can occur in scientific demonstrations (83ᵇ 24-25; 27-28) – i.e. the answers to questions **I** and **II** are negative. If so, no demonstration could have infinitely many steps, which means the answer to question **III** is also negative.

If our interpretation is correct, the two 'determined' extremes Aristotle mentions in **T21** (*APo* I 19, 82ᵃ 2-8), the passage in which question **III** is formulated, are not ultimate subjects and ultimate predicates (particular substances and *summa genera* in the Traditional Interpretation), but any major and minor term in an extended syllogistic demonstration. Thus, it becomes easier to understand Aristotle's argument in *APo* I 19-22 as a defence of his foundationalist project. As we have seen, his argument relies heavily on the claim that no subject has infinitely many essential predicates. Aristotle bases this metaphysical claim on an epistemological thesis: essences can be known, and since we cannot 'survey infinitely many items in thought' (83ᵇ 6-7), it follows that no subject can have an infinite number of essential attributes.[127] As we have seen, essences are the primary causes studied by demonstrative sciences, with the corresponding definitions playing the role of first principles. Thus, it is not surprising that the thesis that every demonstration contains a finite number of steps is ultimately grounded in the belief that essences are knowable.

Moreover, as we can see in **III.1** and **III.2**, a negative answer to question **III** entails that (i) for any major term P in a demonstration ⟨**Π, c**⟩ there will be a middle term Mⁱ 'immediately' or 'indemonstrably' connected to P, and (ii) for any minor term S in ⟨**Π, c**⟩ there will be a middle term Mʲ which is 'immediately' or 'indemonstrably' connected to S. If to be 'immediately' or 'indemonstrably' connected to a term means to be 'definitionally' connected to it, we may have an

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[127] *APo* I 22, 82ᵇ 37-83ᵃ 1; 83ᵇ 8. Aristotle defended the metaphysical thesis that no essence is composed of infinitely many predicates based on the epistemological claim that essences are knowable. Nevertheless, he might well have thought that, in reality, the epistemological thesis is grounded in the metaphysical one, and not the other way around.

answer to one of the questions we raised in the previous chapter: the A-Model and the S-Model are not mutually exclusive; on the contrary, a combination of both would be part of Aristotle's strategy to defend his model of science against the threat of infinite regress. This result, however, is not final. The ontology of the *Categories* and the way Aristotle uses some of its theses in *APo* I 19-22 may give us a preliminary account of the distinction between subjects and attributes and the role their essences play in scientific explanations. However, as we shall see in the next chapter, Aristotle's model includes a much more sophisticated theory of predication, with distinctions that are more fine-grained than the one between 'essential' and 'accidental' attributes.

CHAPTER 4

PER SE BEINGS AND *PER SE* PREDICATIONS

4.1 – Kinds of Being and Ontological Priority

The *Categories* gives us a preliminary account of the distinction between (metaphysical) subjects and (metaphysical) predicates. The doctrine of ontological categories helps us understand the semantical constraints imposed on demonstrative discourse: the logical roles a term can play in scientific propositions depend on the category it signifies. Thus, although some critics take Aristotle's Logic to be completely blind to the logical asymmetry between names and verbs, the concrete use of syllogistic inference in demonstrative sciences is limited and governed by a metaphysical distinction between subjects and attributes.

In the ontology of the *Categories*, beings are hierarchically related depending on the roles they can play in predicative connections. An entity like Socrates is ontologically prior to an entity like whiteness insofar as the latter cannot be part of reality unless there are individuals like the former of which it is (metaphysically) predicated, but which are not (metaphysically) predicated of (and hence are not ontologically dependent on) anything else. It is beyond the purpose of the present study to provide a detailed account of the notion of ontological priority or ontological dependence. However, if these notions are specified purely in existential terms, Aristotle's doctrine

of ontological categories can become (if not unattractive on its own) inadequate to the task of providing his model of science with satisfying metaphysical underpinnings (or so I shall argue).

In *Metaph.* V 11, Aristotle characterises ontological priority – in his words, priority 'in nature and being' (κατὰ φύσιν καὶ οὐσίαν) – in terms of an asymmetrical independence relation:

> **[T30]** τὰ μὲν δὴ οὕτω λέγεται πρότερα καὶ ὕστερα, τὰ δὲ κατὰ φύσιν καὶ οὐσίαν, ὅσα ἐνδέχεται εἶναι ἄνευ ἄλλων, ἐκεῖνα δὲ ἄνευ ἐκείνων μή. ᾗ διαιρέσει ἐχρήσατο Πλάτων.
>
> Besides things called prior and posterior in this way, a thing is prior in nature and being when it is possible for it to be without other things but not them without it. This division was used by Plato [*Metaph.* V 11, 1019ª 1-4; Kirwan 1993, with changes].

The Aristotelian notion of ontological priority has been explained in different manners depending on how the verb 'to be' (εἶναι) is understood. The most usual construal is given in terms of modality and existence. This is, for instance, how contemporary metaphysicians like Kit Fine read **T30**:

> Aristotle in the *Metaphysics* (1019a1-4) takes things to be 'prior and posterior… in respect of nature and substance' when the priors 'can be without the other things, while the others cannot be without them'; and the obvious way to construe him is by reference to the notions of existence and modality [Fine 1995, p. 270].

At first sight, it seems reasonable to read **T30** in this way, especially if we have in mind the core theses of the *Categories*. In the four-fold division of *Cat.* 2, the distinguishing feature of particular substances – the 'primary substances' or 'primary beings' (πρῶται οὐσίαι) – is the fact that they are not predicated of more basic subjects, whereas all the other beings are predicated of them. Thus, secondary substances and non-substantial beings could not exist if there were no particular substances of which they were predicated (see *Cat.* 5, 2ª34-ᵇ6). If understood in this way, ontological priority can be defined as follows:

Priority in Existence (PIE):[128] A is ontologically prior to B iff.

> 1. A can exist without B
>
> 2. B cannot exist without A.

The reference to Plato in 1019ª 14 might be taken to indicate that the notion of ontological priority in **T30** is existential. Gail Fine, for instance, argued that this kind of priority is closely related to one of the senses of 'separation' (χωρίς) in Aristotle, understood as a 'capacity for independent existence'.[129] In *Metaph.* VII 1, 1028ª 31-ᵇ2, she argues, substance is said to be prior 'in nature'

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[128] I draw the acronym 'PIE' from Peramatzis (2008; 2011).
[129] Fine (2003, p. 256)

because it is separate, while the other categories are not. Moreover, Aristotle criticises Plato for having 'separated' the forms[130], attributing to him a notion of separation formulated in terms of existence.[131] Thus, Gail Fine puts the passages together to conclude that A is separate from B just in case A is 'naturally prior to' B, i.e. 'just in case A can exist without, independently of, B' (Fine 2003, p. 256).[132]

However, it has been claimed that, if **T30** is read in existential terms, particular substances do not fulfil the condition for being ontologically primary entities. Interpreters such as Michail Peramatzis (2008; 2011), Phil Corkum (2008) and Lucas Angioni (2010) argued that individuals in the category of substance do not satisfy PIE in relation to non-substance items. In some cases, PIE.1 is satisfied, but not PIE.2. For instance, Socrates may exist without being courageous, but courage may also exist without Socrates' existing, as long as it is predicated of another substance (e.g. Callias). In other cases, not even PIE.1 is satisfied: Socrates may exist without some of his *determinate* accidental attributes (e.g. being white or weighing 71kg), but not without the corresponding *determinables* (e.g. having complexion or having weight).

One may think that the issue can be solved by understanding the priority of particular substances collectively: non-substance beings are not ontologically dependent on one specific particular substance or other, but on particular substances in general – e.g. courage may exist without Socrates or Callias, but not without any particular substance whatsoever. However, PIE would not be, properly speaking, an asymmetrical relation if the ontological independence that is affirmed in PIE.1 were not the same one denied in PIE.2. Hence, the *relata* in PIE must be both understood in the same way, either collectively or individually. However, as we have seen, PIE.1 is false if the *relata* are understood collectively: particular substances may exist without having one specific accidental attribute or other, but not without any accidental attribute whatsoever. On the other hand, if the *relata* are taken individually, PIE.2 is not satisfied: in the same way as Socrates can exist without being white, whiteness can also exist without Socrates' existing, provided that there is another particular substance which also happens to be white.[133]

There might be alternative ways to explain the claim (made in the *Categories,*) that particular substances are prior to all other beings, including non-substance items and secondary substances. This task, however, is beyond our present concerns.[134] However, when it comes to

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[130] *Metaph.* XIII 4, 1088^b 30-31; XIII 9, 1086^{a}32-^{b}7.

[131] *EE* I 8, 1017^b 10-15.

[132] Fine (2003, p. 256).

[133] See Corkum (2008, p. 74) for an elucidating exposition of this problem.

[134] For interpretations that avoid understanding the notion of ontological priority in terms of existence, see Corkum (2008); Peramatzis (2008; 2011, pp. 229-248); Angioni (2010).

address the metaphysical underpinnings of Aristotle's philosophy of science, the *Categories* frustrate us at least with respect to the following two topics:

(1) As we have seen, a subject like *man* may exist independently of some determinate accidental feature such as *being white*, but not independently of the correspondent determinable, such as *being coloured*. Unlike the determinate features, the corresponding determinables are demonstrable properties and belong necessarily to their subjects[135], which explains why they are particularly problematic for the existential construal of the notion of ontological priority. However, the ontology of the *Categories* focuses on the distinction between essential and accidental predicates. *Inherence* and *said-of* relations are the only types of connections into which predications are classified. On the other hand, science deals with a very specific kind of non-essential predicate: the demonstrable attribute, also known as '*per se* accident'. As we have seen, *per se* accidents are significantly different from other (merely contingent) accidental predicates, since they belong to their subjects 'in themselves' and 'by necessity' without being part of their essences. Hence, Aristotle's model of demonstrative science must adopt a theory of predication that elucidates the nature of *per se* accidents and explains how they differ from non-demonstrable attributes.

(2) As we have seen in Chapter 3, one of the problems in reading *APo* I 19-22 according to the Traditional Interpretation was the fact that singular terms naming particular substances would become the basic subjects in scientific discourse. However, we have argued that in Aristotle's philosophy of science the priority is given to universals. Whatever has a given demonstrable attribute has it in virtue of being a member of a universal kind which is explanatorily connected to the attribute in question. For instance, the property 2R belongs primarily to the triangle, while it belongs to (e.g.) the isosceles or to a given triangle in a semi-circle[136] only in a derivative way: the universal *triangle* is the primary subject for the predicate 2R. In the *Categories*, however, priority is given to individuals over their species and genera: particular substances, for instance, are said to be 'primary', while their species and genera are only 'secondary' substances. There is no need to assume that there is a conflict between the priority of individuals in the *Categories* and the priority of universals in the *APo*. The two treatises were written with very different purposes, and the relevant kind of priority in each of them might be different as well. Still, the *APo* require a theory of predication that takes into account the explanatory priority of universal expressions over singular terms, a task the theory of predication of the *Categories* is not able to accomplish.

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[135] Lowe (2013, p. 197).
[136] *APo* I 1, 71ᵃ 19-21; *APo* I 4, 73ᵃ 28-34; 73ᵇ 25 *APo* I 24, 85ᵇ 5-7 *APo* I 9, 76ᵃ 4-9.

Aristotle's model of demonstrative science adopts an alternative (and, in a way, more sophisticated) theory of predication. This theory can be found in *APo* I 4, where Aristotle discusses four uses of the expression 'in itself' (*per se* or καθ᾽ αὑτὸ). In Section 4.2 below, I intend to elucidate each of these uses. I shall argue that Aristotle's discussion in *APo* I 4 assumes the existence of priority relations among the subjects and attributes in a given scientific domain – relations that are different from existential priority and more relevant to his theory of science. In section 4.3, I shall discuss some of the views on *per se* predications and *per se* accidents available in the secondary literature. In section 4.4, I shall indicate how the theory of *per se* predications should be interpreted in order to fill in the two gaps left by the *Categories* – (1) and (2) discussed above. First, I shall clarify the nature of *per se* accidents and explain how they fit in *APo* I 4 (gap 1). In addition, I shall argue that one of Aristotle's aims in *APo* I 4 is to emphasize that, in order to achieve a full-fledged demonstration, a scientist must identify the relevant kind which is explanatorily connected to the demonstrable attribute (gap 2).

4.2 – The four uses of *'per se'*: *Posterior Analytics* I 4

In *APo* I 4, the first of the four senses of 'in itself' (καθ᾽ αὑτὸ) is introduced as follows:

> **[T31]** Καθ᾽ αὑτὰ δ᾽ ὅσα ὑπάρχει τε ἐν τῷ τί ἐστιν, οἷον τριγώνῳ γραμμὴ καὶ γραμμῇ στιγμή (ἡ γὰρ οὐσία αὐτῶν ἐκ τούτων ἐστί, καὶ ἐν τῷ λόγῳ τῷ λέγοντι τί ἐστιν ἐνυπάρχει).
>
> Some things hold of an item in itself both if they hold of it in what it is – e.g. line of triangles and point of lines (their essence comes from these items, which inhere in the account which says what they are) [*APo* I 4, 73ᵃ 34-37; Barnes 1993, with changes].

As we can see, this first use of 'καθ᾽ αὑτὸ' or *'per se'* (hereafter, *'per se₁'*) concerns a predicative connection in which the predicate is part of the 'essence' (τί ἐστιν or οὐσία) of the subject, and hence appears in its definition:

Per se₁: P is a *per se₁* predicate of S iff. P is part of the essence [τί ἐστιν/οὐσία] of S and P 'inheres in' [ἐνυπάρχει] the account that shows what S is.

Line, for instance, is part of the essence of the triangle, 'inheres in' its definition, and hence is predicated of it in the *per se₁* manner.[137]

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[137] Zabarella 1582, 23B suggests that we should read the examples *sano modo*: though line is said to belong in the what-it-is of triangles, Aristotle probably means that something like 'bounded by lines' is predicated of them. For this and other ways of interpreting the examples, see Barnes (1993, p. 112-113).

One may ask whether *per se₁* predications are sentences (or linguistic predications) or real connections between entities (metaphysical predications). On one hand, the *per se₁* predicate is described as an element in the 'essence' of the subject, which indicates that the connection defined in **T31** is a metaphysical predication (like the *said-of* relation in the *Categories*). On the other hand, the predicate is also said to 'inhere in' (ἐνυπάρχει) the subject's definition, which suggests that *per se₁* connections are linguistic predications (like our E-sentences in Chapter 3). This question can be answered if the meaning of 'ἐνυπάρχειν' is properly specified. In 73ᵃ 35-37, Aristotle describes *per se₁* predicates as components of the 'essence' (οὐσία) of their subjects: 'ἡ γὰρ οὐσία αὐτῶν ἐκ τούτων ἐστί.' Certainly, essences and their components are not linguistic but real-world items. Aristotle's appeal to the notion of 'λόγος' (or 'definition') in 73ᵃ 36 is no reason to take the predicative connection described in the passage as linguistic and not metaphysical. First, as an essentialist, Aristotle accepts that not only *words* have definitions (in the sense of having accounts of their meanings), but also *things* have definitions (in the sense of having accounts of their essences). Second, the pronoun 'τούτων' in 73ᵃ 36 refers back to 'ὅσα' in 'καθ᾽αὑτὰ δ᾽ ὅσα ὑπάρχει τε ἐν τῷ τί ἐστιν' (73ᵃ 34-35). Therefore, if 'τούτων' refers to extra-linguistic items (the components of a given essence), so does 'ὅσα [...]' in 73ᵃ34. However (and this is the crucial point), 'ὅσα [...]' also introduces the subject of the verb 'ἐνυπάρχει' in 'ἐν τῷ λόγῳ τῷ λέγοντι τί ἐστιν ἐνυπάρχει' (73ᵃ 36-37). Therefore, if 'τούτων' and 'ὅσα [...]' refer to extra-linguistic items (the components of a given essence), the things which 'inhere in the definition' (ἐνυπάρχει ἐν τῷ λόγῳ) – that is, the *per se₁* attributes – are not linguistic, but real-world items. On the other hand, if 'λόγος' stands for a 'real' definition (i.e. an account of essence), both *relata* of *per se₁* relations are extra-linguistic items.

Therefore, if Aristotle is not committing a use-mention confusion, the text gives us no option but to take the locution 'ὅσα ὑπάρχει τε ἐν τῷ τί ἐστιν' (73ᵃ 34-35) (i) as referring to extra-linguistic entities and (ii) as introducing the subject of 'ἐνυπάρχει' in 73ᵃ37. Since 'τῷ λόγῳ τῷ λέγοντι τί ἐστιν' (73ᵃ 36-37) refers to a linguistic item (namely, a given definition), the verb 'ἐνυπάρχειν' picks out what we can describe as a 'world-language relation', i.e. a relation of the form 'xRy' in which the variable 'x' ranges over extra-linguistic entities such as objects and attributes, whereas 'y' ranges over items of language such as words or definitions – e.g. the point *inhering in* the definition of line is a relation of this sort, since point (and not 'point') is a non-linguistic entity, whereas the definition of line is a linguistic one.[138] Other examples of world-language relations would be 'x is denoted by y' or 'x has the λόγος y' (where 'λόγος' stands for a 'real' definition). On

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[138] In this sense, 'x ἐνυπάρχει …' is close to 'x is mentioned or referred to …'. However, we do not translate the verb in this way to avoid the suggestion that, if triangle 'ἐνυπάρχει' in the definition of 2R (and therefore 2R is a *per se₂* of triangle), the term 'triangle' must be included in the definition of 2R. Since I shall argue that this conditional is false, I prefer the neutral and vague expression 'inhering in'.

the other hand, world-world relations would have only extra-linguistic items as values for their variables. As we saw, the text of *APo* I 4 makes it clear that *per se₁* connections – in contrast to the *inhering in* relation that is used to define it – are world-world relations or, to stick to the vocabulary we have been using, metaphysical predications.

Let us now analyse Aristotle's characterization of the second kind of '*per se*' connection (hereafter, '*per se₂*'):

> **[T32]** καὶ ὅσοις τῶν ὑπαρχόντων αὐτοῖς αὐτὰ ἐν τῷ λόγῳ ἐνυπάρχουσι τῷ τί ἐστι δηλοῦντι, οἷον τὸ εὐθὺ ὑπάρχει γραμμῇ καὶ τὸ περιφερές, καὶ τὸ περιττὸν καὶ ἄρτιον ἀριθμῷ, καὶ τὸ πρῶτον καὶ σύνθετον, καὶ ἰσόπλευρον καὶ ἑτερόμηκες· καὶ πᾶσι τούτοις ἐνυπάρχουσιν ἐν τῷ λόγῳ τῷ τί ἐστι λέγοντι ἔνθα μὲν γραμμὴ ἔνθα δ᾽ ἀριθμός.
>
> And also if the things they hold of themselves inhere in the account which shows what they are – e.g. straight holds of lines and so does curved, and odd and even of numbers, and also prime and composite, and equilateral and oblong [*APo* I 4, 73ᵃ 34-ᵇ1; Barnes 1993, with changes].

Per se₂ connections are also definition-based. Now, however, it is the definition of the predicate that includes a reference to the subject:

Per se₂ : P is a *per se₂* predicate of S iff. S 'inheres in' [ἐνυπάρχει] in the account that shows what it is to be P.

Odd, for instance, is a *per se₂* attribute of number insofar as number 'inheres in' the definition of what odd is. There is no reason to believe that the verb 'ἐνυπάρχειν' works differently in the characterization of *per se₂* connections. Thus, if the verb picks out a world-language relation in **T32** as well, the fact that the subjects of *per se₂* predications 'inhere in' the λόγος of the predicates does not make them linguistic items. Furthermore, since the word 'λόγος' denotes here the definition of an entity (and not of a term), neither the predicates (i.e. the corresponding *definienda*) are linguistic items. Therefore, *per se₂* connections are also world-world relations (or metaphysical predications).

Per se₂ predications play an important role not only in Aristotle's model of demonstrative science but also in his metaphysical theory. As we have seen, in the *Categories* and the *Topics*, Aristotle applies the question 'what is *x*?' indifferently to all categories, overlooking the very hierarchy he is willing to establish (see *Top.* I 9, 103ᵇ28-35). Even when an entity *x* is a non-substantial being, the answer to the question 'what is *x*?' is a homocategorical predication without a sign of the subject on which *x* depends. On the other hand, in the *APo* and the *Metaphysics*, Aristotle introduces the notion of *per se₂* predication: definitions of attributes must register their status as dependent entities by referring somehow to the items of which they are predicated: the

definition of odd must refer to numbers, the definition of male should mention animals, the definition of white must contain a reference to bodily surfaces etc.[139]

However, which kind of ontological priority should definitions account for? As we have seen, interpreting the notion of ontological priority in **T30** in purely existential terms is problematic. Although we do not intend to offer a definitive interpretation of Aristotle's concept of ontological priority, alternative readings of **T30** may shed some light on the metaphysical framework adopted by Aristotle's model of demonstrative science. Some authors tried to preserve an existential construal of the notion of ontological priority by adding important qualifications. According to them, Aristotle understands existence with some sort of essentialism in the background: to be is always to be with regard to a certain nature; to exist for x is to be a member of a certain kind that states what x is.[140] Others avoid the existential construal all together. Michail Peramatzis (2008; 2011), for instance, claims that ontological priority can be understood as what he calls 'Priority in Being':[141]

Priority in Being (PIB): A is ontologically prior to B iff.

1. A can be what it is without B being what it is.

2. B cannot be what it is without A being what it is.

Peramatzis argues that, although the claim put forward in **T30** 'is neutral or open as it can be understood either as PIE or PIB'[142], several of Aristotle's metaphysical views inside and outside the context of *Metaph.* V are successful if ontological priority is understood as PIB, and false or misleading if interpreted in terms of PIE (as we have seen above).

With either PIB or an essentialist approach to the concept of existence, ontological priority would be intrinsically connected to the notion of essence. In Aristotle's vocabulary, x's essence is 'what being is for x' (τὸ + noun in the dative + εἶναι). The philosopher talks of essence as a *way of being*[143] – either in the sense of *existing as something of a certain kind* or in the sense of *being what something is*. If we follow this approach, we could say that an attribute P (a non-substance entity) is ontologically dependent on the relevant subject S (a substance or substance-like entity) in the sense that P does not have the essence it has (i.e. cannot perform the *way of being* that distinguishes it as such) independently of S having the essence it has. Thus, a definition of P would fail to describe what it is to be P if it does not refer to S. Bodily surfaces, for instance, are the proper subjects of

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[139] *Metaph.* VII 1, 1028ᵃ 35-36; VII 5, 1030ᵇ 23-24; *APo* I 4 73ᵃ 37-ᵇ5; II 2, 90ᵃ 14-18; II 10, 93ᵇ 38-94ᵃ 7.

[140] Loux (1991, p. 3-6; pp. 27-28; pp. 34-35); Irwin & Fine (1995, p. 569); Zillig (2010, p. 41).

[141] Compare with Corkum (2008) who also avoids reading **T30** in terms of asymmetrical existential independence.

[142] Peramatzis (2008, p. 191).

[143] Loux (1991, p. 85); Peramatzis (2011, pp. 3-4); Charles (2011).

colours, with the relevant features that make colours what they are. Therefore, doing science about colours and explaining how they come about involves doing science about bodily surfaces as well, of which colours are *per se₂* predicates.

We can say then that the linguistic correlate of ontological priority (understood as PIB) is what Aristotle calls 'Priority in Definition' (PID):[144]

Priority in Definition (PID): A is prior in definition to B iff.

1. A is (correctly) defined without mentioning B
2. B is not (correctly) defined without mentioning A.

Subjects are 'prior' to their *per se₂* attributes precisely in the sense formulated in PID. Odd cannot be defined without mentioning numbers, nor can white be defined without mentioning bodily surfaces. Satisfactory accounts of what it is to be odd or white – the kind of account scientists should provide – must somehow refer to the *way of being* of numbers and surfaces, without which the phenomena of oddness or whiteness could not be properly explained or even identified.

A significant number of interpreters argue that only the first two uses of '*per se*' are relevant to Aristotle's theory.[145] However, there are strong reasons to believe that the other two uses also play significant roles in his model of demonstrative sciences. The third sense of '*per se*' (hereafter, '*per se₃*') is defined as follows:

> [**T33**] ἔτι ὃ μὴ καθ᾽ ὑποκειμένου λέγεται ἄλλου τινός, οἷον τὸ βαδίζον ἕτερόν τι ὂν βαδίζον ἐστὶ καὶ τὸ λευκόν, ἡ δ᾽ οὐσία, καὶ ὅσα τόδε τι σημαίνει, οὐχ ἕτερόν τι ὄντα ἐστὶν ὅπερ ἐστίν. τὰ μὲν δὴ μὴ καθ᾽ ὑποκειμένου καθ᾽ αὑτὰ λέγω, τὰ δὲ καθ᾽ ὑποκειμένου συμβεβηκότα.

> Again, certain items are not said of some other underlying subject: e.g. whereas what is walking is walking being something different (and similarly for white), substances and whatever signifies *this something* are not just what they are being something different. Well, items which are not said of an underlying subject I call things in themselves, and those which are said of an underlying subject I call incidental [*APo* I 4, 73ᵇ 5-10; Barnes 1993, with changes].

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[144] Again, I am borrowing the acronym 'PID' from Peramatzis (2011, p. 6; p. 23). See Fine's notion of ontological dependence as 'the real counterpart to the nominal notion of one term being definable in terms of another' (Fine 1995, p. 275).

[145] For interpretations arguing that the other two senses of '*per se*' are totally or partially irrelevant to Aristotle's purposes in the *APo*, see Ross (1949, p. 519); Sorabji (1981, pp. 210-211); McKirahan (1992, pp. 94-95); Barnes (1993, pp. 110-1120; Ebert (1998, p. 154); Porchat Pereira (2001, pp. 142-143); Tierney (2004, p. 5, n.8). For another view, see Code (1986, pp. 350-351); Furth (1988, p. 237); Ferejohn (1991, pp. 123-128; 2013, pp. 90-05); Angioni (2004); Terra (2009; 2014); Ribeiro (2011).

T33 is an obscure and controversial passage. Aristotle seems to be distinguishing not predicative relations but things: those that are 'in themselves' from those that are 'incidentally'.[146] An entity x is a *per se₃* being if x is what it essentially is – Aristotle uses the expression 'ὅπερ ἐστίν' again – without (i.e. independently of) being predicated of a different underlying subject. Substances, which satisfy PIB in relation to all other beings, are what they are (i.e. have the essences they have) independently of being predicated of something else, whereas 'incidental' beings could not be what they are without being predicated of their proper subjects:

Per se₃: S is a *per se₃* being iff. S is what it is (i.e. S has the essence it has) independently of being predicated of another underlying subject.

One might think that only particular substances are *per se₃* beings, since they are the only entities which are not predicated of anything else. In that case, the expressions 'ἡ δ᾽ οὐσία' and 'ὅσα τόδε τι σημαίνει' in 73ᵇ 7-8 would refer to their substantiality and particularity, respectively.[147] However, Aristotle does not say that *per se₃* beings are not predicated of anything whatsoever. Actually, what is said in **T33** is that they are never predicated of *something different* (ἄλλου), i.e. if x is a *per se₃* being, there is no y such that x is predicated of y as a non-essential predicate.[148] If so, the secondary substances of the *Categories* can also be classified as *per se₃* beings: as we have seen in Chapter 3, for Aristotle, substantial (and substance-like) beings are essential predicates of everything of which they are predicated. If understood in this way, *per se₃* is certainly connected to the other two uses of '*per se*'. The first use (*per se₁*) covers all essential predicates of all kinds of essence-bearers (substances and non-substances). The second (*per se₂*) presupposes the distinction between prior and posterior essence-bearers (as stated in PIB), the former being defined without mentioning the latter, but not the other way around (as stated in PID). Finally, the third use of *per se* (*per se₃*) applies precisely to the primary essence-bearers, which are what they are independently of being predicated of items which differ from them in essence.

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[146] Peramatzis (2010) and Ferejohn (2013, pp. 92-93) are exceptions. Ferejohn (2013, pp. 92-93) argues that this third use of '*per se*' applies to predications (or, more precisely to what we have called 'natural' predications): 'man is walking' is a *per se* predication in this sense because 'man' is the proper 'logical' subject of the predicate 'white'. As Barnes (1993, pp. 114-117) has shown, the third use of *per se* is relevant to the distinction between natural and unnatural predications, since *per se* beings (substances and substance-like entities) are the proper subjects of 'incidental' beings (non-substances); hence, the grammatical subjects of natural predications must be substance-terms. However, the expression 'ὅπερ ἐστίν' and the formula 'τὸ λευκὸν λευκὸν ἐστὶ' indicate that Aristotle's point is that (e.g.) white is not *what it is* independently of it being predicated of another subject (see Angioni 2006, pp. 112-113).

[147] See Ross (1949, p. 519).

[148] See Angioni (2007b, pp. 119-122); Zuppolini (2014c, pp. 33-37).

There are several reasons to believe that the fourth use of '*per se*' (hereafter, *per se₄*) is also relevant to Aristotle's model of demonstrative science. This use is explained in the following passage:

> **[T34]** ἔτι δ᾽ ἄλλον τρόπον τὸ μὲν δι᾽ αὑτὸ ὑπάρχον ἑκάστῳ καθ᾽ αὑτό, τὸ δὲ μὴ δι᾽ αὑτὸ συμβεβηκός, οἷον εἰ βαδίζοντος ἤστραψε, συμβεβηκός· οὐ γὰρ διὰ τὸ βαδίζειν ἤστραψεν, ἀλλὰ συνέβη, φαμέν, τοῦτο. εἰ δὲ δι᾽ αὑτό, καθ᾽ αὑτό, οἷον εἴ τι σφαττόμενον ἀπέθανε, καὶ κατὰ τὴν σφαγήν, ὅτι διὰ τὸ σφάττεσθαι, ἀλλ᾽ οὐ συνέβη σφαττόμενον ἀποθανεῖν.
>
> Again, in another way what holds of something because of itself holds of it in itself, and what does not hold because of itself is incidental. E.g. if there was a lightning while he was walking, that was incidental: it was not because of his walking that there was lightning – that, we say, was incidental. But what holds because of itself holds in itself – e.g. if something died while being slaughtered, it died in the sacrifice since it died because of being slaughtered, and it was not incidental that it died while being slaughtered [*APo* I 4, 73^b 10-16; Barnes 1993, with changes].

It has been argued that this kind of *per se* relation takes place between two events causally linked:[149] the event E1 (slaughtering) relates to the event E2 (death) *in itself* whenever E2 occurs *because* of E1 *itself* (δι᾽ αὑτὸ). Nevertheless, Aristotle would be comfortable with a reduction of events to predications in the following terms:[150] an event E1 (slaughtering) would be reducible to a predication of the form 'S is P¹' (S undergoes a certain slaughtering procedure), whereas E2 (death) would correspond to a predication 'S is P²' (S dies). Therefore, a *per se₄* connection is more properly understood not as holding between a predicate and a subject, but between two predicates occurring to the same subject (or subjects):

Per se₄: if P¹ and P² are *per se₄* related, P² holds of a given S *because* [διὰ] P¹ holds of S.

We are going to argue in more detail in favour of this interpretation in the next section. However, we can say in advance that if every occurrence of P¹ (being slaughtered) causes the occurrence of P² (dying), the causal link between E1 and E2 could be expressed by a universal predicative statement with 'P¹' as in the subject-term and 'P²' as the predicate-term: 'every P¹ is P²': everything that undergoes a slaughtering procedure dies.[151] If this use of '*per se*' is interpreted as we propose, it becomes easier to understand its relevance to the theory of the *APo*. The explanatory character of demonstrations is partially due to the fact that their categorical propositions have subjects and predicates explanatorily connected. Such connection can be understood as a *per se₄* relation: 'triangle' is the appropriate grammatical subject for the predicate '2R' because the

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[149] Ross (1949, p. 520).
[150] See Barnes (1993, p. 117); Angioni (2004, p. 16); Ferejohn (2013, p. 93)
[151] For a similar interpretation of the example, see Ferejohn (2013, p. 93).

metaphysical predicates *being a triangle* and *having 2R* are *per se₄*-related: if a given figure in a semi-circle has 2R, it has 2R *because* it is a triangle. However, a complete understanding of this aspect of Aristotle's theory depends on a satisfactory account of the notions of *per se* accident and primary universality.

4.3 – *Per Se* Accidents and Primary Universality: the Debate

As we know, Aristotle describes demonstrable attributes as *per se* accidents (καθ᾽αὑτὰ συμβεβηκότα).[152] In *Metaph.* V 30, a *per se* accident is defined as a predicate that belongs to a subject 'in itself' (καθ᾽αὑτὸ), but not as a part of its 'essence' (οὐσία):

> [**T35**] λέγεται δὲ καὶ ἄλλως συμβεβηκός, οἷον ὅσα ὑπάρχει ἑκάστῳ καθ᾽ αὑτὸ μὴ ἐν τῇ οὐσίᾳ ὄντα, οἷον τῷ τριγώνῳ τὸ δύο ὀρθὰς ἔχειν.
>
> 'Accident' has also another sense, namely, whatever belongs to each thing in virtue of itself, but is not in its essence; e.g. as having the sum of its angles equal to two right angles belongs to the triangle [*Metaph.* V 30, 1025ᵃ 30-32].

The paradigmatic example is the predicate 2R, i.e. the property of having the sum of internal angles equal to two right angles, a *per se* accident of triangles. Although in *APo* I 4 Aristotle discusses several ways in which a predicate holds of a subject 'in itself', he was accused of not having elucidated the crucial notion of *per se* accident.[153]

Since Aristotle defines the *per se* accident as a predicate belonging to its subject 'in itself', but not as an item in its essence, we are apparently prevented from taking it as a *per se₁* attribute. In the *APo*, the philosopher speaks as if all scientific propositions signify either a *per se₁* or a *per se₂* connection.[154] If so, by elimination, we feel inclined to classify 2R and all *per se* accidents as *per se₂* predicates.[155] In addition to the *APo*, passages from other parts of the *corpus* substantiate this result. In *Ph.* I 3, 186ᵇ 18-23, for instance, Aristotle divides 'accidents' (συμβεβηκότα) attributes into two types, one of which is a predicate that may or may not belong to its subject (which demonstrative sciences do not study) while the other is a '*per se*' accident: the *per se₂* attribute. Certainly, Aristotle secured a place for *per se* accidents in demonstrative sciences, which precludes any possibility of understanding them as contingent attributes. The most intuitive reaction to this

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[152] See *APo* I 6, 75ᵃ 18-19; I 7, 75ᵇ 42-ᵇ2; I 10, 76ᵇ 11-15; *Ph.* II 2, 193ᵇ 22-30; *Metaph.* III 1, 997ᵃ 19-25. For other occurrences of the notion, see Bonitz 713ᵇ43-714ᵃ3.

[153] Barnes (1993, p. 114).

[154] See *APo* I 4, 73ᵇ 3-4; 73ᵇ 16-18; I 6, 74ᵇ 5-12; I 22, 84ᵃ 11-14. As I shall clarify soon, this does not mean that the other two uses of '*per se*' are irrelevant to Aristotle's theory.

[155] See, for instance, Ross (1949, p. 580); Wedin (1973); Graham (1975); Mignucci (1975, p. 64); Granger (1981); Sorabji (1980, p. 18); Terra (2009, pp. 55-121; 2014).

passage is to understand *per se* accidents as *per se₂* predicates. I shall refer to this interpretation as the 'Natural Solution' to the problem of whether and how *per se* accidents fit in *APo* I 4.

Nevertheless, many commentators feel uncomfortable about classifying *per se* accidents and especially the 2R-attribute as *per se₂* predicates.[156] Their reasons are basically two. First, it is hard to see why 'triangle' should be part of the definition of 2R. Second, Aristotle's examples suggest that, if P belongs to S as a *per se₂* predicate, then P is a member of a pair of opposites (like odd and even, straight and curved, male and female) of which one or the other must belong to S. However, 2R is not a member of a pair of opposites and seems to work more like a *proprium* (ἴδιον), since it is coextensive with 'triangle' and cannot fail to hold of it (see *Top.* I 5, 102ᵃ 18-20).[157] Thus, several alternatives to the Natural Solution have been offered in the secondary literature.

The first alternative to the Natural Solution I shall consider (hereafter, 'A1') consists in understanding the notion of *per se* accident according to the first sense of '*per se*' defined in *APo* I 4. A systematic defence of this interpretation comes from Richard Tierney (2001a), who argues that, for Aristotle, a predicate can belong in a subject's 'what-it-is' (τὸ τί ἐστι) without belonging in its 'essence' (οὐσία), which allows him to classify 2R and other demonstrable attributes as *per se₁* predicates without contradicting Aristotle's statement in T35 (*Metaph.* V 30, 1025ᵃ 30-32).[158] It is hard to believe that Aristotle used his vocabulary as rigorously as Tierney's claim requires. In fact, it would be necessary to recognize in Aristotle's texts a distinction even more subtle than the one between 'τὸ τί ἐστι' and 'οὐσία'. On one hand, we would have the items 'from which the essence comes' (οὐσία αὐτῶν ἐκ τούτων ἐστί), which are *per se₁* attributes according to **T31** (*APo* I 4, 73ᵃ34-37). On the other, there would be items 'in the essence' (ἐν τῇ οὐσίᾳ ὄντα), which are not *per se* accidents according to **T35**. Therefore, if it were a *per se₁* predicate, 2R would be one of the items the essence of triangles *comes from*, but not an element *in* their essence (ἐν οὐσίᾳ), since otherwise it would not be a *per se* accident.

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[156] See Inwood (1979, p. 323); Ferejohn (1991, pp. 123-128); McKirahan (1992, pp. 98-100); Barnes (1993, pp. 113-114); Tierney (2001a, pp. 74-78) and even Granger (1981, p. 119, n.2) and Sorabji (1981, p. 189), who nevertheless are willing to classify *per se* accidents as *per se₂* predicates. For a detailed discussion of the 2R example, see Tiles (1983).

[157] Inwood (1979, p. 323) argues that in *APo* I 7, 75ᵇ1-2 Aristotle recognizes two kinds of *explananda*: καθ᾽ αὑτὰ πάθη and καθ᾽ αὑτὰ συμβεβηκότα. According to him, only καθ᾽ αὑτὰ συμβεβηκότα would be coextensive with their subjects. However, Aristotle does not seem to be distinguishing between two classes of predicates in this passage, but rather using two different expressions to refer to the same class of predicates: the *per se* accidents, attributes that belong to their subjects in themselves but not as a part of their essences. See also Bronstein (2016a, pp. 46-48), who also distinguishes between two kinds of demonstrable attributes: *per se₂* predicates and 'in itself incidentals' (or *per se* accidents).

[158] It should be noted that the συμβεβηκότα Tierney classifies as *per se₁* predicates are demonstrable attributes such as 2R – or, as he calls them, 'logical incidentals' –, which follow demonstratively from the essence of their subjects. These should be distinguished from 'inhering incidentals', which belong to underlying subjects (but are not themselves underlying subjects). 'Inhering incidentals', in turn, are distinguished into two types: 'inseparable inhering incidentals' (*per se₂* predicates) and 'separable inhering incidentals' (purely 'accidental' or 'contingent' predicates).

The difficulties A1 has to face are not only textual but also theoretic. According to Tierney (2001a, pp. 75-76), some *per se₁* predicates are 'immediate' and therefore belong not only in the what-it-is of the subject, but also in its essence: namely, the proximate genus and the proximate differentia. Since the relation *belonging in the what-it-is* is transitive – Tierney quotes *APo* II 4, 91ᵃ 9-21 –, the genera and differentiae of the initial genus and differentia would be also (non-immediate or derivative) *per se₁* predicates of the subject in question. It is not clear how it follows from these considerations that 2R can be taken as part of the 'what-it-is' of triangles. One may suggest that 2R would be a non-immediate (or a second-level) differentia of one of the immediate (first-level) differentiae of the triangle – see the discussion on 'intermediate' differentiae in Tierney (2001b, pp. 157-158).[159] Relying on *Ph.* II 9, 200ᵃ 16-17, for instance, we could think that the first-level differentia in question here is being a figure bounded by straight lines, of which 2R would be some sort of second-level differentia (see Tierney 2001a, pp. 77-78).

However, if this is how A1 is underpinned, other objections can be raised. A differentia seems to specify a determinate way of being a member of the corresponding genus. Although being a rectilinear closed figure entails having internal angles equal to a certain amount or another, having 2R is not a specific way of being a rectilinear figure in the same manner as being three-sided, for instance, is.[160] Aristotle seems concerned with this distinction in the *Parts of Animals*:

> **[T36]** Ἔτι διαιρεῖν χρὴ τοῖς ἐν τῇ οὐσίᾳ καὶ μὴ τοῖς συμβεβηκόσι καθ᾽ αὑτό, οἷον εἴ τις τὰ σχήματα διαιροίη, ὅτι τὰ μὲν δυσὶν ὀρθαῖς ἴσας ἔχει τὰς γωνίας, τὰ δὲ πλείοσιν· συμβεβηκός γάρ τι τῷ τριγώνῳ τὸ δυσὶν ὀρθαῖς ἴσας ἔχειν τὰς γωνίας.
>
> One ought to divide by features in a thing's substantial being, and not by its *per se* accidents, as would happen if someone were to divide figures on the ground that some have angles equal to two right angles, while others have angles equal to more; for having angles equal to two right angles is a sort of accident of the triangle [*PA* I 3, 643ᵃ 27-31; Lennox 2001, with changes].

James Lennox comments on the passage:

> Within that context, Aristotle is probably thinking of the error of dividing a general difference by sub-differences that are only incidentally related to it. For example, if figures are divided into those enclosed by straight lines and those enclosed by curved lines, then dividing rectilinear figures based on the equivalence or non-equivalence of the interior angles to two right angles will be incidental. In essence, it is to begin a new division, based on angle-sum equivalencies rather than the nature of lines [Lennox 2001, p. 163].

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[159] See also McKirahan (1992, pp. 169-171) for an interpretation along the same lines. He argues that such implicit definitional predicates are part of what he calls a 'fat definition'.
[160] See Ferejohn (2013, pp. 175-176).

If Lennox is right about **T36**, Tierney's arguments in favour of A1 are not convincing. Another passage challenges Tierney's interpretation more directly. In *APr* I 27, 43^b 6-11, Aristotle distinguishes the predicates in the what-it-is (ὅσα τε ἐν τῷ τί ἐστι) from the so called '*propria*' (ἴδια). This passage is particularly troublesome for A1 since it draws a distinction between the *propria* and the items in the 'τί ἐστι' – and not items in the 'οὐσία' as in **T35** and **T36**. Therefore, Tierney needs either to reject the plausible view that 2R is an ἴδιον of the triangle or to postulate that in *APr* I 27 the clause 'ἐν τῷ τί ἐστι' is used in a stronger sense than the one we find in *APo* I 4.

There is a further objection to consider. Tierney believes that the transitivity of the relation *belonging in the what-it-is* is what enables us to know, by demonstration, that a subject has a certain derivative essential attribute (a *per se* accident) by means of another and more basic essential predicate occurring as the middle term. However, the passages Tierney quotes in support of the demonstrative status of such a deduction are clearly diaporematic (*APo* II 4, 91^a 18-21 and II 6, 92^b 2-13). In fact, Aristotle's final word is that such deduction would be nothing more than a non-demonstrative λογικὸς συλλογισμός (see *APo* II 8, 93^a 9-15) – even though the relation *belonging in the what-it-is* remains transitive.

A second alternative to the Natural Solution (hereafter, A2) is an interpretation which argues that *per se* accidents are covered by the fourth sense of '*per se*' defined in *APo* I 4.[161] The proponents of A2 take *per se₄* connections to take place between a subject and a predicate (and not between two predicates belonging to the same subject, as we have argued). In *APo* I 4, 73^b 3-5, Aristotle says that predicates that are not *per se₁* or *per se₂* are 'accidents' (συμβεβηκότα). If so, they argue that the other kind of *per se* connection discussed in the chapter (*per se₄*) should be understood as occurring between a given subject and one of its 'accidents', one that nevertheless belongs to it 'in itself'.[162] More precisely, the *per se₄* connection would take place between a subject and a predicate that are explanatorily linked in a certain way:

***Per se₄* (according to A2)**: P is a *per se₄* predicate of S iff. P holds of S *because* [διὰ] S is what it is.

Dying (P) happens to an animal that has been *slaughtered* (S) precisely because it has been *slaughtered* (δι᾽ αὐτό). Interpreters who advocate A2 argue that this is the relation that obtains between triangle and 2R. The triangle has 2R because it is what it is, namely, a triangle. Given that *per se* accidents belong by necessity to their subjects, but are not part of their essences, it seems reasonable to understand them as something that necessarily follows from their subjects being what they are.

[161] See Code (1986, pp. 350-351); Furth (1988, p. 237); Ferejohn (1991, pp. 123-128; 2013, pp. 91-94) and, less empathically, Tiles (1983, p. 13).
[162] See Code (1986, p. 350); Furth (1988, p. 237).

Although A2 seems promising, anyone willing to accept it must overcome two crucial difficulties. The first one regards lines 73ᵇ3-4, in which Aristotle says that every item that is not predicated of something as a *per se₁* or a *per se₂* predicate is an 'accident'. We can infer that *per se₄* predicates are 'accidents' in the same sense which occurs in 73ᵇ4 only if we take the four senses of '*per se*' to introduce heterogeneous classes of predicative sentences with no intersection between them.[163] However, sentences expressing a *per se₄* connection could not take part in science unless they signify in addition a *per se₁* or a *per se₂* connection. Some passages deserve our attention:

[T37] τὰ ἄρα λεγόμενα ἐπὶ τῶν ἁπλῶς ἐπιστητῶν καθ᾽ αὑτὰ οὕτως ὡς ἐνυπάρχειν τοῖς κατηγορουμένοις ἢ ἐνυπάρχεσθαι δι᾽ αὑτά τέ ἐστι καὶ ἐξ ἀνάγκης.

Thus, with respect to what is knowable without qualification, whatever is said to hold of things in themselves (in the sense of inhering in what is predicated or of being inhered in) is also said to hold of them because of themselves and from necessity [*APo* I 4, 73ᵇ 16-18; Barnes 1993, with changes].

[T38] Εἰ οὖν ἐστιν ἡ ἀποδεικτικὴ ἐπιστήμη ἐξ ἀναγκαίων ἀρχῶν (ὃ γὰρ ἐπίσταται, οὐ δυνατὸν ἄλλως ἔχειν), τὰ δὲ καθ᾽ αὑτὰ ὑπάρχοντα ἀναγκαῖα τοῖς πράγμασιν (τὰ μὲν γὰρ ἐν τῷ τί ἐστιν ὑπάρχει· τοῖς δ᾽ αὐτὰ ἐν τῷ τί ἐστιν ὑπάρχει κατηγορουμένοις αὐτῶν, ὧν θάτερον τῶν ἀντικειμένων ἀνάγκη ὑπάρχειν), φανερὸν ὅτι ἐκ τοιούτων τινῶν ἂν εἴη ὁ ἀποδεικτικὸς συλλογισμός· ἅπαν γὰρ ἢ οὕτως ὑπάρχει ἢ κατὰ συμβεβηκός, τὰ δὲ συμβεβηκότα οὐκ ἀναγκαῖα.

If demonstrative understanding proceeds from necessary principles (since what you understand cannot be otherwise), and if whatever holds of an object in itself is necessary (since either it holds in what it is, or else the object holds of what is predicated of it in what it is and the predicate are opposites one of which necessarily holds), then it is clear that demonstrative deductions will proceed from certain items of this sort; for everything holds either in this way or incidentally, and what is incidental is not necessary [*APo* I 6, 74ᵇ 5-12; Barnes 1993].

[T39] ἡ μὲν γὰρ ἀπόδειξίς ἐστι τῶν ὅσα ὑπάρχει καθ᾽ αὑτὰ τοῖς πράγμασιν. καθ᾽ αὑτὰ δὲ διττῶς· ὅσα τε γὰρ ἐν ἐκείνοις ἐνυπάρχει ἐν τῷ τί ἐστι, καὶ οἷς αὐτὰ ἐν τῷ τί ἐστιν ὑπάρχουσιν αὐτοῖς·

Demonstration applies to what holds of the objects in themselves – in themselves in two ways: both items which hold of the objects and inhere in what they are, and also the items for which the objects of which they hold inhere in what they are [*APo* I 22, 84ᵃ 11-14; Barnes 1993].

In **T37** and **T38**, Aristotle affirms that scientific knowledge concerns predicative connections in which either the predicate inheres in the definition of the subject or the subject

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163 See Terra (2014, p. 42), who argues that *per se₁* and *per se₂* connections are also *per se₄*, which would be a more general kind of *per se* relation (a solution I reject). This is quite different from saying that a single *sentence* can signify a *per se₂* and *per se₄* connection at the same time, as I shall argue.

inheres in the definition of the predicate. Aristotle's words seem to imply that all scientific propositions express either a *per se₁* or a *per se₂* connection. Tiles (1983, pp. 11-12) conjectured that **T37** and **T38** might be only about the axioms or primary principles of science, so that nothing would commit us to classify the corresponding conclusions (or theorems) as *per se₁* or *per se₂* predications. Although viable for **T37** and **T38**, such a hypothesis would not work for **T39**. As we have seen in Chapter 3, Aristotle intends to deny the possibility of there being infinite chains of proofs in demonstrative sciences, in which all premises would be themselves demonstrated from more basic premises and so on *ad infinitum*. In the paragraph in which **T39** belongs, 84ª 7-28, Aristotle argues that a demonstrative chain could not proceed *ad infinitum* insofar as it would contain infinite series of *per se₁* or *per se₂* predications, which is impossible according to him. The argument implies that only the premises that interrupt the sequence are indemonstrable, whereas the other premises would occur also as conclusions at some point of the chain. Therefore, Aristotle does not limit *per se₁* and *per se₂* connections to indemonstrable propositions.[164]

If all scientific propositions must signify either a *per se₁* or a *per se₂* connection, it seems more convenient to read 'συμβεβηκότα' in 73ᵇ4 as referring to contingent predicates, in respect of which there is no demonstrative knowledge (see *APo* I 6, 75ª18-22). In fact, the examples we find in 73ᵇ 5 (musical and white said of animal) are predicates of this kind, and not *per se* accidents as readers sympathetic to A2 would expect.[165] Furthermore, in **T37**, Aristotle states that, when we have knowledge 'without qualification' (ἁπλῶς), *per se₁* and *per se₂* predicates hold of their subjects also 'because of themselves'. Here, the philosopher uses again the same formula 'δι᾽ αὑτὸ(ά)' we find in the characterization of *per se₄* connections in **T37**. Thus, there seems to be some sort of overlap between these types of relations, which should prevent us from inferring that *per se₄* items are 'συμβεβηκότα' in the same sense in which the word is used in 73ᵇ4.[166]

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[164] One could think that, in relying on T39, we are committed to at least some demonstrable *per se₁* connections. However, a demonstrative chain can proceed *ad infinitum* if at least one of its branches contains infinitely many demonstrable propositions (even if the other branch contains only indemonstrable premises). Therefore, a sequence of syllogisms in *Barbara*, for instance, would go on *ad infinitum* if all the major premises within it were demonstrable, even if all the minor premises were 'immediate' or indemonstrable. Aristotle seems take essence-specifying propositions (that is to say, *per se₁* predications) as indemonstrable (see, for instance, *APo* II 3, 90ᵇ 24-7; II 8; 93ª 9-15). Therefore, if the minor premises in our example signify *per se₁* connections, our (infinite) syllogistic chain would contain infinitely many sentences signifying *per se₁* connections, even though these connections are indemonstrable. Since the argument assumes that all sentences involved in demonstrative chains signify either *per se₁* or *per se₂* connections, we can conclude that at least *per se₂* predications are not limited to first principles of science. Furthermore, as we have seen, while we have textual evidence for taking *per se₁* connections as indemonstrable, the same does not apply to *per se₂* connections.

[165] One could accept a version of A2 that takes *per se* accidents as *per se₂* and a *per se₄* predicates at the same time. However, as I shall argue, the *per se₄* connection is not a predicative relation between an object and an attribute (as a *per se₂* connection is), but a causal or explanatory relation between two attributes occurring to the same object (or objects).

[166] I shall clarify what kind of overlap this is. As I shall argue, the fact that all scientific propositions must signify either a *per se₁* or a *per se₂* predication does *not* mean that *per se₄* connections are out of the scope of science.

The other difficulty that interpreters advocating A2 have to face is conceptual rather than textual. According to them, if a *per se* accident is an attribute that simply follows from its subject being what it is, there is a way in which the *per se* accidents of a genus are also *per se* accidents of its species; in other words, if P is a *per se* accident of (the genus) S and S is a *per se₁* predicate of (the species) S', then P is a *per se* accident of (the species) S' (see Code 1986, p. 351). Therefore, if 2R is a *per se* accident of the triangle, it must be a *per se* accident of the isosceles as well. Identifying *per se* accidents with *per se₄* predicates, as A2 suggests, we have that, if P is a *per se₄* predicate of (the genus) S and S is *per se₁* predicate of (the species) S', then P would be a *per se₄* predicate of (the species) S'. For instance, if 2R is a *per se₄* predicate of the triangle, it would be a *per se₄* predicate of the isosceles as well. At first sight, this seems to be a welcome result. After all, the sentence 'every isosceles (triangle) has 2R' seems to be under the scope of science and therefore must signify a *per se* connection in one way or another.[167]

However, according to Aristotle, someone who knows that the members of the genus triangle have 2R is in possession of a prior and more basic knowledge than someone else who knows only that the members of the species isosceles have the same attribute. Triangle, and not isosceles, is the relevant universal type – the primary universal (πρῶτον καθόλου) – that comprises all the instances of the property 2R.[168] Therefore, Aristotle says that the equilateral or the isosceles has 2R only 'incidentally' (κατὰ συμβεβηκός, *Top.* II 3, 110ᵇ 22-25). In the same vein, he affirms that a demonstration applies universally to the triangle 'in itself', whereas it applies to the equilateral or the isosceles 'in a certain way not in itself' ('τρόπον τινὰ οὐ καθ᾽ αὑτό', *APo* I 4, 74ᵃ 2).

It would be inappropriate to say that 2R belongs to isosceles triangles 'κατὰ συμβεβηκός' in the same way in which a contingent predicate is said to be a 'συμβεβηκός'. After all, 2R is a demonstrable attribute (that is, a *per se* accident) of triangles in general, including isosceles triangles. If so, there is a sense of 'συμβεβηκός' (namely, that of 'καθ᾽ αὑτό συμβεβηκός') according to which 2R is a συμβεβηκός of the (species) isosceles in the same way as it is a συμβεβηκός of the (genus) triangle. However, Aristotle's point in *Top.* II 3, 110ᵇ 22-25, is that there is still another sense of 'συμβεβηκός' according to which 2R belongs to the (species) isosceles 'κατὰ συμβεβηκός', but *not* to the (genus) triangle. If there is a sense of 'καθ᾽ αὑτό' contrasting this other sense of 'κατὰ συμβεβηκός', we can think that a similar point is made in *APo* I 4, 73ᵇ38-74ᵃ3: there is a use of 'καθ᾽ αὑτό' according to which 2R belongs to the (genus) triangle 'καθ᾽ αὑτό', but *not* to the (species) isosceles. Thus, we have to face a pressing question: when Aristotle affirms that a demonstration of the 2R-theorem applies to the isosceles 'τρόπον τινὰ οὐ καθ᾽ αὑτό' (*APo* I 4, 74ᵃ 2), which kind of

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[167] Sentences like 'every isosceles triangle has 2R' are demonstrated by what Lennox's 'type A' syllogisms (see Lennox 1987) and McKirahan calls 'application arguments' (see McKirahan 1992, pp. 177-187).

[168] See *APo* I 4 73ᵇ32-74ᵃ3; I 5, 74ᵃ16-ᵇ4; I 24, 85ᵇ4-15; 85ᵇ23-27; 85ᵇ38-86ᵃ3.

καθ᾽ αὐτό connection is he denying? If we follow A2, the only way we can consider 2R a *per se* predicate (either of isosceles or of triangles in general) is by appealing to the notion of *per se₄* connection. However, such interpretation leaves us with no grasp of the meaning of 'in itself' according to which 2R belongs to the triangle 'in itself', but to the isosceles 'not in itself'. Therefore, at least in the terms it was proposed, A2 is not completely satisfactory.

The three interpretations we have considered so far present disappointing results. Interpreters who advocate the Natural Solution fail to explain how the paradigmatic example of *per se* accidents (2R predicated of triangles) could match the characterization and examples of *per se₂* predications in *APo* I 4. Interpretation A1 seems to violate Aristotle's claim that essential predications (in which the predicate is part of the τί ἐστι of the subject) are not demonstrable in the strict sense. Interpretation A2, in turn, overlooks the passages in which Aristotle takes *per se₁* and *per se₂* predications to cover all scientific propositions; moreover, A2 is unable to explain in which sense of 'in itself' 2R belongs to the triangle 'in itself', but to the isosceles 'not in itself'. Thus, understanding the concept of *per se* accident and its role in the *APo* involves addressing three basic difficulties:

(A) Does the 2R-example satisfy the definition of *per se₂* predication? If it does, is there a pattern in all of Aristotle's examples of *per se₂* predicates (including 2R)?

(B) What does Aristotle mean when he says that *per se₁* and *per se₂* connections cover all scientific propositions? Would not this make his theory excessively restricted?

(C) In which sense of '*per se*' is 2R *per se*-related to triangle, but not to isosceles?

4.4 – *Per Se* Accidents and Primary Universality: Remodelling the Natural Solution

The discussion about the nature of demonstrable attributes is crucial for understanding Aristotle's model of scientific explanation. A successful account of the relation between a subject and its *per se* accidents would help us determine whether Aristotelian demonstrations follow the S-Model, the A-Model or a combination of both.[169] For instance, each of the three interpretations discussed in the last section is associated with one of these models of essence-based explanation. The Natural Solution takes *per se* accidents to be *per se₂* predicates. As we have seen, P is a *per se₂* predicate of a subject S if the definition of P somehow refers to S. Here, what grounds the *per se* relation between S and P would be the essence of the predicate P, as we have in the A-Model. However, demonstrable attributes are predicated of their subjects by necessity, which makes several

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[169] For a similar point, see Bronstein (2016a, pp. 46-50).

interpreters think that *per se* accidents are somehow attached to the essence of the items to which they belong, along the lines of the S-Model.[170] In the same vein, alternatives to the Natural Solution take the *per se* accident to be either part of the essence of the subject (A1) or a consequence of the subject being what it is (A2). In this section, I shall defend the Natural Solution. Nevertheless, in my analysis of the concept of primary universality, I shall preserve some of the intuitions underpinning interpretation A2. As a result, our account will once again suggest that the S-Model and the A-Model are both part of Aristotle's doctrine.

As we have noted, the Natural Solution to the problem of *per se* accidents has met with resistance from interpreters of Aristotle. I believe that such resistance is due to a confusion between two levels of analysis in which this discussion should take place: the level of extra-linguistic connections between objects and their attributes (metaphysical predications), on one hand, and the level of sentences expressing these connections (linguistic predications), on the other. As we have argued, *per se* connections are metaphysical predications. Therefore, the proponents or opponents of the Natural Solution must address two distinct questions:

The Metaphysical Question: What characterizes a *per se₂* connection?
The Linguistic Question: What kinds of sentences (or linguistic predications) express *per se₂* connections?

Despite being interconnected, the Metaphysical and the Linguistic Question are substantially different from each other and must be addressed separately. In the following, we shall first address the Metaphysical Question, which involves identifying the kinds of entities that participate in *per se₂* connections and understanding the role these connections play in Aristotle's metaphysical theory as a whole.

It has been said that the subjects of *per se* predications are always universal (Sorabji 1980, pp. 189-191). Aristotle affirms – in *Metaph.* VII 15, for instance – that it is impossible to give a definition of individuals, whereas *per se₁* and *per se₂* predications are such that subject and predicate maintain a definitional link in one direction or the other. However, the fact that definitions are only of universals does not entail that particulars cannot be subjects of *per se₁* predications, as it might seem at first sight. The impossibility of giving a definition of Socrates, for instance, probably means that there is not a definition exclusive to Socrates, with the proper name 'Socrates' as the *definiendum*. Nevertheless, according to 73ᵃ 36-37 in **T31**, in order to be a *per se₁* predicate of a given subject S, an attribute P only needs to inhere in 'the account that says what S is', which is not necessarily a

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[170] See, for instance, Loux (1991, p. 73); Barnes (1993, p. 120); Charles (2000, p. 203); Malink (2013, pp. 124-126); Bronstein (2015, pp. 724-725); Shields (2016, pp. 84-85).

definitional statement with 'S' occurring as the subject-term. If S is an individual, the account displaying what S is will be the definition of the species of which S is a member. As Aristotle himself admits, animal is a *per se₁* predicate of Callias insofar as animal is mentioned in the definition of the species man, of which Callias is a member (see *Metaph.* V 18, 1022ᵃ 27-29). Moreover, the argument that there is no definition of individuals (and therefore the subjects must be universals) is inconsequential in the case of *per se₂* predications. After all, it is the definition of the predicate (and not of the subject) that occurs in the characterization of this kind of *per se* connection.

In a series of articles, Richard Tierney (2001a; 2001b; 2004) argued that particular substances – and also substance-like entities such as numbers and surfaces – are subjects of *per se* predications. According to his view, odd would be a *per se₂* predicate of numbers like 5 or 7, whereas male would be a *per se₂* predicate of animals such as Socrates or Secretariat. Without accepting all the reasons Tierney sets out in favour of his interpretation, I would like to subscribe to his understanding of *per se₂* connections in the following terms.[171]

The possibility of individuals being subjects of *per se* predications is congenial to Aristotle's *Categories*, according to which the subjects of predication *par excellence* are particular substances, on which other beings are ontologically dependent. As we have seen, the ontological priority of substances over incidental beings (PIB) has a definitional priority (PID) as its linguistic correlate: definitions of non-substantial entities must somehow register their dependent status by containing a reference to their proper subjects. However, since an attribute can be instantiated in a plurality of individuals, it would be unreasonable to require its definition to provide us with a complete list of the particular objects to which it belongs. For that reason, all Aristotle expects is the presence of a kind-term that picks out the subjects to which the *definiendum* attribute belongs as a *per se₂* predicate (*Metaph.* VII 5, 1030ᵇ 23-24).[172] Animals are the sort of things that are either male or female and therefore the definition of male must contain the kind-term 'animal'. In that case, we could say, following Tierney, that animals satisfying the relevant criteria (such as Socrates or Secretariat) are subjects to which male belongs as a *per se₂* predicate. Similarly, (bodily) surfaces are the sort of things that have colours. For that reason, the term 'surface' should be part of the definition of white, which makes it a *per se₂* attribute of surfaces of a given kind (see *Metaph.* V 18, 1022ᵃ 29-31; VII 4, 1029ᵇ 16-18).

However, since the subjects of a given predicate can be described in many ways, it is not immediately clear which kind-term should be part of its definition. As Tiles (1983, p. 10) points

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[171] Yet, as we saw in the last section, Tierney would not allow us to infer from his thesis that the term 'triangle' does not need to occur in the definition of 2R if 2R is a *per se₂* predicate of triangles (as I shall argue).

[172] See Goldin (1996), who argues that *per se* accidents are things such as eclipse, thunder or deciduousness, whose subjects, on which their being depends, are mentioned in their definitions.

out, Aristotle seems to believe that definitions of attributes should determine their *range of significance*. In other words, what is expected is a sortal expression – which can be either a substance term, such as 'animal', or a substance-like term, such as 'number' or 'surface' – that refers to the objects it applies to as countable discrete wholes, establishing thereby a homogeneous domain of application for the attribute in question. For that reason, white is a συμβεβηκός of some men (in the sense of being a contingent predicate of them) and nevertheless is a *per se$_2$* predicate of the surfaces that are part of their bodies.[173] Surfaces are the primary (proximate) subjects in which colours are naturally found (ἐν ᾧ πρώτῳ πέφυκε γίγνεσθαι, *Metaph*. V 18, 1022^{a}16), which means that the property of being a (bodily) surface or being composed of a (bodily) surface is what unifies very dissimilar objects (such as a pale man, a painting by Barnett Newman or a snowball) in a cohesive domain. Therefore, doing science about colours and explaining how they come about involves doing science about bodily surfaces as well, since they are the proper subjects of colours with the relevant features that make colours what they are.

The fact that particular objects can be subjects of *per se$_2$* predications (provided that the relevant kind is mentioned in the predicate's definition) gives us a preliminary answer to the Metaphysical Question. However, this picture still needs to turn out consistent with a plausible answer to the Linguistic Question. Naturally, the Metaphysical Question takes precedence over the Linguistic one, since, in order to evaluate whether a given sentence expresses a certain fact or state of affairs appropriately, we need to know previously – at least, in general lines – what this fact or state of affairs is. However, without bothering to give a precise answer to the Metaphysical Question, several interpreters have assumed, for instance, that all categorical statements expressing a metaphysical predication in which odd occurs as a *per se$_2$* predicate must have the term 'number' as their grammatical subject. Under this assumption, the options available would be the following:

(i) 'Every number is odd.'

(ii) 'Every number is odd or even.'[174]

(iii) 'Some numbers are odd.'[175]

Option (i) should be rejected as false. Option (ii), on the other hand, can hardly be extracted from the texts – especially from *Metaph*. VII 5, 1030^b 18-26 – and sounds too eccentric for the important

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[173] Tierney (2004, p. 14) notes that the kind-term appearing in the definition of an attribute applies to its 'immediate subjects' (surfaces in the case of white) rather than its 'ultimate subjects' (a particular pale man). Mignucci (1975, p. 63), speaks in terms of 'condizione prossima' and 'condizione remota': '… mentre numero è condizione prossima di pari o dispari, uomo è solo condizione remota (in quanto ha superficie) di bianco.'

[174] See Ross (1949, pp. 59-62; pp. 521-522); Wedin (1974, p. 34); Mignucci (1975, p. 63); Granger (1981, p. 120).

[175] See Ferejohn (1991, p. 99-108).

role Aristotle ascribes to *per se₂* connections in his theory of demonstrative science.[176] Particular statements like (iii), in turn, also do not get support from the text and conflict with Aristotle's preference for universal propositions in scientific demonstrations (see Barnes 1993, p. 114).

However, there is no textual evidence forcing us to assume that, if P is a *per se₂* predicate of S, the term 'S' must be part of the definition of what P is. Indeed, this would be the case only if the verb 'ἐνυπάρχειν' signified what we could describe as a language-language relation – that is, a relation assuming only linguistic items as values. Actually, we cannot take 'ἐνυπάρχειν' as a relation of this kind without committing Aristotle to a theory that is based on use-mention confusions, as we have seen. On the other hand, if we take 'inhering in' as a world-language relation, the number of sentences that can be interpreted as signifying *per se₂* connections is considerably higher than it is usually thought. Consequently, the important place Aristotle reserves for them in his theory of science becomes much easier to understand. Let us clarify this point.

The characterization of *per se₂* connections in **T32** is the following: 'ὅσοις τῶν ὑπαρχόντων αὐτοῖς αὐτὰ ἐν τῷ λόγῳ ἐνυπάρχουσι τῷ τί ἐστι δηλοῦντι' (73ᵃ 37-38). Answering the Metaphysical Question requires identifying the referent of the pronoun 'αὐτὰ', the grammatical subject of 'ἐνυπάρχουσι'. In *Metaph.* V 18, 1022ᵃ 29-31, Aristotle describes white as a *per se₂* predicate of *the* surface, using a definite article (ἡ). One could say that the definite article introduces the word 'surface' as the (grammatical) subject of a linguistic predication. However, we have already ruled out this option by reading 'ἐνυπάρχουσι' as picking out a world-language relation. Another option would be to take the article to introduce a universal entity (*the surface*), as when we say, for instance, that '*the* elephant is a mammal.' However, this use of the article seems to imply a universal quantification (all elephants are mammals), which is not compatible with the surface/white case (since not all surfaces are white). A third and more viable option would be to take the article to introduce a particular object. When we say, for example, that 'the chair is made of wood', the referring expression 'the chair' denotes a particular chair. In the same vein, in sentences like 'the surface is white' or 'white is a *per se₂* predicate of the surface', the expression 'the surface' would refer to a particular surface. Therefore, not only Aristotle's example of *per se₁*, but also his example of *per se₂* connections in *Metaph.* V 18 indicates that particular objects can be taken as subjects of *per se* predications.[177] A similar reasoning applies to the use of the definite articles 'τῇ' and 'τῷ' in *APo* I 4, 73ᵇ29-30.

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[176] Although sentences of this form may appear in arguments that are relevant to scientific inquiry (such as *reductio ad absurdum* or arguments relying on platonic division), they do not seem to fit Aristotle's characterizations of (full-fledged) demonstrations. Barnes (1993, p. 113) correctly points out that, for Aristotle, such propositions are 'likely to be, at best, rare in the sciences'.

[177] Of course, this does not imply that universals cannot be subjects of *per se* predications.

Well, if the definite article in Aristotle's example is interpreted as implying that white can be taken as a *per se₂* predicate of some particular (bodily) surfaces, these surfaces must somehow 'inhere in' the definition of white. For the same reason, if male is a *per se₂* predicate of animals such as Socrates and Secretariat, Socrates and Secretariat must somehow 'inhere in' the definition of male. Certainly, this *does not mean* that 'Socrates' and 'Secretariat' need to be present in the definitional locution specifying what male is. Indeed, this absurdity comes out only for those who take 'inhering in' as introducing a language-language relation, as several interpreters seem to do. On the other hand, those who take 'inhering in' as introducing a world-language relation find themselves able to explore the following exegetical hypothesis: a subject S 'inheres in' (ἐνυπάρχει) the definition of a predicate P if the relevant kind-term 'K' applying to S appears in the definition of P.[178] If this hypothesis is correct, we could say that insofar as 'animal' is part of the definition of male, some of the members of the kind animal (like Socrates and Secretariat) are subjects to which male belongs in the *per se₂* way. Similarly, the definition of straight contains the kind-term 'line', which makes straight a *per se₂* predicate not of the kind *line* itself – after all, not all lines are straight –, but of the members of the kind that satisfy the relevant criteria for being considered a straight line.[179]

With this background in mind, we are able to address the reasons set out by those who oppose the Natural Solution and resist classifying *per se* accidents (especially the property 2R) as *per se₂* predicates. The first of these reasons states that there is no good motivation to include the term 'triangle' in the definition of 2R.[180] Consequently, the attribute 2R would not satisfy the most basic requirement to be considered a *per se₂* predicate of triangles. This objection to the Natural Solution relies on the assumption we have just undermined; namely, that if P is a *per se₂* predicate of S, the term 'S' must be part of the definition of what P is. As we saw, the kind-terms 'number' and 'animal' appearing in the definitions of odd and male are responsible for marking off their ranges of significance. Thus, those kind-terms do not apply exclusively to the actual instances of these attributes, but to all the items to which 'odd' and 'male' apply meaningfully. Similarly, there is no

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[178] Perhaps, in some special cases, the proper name of S itself will be in the definition of the predicate. For instance, 'Moon' is part of the definition of the lunar eclipse and not a generic term applying to the Moon (*APo* II 2, 90ᵃ 15).

[179] The interpretation that Socrates, Callias and all male animals 'inhere in' the definition of male (in the precise way I have defined the 'inhering in' relation) – and similarly for the other examples – is also reinforced by the irregular combination of a neuter plural and a plural verb in 73ᵃ37-38. As has been noted, the plural verb may be used 'when variety is emphasized (distributive plural)' (Gildersleeve 1980, p. 48, §102) and 'when stress is laid on the fact that the neuter plural subject is composed of persons or of several parts' (Smyth 1920, p. 264, §959). See *De An.* II 3, 415ᵃ5-6; II 8, 420ᵇ9-10, II 9, 421ᵇ10-11; Plato, *Laches*, 180ᵉ; *Laws*, 856ᵈ⁻ᵉ. For other references, see Gildersleeve (1980, pp. 48-49).

[180] One could argue that, for Aristotle, there is indeed good reason to include the term 'triangle' in the definition of 2R because 2R and triangle have a relation of primary universality. However, Aristotle never says that if there is a relation of primary universality between S and P then 'S' should be part of the definition of P. In addition, it would be hard to unify Aristotle's examples in a single pattern – and hence to answer our question (A) – if one pursues this solution.

need to have the term 'triangle' as a part of the definition of 2R in order to classify 2R as a *per se₂* predicate of triangles. What is required of the definition of a predicate is no more than a reference to the objects to which the predicate applies *with meaning*, not necessarily *with truth*. Therefore, as 'number' in the case of odd or 'animal' in the case of male, the kind-term that needs to be present in the definition of 2R shall be something like 'rectilinear closed figure'[181], since only rectilinear closed figures can have internal angles equal to a certain amount or another. In that case, we could say that triangles 'inhere in' (ἐνυπάρχουσι) the definition of 2R insofar as this definition contains a kind-term applying to them: 'rectilinear closed figure'. Thus, just as odd is a *per se₂* predicate of *certain numbers* and male is a *per se₂* predicate of *certain animals*, 2R is a *per se₂* predicate of *certain rectilinear figures*, namely, triangles.

We must also not overestimate the impact of a second objection raised against the Natural Solution, according to which all *per se* accidents (2R included) should be members of a pair of opposite attributes in order to be classified as *per se₂* predicates. As some scholars have noted, Aristotle is not concerned with pairs of opposites when he defines and exemplifies the *per se₂* connection, but at most to a limited range of mutually exclusive attributes – otherwise, it would be hard to see why Aristotle takes white as an example of *per se₂* predicate in *Metaph.* V 18.[182] Although 2R is a not a member of a pair of opposites, it is indeed a member of a set of incompatible attributes, which is given, as Tiles (1983, p. 7) puts it, by the values of the function 'having internal angles equal to X'. All rectilinear closed figures – i.e. all items in the domain of application of the predicate 2R – must present one or another of the values of this function as a necessary and demonstrable property.

Our answer to the Metaphysical Question allows us to answer the Linguistic Question in such a way that, although *per se₂* predicates belong to a range of mutually exclusive attributes, the predicate-terms that signify them may be coextensive with a given subject-term depending on the statements in which they occur. Let us consider the following sentences:

(iv) '5 is odd'

(v) 'this rectilinear figure in the semi-circle has 2R'

(vi) 'every prime number other than 2 is odd'

(vii) 'every triangle has 2R'

At first sight, Tierney's interpretation suggests that sentences like (iv) and (v) are the most likely candidates to be interpreted as signifying *per se₂* connections, but this cannot be the whole story.

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[181] For more accurate options, see Tiles (1983, p. 10).

[182] See Wedin (1973, p. 34, n. 9); Granger (1981, p. 120); McKirahan (1992, pp. 89-90); Tierney (2004, p. 11, n. 38).

Odd is a *per se₂* predicate of certain numbers and therefore a universal affirmative sentence such as (vi) could be interpreted as expressing, in a distributive reading, several *per se₂* connections between odd and all prime numbers other than 2. Similarly, 2R is a *per se₂* predicate of certain rectilinear figures, namely, triangles. Therefore, we can say that sentence (vii) signifies (distributively) several *per se₂* connections between 2R and each particular triangle. In this case, nothing prevents statements with coextensive subject- and predicate-terms from signifying *per se₂* connections.

This entire debate opposes two different exegetical hypotheses. Most interpreters assume that P being a *per se₂* predicate of S entails that the term 'S' appears in the definition of P and is the subject-term of *all* sentences expressing a *per se₂* connection between S and P. Not only the opponents of the Natural Solution but even some of its proponents make this assumption, which explains why they were unable to show how the 2R-example fits Aristotle's characterization of *per se₂* connections.[183] We, on the other hand, suggested that P will be a *per se₂* predicate of S if S is a member of a kind K and the corresponding kind-term 'K' appears in the definition of P (determining thereby its range of significance). This second hypothesis is preferable on its own insofar as it interprets the verb 'ἐνυπάρχει' in a way that does not commit Aristotle to use-mention confusions. In addition, it allows particular objects to be subjects of *per se* predications, being therefore in tune with the examples and the use of definite articles in *Metaph.* V 18 and *APo* I 4. Moreover, our interpretation provides solutions to problems (A) and (B) raised at the end of section 4.3: first, it enables us to understand passages in which *per se* accidents seem to be taken as equivalent to *per se₂* predicates and at the same time explain how the paradigmatic example of 2R fits the description of *per se₂* connections in *APo* I 4 (problem A); second, a larger number of sentences can now be interpreted as expressing *per se₂* connections, which allows us to explain the passages where Aristotle takes *per se₁* and *per se₂* connections to cover all scientific propositions without limiting his theory to sentences like (i), (ii) and (iii) (problem B).

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[183] Ross (1949, pp. 59-62) and Granger (1981, p. 120), who accept the Natural Solution, assume that a disjunction of exclusive attributes should appear in the predicate position, as we have in sentence (ii) above. This seems to be an awkward and *ad hoc* way out, which is unnecessary in our interpretation. Certainly, sentences with coextensive subject- and predicate-terms are not the only ones to express *per se₂* connections. For that reason, it would be wrong to claim that the class of *propria* coincides with the class of *per se* accidents (see Barnes 1970, pp. 139-140). Wedin (1973) adopts the disjunctive reading but argues that each member of the disjunction is a *per se* accident and not the disjunction as a whole, taken as a single attribute. He believes that *per se* accidents are always disjunctive and, therefore, cannot be *propria*. Graham (1975) has a more inclusivist view and argues that *propria* and *per se₂* attributes are subtypes of *per se* accidents. However, he assumes that *per se₂* attributes, unlike *propria*, are not counterpredicable (i.e. coextensive) with their subjects. As we have argued, this assumption conflates linguistic and extra-linguistic levels in which we can speak of predications. For a way of interpreting the necessity of *per se₂* predications that does not require the disjunctive reading, see Tierney (2007).

What about question (C)? According to the interpretative schema we are advancing, a sentence like

(viii) 'every isosceles triangle has 2R'

also expresses (distributively) *per se₂* connections between 2R and each isosceles triangle. Insofar as it signifies a *per se* connection, (viii) is under the scope of demonstrative science, as we would expect (since 2R is not a contingent attribute of isosceles triangles). However, Aristotle believes that sentence (vii) takes precedence over (viii) because (as it is usually phrased) 2R belongs to isosceles triangles not *qua* isosceles, but *qua* triangles. But what does this mean exactly? In other words, in which sense of 'συμβεβηκός' does 2R belong to the isosceles (or equilateral) 'κατὰ συμβεβηκός' (*Top.* II 3, 110ᵇ 23-25)? When Aristotle says that the demonstration of the 2R-theorem applies to the isosceles 'τρόπον τινὰ οὐ καθ᾽ αὑτό' (*APo* I 4, 74ᵃ 2), to which sense of 'καθ᾽ αὑτό' does the expression 'τρόπον τινὰ' refer?[184]

The concept of primary universality seems to be related to the fact that, for Aristotle, the subject-term of demonstrable propositions should somehow be explanatorily related to the predicate. If this is the case, the *per se* connection that characterizes primary universality must hold between a demonstrable property and another feature (expressed by the subject-term) *in virtue of which* all the objects that have such property happen to have it (see Kosman 1973, pp. 374-375).

As we have seen, Aristotle characterizes the *per se₄* connection as an explanatory relation, as the proponents of A2 would accept. However, these interpreters do not seem to capture the relevant kind of explanatory relation Aristotle has in mind. According to them, P being *per se₄*-related to S means that P merely follows from S being what it is. Thus, they assume that a *per se₄* predicate (in their view, a *per se* accident) of a genus would be a *per se₄* predicate (that is, a *per se* accident) of its species as well – since being a member of the species entails being a member of the genus. This result, however, leaves us with no sense of '*per se*' in which 2R is *per se*-related to triangle, but not to isosceles, equilateral or scalene. Consequently, A2 is unable to identify the kind of *per se* connection that characterises primary universality (*APo* I 4, 73ᵇ26-28). We can avoid this unpleasant outcome if we reinterpret the *per se₄* connection as follows.

First, in **T34**, Aristotle does not seem to describe the *per se₄* connection as holding between a subject and a predicate (as the proponents of A2 assume it to be). At first, the connection in question seems to take place between events causally linked: a slaughtering procedure and the

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[184] On the equivalence between the 'κατὰ συμβεβηκός' in *Top.* II 3 and the 'οὐ καθ᾽ αὑτό' in *APo* I 4, 74ᵃ 2, 110ᵇ 23-25, see section 4.3 above. In my view, 2R is a *per se* accident (that is, a *per se₂* predicate) of all triangles, which implies that sentences like (vii) –'every triangle has 2R' – and (viii) – 'every isosceles triangle has 2R' – express relations between certain objects and one of their *per se* accidents. However, as I shall now argue, sentence (vii) signifies a kind of *per se* connection that (viii) does not (namely, a *per se₄* connection).

death of an animal, for instance. However, we have seen that the kind of relation between events Aristotle has in mind consists in an explanatory connection between two predicates occurring to the same subject (or subjects): *being slaughtered* and *dying*:

Per se₄: if P¹ and P² are *per se₄* related, P² holds of a given S *because* [διὰ] P¹ holds of S.

This characterization of *per se₄* connections might be compatible with the one advanced by A2. However, the presence of the concept of primary universality in the context in which this connection is introduced forces us to take the *per se₄* connection as a very precise kind of explanatory relation, which is stronger than the mere 'following from' relation that A2 suggests. That this is so becomes clear once we realize that in *APo* I 4 Aristotle intends not only to classify the meanings of the expression 'in itself', but also to hierarchize demonstrable propositions. Suppose a geometer, for instance, discovers that all isosceles triangles have 2R and starts looking for an explanation for that fact. Her investigation is likely to end up with a demonstration concerning only the cases examined, viz. the occurrences of 2R in isosceles triangles.[185] Even if the geometer includes in his agenda finding explanations for the presence of 2R in scalene and equilateral triangles as well without unifying them in a single kind, the knowledge acquired in this way would be nothing more, in Aristotle's words, than a sophistic (κατὰ συμβεβηκός) understanding of the 2R-theorem (see *APo* I 5, 74ᵃ 25-32; I 2, 71ᵇ 9-10).[186] In order to have scientific knowledge without qualification, it is not enough to figure out the range of significance of the attribute in question, not even the whole domain of its actual instances: the appropriate *extension* cannot be grasped only 'in number' (74ᵃ 31). There is an appropriate *intension* to be considered, which consists in a property or cluster of properties explanatorily related to the attribute whose occurrence we seek to demonstrate. For example, whatever has the attribute 2R has it *independently* of having two, three or none of their sides equal to each other (i.e. independently of being an equilateral, an isosceles or a scalene figure), but ultimately because it is, by definition, a three-sided rectilinear closed figure, that is, a triangle.[187] The vocabulary used in passages where 2R is said to be *per se*-related to triangle, but not to isosceles, is close to the vocabulary used in the discussion of *per se₄* connections in *APo* I 4. As we have seen, Aristotle affirms that 2R belongs to triangle 'in itself' in the sense that whatever has the property

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[185] Smith (2009, p. 60) gives a helpful example: 'it can be proved that every isosceles triangle has 2R as follows: bisect the triangle's base and connect this to its opposite vertex, producing two congruent triangles. Invert one of these halves and join it to the other, producing a rectangle. It is then evident that the angles of the two triangles add up to four right angles, so the angles of each add up to two. From Aristotle's perspective, this is not really a demonstration since it cannot explain why *all* triangles have 2R, even though all triangles do have 2R.'

[186] Of course, just failing to capture the appropriate kind-term (from an explanatory point of view) is not enough to classify an explanation as 'sophistic'. What makes an explanation sophistic is the intention of producing a false appearance of knowledge and wisdom. On this, see Hasper (2006); Angioni (2016).

[187] For similar views, see Lennox (1987, p. 91); Kosman (1973, p. 375); Hasper (2006); Angioni (2007a; 2014b, pp. 97-98; 2014c; 2016).

2R has it 'in virtue of' (διά) triangle, whereas triangle has 2R 'not in virtue of something different' (οὐκέτι δι'ἄλλο).[188] If this is the kind of explanatory relation underlying Aristotle's characterization of the *per se₄* connection, we can say that 2R is *per se₄*-related to triangle, but not to its subspecies: for any S that has 2R, S has 2R in virtue of being a triangle and *independently* of being an isosceles, equilateral or scalene figure.

As we have seen, Aristotle argues that demonstrable propositions like (vii) – 'every triangle has 2R' – are prior to sentences like (viii) – 'every isosceles triangle has 2R'. The reason is that, for every demonstrable attribute, there is one subject-term which is the most qualified to occur in the corresponding (demonstrable) proposition. The *per se₄* connection, if understood as we propose, can be used to explain this aspect of Aristotle's theory. If a *per se₄* connection holds between two predicates P^1 and P^2, whatever is P^2 is so in virtue of being P^1, and hence must fall under denoting phrases such as 'the P^{1}' or 'every P^{1}'. Thus, if a sentence expresses a *per se₄* connection, its grammatical subject must be a denoting phrase that is explanatorily related to the predicate in question in the precise way we have described. As we have argued, *per se* accidents such as 2R are *per se₂* predicates of the objects of which they are predicated. For instance, sentence (viii) – 'every isosceles triangle has 2R' – is demonstrable insofar as it expresses *per se₂* connections between 2R and every isosceles triangle. However, only propositions that also exhibit a *per se₄* connection can be considered the primary *demonstranda* of science, since they have as their grammatical subject a denoting phrase that not only comprises all (and only) the actual instances of the predicate, but also stands for a set of features that are explanatorily linked to it. This is the case of sentence (vii), which, in virtue of having the denoting phrase 'every triangle' as its grammatical subject, not only expresses *per se₂* connections between 2R and all the figures to which 2R belongs (i.e. all triangles), but simultaneously signifies a *per se₄* connection between *being a triangle* and *having 2R*.

If our interpretation of the nature of *per se₄* connections is correct, the corollary of alternative A2 does not follow. In fact, it would be false to say that if P is *per se₄*-related to S and S is *per se₁*-related to S', then P would be *per se₄*-related to S'. There is a *per se₄* connection between being a triangle and having 2R. However, although being a triangle is a *per se₁* predicate of isosceles triangles, there is not a *per se₄* relation between having 2R and being isosceles. Therefore, we have our solution to problem (C): when Aristotle affirms that 2R is *per se*-related to triangle but not to isosceles or equilateral, he has a *per se₄* connection in mind, which is the kind of *per se* relation that enables him to take sentences like (vii) – and not (viii) – as primary *demonstranda*.

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[188] See *APr* I 35, 48ᵃ 33-36.

The most natural reaction to texts like *Ph.* I 3, 186^b 18-23, and our **T37**, **T38** and **T39** is to take *per se* accidents to be *per se$_2$* predicates, as several interpreters have done. However, Aristotle's paradigmatic example of a *per se* accident in **T35** (2R predicated of triangles) seemed to challenge this view. We advanced an interpretation that maintains the natural reading of those passages and explains how 2R could be taken as a *per se$_2$* predicate of triangles. In our interpretation, the number of sentences that can be interpreted as expressing *per se$_2$* connections is significantly larger than alternative interpretations would be able to admit, rendering Aristotle's theory richer and more likely to apply to actual scientific cases. In addition, it is perfectly possible to make sense of **T37**, **T38** and **T39** without excluding *per se$_4$* connections from the scope of science: sentences like (vii) – 'every triangle has 2R' – express *per se$_2$* connections between 2R and triangles *and* a *per se$_4$* connection between the predicates *being a triangle* and *having 2R*. The *per se$_4$* connection is not only relevant, but crucial to Aristotle's theory, since it enables him to distinguish between primary and secondary demonstrable propositions. In fact, it seems Aristotle tried to make this point explicit in **T37**: 'with respect to what is knowable without qualification, whatever is said to hold of things in themselves (in the sense of inhering in what is predicated or of being inhered in) is also said to hold of them because of themselves [δι᾽ αὑτά]' (*APo* I 4, 73^b 16-18).[189] Sentences like '5 is odd' and 'every isosceles has 2R' are under the scope of science, but only propositions like 'every triangle has 2R', which signify both *per se$_2$* and *per se$_4$* connections, are scientific 'without qualification.'

This picture helps us determine which model of essence-based explanation Aristotle endorses. As we have said, the Natural Solution to the problem of *per se* accidents is in accordance with the A-Model. The definitions of *per se* accidents, understood as a *per se$_2$* predicates, contain a reference to their proper subjects. If so, we can affirm that the relation between a subject and a demonstrable attribute is part of the essence *of the attribute*. Interpretations A1 and A2 are more sympathetic to the S-Model: *per se* accidents would either be part of the essence (A1) or follow from the essence (A2) *of the subject*. Since we have argued in favour of the Natural Solution, we are committed to the view that the relation between a subject and a demonstrable attribute is somehow part of the *way of being* of the attribute, which is why the subject is mentioned in the attribute's definition.[190] If our interpretation is correct, in addition to significant textual evidence from *APo* II, the notion of *per se* accident in *APo* I also corroborates the A-Model.

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[189] Passage T37 seems to imply that sentences expressing *per se$_1$* connections can also signify *per se$_4$* connections, if they are knowable 'without qualification'. Aristotle's words in T37 seem to make sense: lines have points precisely in virtue of their being lines (the same seems to be true of other *per se$_1$* predicates). Of course, in our interpretation, *per se$_1$* predications are first principles of science, and hence knowable not by demonstration. On the other hand, sentences expressing *per se$_2$* connections are knowable by demonstration. If, in addition, they also signify a *per se$_4$* connection, they are knowable by demonstration and 'without qualification' (i.e. as a primary *demonstrandum*).

[190] See Bronstein (2016a, pp. 46-50).

Nevertheless, we have also seen that if a (linguistic) predication is a primary *demonstrandum*, it has as its (grammatical) subject a denoting phrase (e.g. 'every triangle') containing a predicate that is explanatorily connected to the demonstrable attribute in question (e.g. '2R') in a precise way: the corresponding (metaphysical) predicates (e.g. *being a triangle* and *having 2R*) are *per se₄*-related. If triangles have 2R *in virtue of being triangles*, there is a sense in which the S-Model is also part of this picture. Although the essence of 2R involves its being predicated of rectilinear figures of a certain sort (namely, triangles), the occurrence of 2R in those figures is also grounded in *their* essence: if they were not essentially three-sided rectilinear closed figures, 2R would not be predicated of them as a demonstrable attribute. If we are right, Aristotle endorsed both the A- and the S-Model. However, several questions must be raised: Are these patterns of explanation incompatible or complementary? Could there be two (or even more) alternative and independent explanations of the same phenomenon? Or can the essences of subjects and attributes be parts of the same coherent causal story?

CHAPTER 5

EXPLANATION, ESSENCE, AND PRIMARY UNIVERSALITY

5.1 – Two Problems in *Posterior Analytics* II 16-17

Few chapters of the *APo* are as elucidating as II 16-17. Aristotle spells out, with helpful examples, what kind of syllogism can be taken as a full-fledged demonstration – i.e. a demonstration of the 'primary universal' – and what kind of explanatory role definitions play in demonstrative arguments. However, these chapters also present us with at least two major difficulties.

(1) In *APo* II 16, Aristotle raises the question of whether a scientific *explanandum* always entails and is explained by the same *explanans* (98^a 35-98^b 2). As we shall see below, the philosopher discusses two hypothetical scenarios, each of which leads to different answers to this question (98^b 25-28). In the first of them, different middle terms play the role of *explanans* depending on the subjects of which the *explanandum* attribute is predicated. Thus, the answer to the question raised in *APo* II 16 would be negative. In the second scenario, the demonstration is of the 'primary universal': the major and minor terms of a syllogism are coextensive, which entails that the major (*explanandum*) and the middle term (*explanans*) also counterpredicate (since demonstrations of this kind are in *Barbara*). In *APo* II 17, the philosopher goes on to argue that in proper scientific contexts – in which we demonstrate something 'in itself' (καθ᾽ αὑτὸ) – there cannot be several *explanantia* of the same *explanandum*. Hence, only instances of the second scenario, in which the three terms of the syllogistic demonstration are coextensive, would be properly scientific. If so, Aristotelian

demonstrations seem to be restricted to very specific kinds of phenomena, while certain *explananda* we would like to admit as truly scientific – some of which considered by Aristotle himself in *APo* II 17 – would be out of the scope of science.

(2) It has been argued that in *APo* II 16-17 Aristotle advances two different (and potentially incompatible) models of scientific explanation, which correspond to what we have been calling the 'S-Model' and the 'A-Model.' Michael Ferejohn (2013), for instance, claims that these chapters present 'two alternative ways of explaining' the fact that certain plants shed their leaves.[191] According to Ferejohn (2013, p. 104), lines 98ª35-ᵇ4 favour the S-Model: broad-leaved plants are deciduous precisely because they 'have broad leaves' (τὸ πλατέα ἔχειν τὰ φύλλα). This is, Ferejohn argues, Aristotle's 'canonical' model of scientific explanation: the demonstrable attributes of a given subject are explained by the subject's essence. However, lines 98ᵇ 36-8 and 99ª 23-29 support the A-Model, which Ferejohn would describe as a 'non-canonical' pattern of explanation: the *explanans* (coagulation of sap) is the essence (or rather the causal or explanatory part of the essence) of the *explanandum* attribute (deciduousness).

In the following, I shall argue that Aristotle's solution to the first problem involves showing that certain problematic attributes, which appear to admit more than one explanation, actually fall into the privileged scenario of primary-universal demonstrations. In addition, his solution suggests a conciliatory way-out to our second problem (or so I shall argue): both the essence of subjects and the essence of demonstrable attributes can play explanatory roles in demonstrations. I shall indicate how these results are underpinned by two of Aristotle's views on essence and causation: (i) causal or explanatory connections have a three-fold configuration, which means that one cannot evaluate whether a feature x is the primary explanation of a feature y unless the relevant domain of objects for the occurrences of x and y is properly specified; (ii) the existence of a demonstrable attribute as a unified phenomenon (i.e. as having such and such essence) depends on its subject having the essence it has.

5.2 - The Uniqueness Requirement

Aristotle begins *APo* II 16 interested in knowing whether every 'occurrence' of an attribute – the verb used is 'ὑπάρχειν' – that can be scientifically explained involves the occurrence of its putative explanatory factor (*APo* II 16, 98ª 35-36). In other words, does the *explanandum* always entails its *explanans*? We can formalize the question in the following way:

Q1: ∀x∀y((x is explanatory of y) → (y occurs → x occurs)) [?]

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[191] Ferejohn (2013, p. 149).

In *APo* II 16, 98ᵇ 2-4, a second question, apparently less controversial, is added. It concerns sufficient causality as it is usually conceived: given a certain cause, does its effect follow?

Q2: ∀x∀y((x is explanatory of y) → (x occurs → y occurs)) [?]

If affirmative answers are given to both of these questions, there will be a mutual entailment between *explanans* and *explanandum*: given a certain cause, its effect follows (affirmative answer to Q2) and, given a certain effect, its putative explanation occurs as well (affirmative answer to Q1).[192] The use of 'ὑπάρχειν' without a dative in 98ᵃ35-ᵇ4 may suggest that, for Aristotle, causation (or 'being explanatory of') is a relation that takes place between events or processes. However, the next lines make it clear that 'x is explanatory of y' is short for 'x is explanatory of y for z'[193] – that is to say, we have to consider not only the 'cause' (αἴτιον) and 'that of which it is cause' (οὗ αἴτιον) or 'the thing caused' (τὸ αἰτιατόν), but also the subject or subjects 'for which it is cause' (ᾧ αἴτιον).[194] In the same vein, an expression such as 'x/y occurs' (ὑπάρχει) is short for 'x/y holds of z' or 'x/y is predicated of z' (ὑπάρχει plus dative). In fact, the introduction of a third item in the analysis of causal relations is a crucial part of Aristotle's solution to the problems addressed in *APo* II 16-17. In 98ᵃ35-ᵇ24, for instance, the philosopher is concerned with the following difficulty: do affirmative answers to Q1 and Q2 entail that 'being explanatory of' is a symmetrical relation? His tripartite analysis of causation allows him to approach the problem in syllogistic terms. If x and y entail each other, one can prove syllogistically that 'x holds of z' from the premise 'y holds of z' and vice-versa (98ᵇ 4-5). Let us say, for instance, that being a broad-leaved plant is the reason why vines are deciduous. If Q1 and Q2 are answered affirmatively, one could formulate the following two syllogisms (98ᵇ 5-16):

Syllogism X:

Deciduousness holds of all *broad-leaved trees, Being a broad-leaved tree* holds of all *vines*
Deciduousness holds of all *vines*

Syllogism XI:

Being a broad-leaved tree holds of all *deciduousness trees, Deciduousness* holds of all *vines*
Being a broad-leaved tree holds of all *vines*

In this passage, Aristotle addresses the mistake of taking both X and XI as demonstrative syllogisms. In demonstrations, the middle term explains why the major term is predicated of the minor. Hence, if X and XI were both demonstrative syllogisms (in the strict sense of the term), the

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[192] Barnes (1993, p. 252) notes that, in *APo* II 16, Aristotle is not interested in temporal relations between *explanans* and *explanandum* (like in *APo* II 12), but in logical relations.
[193] See Barnes (1993, p. 252).
[194] Angioni describes this as 'the triadic structure' of scientific explanations. See n. 25.

attributes *deciduousness* and *being a broad-leaved tree* would be 'mutually explanatory' (αἴτια ἀλλήλων, 98ᵇ 17). However, says Aristotle, 'an explanation is prior to what it is explanatory of' (τὸ γὰρ αἴτιον πρότερον οὗ αἴτιον, 98ᵇ 17). Since priority is an asymmetrical relation[195], the relation 'being explanatory of' is also asymmetrical. By arguing that explanatory relations are asymmetric, Aristotle points out that, in demonstrations, the priority of the premises over the conclusion goes beyond mere inferential connections between them: although the properties *being a broad-leaved tree* and *being deciduous* entail each other, the former is explanatory of the latter, but not the other way around, which means that only Syllogism X is of 'the reason why' (τοῦ διότι ὁ συλλογισμός, *APo* I 13, 78ᵃ 28-ᵇ4; II 16, 98ᵇ 19-21).

As has been noted, in *APo* II 16-17, Aristotle takes Q2 as uncontroversial.[196] From 98ᵇ 25, the focus is on Q1 or, more specifically, on a different (and in a certain way more relevant) problem related to it. Let us say that, in a given context c_1, x is the putative *explanans* of the *explanandum* y. If there is a context c_2 in which y occurs without x occurring, there must be a different item z which is explanatory of y in c_2. Thus, if Q1 is answered negatively, it follows that an *explanandum* can be explained by different *explanantia*. This motivates Aristotle to address the following requirement:

Uniqueness Requirement (UR):

$$\forall x \forall y((x \text{ is explanatory of } y) \rightarrow \forall z(z \text{ is explanatory of } y \rightarrow z = x))$$

Of course, Aristotle recognizes that a demonstration may be composed of several syllogistic inferences, which happens when one or more of the premises that contribute to explain the conclusion are themselves demonstrable.[197] If so, all middle terms of such a syllogistic chain may be said to be 'explanatory of' the conclusion in a certain sense. However, in II 16-17, as well as in other key passages of the *APo*, Aristotle has a stronger explanatory connection in mind, in which the *explanans* is not something that merely contributes to explain the *explanandum*, but the determinant causal factor in virtue of which the *explanandum* is the case – or the 'primary middle term' (τὸ πρῶτον μέσον, 99ᵃ 25).[198] In the rest of *APo* II 16-17, the philosopher argues that every phenomenon susceptible to scientific explanation has a 'primary middle term' satisfying UR.[199] Let us now examine Aristotle's strategy.

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[195] See *Cat.* 12, 14ᵃ 29-35; 14ᵇ 11-22; *Metaph.* V 11, 1019ᵃ 1-4; VII 10, 1034ᵇ 30-32; 1035ᵇ 6-7.

[196] See Barnes (1993, p. 252).

[197] *APr* I 23, 41ᵇ 18-20; *APr* II 18, 66ᵃ 17-18; *APo* I 19-22.

[198] What Aristotle calls the 'primary middle term' is probably the one which produces ἐπιστήμη ἁπλῶς – as defined in *APo* I 2, 71ᵇ 9-12 – by apprehending the primary αἰτία of a given πρᾶγμα.

[199] It is worth saying that UR is compatible with *APo* I 29, where Aristotle claims that 'it is possible for there to be several demonstrations of the same thing' (87ᵇ 5). As Barnes (1993, p. 191) argues, Aristotle shows, at best, that there

In the last part of *APo* II 16, Aristotle discusses UR in two hypothetical scenarios (98ᵇ 25-28). In the first of them, the same *explanandum* attribute belongs to distinct subjects, each of which relates to distinct *explanantia* (*APo* II 16, 98ᵇ 25-29). Let us call it the 'multiple causes' scenario or 'MC-scenario.' For instance, if a single attribute A is predicated of distinct subjects D and E, nothing prevents us from elaborating two demonstrative syllogisms with also distinct middle terms, B and C respectively:

$$\frac{\text{AaB, BaD}}{\text{AaD}} \qquad \frac{\text{AaC, CaE}}{\text{AaE}}$$

If C and B are incompatible but equally adequate explanations for the major term A, UR is not satisfied. Later on, in *APo* II 17 99ᵇ 5-7, Aristotle seems to exemplify the MC-scenario: 'the explanation of longevity for quadrupeds is their not having bile, while for birds it is their being dry (or something else):'

Syllogism XII:

Longevity holds of *absence of bile*, *absence of bile* holds of *quadrupeds*
Longevity holds of *quadrupeds*

Syllogism XIII:

Longevity holds of *having dry bodies*, *having dry bodies* holds of *birds*
Longevity holds of *birds*

The longevity of quadrupeds cannot be explained by the same item used to explain the longevity of birds.[200] Therefore, at least at first sight, none of the explanations of longevity satisfies UR.

Next Aristotle discusses a second scenario in which the *explanandum* entails the occurrence of the same *explanans* – I shall call it the 'one-cause scenario' or 'OC-scenario': 'or if problems are universal, then must the explanation be some whole and what it is explanatory of be universal?' (*APo* II 16, 98ᵇ 32-33).[201] Aristotle brings up here the notion of 'universal problem.' 'Problem' translates the Greek 'πρόβλημα' probably in its technical sense of *APo* II 14, i.e. the conclusion of a demonstrative syllogism whose premises provide its adequate explanation. The meaning of 'universal' (καθόλου), on the other hand, is not as clear. However, a case can be made

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can be several valid arguments for the same conclusion, which suggests that the term 'ἀπόδειξις' is being used in a weaker sense.

[200] I shall take for granted, as the intelligibility of the example requires, that the minor 'quadrupeds' denotes all the objects for which longevity is a consequence of the absence of bile. The example is problematic. First, this explanation would work only for *some* quadrupeds – perhaps blooded quadrupeds (see *PA* IV, 677ᵃ 30-ᵇ10) or quadrupeds without gall bladders (see Ferejohn 2013, pp. 104-105). Second, in *PA* IV 2, 677ᵃ 30-35, Aristotle recognizes that also among dolphins longevity is caused by absence of bile. We should not assume that the examples express Aristotle's own scientific views. In one of his best-known examples of scientific explanation, thunder is said to be caused by fire being extinguished in the clouds, which is not the view he advances in *Mete.* II 9, 369ᵃ 14-369ᵇ 4. At any rate, the inadequacy of the example does not affect Aristotle's philosophical point.

[201] Barnes' (1993) translation with changes.

for the following interpretation: the example – deciduousness predicated of broad-leaved plants (*APo* II 16, 98ᵇ 32-33) – suggests that 'universal' refers to the concept introduced in *APo* I 4, 73ᵇ 25-27. As we have argued, the notion in question is more properly called 'πρῶτον καθόλου' or 'primary universal' (see *APo* I 5, 74ª 4-6; II 17, 99ª 33-35) – although Aristotle himself is flexible with his vocabulary.[202] What is particularly relevant in the context of *APo* II 16-17 is that, among other intensional features, the πρῶτον καθόλου attribute is coextensive with the subject it belongs to (see *APo* I 4, 73ᵇ 32-39; II 17, 99ª 33-35). In fact, the role played by the concept of primary universality is, among other things, to require scientific explanations to cover all instances of the attribute taken as *explanandum*. Suppose that distinct subjects D and E are both members of a kind F and that A belongs not only to D and E, but to all Fs and nothing more. Thus, it is reasonable to seek for a single middle term explaining why all Fs are A. If there is such a term (let it be G), D and E would be A insofar as they are F or, put in Aristotelian terms, A would not belong 'primarily' to D and E (see 'πρώτῳ ὑπάρχον' in 98ᵇ 27) but 'primarily' to their common kind F.[203] In this case, the *demonstranda* 'AaD' and 'AaE' would not fall into our MC-scenario, since a syllogistic proof of greater explanatory power would be available:

$$\frac{\text{AaG, GaF}}{\text{AaF}}$$

Primary-universal demonstrations explain all occurrences of the *explanandum* attribute in a single syllogistic argument. If all its occurrences can be explained at once, there must be a single cause for all them. In this scenario, a simple syllogistic deduction can establish a mutual entailment between *explanans* and *explanandum*. In *Barbara*, the sole syllogistic mood that proves universal affirmative sentences, co-extensiveness between major and minor terms entails co-extensiveness between the major and the middle (see *APr* II 5). Thus, in a demonstration with a primary-universal conclusion, in which major and minor terms counterpredicate, the major (*explanandum*) and the middle (*explanans*) counterpredicate as well. In *APo* II 16, Aristotle's example of such syllogism runs as follows:

Syllogism XIV:

> *Deciduousness* holds of *coagulation of sap*, *coagulation of sap* holds of all *broad-leaved trees*
> *Deciduousness* holds of all *broad-leaved trees*

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[202] See *APo* I 4, 73ᵇ 25-74ª 3; I 24.
[203] I am following Barnes (1993) in translating these occurrences of 'πρώτῳ' with adverbial locutions – 'primarily', where Barnes has 'primitively' – for the sake of the clarity and fluency. However, it might be useful to have in mind that 'πρώτῳ' qualifies the subject-term of categorical sentences occurring in demonstrations, and is being used here to specify the relation that the major term has with the middle and the minor terms.

The conclusion of the syllogism states a primary-universal predication, i.e. the phenomenon of deciduousness is considered in all its instances (i.e. all broad-leaved trees), not only in vines or fig-trees (*APo* II 16, 98^b 5-10; II 17 99^a 23-26). In this case, the explanation is 'some whole' (ὅλον τι, 98^b 32) or, as Ross (1949, p. 667) puts it, 'the whole and sole cause of the effect.' That is to say, the middle term (*coagulation of sap at the connection of the seed*) holds of and (more importantly) explains all instances of the major. Predicates such as '2R' and 'deciduousness' are, in Aristotle's words, 'determined to some whole' (ὅλῳ τινὶ ἀφωρισμένον, 98^b 33), i.e. they are restricted to a domain of objects that can be grasped by a single kind-term (the ᾧ αἴτιον item), which clears the way for a single, unifying explanation (the αἴτιον).

As we have seen, Aristotle addresses Q1 and UR introducing a third item (ᾧ αἴτιον) in his analysis of causal connections: the subject (or subjects) to which the οὗ αἴτιον-attribute belongs *primarily* (πρώτῳ ὑπάρχει). At first sight, it seems that UR is satisfied or not depending on how the ᾧ αἴτιον-term (minor) relates to the other two, the αἴτιον (middle) and the οὗ αἴτιον (major). When the demonstration is of the πρῶτον καθόλου – and minor (ᾧ αἴτιον) and major terms (οὗ αἴτιον) are coextensive –, there is a single middle term (αἴτιον) which not only is coextensive with the major, but also (and more importantly) explains all its instances. On the other hand, when the relation between the major (οὗ αἴτιον) and the minor term (ᾧ αἴτιον) is not one of primary-universality, nothing seems to prevent us from demonstrating the same *explanandum*/major term with two syllogisms with distinct middle terms as *explanantia*.

5.3 - Aristotle's Answer and the Two Models of Scientific Explanation

In *APo* II 17, Aristotle goes on to state the conditions under which UR is satisfied.

> [**T40**] Πότερον δ᾽ ἐνδέχεται μὴ τὸ αὐτὸ αἴτιον εἶναι τοῦ αὐτοῦ πᾶσιν ἀλλ᾽ ἕτερον, ἢ οὔ; ἢ εἰ μὲν καθ᾽ αὑτὸ ἀποδέδεικται καὶ μὴ κατὰ σημεῖον ἢ συμβεβηκός, οὐχ οἷόν τε· ὁ γὰρ λόγος τοῦ ἄκρου τὸ μέσον ἐστίν· εἰ δὲ μὴ οὕτως, ἐνδέχεται.
>
> Can it or can it not be the case that what is explanatory of some feature is not the same for every item but different? If the conclusions have been demonstrated in themselves, and not in virtue of a sign or incidentally, then perhaps the explanations cannot be different (for the middle term is the account of the extreme); but if they have not been demonstrated in this way, perhaps they can be different [*APo* II 17, 99^a 1-4; Barnes 1993, with changes].

An answer to the question raised in 99^a 1-2 depends on the way the *explanandum* attribute is demonstrated to belong to its subject. Can there be different explanations of the same item? If the conclusion is proved *in itself* (καθ᾽ αὑτὸ), the answer is negative. If it is demonstrated *in virtue of a sign*

(κατὰ σημεῖον) or *incidentally* (κατὰ συμβεβηκός), nothing prevents the existence of several *explanantia* for the same attribute.

As we know, Aristotle uses the expression 'καθ᾽ αὐτὸ' to refer to authentic demonstrative knowledge, in opposition to the mere pretence of knowledge labelled as 'κατὰ συμβεβηκός'.[204] Is Aristotle claiming that only phenomena falling into the OC-scenario are scientifically explainable? Would not it be possible to admit *explananda* such as longevity as properly scientific by arguing that, in those cases, there is a single *explanans* for them *in restricted domains* (quadrupeds in one case, birds in the other)? Could not we understand the minor terms as imposing a domain restriction in Syllogisms XII and XIII? After all, what is being sought is an explanation for longevity *in quadrupeds* in one case and *in birds* in the other. If there is a single item explaining longevity in each of those domains (*not having bile* and *being dry* respectively), would not be too demanding to say that here 'something else will be explanatory' (*APo* II 16, 98ᵇ 1-2)?

Answering these questions requires identifying what Aristotle takes to be the most determinant feature of authentic demonstrative knowledge. When the conclusion of a syllogism is demonstrated 'καθ᾽ αὐτὸ', says he, the middle term is the definition (λόγος) of the extreme (99ᵃ 3-4). Again, is the middle the λόγος of the major or of the minor term? Is the *cause* (αἴτιον) the essence of the attribute *of which it is cause* (οὗ αἴτιον) or of the subject *for which it is cause* (ᾧ αἴτιον)? Michael Ferejohn (2013) has argued that Aristotle does not answer this question consistently in the *APo*. According to the author, lines 98ᵃ35-ᵇ4 favour the S-Model: broad-leaved plants such as vines and fig-trees shed their leaves precisely because they are broad-leaved (τὸ πλατέα ἔχειν τὰ φύλλα). Thus, the αἴτιον would be the essence of the ᾧ αἴτιον-subject and the middle term, the definition of the minor term:

Syllogism XV:

Deciduousness holds of *Def(broad-leaved tree)*, *Def(broad-leaved tree)* holds of all *broad-leaved trees*
Deciduousness holds of all *broad-leaved trees*

However, as we have seen, what predominates in book II of the *APo* is what Ferejohn claims to be a 'non-canonical' model of scientific explanation:[205] the αἴτιον is the essence (or the

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[204] *APo* I 2, 71ᵇ 9-12; I 4, 74ᵃ 1-3; I 5, 74ᵃ 25-32. Proofs '*in virtue of a sign*' are not properly explanatory, since they establish the truth of its *probandum* through one of its consequences (one that is more easily perceived than the *probandum* itself). See *APr* II 27. Ross (1949, p. 669) also quotes *APo* II 8, 93ᵃ37-ᵇ3 as providing an example of such a proof. I will not discuss in detail the use of the expression 'κατὰ σημεῖον', since it is usually absent from Aristotle's most relevant accounts of scientific knowledge, while the concept of 'καθ᾽ αὐτὸ' is often characterized in opposition to that of 'κατὰ συμβεβηκός.' For more accurate accounts of this opposition, see Hasper (2006) and Angioni (2016).
[205] Ferejohn (2013, pp. 131-155).

causal part of the essence) of the οὗ αἴτιον-attribute.[206] Chapter II 17 is no exception to this pattern. The following passage is particularly eloquent:

> **[T41]** ἔστι δὲ τὸ μέσον λόγος τοῦ πρώτου ἄκρου, διὸ πᾶσαι αἱ ἐπιστῆμαι δι᾿ ὁρισμοῦ γίγνονται. οἷον τὸ φυλλορροεῖν ἅμα ἀκολουθεῖ τῇ ἀμπέλῳ καὶ ὑπερέχει, καὶ συκῇ, καὶ ὑπερέχει· ἀλλ᾿ οὐ πάντων, ἀλλ᾿ ἴσον. εἰ δὴ λάβοις τὸ πρῶτον μέσον, λόγος τοῦ φυλλορροεῖν ἐστιν. ἔσται γὰρ πρῶτον μὲν ἐπὶ θάτερα μέσον, ὅτι τοιαδὶ ἅπαντα· εἶτα τούτου μέσον, ὅτι ὀπὸς πήγνυται ἤ τι ἄλλο τοιοῦτον. τί δ᾿ ἐστὶ τὸ φυλλορροεῖν; τὸ πήγνυσθαι τὸν ἐν τῇ συνάψει τοῦ σπέρματος ὀπόν.

> The middle term is an account of the first extreme (which is why all sciences come about through definitions). Shedding leaves both follows vine and exceeds it, and it follows fig and exceeds it – but it does not exceed all of them: rather, it is equal to them. If you take the primary middle term, it is an account of deciduousness. For there will be first a middle term in the one direction (that all are such-and-such); and then a middle term for this (that the sap coagulates, or something of the sort). What is deciduousness? – The coagulation of the sap at the connection of the seed [*APo* II 17, 99ᵃ 21-29; Barnes 1993, with changes].

Aristotle not only affirms that the middle term is the λόγος of the major term (τοῦ πρώτου ἄκρου), but claims that this is the reason why 'all sciences come about through definitions' (διὸ πᾶσαι αἱ ἐπιστῆμαι δι᾿ ὁρισμοῦ γίγνονται, 99ᵃ 22-23). Quite emphatically, Aristotle seems to endorse the view that our Syllogism XIV (rather than Syllogism XV) is the one providing the primary explanation – the 'primary middle term' (τὸ πρῶτον μέσον) – of the fact that all broad-leaved trees shed their leaves:

Syllogism XIV:

> *Deciduousness* holds of *coagulation of sap, coagulation of sap* holds of all *broad-leaved trees*
> *Deciduousness* holds of all *broad-leaved trees*

An important thesis of *APo* II corroborates the A-model. As we have seen in Chapter 2, there is an isomorphism between the definition of an attribute and the explanation of its occurrence in the relevant subject. For instance, thunder is defined as a noise in the clouds caused by fire being extinguished. On the other hand, we explain why the noise we call 'thunder' is predicated of clouds through the middle term 'extinction of fire' (*APo* II 8, 93ᵃ 7-ᵇ14). This is our Syllogism VIII:

Syllogism VIII:

> *Thunder* (or *such-and-such noise*) holds of *extinction of fire, Extinction of fire* holds of *clouds*
> *Thunder* (or *such-and-such noise*) holds of *clouds*

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[206] *APo* II 2, 89ᵇ 36 - 90ᵃ 14; 90ᵃ 31-35; II 8, 93ᵃ31-33; *APo* II 16, 98ᵇ 21-24; II 17 99ᵃ 21-22, 25-26.

The definition of thunder, in turn, is isomorphic to Syllogism VIII:

Def. (Thunder):

Thunder is(df.) *noise of fire being extinguished in the clouds* (*APo* II 10, 94ᵃ 5-6).

If this pattern is followed also in the case of deciduousness, its whole definition would be isomorphic to Syllogism XIV:

Def. (Deciduousness):

Deciduousness is(df.) *the loss of leaves in broad-leaved trees caused by coagulation of sap.*

As we can see, the λόγος that plays the role of middle term in Syllogisms VIII and XIV is not the entire definition of the major term, but the causal or explanatory element in it. Still, the middle term is a specification of the attribute's essence – in fact, of the most determinant element of its essence.[207] Therefore, the A-Model is definition- or essence-based no less than the S-Model.[208]

Still in favour of the A-model, one could argue that there is no textual evidence for us to assume that Aristotle is committed to the S-model in *APo* II 16. When in 98ᵃ 35-ᵇ4 Aristotle presents 'having broad leaves' (τὸ πλατέα ἔχειν τὰ φύλλα) as the αἴτιον of deciduousness, he probably has in mind our Syllogism X, formulated in 98ᵇ 5-10 – and not Syllogism XV as Ferejohn (2013, p. 104) supposes.

Syllogism X:

Deciduousness holds of all *broad-leaved trees*, *Being a broad-leaved tree* holds of all *vines*
Deciduousness holds of all *vines*

Syllogisms of this sort have been called 'application arguments.'[209] One way of approaching these arguments is to take them not as properly explanatory, but as mere classificatory inferences meant to 'upgrade' non primary-universal problems into primary-universal ones. The deciduousness example is an instance of the OC-scenario. Since a problem with coextensive terms such as '*deciduousness* holds of all *broad-leaved plants*' is available, sentences like '*deciduousness* holds of all *vines*' or '*deciduousness* holds of all *fig-trees*' are not 'primary *demonstranda*' – i.e. sentences in which the predicate belongs *primarily* (πρώτῳ ὑπάρχει) to the subject. In *APo* II 18, Aristotle generalises a rule that was already implied in **T41**: it would be wrong to demonstrate a non-primary-universal conclusion such as '*deciduousness* holds of all *vines*' with the λόγος of deciduousness as the middle term. Aristotle begins the chapter affirming that not all scientific problems are explainable directly

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[207] Williams & Charles (2013, pp. 122-124).
[208] Cf. Ferejohn (2013, p. 155), who seems to assume that only the 'canonical' model is essence-based or definition-based, whereas the 'non-canonical' or 'causal' model would at best 'generate definitions.'
[209] See McKirahan (1992, pp. 177-187); Ferejohn (2013, pp. 122-131). Application arguments are called 'type A' syllogisms by Lennox (1987).

by 'atomic' (i.e. immediate) premises (εἰς τὸ ἄτομον μὴ εὐθὺς ἔρχονται, 99^b 7). As we know, demonstrations may be composed of several syllogistic inferences and contain premises that are themselves demonstrable. Therefore, in the deciduousness example, the *first* deductive step of the demonstration (πρῶτον, 99^a 26) – 'first' in the 'analytic' or 'proof-search' order, i.e. from the conclusion to the premises –, subsumes 'vine' under the wider kind 'broad-leaved tree' (ὅτι τοιαδὶ ἅπαντα, 99^a 26-27). Hence, the major premise of this first inference would state a primary-universal *demonstrandum* ('*deciduousness* holds of all *broad-leaved plants*') and only then (εἶτα, 99^a 27) the 'primary middle term' (τὸ πρῶτον μέσον, 99^a 25) – the λόγος of deciduousness – becomes part of the demonstration:

(Extended) Syllogism (X + XIV)

Deciduousness holds of *coagulation of sap*, *coagulation of sap* holds of all *broad-leaved trees*
Deciduousness holds of all *broad-leaved trees*

↑

Deciduousness holds of all *broad-leaved trees*, *Being broad-leaved* holds of *vines*
Deciduousness holds of all *vines*

Not only is the presence of the S-Model in *APo* II 16-17 questionable, but also the A-model appears to serve the purpose of these chapters more successfully. From *APo* II 8, it is clear that Aristotle takes the *definiendum* and the causal part of its *definiens* as coextensive.[210] Thus, if the *explanans* is the causal element in the *definiens* of the *explanandum* attribute, affirmative answers to Q1 and Q2 are mere corollaries of this definitional tie. Moreover, the A-model is part of Aristotle's reply to those willing to take coextensive middle and major terms as reciprocally explanatory (see *APo* II 16, 98^b 4-16): if x is part of the definition of y (and if the definition of y avoids circularity), x and y cannot be mutually explanatory, x being used to clarify what y is, but not vice-versa (see *APo* II 16, 98^b 21-24).

Therefore, at first sight, our problem (2) does not seem to be that challenging (see Section 5.1). At least in *APo* II 16-17 – letting aside the question of whether this is the case in respect of the *APo* as a whole –, Aristotle seems to be committed not to two alternative models of explanation, but only to the A-model. However, this is just an apparent solution. Even if an 'application argument' such as Syllogism X is implied in 98^a 35-^{b}4, Ferejohn is right in recognising

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[210] Or at least within a restricted domain, determined by the minor term. See Barnes (1993, p. 253). The major premises in syllogisms such as XIV and VIII and the corresponding definitions yield this result: every deciduous plant undergoes coagulation of sap (from the definition of deciduousness) and every plant that suffers coagulation of sap is deciduous (major premise of Syllogism XIV).

the presence of the S-Model in the passage (or, at least, some modified version of it). Let us spell this out.

The question of whether or not a predicate holds *primarily* of a given subject (πρώτῳ ὑπάρχει) cannot be decided in purely extensional terms. If the scientist arbitrarily selects a ᾧ αἴτιον-term that counterpredicates with the οὗ αἴτιον-term, the *demonstrandum* does not immediately qualify as a πρῶτον καθόλου problem. In *APo* I 5, 74ᵃ 25-32, Aristotle argues that the mere extensions of the terms involved in a demonstrative syllogism are not enough to warrant its scientific status. Let us say, for instance, that 2R is predicated of two different subjects: a simple one ('triangle') and a disjunctive complex one ('everything that is either equilateral or isosceles or scalene'). The extension of the subject 'everything that is either equilateral or isosceles or scalene' would cover all instances of 2R only 'in number' (κατ᾽ ἀριθμόν, *APo* I 5, 74ᵃ 31): although the disjunction exhausts the desired extension (*extensional* grasp), the objects it denotes are not described as members of a cohesive kind (*intensional* grasp), e.g. *being a triangle*.[211]

This intensional requirement becomes perfectly understandable if we assume that something along the lines of the S-Model underlies the notion of primary-universality. The reason why 'triangle' – and not some other coextensive term – is the proper subject-term for the predicate '2R' may lie with the fact that the definition of triangle plays an important role in explaining the 2R-theorem. Whatever has the attribute 2R has it independently of having two, three or none of its sides equal to one another (i.e. independently of being an equilateral, an isosceles or a scalene figure): a given figure may have the property 2R without being an isosceles (negative answer to Q1), which means that something else in this case must be explanatory.[212] Rather, the demonstration of the 2R-theorem is meant to show how 2R is explanatorily related to a specific property (or cluster of properties) common to all objects that have 2R: being a three-sided rectilinear closed figure, i.e. being a triangle. If being a triangle is actually explanatory of certain figures having 2R, application arguments are not meant to promote minor classificatory adjustments. In fact, Aristotle's vocabulary makes it clear that the kind of upgrade accomplished by arguments such as Syllogism X are truly explanatory rather than merely taxonomic. If, as Aristotle affirms, the triangle has 2R 'not in virtue of something different' (οὐκέτι δι᾽ἄλλο)[213], one may argue that the reason why (αἴτιον) triangles have 2R is not something different from what it is to be a triangle, i.e. the essence of triangle.

If this account is correct, we can say that the S-Model is viable after all. Additionally, a serious objection can be formulated against the A-Model. If the middle term of demonstrative

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[211] Lennox (1987, p. 91).

[212] See Kosman (1973, p. 375); Hasper (2006); Angioni (2014b, pp. 97-98; 2014c; 2016).

[213] *APr* I 35, 48ᵃ 33-36.

syllogisms is always the λόγος of the major term, a phenomenon such as longevity does not seem to be scientifically explainable, or even properly definable. When it occurs in quadrupeds, longevity is explained by absence of bile, whereas its presence in birds is explained by their bodies being dry or something similar. Since one and the same item cannot have two alternative and incompatible definitions, attributes such as longevity would not be scientifically definable or explainable. However, why would Aristotle – who devoted a whole treatise to the topic: *De Longevitate et Brevitate Vitae* – exclude an attribute such as longevity from the scope of science? This question brings us back to our problem (1), raised in Section 5.1. As Aristotle's solution to it sheds some light on (2) as well, I shall first concentrate on (1), which is the topic of our next section.

5.4 - The appearance of 'multiple causes': 'in-a-kind' and homonymous *explananda*.

In order to understand Aristotle's solution to our problem (1), it is worth mentioning some of the views set out in *APo* II. As we have seen in Chapter 2, Aristotle claims that a question of the form 'does P holds of S?' (Q1) is equivalent to 'does P exist?' (Q3.1), whereas a question like 'why does P holds of S?' (Q2) is equivalent to 'what is P?' (Q4.1). We have also seen that Aristotle believes that questions Q1 and Q3.1 are reducible to a question about the existence of a middle term:

(Q1*/Q3*) Is there an M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

On the other hand, we answer questions Q2 and Q4.1 by finding out what that middle term is:

(Q2*/Q4*) What is M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

We have argued that, for Aristotle, asking question Q3.1 – 'Does P exist?' – is equivalent to asking whether there is a middle term M which could be used not only to explain why P belongs to its subject S, but also to formulate a unifying, causal definition of P. Hence, it would be wrong to take question Q3.1 as concerning the mere existence of an attribute. Actually, what is a stake is its existence *as a definable unity* or a *genuine kind*.

That being said, let us analyse the solution Aristotle offers to our problem (1):

> **[T42]** ἔστι δὲ καὶ οὗ αἴτιον καὶ ᾧ σκοπεῖν κατὰ συμβεβηκός· οὐ μὴν δοκεῖ προβλήματα εἶναι. εἰ δὲ μή, ὁμοίως ἕξει τὸ μέσον· εἰ μὲν ὁμώνυμα, ὁμώνυμον τὸ μέσον, εἰ δ᾽ ὡς ἐν γένει, ὁμοίως ἕξει.
>
> You can inquire incidentally both about what is explanatory of and about what is explanatory for – but such things are not thought to count as problems. Otherwise, the middle term will have a similar character – if the items are homonymous, the middle terms will be homonymous; and if

they are in a kind, the middle terms will have a similar character [*APo* II 17, 99ª 4-8; Barnes 1993, with changes].

At least in this context, to investigate something 'incidentally' (σκοπεῖν κατὰ συμβεβηκός, 99ª 5) is to approach a scientific problem inappropriately, as if it were a case of the MC-scenario. If, on the other hand, the scientist investigates something 'non-incidentally', (εἰ δὲ μή, 99ª 6), 'the middle term will have a similar character' (ὁμοίως ἕξει τὸ μέσον).[214] In order to clarify the point, let us consider two syllogisms with non-coextensive extreme terms:

<div align="center">

AaB, BaD   AaC, CaE

AaD   AaE

</div>

Aristotle's examples suggest that the obscure phrase 'ὁμοίως ἕξει τὸ μέσον' refers to two types of apparent (but not real) cases of the MC-scenario – and therefore two apparent (but not real) counterexamples to the validity of UR (99ª 7-15).[215]

- If A holds of D and E *in a kind* (ὡς ἐν γένει), so A holds of B and C *in a kind*.

- If A holds of D and E *as homonymous* (ὁμώνυμα), so A holds of B and C *as homonymous*.

The first of these two situations is exemplified by the following problem: 'why do proportionals alternate?' (99ª 8).[216] Someone may commit the mistake of thinking that the explanation depends on the subjects considered: proportional *numbers* and proportional *lines* 'alternate' for different reasons (see *APo* I 5, 74ª 17-24; I 14, 85ª 36-ᵇ1). Aristotle believes, however, that a single explanation could be reached if numbers and lines were treated as members of a common kind (ὡς ἐν γένει), i.e. not *qua* numbers or *qua* lines, but *qua* items having such-and-such ratio (ἧ δ᾽ ἔχον αὔξησιν τοιανδί, 99ª 10). The mistake consists in 'investigating the ᾧ αἴτιον incidentally': minor terms D and E were mistaken for subjects to which A belongs 'primarily' (πρώτῳ), when in fact D and E are A not in themselves, but as members of a wider-kind F, which is A 'not in virtue of something different' (οὐκέτι δι᾽ἄλλο).[217] If so, the conclusions 'AaD' and 'AaE' can be upgraded, by application arguments, into a single *demonstrandum* with coextensive terms: 'AaF.' Moreover, if two subjects D and E are A 'in a kind', the respective middle terms B and C can also be replaced by a unifying

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[214] I here follow Ross (1949, p. 669), who argues, against most commentators, that 'εἰ δὲ μή' in 99ª 6 means 'if we study *not* κατὰ συμβεβηκός the οὗ αἴτιον or the ᾧ αἴτιον.' I take the future 'ἕξει' as consequential: a scientist who is dealing with an apparent case of the MC-scenario infers that the middle term has 'a similar character' as soon as she starts investigating the problem 'non-incidentally.' For a defence of the common reading, see Hasper (2006, p. 268).

[215] In *APo* II 17, 99ª 4-8, Aristotle also mentions a third case: explanations 'by analogy' (κατ᾽ ἀναλογίαν). Analogical explanations are neither about one attribute predicated of two subjects of the same kind, nor about two different attributes called by the same name (see Ross 1949, p. 670). The terms 'bone' and 'fish-spine' refer to quite different things, which nonetheless play the same function in the animals in which they are found (*APo* II 14, 98ª 20-23). These *explananda* do not threat the validity of UR as homonymous *explananda* do, which explains why Aristotle mentions them very briefly without a proper discussion. See *APo* II 14, 98ª 20-23.

[216] That is to say: 'why is the case that if W is to X as Y is to Z, then W is to Y as X is to Z?' See Ross (1949, p. 525).

[217] *APo* I 5, 74ª 25-32; cf. I 2, 71ᵇ 9-12

middle term G: ὁμοίως ἕξει τὸ μέσον. For instance, deciduousness belongs to vines and fig-trees 'in kind' (ὡς ἐν γένει). Hence, we should obtain a primary-universal *demonstrandum* in the major premise of an application argument such as Syllogism X before trying to propose a unifying explanation for the major term 'deciduousness.' Thus, any causal story about vines being deciduous that does not work for fig-trees as well can and should be improved by a wider explanation covering all instances of deciduousness (i.e. all broad-leaved trees), like in Syllogism XIV. Therefore, the violation of UR is merely apparent.

However, not only the ᾧ αἴτιον but also the οὗ αἴτιον-term can be investigated 'incidentally' (σκοπεῖν κατὰ συμβεβηκός, 99ᵃ 5). In this case, a scientist may falsely believe that the conclusions 'AaD' and 'AaE' fall into the MC-scenario not because she did not realize that D and E are subspecies of a common kind F, but because D and E appear to be subjects of the same attribute, whereas in fact 'A' is an ambiguous term and holds of D and E *homonymously*. In the *Categories*, Aristotle defines homonymy as follows: 'when things have only a name in common and the definition of being which corresponds to the name is different, they are called *homonymous*' (*Cat.* I 1, 1ᵃ 1-2).[218] Aristotle's notion of homonymy is not that of equivocality or ambiguity, though the former may be derived from the latter. Homonymy is a property of things in relation to a certain expression, while equivocality (or ambiguity) is a feature of the expressions themselves.[219] Two subjects D and E are homonymous in relation to a certain expression 'A' when 'A' applies to both of them but each application is associated with different definitions of 'A'. Consequently, 'A' must be an ambiguous word if it applies homonymously to D and E.

However, homonymy can obtain at different levels.[220] In cases of what has been called 'strong homonymy', the expression 'A' has associated with it totally unrelated definitions, as when we apply the word 'bank' to disparate types of thing such as a riverbank and a financial institution.[221] On the other hand, 'weak homonymy' occurs when the distinction between the different definitions of 'A' is more subtle. In this case, the two homonymous items D and E may share a property in virtue of which they are both called 'A' and consequently the corresponding definitions may also have something in common – though the complete definitions must obviously remain distinct if weak homonymy is to be case of homonymy at all.[222] Aristotle's example in *APo* II 17 suggests that he has in mind this second and weaker kind of homonymy: 'similar' signifies different things when applied to figures and colours (*APo* II 17, 99ᵃ 11-15). Between figures, similarity means 'having proportional sides and equal angles' (99ᵃ 13-14), while between colours it means 'the fact

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[218] Ackrill's translation (1963).
[219] See Ackrill (1963, pp. 71-72).
[220] For a systematic discussion of those different levels, see Shields (1999).
[221] See Wedin (2000, p. 13).
[222] See Wedin (2000, pp. 13-14). See Zingano (2013), for a detailed discussion of what he calls 'attenuated homonymy'.

that perception of them is one and the same' (99ª 14-15). Hence, figures and colours are homonymous in relation to the expression 'similar' and hence 'similar' is an equivocal term. However, there is no equivocality at the level of ordinary parlance, since the word currently means, regardless the items it applies to, a likeness or resemblance of a certain sort. Therefore, similarity is a case of weak homonymy.

Scientific definitions are explanatory and involve more than a brief account of the current meaning of the *definiendum* term. At a scientific level of analysis, similarity in figures and in colours relates to very different sets of truth-conditions and explanatory factors. Thus, part of the process of defining something in contexts of weak homonymy is to realize that there is no single attribute to be defined (similarity without qualification), with two (or more) competing explanatory accounts, but actually two (or more) different attributes (similarity in figures and similarity in colours) with their own definitions and explanations. Apparently, the same diagnosis applies to the case of longevity.[223] Aristotle believed that the phenomenon of longevity is realized in very different manners depending on the group of living-beings considered, in such a way that it becomes impossible for us to come up with a single explanation for all its instances.[224] Being long-lived for a quadruped is so different from what being long-lived is for birds that we have different middle terms for the major 'longevity' in each case: 'absence of bile' and 'being dry' respectively. If the middle term is the causal part of the definition of the major, the term 'longevity' gets one definition when predicated of quadrupeds and another when predicated of birds. Therefore, longevity holds of quadrupeds and birds homonymously. Consequently, the respective middle terms 'absence of bile' and 'being dry', as long as they refer to very distinct ways of being long-lived, also have 'longevity' predicated of them in the respective major premises homonymously: ὁμοίως ἕξει τὸ μέσον.

Again, this reasoning does not entail that 'longevity' is equivocal at the level of ordinary language. Rather, homonymy comes up only when we find out that there is no such thing as *longevity without qualification* that could be object of scientific definition. Rather, what can be defined in a scientific way are quite distinct attributes: *longevity-for-quadrupeds* (or *Q-longevity*) and *longevity-for-birds* (or *B-longevity*):

> *Q-longevity* is(df.) quadrupeds living long because of absence of bile.
> *B-longevity* is(df.) birds living long because of their bodies being dry.[225]

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[223] I am indebted to Lucas Angioni and David Bronstein on this point.
[224] See *Long.* 1, 464ᵇ 22-464ᵇ 25; 4, 466ª1- 466ª 8.
[225] These definitions avoid circularity precisely because the *definienda* are specific kinds of longevity, 'living long' being an expression that accounts for what Q-longevity and B-longevity have in common (since this is not a case of strong homonymy).

If this interpretation is correct, longevity is not an *explanandum* that fails to satisfy UR. What appears to be a single *explanandum* attribute at the level of ordinary language gives way to two different attributes (*Q-longevity* and *B-longevity*), each of which holds of its subject (quadrupeds and birds) *primarily* (πρώτῳ) and relates to one single item as its proper explanation (absence of bile and dryness respectively). If so, what appears to fall into the MC-scenario is actually an instance of the OC-scenario. Once we restrict the domains of the demonstrations in order to disambiguate the major term, what appeared to exemplify the MC-scenario turns out to be a case of the OC-scenario and no longer threatens the validity of UR.

In other words, *longevity* (without any disambiguation) does not exist *as a definable unity* or a *genuine kind*, but *Q-longevity* and *B-longevity* do. As Aristotle makes it clear since the beginning of *APo* II, when a scientist attempts to define an attribute such as longevity, she does not seek for a vague and abstract account of the term 'longevity' covering its (standard) uses in ordinary speech. Rather, she is interested in knowing whether these uses refer to a single homogenous phenomenon, i.e. whether they are all associated with one and the same underlying cause. If not, it is possible to look for unifying causes in more restricted domains than the one assumed in ordinary language. In this case, either there will not be restricted domains in which UR is satisfied (and the phenomenon is not scientifically explainable) or the scientist will find herself dealing with several scientific *explananda* – instead of just one as everyday discourse makes it appear.

Now, I shall explain how this picture invites us to pursue a conciliatory solution to our problem (2).

5.5 - A Conciliatory Solution

As we have seen in *APo* II 16, 98[b] 21-24, the priority of the *explanans* over the *explanadum* is illustrated in terms of an asymmetric relation of definitional dependence: *thunder* (the *explanandum* attribute) cannot be defined without mentioning *extinction of fire* (*explanans*), whereas *extinction of fire* can be defined without mentioning *thunder*.[226] However, definitions of attributes contain reference not only to its *explanans* (e.g. extinction of fire), but also to its proper subject (e.g. clouds). *Thunder* cannot be defined without mentioning *clouds*, but *clouds* can be defined without reference to *thunder*. Can this definitional priority of subjects tell us something about the role their essences play (if any) in Aristotelian demonstrations?

In Chapter 4, we have seen that, for Aristotle, definitions of attributes (i.e. non-substantial beings) must somehow account for their status as dependent entities.[227] That is to say,

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[226] The example in the passage is the lunar eclipse, but the two cases are strictly parallel.
[227] *Metaph.* VII 1, 1028[a] 35-36; VII 5, 1030[b] 23-24; *APo* I 4 73[a] 37-[b]5; II 2, 90[a] 14-18; II 10, 93[b] 38-94[a] 7.

ontological priority of subjects over their attributes would have definitional priority as its linguistic counterpart. We have also argued, following Peramatzis (2011), that the 'real' or 'metaphysical' correlate of definitional priority (PID) should be understood as PIB. An attribute P (a non-substance entity) is ontologically dependent on the relevant subject S (*per se₃* being, i.e. a substance or substance-like entity) in the sense that P does not have the essence it has (i.e. cannot perform the *way of being* that distinguishes it as such) independently of S having the essence it has.

The way Aristotle deals with problem (1) corroborates this approach. After all, his solution involves arguing that a single term 'A' may stand for two (or more) different attributes, with different causal definitions, depending on the subjects of which it is predicated. In other words, attributes are not what they are and do not get the definitions they get independently of the subjects to which they belong *primarily*. Their identity is partially fixed by these subjects, on which their status as definable unities ultimately depends. For that reason, the definitions of *Q-longevity*, *B-longevity* and deciduousness should mention quadrupeds, birds and trees respectively. If quadrupeds were not the sort of animals they are, their longevity would not have absence of bile as its primary explanation (and, consequently, as the causal part of its definition). Similarly, if broad-leaved plants had not the essences they have, they would not undergo coagulation of sap, which is the process that makes deciduousness the unified phenomenon it is. Therefore, given that the essence of subjects is prior to the essence of attributes, guaranteeing a place for the definitions of attributes in demonstrative sciences and denying one for the definitions of their proper subjects seems, at best, uncongenial to Aristotle's philosophy.

In fact, the structure of demonstrations allows definitions of subjects (as much as definitions of attributes) to play the role of explanatory middle term. As we have seen in our analysis of *APo* II 17, 99ᵃ 16-9, a complete demonstration may have the form of an extended argument with several syllogistic inferences. Moreover, the passage is also clear that it is not in every deductive step that the middle term is the λόγος of the major term. The demonstration may involve (as it does when it contains application arguments) further syllogistic steps in which the middle term is not definitionally connected to the major. In Syllogism XIV, for instance, the definitional connection between *coagulation of sap* and *deciduousness* makes the major premise 'immediate'.[228] Nevertheless, the relation between *coagulation of sap* and *broad-leaved tree* in the minor premise remains demonstrable. Therefore, in a complete demonstration, this branch of the demonstration would go on until it reaches a middle term 'immediately' connected to *broad-leaved tree*, i.e. the λόγος of *broad-leaved tree*. Otherwise, the demonstration would proceed *ad infinitum*, since it would always

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[228] This result follow if we apply to the deciduous example what Aristotle says about the syllogism of the lunar eclipse in *APo* II 8, 93ᵃ 35-36.

contain at least one demonstrable premise (as we have seen in Chapter 3). If this is how a complete demonstration of the phenomenon of deciduousness should be, the pieces of textual evidence in favour of the A- and the S-Model are not incompatible, but complementary.[229]

The same pattern holds true *mutatis mutandis* for other examples. In the major premise of Syllogism VIII, *thunder* is said to follow the causal part of its definition, namely, *extinction of fire*. The minor premise, in turn, introduces a new *demonstrandum*: why do clouds undergo extinction of fire? *Extinction of fire* is what explains why *thunder* holds of *clouds* 'non-incidentally', i.e. why there is a regular connection between *thunder* and *clouds*. However, this could hardly be the case if *extinction of fire* were 'incidentally' connected to *clouds*. Thus, it would not be surprising if the nature of clouds were what directly or indirectly explains why, under certain conditions, fire is regularly extinguished in them. In other of Aristotle's favourite examples, the occurrence of the *lunar eclipse* in the *moon* is explained by the middle term *earth screening* (see *APo* II 8, 93^b 3-7). Whereas the connection between *eclipse* and *earth screening* (the causal part of its definition) is 'immediate' (93^a 35-36), the link between *earth screening* and *moon*, on the other hand, requires further explanation. According to Aristotle's cosmology, having the earth interposed between it and the sun is due to the location of the moon in the system of celestial spheres combined with its natural movement, which the philosopher would probably take either as essential to the moon or as features following from its essence.

Finally, a combination of the A- and the S-Model is especially attractive in contexts of weak homonymy. In the major premise of Syllogism XII, for instance, the middle term *absence of bile* and the major *longevity* (which here stands for *Q-longevity*) are definitionally connected, whereas the connection between *absence of bile* and *quadrupeds* requires further premises in order to be fully understood. According to Aristotle, bile is a residue of impure blood that affects the conditions of the liver, which is a vital organ to quadrupeds in virtue of their being essentially blooded animals.[230] Therefore, in an extended version of Syllogism XII, absence of bile in quadrupeds may be explained, directly or indirectly, by one or more of their essential features.

This new perspective also corroborates our analysis of the intensional aspect of primary-universality. As we have seen, a disjunction of all deciduous trees ('everything that is vine or fig trees or oak ....'), despite covering (extensionally) the desired domain, would not work (intensionally) as a minor term in a primary-universal demonstration. The reason is the following: the essence or *way of being* on which the essence of *deciduousness* depends is the one picked up by the definition of *broad-leaved tree*. In other words, what ultimately explains why coagulation of the sap

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[229] This solution has been recently defended, with different arguments, by David Bronstein (2016a, pp. 48-51).
[230] *PA* IV 2, 677^a 30-677^b 10. In this passage, Aristotle mentions very specific kinds of quadrupeds (and also dolphins). On the inadequacy of Aristotle's example, see n. 200 above. Nevertheless, we believe the philosophical point we attribute to him remains solid.

occurs to all deciduous trees is the essence displayed by a definition whose *definiendum* is neither 'vine' nor an exhausting disjunctive term, but 'broad-leaved tree'. For the same reason, we cannot explain why 'all isosceles triangles have 2R' with the definition of 2R as the middle term without first subsuming 'isosceles triangle' to the wider term 'triangle.' 'Triangle' is the sole term apt to occur as subject in the primary-universal *demonstrandum* because what is part of the demonstration of the 2R-theorem is the definition of triangle, not the definition of any of its subspecies.

Ferejohn (2013, p. 151) rejects this kind of conciliatory solution on the grounds that it does not get support from Aristotle's texts. He argues that the philosopher never combines Syllogisms XIV and XV to formulate a complete demonstration, and this is what we would expect him to do if the S-Model and the A-Model were complementary to each other. However, Aristotle's aim in *APo* II 16-17 is to deal with problem (1), whose formulation and solution is under the influence of what can be taken as the main topic of *APo* II: the isomorphism between definitions and syllogistic demonstrations. Aristotle's favourite examples of this phenomenon are attributes or processes such as thunder, eclipse, and deciduousness. For that reason, the essence of attributes is under the spotlight, which explains why the A-Model stands out in comparison to the S-Model. Problem (2), on the other hand, does not seem to bother Aristotle, which suggests he endorsed both models as parts of the same coherent doctrine. We have tried to show how his own solution to problem (1) leads to the same result.

CHAPTER 6

COMING TO KNOW THE ESSENCE OF SUBJECTS

6.1 – The Essence of Subject-Kinds: An Exception?

The different aspects of Aristotle's theory we have discussed in Chapters 3, 4, and 5 point to the same result: the S-Model and the A-Model are not antagonistic patterns of explanation; actually, the philosopher seems to endorse both of them as parts of the same coherent doctrine. The 'primary middle term' of P belonging to S – let it be 'M' – is the causal part of the definition of P (following the A-Model). However, the causal-definitional relation between M and P does not take place independently of S being what it is, since the identity of demonstrable attributes is partially fixed by their proper subjects – as becomes clear once we examine, for instance, cases of homonymy. The consistency and regularity that make P a demonstrable attribute of S (and, therefore, a genuine kind) depends on there being a more or less close connection between M (the causal part of the definition of P) and the essence of S, which will appear as a middle term at some point of the demonstration (in accordance with the S-Model). Consequently, a scientist does not have scientific knowledge of S being P – at least, not in the full sense of the term – if she does not know the essence of S. But how do scientists come to know the essence of subjects?

It is time for us to address a problem we raised in Chapter 2. As we have seen, according to *APo* II 1-2, scientists investigate four kinds of question:

(Q1) Does P belong to S?

(Q2) Why does P belong to S?

(Q3) Does S exist?

(Q4) What is S?

Questions Q1 and Q2 concern the occurrence of an attribute in a given subject, whereas questions Q3 and Q4 concern the existence and essence of subject-kinds. In the order of inquiry, Q1 and Q3 are prior to Q2 and Q4, respectively. We cannot investigate *why* S is P (Q2) unless we already know *that* S is P (Q1). Similarly, it is not possible to determine *what* S *is* (Q4) without knowing in advance that S *exists* (Q3).

We have argued that the distinction between subjects and attributes in *APo* II 1-2 should not make us think that questions about existence (like Q3) and essence (like Q4) are exclusive to subjects. Actually, the existence of an attribute P can be analysed as a predicative relation between P and its subject S. The essence of P, in turn, can be identified with the reason why S is P – as we can see in our **T7**, *APo* II 2, 90^a 14-18. In addition, answering the question about the existence of P, understood as a question about its presence in a subject S, is the same as determining whether there is a middle term M explaining why P belongs to S. Finding out what P is, on the other hand, is the same as identifying M:

$$(Q1) \text{ Does P holds of S?}$$
$$\equiv$$
$$(Q3.1) \text{ Does P exist?}$$
$$\equiv$$
$$(Q1^*) \text{ Is there an M such that PaM, MaS} \vdash \text{PaS \& M is the reason why PaS?}$$

$$(Q2) \text{ Why does P holds of S?}$$
$$\equiv$$
$$(Q4.1) \text{ What is P?}$$
$$\equiv$$
$$(Q2^*) \text{ What is M such that PaM, MaS} \vdash \text{PaS \& M is the reason why PaS?}$$

These equivalencies reflect two correlate theses we have attributed to Aristotle. The first of them is the interdependence between noetic and demonstrative knowledge, as argued in Chapter 1. Full-fledged demonstrative knowledge of a conclusion **c** requires noetic knowledge of the immediate premises $\mathbf{p_1} \ldots \mathbf{p_n}$ from which **c** is demonstrated. On the other hand, acquiring noetic knowledge itself requires some demonstrative practice: to know a first principle $\mathbf{p_i}$ as such involves realizing (i) that there are propositions (such as **c**) that can be demonstrated from $\mathbf{p_i}$ and (ii) that there are no propositions from which $\mathbf{p_i}$ can be demonstrated. The second thesis is closely related to the first: the interdependence between defining and explaining, as discussed in Chapter

2. Definitions (objects of noetic knowledge) become known *as such* insofar as they are seen as explanatory of demonstrable propositions (objects of demonstrative knowledge). After all, definitions are 'revealed' by demonstrations (*APo* II 8, 93ᵇ 17-18) and in fact are described by Aristotle as demonstrative syllogisms 'differing in arrangement' (*APo* II 10, 94ᵃ 2). The interdependence between noetic and demonstrative knowledge, defining and explaining, helps us understand the equivalencies between Q1, Q3.1, and Q1*, on one hand, and Q2, Q4.1, and Q2*, on the other. Acquiring noetic knowledge of the essence of P requires the ability to explain, in a demonstrative syllogism, why P belongs to its subject S. For instance, we grasp the complete definition of thunder – thunder is(df.) noise of fire being extinguished in the clouds (*APo* II 10, 94ᵃ 5-6) – when we discover a middle term that can be used to explain why the noise we call 'thunder' is predicated of clouds. To know that there is such a middle term (Q1*) is to know that 'thunder holds of clouds' is a demonstrable proposition (Q1) and that thunder *exists* as a genuine kind (Q3.1) – i.e. that it happens with the kind of regularity that implies an underlying causal factor. When we find out what that causal factor is (Q2*), we grasp at once the reason why thunder occurs to the clouds (Q2) and the essence of thunder (Q4.1).

What about subjects? How should scientists investigate Q3 and Q4? One reaction to this question is to affirm that subjects and their essences constitute an exception to the interdependence between defining and explaining. The following passage may suggest that Aristotle himself admits such an exception:

> **[T43]** Ἔστι δὲ τῶν μὲν ἕτερόν τι αἴτιον, τῶν δ᾽ οὐκ ἔστιν. ὥστε δῆλον ὅτι καὶ τῶν τί ἐστι τὰ μὲν ἄμεσα καὶ ἀρχαί εἰσιν ἃ καὶ εἶναι καὶ τί ἐστιν ὑποθέσθαι δεῖ ἢ ἄλλον τρόπον φανερὰ ποιῆσαι (ὅπερ ὁ ἀριθμητικὸς ποιεῖ· καὶ γὰρ τί ἐστι τὴν μονάδα ὑποτίθεται, καὶ ὅτι ἔστιν)· τῶν δ᾽ ἐχόντων μέσον, καὶ ὧν ἔστι τι ἕτερον αἴτιον τῆς οὐσίας, ἔστι δι᾽ ἀποδείξεως, ὥσπερ εἴπομεν, δηλῶσαι, μὴ τὸ τί ἐστιν ἀποδεικνύντας.
>
> Of some things there is something else which is their explanation, of others there is not. Hence it is plain that in some cases what something is is immediate and a principle in relation to which we must assume or make clear in some other way both that the thing exists and what it is. (Arithmeticians do this: they suppose both what a unit is and that there are units.) But in cases where there is a middle term and something else is explanatory of its being, you can – as we have said – show what something is through a demonstration without demonstrating what it is [*APo* II 9, 93ᵇ 21-28; Barnes 1993, with changes].[231]

Here Aristotle affirms that only the essence of things 'whose cause is something else' is made clear through demonstrations. Some interpreters claim that **T43** is meant to show that the

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[231] Deleting Ross' comma in 93ᵇ 22, which implies that only definitions of things 'whose cause is not something else' are immediate and principles.

interdependence between defining and explaining holds good for the essence of processes and attributes such as thunder and eclipse, but not the essence of substances such as human beings or broad-leaved plants.[232] David Bronstein, for instance, argues that the essence of attributes are 'causally complex', having a structure of the form 'A holds of C because of B' – e.g. the being of thunder can be reduced to a predicative relation between two items (noise and clouds) caused by a middle term (extinction of fire).[233] Because of their causally complex structure, the essences of attributes are isomorphic to syllogistic demonstrations. On the other hand, claims the author, the essences of subjects are 'causally simple'. Their structure is a combination of genus plus differentiae, which can be known by division and induction independently of explanatory connections between the elements in the *definiens*.[234]

I believe this interpretation, although attractive, is mistaken for the following reasons. First, **T43** is not conclusive on the issue. It is far from clear that Aristotle is interested in the distinction between subjects and attributes in this passage. Strictly speaking, the distinction is between items whose definition is isomorphic to a demonstration, because their cause is 'something else', and items whose definitions are 'assumed' (the verb in 93ᵇ 23 is 'ὑποθέσθαι') or 'made clear in some other way'. It is not clear what it means to say that an item has 'something else' as its cause. But it is even less clear that Aristotle's intention is to affirm that attributes have 'something else' as their causes, while substances do not. As Ross (1949, p. 633) notes, the example of something whose cause is not 'something else' – the unit (τὴν μονάδα) – is not strictly speaking a substance. Moreover, we do not have an example of something whose cause is 'something else' in *APo* II 9. Even if we take the main examples from the previous chapter (thunder and eclipse) as beings whose cause is 'something else' (which I think is correct), nothing in the text suggests that this class of things does not include substances. Quite on the contrary, if we are allowed to take the examples from *APo* II 8 into account, we must notice that 'human' and 'soul' are also examples found in the chapter (93ᵃ 22-24), which suggests that the isomorphism between definition and demonstration applies to substances as well.[235]

However, the main reason to reject the view that the essence of subjects constitute an exception to the interdependence between defining and explaining comes from *APo* II 2. As we have seen in Chapter 2, Aristotle affirms that Q3 – Does S exist? – and Q4 – What is S? – are also answered by investigating a middle term (*APo* II 2, 89ᵇ 37-90ᵃ5). What does it mean if not that the

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[232] Ross (1949, p. 633); Bronstein (2016a, pp. 131-143).
[233] See Bronstein (2016a), Chapter 7, 9, and 10.
[234] See Bronstein (2016a), Chapter 9 and 12. Nevertheless, Bronstein claims that the knowledge of a definition, if acquired only by induction and division, is 'non-noetic'. According to the author, we acquire noetic knowledge of the definition of a subject-kind when we are able to use its definition to explain its demonstrable attributes.
[235] See Peramatzis (2011, p. 11). In addition, I shall argue that even in the case of items whose cause is not something else (e.g. unit) there is a sense in which defining and explaining remain interdependent practices.

essence of subjects are somehow revealed by demonstrations? Nevertheless, as we have discussed, one could argue that Aristotle's own theory gives him reasons to exclude subjects from the picture advanced in *APo* II 2: the existence of subjects cannot be reduced to their presence in a more basic entity; if the existence of S cannot be spelled out in terms of a predication in which S occurs as an attribute, it would not make sense to seek for a middle term when the essence of S is being investigated. However, this is not Aristotle's view. In *Metaph.* VII 17 and VIII 2-4, the philosopher explicitly claims that the model presented in the *APo* also works for subject-kinds. Before we see how Aristotle applies his model to substances as well, let us address the theoretical resource that allowed him to do so: the hylomorphic analysis.

6.2 – The Hylomorphic Analysis

In the *Categories*, Aristotle affirms that one of the most distinctive features of particular substances is their capacity to receive contraries while remaining numerically one: one and the same man can be pale at one time and dark at another, and hot and cold, and good and bad etc. (*Cat.* 5, 4^a 10-22). Already here we can have a rough idea of how Aristotle thinks change should be described: a subject x which is not-F (at instant t^1) becomes F (at instant t^2). However, the issue receives the careful discussion it deserves only in *Ph.* I 6-8. Aristotle affirms that the process of an unmusical man becoming musical can be described in the following ways (*Ph.* I 7, 189^b 35-190^a 1):

1. The man comes to be musical.
2. The unmusical comes to be musical.
3. The unmusical man comes to be a musical man.

The three sentences contain one subject- and one predicate-term. In sentence 1, the subject-term refers to the subject of change, whereas in 2 and 3 it denotes the *terminus a quo*, the state of the subject before the process begins. In all of them, the predicate-term captures the *terminus ad quem*, the final result of the process.[236] The distinction between these three sentence-patterns relies on the use of 'simple' terms (ἁπλᾶ), such as 'man' and 'musical', or 'compound' (συγκείμενα) expressions, such as 'musical man'.[237] The fact that each of them contains one subject- (simple or complex) and one predicate-term (simple or complex) should not let us think that there are only two items involved in the process. In this context, the expressions 'the man' and 'the unmusical' should *not* be interpreted as definite descriptions refereeing to one single being. Actually, these expressions designate two different entities: a substance (the man) and what has been described as

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[236] For this vocabulary and its use in this context, see Charlton (1992); Angioni (2007c, pp. 58-64; 2009).
[237] *Ph.* I 7, 189^b 33; 190^a 1-5. See Angioni (2009, pp. 145-16).

an 'accidental compound' (man plus unmusicality).[238] Although 'numerically one', these entities are different 'in form' (190ª 16). In other words, 'the being of man is not the same as the being of the unmusical' (190ª 17), which means they have different essences and are therefore defined in different ways (*Ph.* I 7, 190ª 15-16).[239] Thus, the man and the unmusical (the latter being understood as accidental compound) are the same only 'by accident': even if, in a particular context such as the initial state of the change, we cannot count them as two discrete wholes (which makes them, in a sense, 'numerically one'), they *do not* share all properties in all contexts.[240] In fact, Aristotle wants to stress one specific difference between them: the man persists through the change, while the unmusical do not – i.e. by the time the man becomes musical, the accidental compound man-plus-unmusicality ceases to exist.[241] As a result, three elements are involved in the process: the man, the musical and the unmusical. In fact, this is the main outcome of Aristotle's discussion in *Ph.* I: any change involves a subject that persists through the process and a pair of contrary attributes, these three items being the 'principles' (ἀρχαί) of nature and natural change.

Although the example discussed in the first half of in *Ph.* I 7 is a case of what Aristotle calls 'alteration' (ἀλλοίωσις), the philosopher makes it clear that this formula captures what is common to all kinds of change (*Ph.* I 7, 189ᵇ 30-32). However, substances cannot play the role of subject in all of them. Suppose we are interested in describing a particular substance coming into being or going out of existence. In that case, the underlying subject *x* cannot be the substance itself, nor can the contraries F and not-F be the substance's existence and nonexistence, for the underlying subject must persist through the process (see Lewis 2009, p. 163). In the second half of *Ph.* I 7 (190ᵇ 1 ff.), Aristotle addresses the issue by comparing natural substances to products of craft. When a bronze statue is produced, the bronze – which is present at the beginning of the process, persists through it, and constitutes its product – is called 'matter' (ὕλη); the final arrangement that makes the statue what it is is the 'form' (εἶδος); at last, there is the 'absence of form' (ἀμορφία), the 'shapelessness' (ἀσχημοσύνη) and 'disarray' (ἀταξίαν) found in the bronze before the process begins (*Ph.* I 7, 190ᵇ 13-17).

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[238] For a detailed defence of this reading, see Lewis (1982). While Lewis argues that this is Aristotle's canonical use of expressions such as 'the unmusical [thing]', I prefer to restrict my claim to the context of *Ph.* I 7 – although I recognize that this is not the only place where these expressions refer to an accidental compound (substance plus accident).
[239] Cf. Lewis (1982, pp. 15-18).
[240] See *Top.* I 7, 103ª 23-32. For a comparison between accidental sameness and sameness 'in essence' and 'being', see *SE* I 24, 179ª 37-39; *Ph.* III 3, 202ᵇ 14-16. See Code (1976, p. 364), who argues that 'to say that the man and the unmusical are one in number at any given time is that the latter is a spatio-temporal segment of the former and they are taking up the same space right now – or to use Aristotle's phrase (190ᵇ 18-19, 26-27, 192ª 31-32), the one coincides in the other.'
[241] See *Ph.* I 7, 190ª 9-21. Aristotle affirms that both the accidental compound and the contrary attribute (unmusicality) go out of existence (190ª 11-13, 18-20).

One may think that this picture does not apply to natural substances as easily as we may think at first sight. We know the form is the factor that, once instantiated in a given portion of matter, makes the resulting hylomorphic compound what it is. However, Charlton (1992, p. 76) points out that we can describe a dog coming into being either (i) as a seed (matter) being fertilized in a certain way (form) or (ii) as flesh, bones, etc. (matter) being animated or having a certain kind of life (form). In both cases, the matter does not seem to persist through the process.[242] If we follow the first alternative, the seed is not a constituent element of the final product.[243] In the second alternative, flesh, bones and organs are not given at the beginning of the process. Therefore, the matter cannot be at the same time the item *from which* and *of which* the compound is made.

However, in *Ph.* I 7, 190ª 5-13, Aristotle says that a natural way to rephrase sentence 2 – 'the unmusical comes to be musical' – is the following:

2*. The musical comes to be *from* (ἐκ) the unmusical.

On the other hand, sentence 1 – 'the man comes to be musical' – cannot be translated as:

1*. The musical comes to be *from* (ἐκ) the man.

In other words, the preposition 'ἐκ' should be reserved for the non-persisting element, i.e. the unmusical (*Ph.* I 7, 190ª 7-13). Nevertheless, in *Ph.* I 7, 190ª 21-30, Aristotle admits that in some changes the product is said to come *from* the persisting element. That is, in natural language, we can say things such as:

4. The statue comes to be *from* (ἐκ) bronze.

Commenting on the passage, Alan Code (1976, pp. 359-362) persuasively argues that Aristotle wants to avoid the following confusion: because the statue is said to come *from* the bronze in the same way as the musical is said to come *from* the unmusical, we may think that the bronze, like the unmusical, does not persist through the process.[244] Aristotle explains that sentences like 4 are acceptable in natural language only because, in these cases, the non-persisting element is 'nameless' – e.g. there is no name for the configuration of the bronze before it receives the form of a statue (see *Metaph.* VII 7, 1033ª 5-23). However, we should avoid using these sentences 'without qualification'[245] precisely because they give the wrong impression that the matter does not persist through the process described. Therefore, when Aristotle says that an animal comes to be *from* (ἐκ)

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[242] For this and other related difficulties, see Ackrill (1997, pp. 169-178). See also Angioni (2007c, pp. 64-67).
[243] See *GA* II 3, 736ª 24 ff.
[244] See Furth (1988, p. 217); Angioni (2009, pp. 151-155).
[245] *Metaph.* VII 7, 1033ª 19-22. The 'qualification' required, explains Code (1976, p. 363), is that the sense of 'from' used in 4 does not imply that the item 'from which' the final product comes perishes in the process.

the seed (*Ph*. I 7, 190ᵇ 4-5), he must be using the preposition in the canonical sense. If so, we can rule out Charlton's option (i): even if the seed initiates the process of a man coming into being, we cannot say that the seed is the man's 'matter', and hence we should not expect it to be one of his constituent elements.[246]

On the other hand, how could we say that flesh, bones, organs etc. are the man's 'matter' – Charlton's option (ii) – if they are not given before the process begins? Interpreters solve this difficulty by unpacking the steps involved. Alan Code summarizes Aristotle's account of the generation of human beings:

> What a man is made of is flesh and bones since the primary nutrient (the menstrual fluid) is converted into flesh upon fertilization, the flesh is converted into a heart, and then through the successive stages of development and growth explained in the second book of the *Generation of Animals* a human being finally comes to be [Code 1976, p. 364].[247]

Since the generation of a man is complex, we should not expect all his material constituents to be present at the very first stage of the process. Nevertheless, the account of change proposed at *Ph*. I 7 remains solid. At each step, it is possible to identify a pair of contrary attributes and an underlying matter that persists through it. However, as Angioni (2007c, pp. 68-87) points out, one thing is to be an underlying matter at some point of the process, and another is to be the 'proper' matter of the final product.[248] All the different portions of matter that suffer alterations during the generation of a man should be taken into account when the process itself is the *explanandum*. However, only the matter that underlies its final stage and remains as a constituent element of its product is useful to explain the basic properties of the generated human being. After all, as we shall see in the next section, to find out the cause in virtue of which this 'proper' matter constitute a human being is the same as discovering the essence of human beings.

6.3 – The *Analytics*-model in the *Metaphysics*

In this section, we shall analyse how Aristotle, in the *Metaphysics*, applies to subject-kinds the model developed in the *Analytics*. However, before we start, a couple of comments on our strategy might be required. One could object that the idea that sensible substances can be analysed as compounds of form and matter is not present in the *APo* and was developed in later treatises such as the *Physics* and the *Metaphysics*. If so, we should not rely on Aristotle's

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[246] Code (1976, pp. 364-366) quotes *GA* I 18, 724ᵃ36 ff. to argue that when Aristotle says that a man comes to be *from* semen or an embryo (see *Ph*. I 7, 190ᵇ 4-5), he means that this is his efficient cause. See also *Metaph*. VIII 4, 1044ᵃ 35.
[247] See also Furth (1988, pp. 111-113).
[248] 'Not fire or earth, but the matter proper to the thing' (*Metaph*. VII 4, 1044ᵇ 1-2).

hylomorphism to sustain that the essence of substances are also known through demonstrations.[249] However, why should we think that the only reason Aristotle had for not presenting his hylomorphism in detail in the *APo* is that his theory was not completely developed by the time the treatise was written? The theses advanced in the *APo* are meant to apply to all sciences independently of their particular domains. Hence, the peculiarities of physical objects should not affect Aristotle's main claims in the treatise. Of course, that does not mean Aristotle is never interested in topics that are characteristic of natural sciences. In *APo* II 11, for instance, he discusses one of the best-known doctrines of his philosophy of nature: there are four canonical types of explanation in the natural world, the material, the formal, the efficient, and the final.[250] All this shows that even if Aristotle is not primarily concerned with physical phenomena in the *APo* – which explains why we do not find there a detailed defence of his hylomorphism –, there is no reason to doubt that he already had consolidated views on the metaphysical structure of the natural world. More importantly, there is a simpler reason to believe that at least some aspects of Aristotle's hylomorphism are assumed in the *APo*: such a hypothesis has a greater explanatory power than its alternative. As explicitly stated in *APo* II 2, the essence of subjects is discovered when a middle term is identified. In addition, as we have seen, two of the examples provided in *APo* II 8 are substances (93ᵃ 22-24), which suggests that defining and explaining are interdependent practices even for subject-kinds. If it was not for all that, one could say that the reappearance of the 'interdependence' thesis in *Metaph.* VII 17 and VIII 2-4 should be ignored by interpreters of the *APo*. However, given this scenario, the fact that Aristotle actually uses the *Analytics*-model in the *Metaphysics* provides further corroboration for our strategy instead of undermining it.

That being said, we can turn to *Metaph.* VII 17. As we have seen, to ask whether the kind thunder exists is the same as asking whether a certain noise occurs in the clouds. However, this question should not be interpreted as concerning an episodic event. Rather, what is being sought is the existence of a middle term: does this sound occur in the clouds with the kind of regularity that implies the agency of the same underlying cause? Thus, when a scientist investigates the existence of thunder, she is not interested in whether 'thunder' is an empty term or not. Actually, what is at stake is whether the kind of noise we call 'thunder' can be treated as a genuine, definable kind. If the scientist finds what that middle term is, she will have found the factor that makes the thunder the kind of thing it is. Could we ask the same question about subject-kinds?

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[249] See, for instance, Bronstein (2016a, p. 101)

[250] See *Ph.* II 3; II 7; *Metaph.* I 3; V 2. The only kind of explanation listed in *APo* II 11 which is not clearly identified with one of the four causes is the first one (94ᵃ 24-35), although the natural candidate is the material cause. See Ross (1949, pp. 638-639).

Does it makes sense to ask why a man is what he is? According to Aristotle, it depends on how we formulate the problem:

[T44] ζητεῖται δὲ τὸ διὰ τί ἀεὶ οὕτως, διὰ τί ἄλλο ἄλλῳ τινὶ ὑπάρχει. τὸ γὰρ ζητεῖν διὰ τί ὁ μουσικὸς ἄνθρωπος μουσικὸς ἄνθρωπός ἐστιν, ἤτοι ἐστὶ τὸ εἰρημένον ζητεῖν, διὰ τί ὁ ἄνθρωπος μουσικός ἐστιν, ἢ ἄλλο. τὸ μὲν οὖν διὰ τί αὐτό ἐστιν αὐτό, οὐδέν ἐστι ζητεῖν. […] ζητήσειε δ᾽ ἄν τις διὰ τί ἄνθρωπός ἐστι ζῷον τοιονδί. τοῦτο μὲν τοίνυν δῆλον, ὅτι οὐ ζητεῖ διὰ τί ὅς ἐστιν ἄνθρωπος ἄνθρωπός ἐστιν: τὶ ἄρα κατά τινος ζητεῖ διὰ τί ὑπάρχει (ὅτι δ᾽ ὑπάρχει, δεῖ δῆλον εἶναι: εἰ γὰρ μὴ οὕτως, οὐδὲν ζητεῖ), οἷον διὰ τί βροντᾷ; διὰ τί ψόφος γίγνεται ἐν τοῖς νέφεσιν; ἄλλο γὰρ οὕτω κατ᾽ ἄλλου ἐστὶ τὸ ζητούμενον. καὶ διὰ τί ταδί, οἷον πλίνθοι καὶ λίθοι, οἰκία ἐστίν;

When one asks why, one is always asking why one thing belongs to another. For to ask why a musical man is a musical man is either, as we have just said, to ask why a man is musical, or it is something else. But to ask why a thing is itself is to ask nothing at all. […] However, one could ask why a man is such a kind of animal. It is clear that this is not to ask why one who is a man is a man. So what one asks is why it is that one thing belongs to another. (It must be evident that it does belong, otherwise nothing is being asked at all.) Thus one may ask why it thunders, for this is to ask why a noise is produced in the clouds, and in this way what is sought is one thing predicated of another. And one may ask why these things here (e.g. bricks and stones) are a house [*Metaph.* VII 17, 1041ᵃ 10-27 Bostock 1994, with changes].

Aristotle's point is the following. At first sight, it might seem useless to ask questions such as:

(i) Why is the musical musical? (1041ᵃ 17-18)

(ii) Why is this man a man? (1041ᵃ 18)

These questions may be interpreted as expressing trivialities, which would make them illegitimate *explananda* (see Lewis 1985, p. 69). One may think that the issue can be solved by appealing to the semantic rules Aristotle formulates in *APo* I 22, discussed in Chapter 3. According to these rules, question (i) is ill-formed. The referring expression 'the musical' does not describe the denoted object appropriately. For Aristotle, the grammatical subject must signify *just what* the metaphysical subject *is* (ὅπερ ἐστίν), and whatever is musical is not essentially musical. Thus, what we want to ask is why (e.g.) a certain (musical) man is musical (1041ᵃ 12). If we comply with Aristotle's rules, a non-trivial version of question (i) can be provided (1041ᵃ 13-14), one which asks 'why *one* thing belongs to *another*' (1041ᵃ 11; 25-26):

(i*) Why is this man musical? (1041ᵃ 13-14)

Although effective for question (i), this analysis would not work for question (ii), since the grammatical subject 'this man' captures *just what* the metaphysical subject *is*. In **T44**, Aristotle

is probably suggesting the same strategy for reinterpreting both questions. If so, there must be another way of finding a non-trivial version of question (i), one which also works for question (ii). As we have argued in the previous section, in some contexts – especially when notions like form and matter are at stake – an expression such as 'the musical' refers not to a particular substance which happens to be musical, but to an accidental compound, i.e. the combination of a subject (man) and an attribute (musicality). Therefore, if we want to know why a musical man is as he is (namely, a musical man), we just need to disarticulate its constituent parts and ask why they are connected as they are. If 'cloak' is the name given to the accidental compound man-plus-musicality[251], to ask why a cloak is a cloak – i.e. why the musical (man) is (a) musical (man), like in question (i) – is the same as asking why the man is musical – as we have in question (i*).[252] Since the hylomorphic analysis allows Aristotle to treat man as a compound of form and matter, he can reinterpret question (ii) as follows:

(ii*) Why is this body with this feature a man? (1041^b 6-7)

Let us discuss Aristotle's argument in detail. At the end of **T44**, the philosopher applies his strategy to processes and artefacts. To investigate why the musical (man) is musical is the same as asking why the components of the complex man-plus-musicality are connected. Likewise, we can investigate why thunder is what it is by seeking the cause in virtue of which its constituent elements (noise and clouds) are related as they are.[253] Here, Aristotle is reaffirming the isomorphism between demonstrations and definitions, as argued in the *APo*. As we have seen, the essence of thunder is revealed by our Syllogism VIII, which is isomorphic to the definition of thunder:

Syllogism VIII:

Noise holds of *fire being extinguished, fire being extinguished* holds of *clouds*
Noise holds of *clouds*

Def. (Thunder):

Thunder is$_{(df.)}$ *noise of fire being extinguished in the clouds* (*APo* II 10, 94^a 5-6).

Similarly, a house can be described as a connection between a set of materials (bricks, stones etc.) and a certain structure. Thus, if we want to investigate why a house is a house, what we seek is the reason why these bricks, stones etc. are arranged in this way (*Metaph.* VII 17, 1041^a 26-27; ^{b}5-6). The example of an artefact is not introduced without reason. What fixes the identity of

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[251] As Aristotle does with 'pale man' in *Metaph.* VII 4, 1029^b 22-1030^a 17.
[252] In general lines, I am following the interpretation proposed by Angioni (2008, p. 333).
[253] See the examples of eclipse and sleep in *Metaph.* VIII 4, 1044^b 8-20.

processes such as thunder and eclipse is an efficient cause, whereas what makes a house or a bed what they are is a final cause (*Metaph*. VII 7, 1041ᵃ 27-30). What makes something a house is its being structured so as to protect human beings, their belongings etc. (*Metaph*. VIII 2, 1043ᵃ 14-18). If so, the syllogism and the definition that display the essence of a house would run as follows:[254]

Syllogism XVI:

This structure holds of *protecting etc.*, *protecting etc.* holds of *these bricks and stones*
This structure holds of *these bricks and stones*

Def. (House):

House is₍df.₎ *a structure made of bricks, stones etc. for the sake of protecting human beings, their belongings*
etc.

As the reader of *Metaph*. VII 17 can expect at this stage of the argument, the essence of human beings can be grasped through the same explanatory practice that reveals the essence of process-types and artefacts:

[**T45**] λανθάνει δὲ μάλιστα τὸ ζητούμενον ἐν τοῖς μὴ κατ᾽ ἀλλήλων λεγομένοις, οἷον ἄνθρωπος τί ἐστι ζητεῖται διὰ τὸ ἁπλῶς λέγεσθαι ἀλλὰ μὴ διορίζειν ὅτι τάδε τόδε. ἀλλὰ δεῖ διαρθρώσαντας ζητεῖν· εἰ δὲ μή, κοινὸν τοῦ μηθὲν ζητεῖν καὶ τοῦ ζητεῖν τι γίγνεται. ἐπεὶ δὲ δεῖ ἔχειν τε καὶ ὑπάρχειν τὸ [5] εἶναι, δῆλον δὴ ὅτι τὴν ὕλην ζητεῖ διὰ τί τί ἐστιν· οἷον οἰκία ταδὶ διὰ τί; ὅτι ὑπάρχει ὃ ἦν οἰκίᾳ εἶναι. καὶ ἄνθρωπος τοδί, ἢ τὸ σῶμα τοῦτο τοδὶ ἔχον. ὥστε τὸ αἴτιον ζητεῖται τῆς ὕλης (τοῦτο δ᾽ ἐστὶ τὸ εἶδος) ᾧ τί ἐστιν.

One is particularly liable not to recognize what is being sought in things not predicated one of another, as when it is asked what a man is, because the question is simply put and does not distinguish these things as being that. But we must articulate our question before we ask it, otherwise there would be something common between investigating something and nothing. And since the existence of the thing must already be given it is clear that the question may be 'Why are these things here a house?' (and the answer is 'because what being is for a house belongs to them'), or it may be 'Why is this thing here a man?', or 'Why is this body with this feature a man?' So what is sought is the cause by which the matter is so-and-so, i.e. the form [*Metaph*. VII 17, 1041ᵃ 32-ᵇ8; Bostock 1994, with changes].

For Aristotle, the essence of natural substances is, like the essence of artefacts, specified in teleological terms. The parts of the human body and its structure as a whole are *for the sake of* a certain kind of life, a soul of a certain type. To spell out what that soul is is the same as specifying *what it is to be* (τὸ τί ἦν εἶναι) a human being (*Metaph*. VII 10, 1035ᵇ 14-22). Since the interdependence

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254 See Charles (2000, pp. 286-290); Peramatzis (2013, p. 303).

between defining and explaining holds good for substance-kinds, we can determine the essence of human beings by specifying (syllogistically) the reason why the human body is structured as it is:

Syllogism XVII:

<u>*This arrangement* holds of *being rational soul, being a rational soul* holds of *this type of body*</u>
This arrangement holds of *this type of body*.

Correspondingly, the definition of human being would run as follows:

Def. (Human Being):

Human being is(df.) *a body arranged in such-and-such way for the sake of being a rational soul*.[255]

If at least part of the ideas spelled out in *Metaph.* VII 17 and VIII 2-4 are implied in *APo* II, it becomes easier to understand why Aristotle affirms that the essence of a subject S is discovered when the cause of S's being ἁπλῶς is identified. However, according to **T43**, the essence of S can be revealed by a demonstration only if 'its cause is something else' (ἕτερόν τι αἴτιον). Therefore, if the essence of natural substances becomes known through demonstrations, their 'cause' must be something distinct from them. But what does this mean?

We can surely affirm that the cause that makes the thunder what it is is not the same thing as the thunder itself. A thunder is a certain kind of noise whereas its 'cause' is fire being extinguished in the clouds. The distinction between thunder and the cause of its 'being' is what enables us to decompose its essence in three basic elements and articulate them in a syllogistic structure: a certain noise (major term) belongs to the clouds (minor term) in virtue of fire being extinguished (middle term). Similarly, composite substances are not identical to the cause of their 'being' (namely, their form). Human beings are compounds of body and soul, not souls. However, in *Metaph.* VIII 3, Aristotle warns us that we may not realize this fact due to a linguistic phenomenon:

[**T46**] δεῖ δὲ μὴ ἀγνοεῖν ὅτι ἐνίοτε λανθάνει πότερον σημαίνει τὸ ὄνομα τὴν σύνθετον οὐσίαν ἢ τὴν ἐνέργειαν καὶ τὴν μορφήν, οἷον ἡ οἰκία πότερον σημεῖον τοῦ κοινοῦ ὅτι σκέπασμα ἐκ πλίνθων καὶ λίθων ὡδὶ κειμένων, ἢ τῆς ἐνεργείας καὶ τοῦ εἴδους ὅτι σκέπασμα, καὶ γραμμὴ πότερον δυὰς ἐν μήκει ἢ ὅτι δυάς, καὶ ζῷον πότερον ψυχὴ ἐν σώματι ἢ ψυχή: αὕτη γὰρ οὐσία καὶ ἐνέργεια σώματός τινος.

One must bear in mind that sometimes it is not clear whether a word signifies the compound substance or the actuality and shape; for instance whether 'house' is a sign for the compound, a shelter made from bricks and stones placed thus, or for the actuality and form, a shelter, and similarly whether 'line' means duality in length or just duality, whether 'animal' means a soul in a body or just a soul (for the soul is the substance

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255 See Charles (2000; 2010b, pp. 268-328); Peramatzis (2011, pp. 180-200; 2013, pp. 303-305).

and actuality of a certain kind of body) [*Metaph.* VIII 3, 1043ᵃ 29-36; Bostock 1994, with changes].

The fact that a word designating a natural substance may also be used to refer to its soul should not prevent us from distinguishing the two things. Actually, Aristotle explicitly distinguishes one thing from the other few lines after **T46**: 'a man', he says, 'is not the same as what-being-is-for-a-man, unless the soul too is to be called man' (*Metaph.* VIII 3, 1043ᵇ 3-4). In some contexts, the philosopher uses the locution 'what being is for S' (τὸ + noun in the dative + εἶναι) to refer the most basic component of S's essence, namely, its form. In **T45**, for instance, Aristotle affirms that bricks, stones etc. become a house when 'what being is for a house belongs to them' (ὅτι ὑπάρχει ὃ ἦν οἰκίᾳ εἶναι), i.e. when the form of a house inheres in its material constituents (minor premise in Syllogism XVI). Similarly, in 1043ᵇ 3-4, what-being-is-for-a-man is identified with the human soul. Thus, to distinguish the man from what-being-is-for-a-man is the same as distinguishing the hylomorphic compound from its form.

Again, nothing in **T43** should make us think that the essence of substances are not discovered through demonstrations.[256] The passage does not affirm or imply that the 'cause' of natural substances being what they are is identical to them. Actually, as we have just seen, the *Metaphysics* provides us with evidence to the contrary. In the absence of proof that Aristotle changed his mind, we have good reason to believe that the essence of subject-kinds become known through the explanatory practices described in *APo* II 8 and reaffirmed in *Metaph.* VII-VIII.

The example of an 'item whose cause is not something else' offered in **T43** is 'unit', which suggests that the exceptions to the method proposed in *APo* II 8 are conceptually simple notions, and not hylomorphic compounds. However, there is a sense in which the interdependence between defining and explaining remains solid even for *definienda* such as 'unit'. Even if the definition of unit is not isomorphic to a demonstrative syllogism, its status as a first principle depends on its being used to explain arithmetic theorems. This conclusion can be drawn from a famous passage in *De An.* I 1:

[**T47**] ἔοικε δ᾽ οὐ μόνον τὸ τί ἐστι γνῶναι χρήσιμον εἶναι πρὸς τὸ θεωρῆσαι τὰς αἰτίας τῶν συμβεβηκότων ταῖς οὐσίαις [...] ἀλλὰ καὶ ἀνάπαλιν τὰ συμβεβηκότα συμβάλλεται μέγα μέρος πρὸς τὸ εἰδέναι τὸ τί ἐστι. [...] Πάσης γὰρ ἀποδείξεως ἀρχὴ τὸ τί ἐστι, ὥστε καθ᾽ ὅσους τῶν ὁρισμῶν μὴ συμβαίνει τὰ συμβεβηκότα γνωρίζειν, ἀλλὰ μηδ᾽ εἰκάσαι περὶ αὐτῶν εὐμαρές, δῆλον ὅτι διαλεκτικῶς εἴρηνται καὶ κενῶς ἅπαντες.

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[256] Of course, that does not mean that other methods like induction and division are not useful for investigating the essence of subjects (or even the essence of attributes). Perhaps, these practices reveal part of their essences (namely, the one appearing in nominal definitions, based on which the scientist starts its inquiry). For another view, see Bronstein (2016a, pp. 189-222).

> It seems that not only is ascertaining what a thing is useful for considering the causes of the properties of substances […], but also, conversely, that ascertaining the properties of a substance plays a great part in knowing what a thing is. […] For the principle of every demonstration is what a thing is, so that those definitions which do not lead us to ascertain the properties of a substance, or at least to know them in a ready sort of way, will clearly and in every case be dialectical and vacuous [*De An.* I 1, 402^b 16-403^a 2; Shields 2016, with changes].

In this passage, Aristotle is relying on the claim that what characterizes the essence of a substance – in comparison to other necessary (but non-essential) properties – is its being explanatorily basic, i.e. their presence in the substance explains the substance's having other derivative properties, but is not explained by any other property the substance may have. Thus, to know the essence of a substance *as the essence of that substance* involves realizing that it explains the substance's demonstrable attributes. Similarly, to recognize propositions as an *authentic definitions* – and not merely 'dialectical and vacuous' – involves realizing that certain phenomena can be demonstrated from them.

This result is in accordance with our account of the relation between demonstrative knowledge and νοῦς. Νοῦς is the cognitive state that knows definitions. Since demonstrations are based on definitions, demonstrative knowledge is dependent on νοῦς. However, if we cannot get to know a definition independently of the act of demonstrating, it is impossible to have νοῦς without having demonstrative knowledge. Again, the interdependence of these two kinds of knowledge just mirrors the interdependence between defining and explaining.

CONCLUSION

Knowledge 'without qualification', the kind of knowledge expert scientists have, consists in grasping stable connections between subjects and attributes in the world and explaining them from 'appropriate principles', i.e. indemonstrable premises that are true, primitive, immediate, more familiar than, prior to, and explanatory of the conclusion (*APo* I 2, 71$^\text{b}$ 19-22). The possibility of relying on indemonstrable principles is what allows scientists to explain phenomena without producing circular demonstrations or running the risk of infinite regress. Given this scenario, it is understandable that Aristotle has been classified as a foundationalist. However, his foundationalism should not be understood as a rationalist theory of epistemic justification, as if the indemonstrable principles of science were self-evident propositions acquired by non-inferential procedures. First, Aristotelian explanations are not justifications, i.e. they answer questions of the form 'why is it the case that **p**?' and not questions such as 'why do I believe that **p**?' Second, his acknowledgement of indemonstrable principles amounts to the recognition of essences, understood as ultimate explanations. Essences do not become known as such independently of their being used to explain scientific problems. Noetic knowledge of indemonstrable principles and demonstrative knowledge of explainable facts are therefore interdependent cognitive states in the same way as defining and explaining are interdependent scientific practices.

Aristotle's philosophy of science cannot be fully understood unless its ontological underpinnings are properly specified. For him, essences are primary explanatory factors. However, in every scientific domain, we can distinguish two basic kinds of essence-bearers: subjects and demonstrable attributes. Subjects are defined without mentioning a more basic subject in the domain, since there is not another being of which they could be predicated that differs in essence from them. On the other hand, demonstrable attributes (or *per se* accidents) cannot be defined without specifying the kind of objects in which they inhere. With the distinction between subjects and attributes in mind, Aristotle imposes a set of semantical rules on scientific discourse as a way of guaranteeing that linguistic predications will capture the corresponding metaphysical predications appropriately. These semantical rules are also part of Aristotle's foundationalist project, since they prevent a syllogistic chain of demonstrations from proceeding *ad infinitum*.

Notwithstanding the differences between the essence of subjects and the essence of attributes, there is room for both of them in demonstrative sciences. The 'primary' middle term explaining why an attribute belongs to a subject is the causal part of the attribute's essence. In other words, the final and crucial step in a demonstration follows the A-Model. However, if there is a stable, regular connection between attribute and subject, the attribute's essence and the subject must be connected in a similar way – after all, the attribute's 'way of being' involves its being predicated of that subject. If the *demonstrandum* is a primary-universal problem, the attribute counterpredicates with the subject and belongs to it in virtue of the subject being what it is. That is to say, the subject's essence partially explains why it possess its demonstrable attributes. Thus, it is not without reason that Aristotle seems to endorse something along the lines of the S-Model as well.

As it is clear from the examples used in *APo* II, the essence of attributes are discovered through demonstrations. It is not possible to know their essences without having the corresponding explanatory syllogism, which turns out to be isomorphic to the attribute's definition. As we have argued, the essence of subjects does not constitute an exception to the 'interdependence' principle. In the *Metaphysics*, Aristotle explicitly applies the model developed in *APo* II to substance-kinds – in fact, examples of substances are already mentioned, although not fully explored, in *APo* II 8. In addition, we argued that subjects that cannot be analysed as compounds of form and matter also have their essences revealed by explanatory practices. The essence of an unanalysable subject cannot be recognized *as the essence of that subject* without its being used to explain the subject's demonstrable attributes.

It is not exactly surprising that Aristotle uses some of his ontological theses in his attempt to formulate general principles about how ἐπιστήμη ἁπλῶς should be pursued and

expressed. Certainly, other aspects of the relation between Aristotle's metaphysics and his philosophy of science remain to be clarified and further explored. However, we hope we have offered a relatively comprehensive reconstruction of the ontological framework associated with his theory of demonstration. We should be particularly satisfied if our reader is convinced, among other things, that, for Aristotle, the intelligibility of reality depends on there being finite chains of explanatory connections in the world and entities whose 'ways of being' are associated with one another in a hierarchical structure.

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