

# KATH' HAUTA PREDICATES AND THE 'COMMENSURATE UNIVERSALS'

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**Abstract:** What lies behind Aristotle's declarations that an attribute or feature that is demonstrated to belong to a scientific subject is proper to that subject? The answer is found in *APo.* 2.8-10, if we understand these chapters as bearing not only on Aristotle theory of definition but also as clarifying the logical structure of demonstration in general. If we identify the basic subjects with what has no different cause, and demonstrable attributes (the *kath' hauta sumbebekota*) with what do have 'a different cause', the definitions of demonstrable attributes necessarily have the minor terms of the appropriate demonstrations in their definitions, for which reason the subjects and demonstrable attributes are coextensive.

## I

Distinctions between what is basic and what is derivative run through Aristotelian metaphysics and epistemology. Aristotle's ontological analyses rest on the distinction between substances and the nonsubstantial beings dependent on them. This distinction is mirrored by (and partially corresponds to)<sup>1</sup> an epistemological distinction between two different kinds of beings studied by the sciences: those kinds that constitute the subject matter of the sciences and the derivative features of those kinds, which are accounted for on their basis. Just as, from the point of view of ontology, substances are ultimate substrates, and nonsubstances ontologically depend on substances, so, epistemologically, certain kinds are taken to be basic by the science that studies them, and scientific understanding of all other beings considered by that science is derived from what the science presumes about those kinds.

*APo.* 1 sets out the basics of Aristotle's theory of demonstration, the form in which scientific explanations can ideally be cast. Demonstrations are syllogisms, of which the minor term is the subject kind under consideration, and of which the major term is the feature belonging to the subject that is being explained. Demonstrations presuppose that certain definitional features belong to the subject kinds. Such features constitute what the subjects of the science are; they are to be distinguished from demonstrated features.

This much is clear enough. But much of the theory of explanation that Aristotle works through in the *Posterior Analytics* is notoriously complex and obscure. In part this is

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<sup>1</sup> The correspondence is partial because, although all substantial kinds are basic from the point of view of the sciences studying them, some sciences (like the mathematical ones) consider nonsubstantial kinds as basic, disregarding their inherence in more basic entities. On this see Goldin (1996, pp. 73-7).

because Aristotle uses a number of phrases (*kath' hautō*, *atomos*, *katholou*, *heteros aitiōs*, *hupokeimenon*) in a technical manner, without always clearly distinguishing what sense of a term is being used in a particular passage. Add to this the terse nature of the argumentation, and it is no surprise that for millennia particular passages have admitted of many interpretations. Lingered problems in interpreting the *Posterior Analytics* have resulted. Although Aristotle's account is honored as having hit on the notion that explanation involves a kind of inference from the essences of real kinds, it is often considered confused and incoherent in parts, and as containing significant gaps in working through how these explanations are supposed to work.

Aristotle's account can be acquitted of many such charges if we appreciate that in the *Posterior Analytics* the terminology by which he distinguishes scientific subjects and demonstrated attributes is more fluid than usual. The distinction between basic kinds and demonstrated features is referred to in a number of ways, since different contexts require focusing on different aspects of the distinction. The following distinctions made by Aristotle, I shall argue, are either equivalent or are closely related, made in different contexts in order to solve different problems.

A	Those items whose existence is presupposed by the sciences	Those items whose existence is demonstrated by the sciences
B	Subjects of the sciences, Primary items, the things whose scientific definitions are presupposed by demonstration, minor terms of demonstrations	Derivative attributes explained by the sciences (the <i>kath' hanta sumbebekota</i> ) or <i>pathē</i> (attributes), the things whose scientific definitions are not presupposed by demonstration, major terms of demonstrations
C	What has no cause different from itself	What has a cause different from itself (93a5-6, 93b19, 2.9 93b21-28)
D	Atoms, simple subjects	Complexes, derivative subjects
E	Predicates that are <i>kath' hanta</i> in the sense indicated at 1.4 73a34-7	Predicates that are <i>kath' hanta</i> in the sense indicated at 1.4 73a37-b3

The relationships among these distinctions have not wholly escaped commentators but they have not been thoroughly worked through in a way that sheds light on otherwise obscure aspects of Aristotle's theory of demonstration. The present paper focuses on one such issue: what lies behind Aristotle's declarations that an attribute or feature that is demonstrated to belong to a scientific subject is proper to that subject? The answer is found in *APo.* 2.8-10, if we understand these chapters as bearing not only on Aristotle theory of definition but also as clarifying the logical structure of demonstration in general. If we identify the basic subjects with things that have no different cause, and demonstrable attributes (the *kath' hanta sumbebēkota*) with those that do have 'a different cause,' the definitions of the demonstrable attributes necessarily have the minor terms of the appropriate demonstrations in their definitions, for which reason the subjects and demonstrable attributes are coextensive. In this paper I show how and why this is so.

## II

Book 1 tells us that each of the sciences posits certain basic kinds as objects of study. "For every demonstrative science concerns three things, first, those for which it posits the being (this is the kind of which it studies the *kath' hanta* attributes). . ." (*APo.* 1.10 76b11-13).<sup>2</sup> Each science posits as principles of explanation the definitions of the basic kinds that it studies. "In the case of some things one must already grasp that they are; in the case of others, one must know what that which is referred to (*to legomenon*) is, and in the case

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<sup>2</sup> Here and elsewhere, translations are my own.

of some things, both . . . In the case of triangle, one must know that [the term] signifies this and in the case of the monad one must know both, what [it is that] is signified and that there is [such a thing] (1.1 71a12-6).<sup>3</sup> (This is distinction A.) Aristotle identifies this distinction with that between those items of which the existence is presupposed by the sciences, the primary items, and the derivative items of which it is not: “In the case of the primary items and the things [derivative] from them, what it signifies is assumed, but that they are is assumed for the principles and is proven for the others. For example, what monad and straight and triangle are is assumed, but that they are is assumed for the monad and magnitude, but is proven for the others” (I.10 76a32-6).<sup>4</sup> The facts that there are such things, and that they have certain essences, are not themselves objects of explanation and accordingly cannot be demonstrative conclusions. The determinations of which basic kinds are actually to be found in the world (expressed in what Aristotle calls hypotheses) and the expression of their explanatorily basic features (in

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<sup>3</sup> Aristotle here and elsewhere uses the phrase *ti sēmainei* both to refer to one’s pretheoretical grasp of the use of a term and a basic essence of the reference of a term. There is scholarly consensus that the former is what is presupposed for a term like ‘triangle’ and the latter for a term like ‘monad’.

<sup>4</sup> As in 1.1 71a12-6, for basic subjects, ‘what it signifies’ (*ti sēmainei*) refers to a scientific definition expressing a basic essence; in the case of other things, it refers to the a pretheoretical grasp of the meaning of a term, the sort of account from which the kind of inquiry described in 2.8 begins (2.8 93a21-4). See Bronstein (2016, p. 185) on the “weak” kind of preliminary knowledge presupposed here.

what Aristotle calls definitions)<sup>5</sup> are not absolute starting points of inquiry, for they are the results of empirical investigation, dialectical discussion, and a process of seeing which purported explanations hold water and which do not. Nonetheless, in the context of demonstration, they are presented as basic.<sup>6</sup> On the basis of the definitions of the primary things one demonstrates that the derivative entities are predicated of them, and in that way demonstrates their existence.<sup>7</sup> These derivative entities are accordingly to be understood as demonstrable attributes, which Aristotle elsewhere calls the *kath' hauta sumbebēkota* or the *pathē kath' hauta*.<sup>8</sup>

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<sup>5</sup> 1.2.72a18-21. For this (standard) understanding of the distinction between definitions and hypotheses (in the sense employed here) see Ross (1949, p. 508) and Landor (1981).

<sup>6</sup> I agree with Charles (2010, p. 303) that Aristotle does not take demonstrations to consist in the unpacking of what is analytically contained in a priori truths, but do not agree that an interpretation such as mine derives from such an assumption. Aristotle is discussing the structure of demonstrations based on first principles, and it is puzzles concerning their logical structure that motivates Aristotle's account, as I understand it. Epistemological issues concerning how one arrives at those first principles are another matter altogether.

<sup>7</sup> On this see Goldin (1996, pp. 48-51) and McKirahan (1992, pp. 188-97). McKirahan writes that there is "a surprisingly close fit between existence proofs and subject-attribute demonstrations." As I shall show in this paper, that is because they are the same.

<sup>8</sup> See *Meta.* Δ 30 1025a30-2: "The term 'accident' (*sumbebēkos*) is used in another way, in regard to all of those things that belong to each in itself (*kath' hauta*) but not in the essence, for example, having [the interior angles equal to] two right angles, in relation to triangle." (Henceforth I will abbreviate 'having the interior angles equal to two right angles' as 2RA.) See also 1.7 75b1, where the

Book 1 suggests that there are two kinds of definitions: scientific ones, which are basic to explanation and are accordingly indemonstrable, and pretheoretical accounts of the signification of terms. Book 2 however argues that there is a way, or a sense, in which definitions can be both demonstrable (and are accordingly not basic) yet express essences grasped by science. The key to the apparent discrepancy lies in a proper understanding of Distinctions A and B and showing how implicit appeal is made to them in Book 2.

The account of how there can be a kind of ‘demonstration of the definition,’ is the culmination of a long continuous stretch of argumentation which begins by discussing the kinds of inquiry for which a demonstration provides the answers. Aristotle asserts that the answer to a ‘why is it’ question is the same as the answer to a ‘what is it’ question, and supports this by means of examples (*APo.* 2.2 90a14-23). The answer to the question ‘why is the moon eclipsed?’ is found in the answer to the question ‘what is an eclipse?’: a privation of light from the moon on account of the interposition of the earth. The two answers differ only

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explicative *kai* identifies them with the *pathē kath’ hanta*. On the identification of derivative entities with the *kath’ hanta sumbebēkota* see Goldin (2004). Granger (1981, p. 123, n. 2) denies that the *kath’ hanta sumbebēkota* are demonstrable attributes but he frankly confesses that he is at a loss in how to account for Aristotle’s reference to 2RA as *kath’ hanta sumbebēkos*. In contrast, the scholarly consensus is that this is key evidence in reconstructing Aristotle’s account of the logic of demonstration and that one ought not worry much about Aristotle’s remark at *APo.* 1.4 73b16-24 (central to Granger’s account) which suggests that those *kath’ hanta* attributes that are not definitional always come in pairs, such that it is necessary that one or the other belong to their subject term.



in their linguistic formulation.<sup>9</sup> A second example that Aristotle gives is that of the definition of a concord (what we, though not the Greeks, would call a 'harmony') and the answer to the question "why is there a concord?": A concord is a numerical ratio between high and low; two notes form a concord because there is numerical ratio between them. Accordingly, demonstrations, which are explanatory insofar as their premises reveal the cause of their conclusion, can thereby serve as expressions of the 'what is it'. Definitions can, in a sense, be demonstrated.

Aristotle's account of when and how this is so is not clear and even the main lines of his account have always been the occasion for significant controversy. Crucial is how we interpret Aristotle's assertion that this sort of demonstration is possible only when "there is a different cause" (2.8 93a3-7, 93b19, 2.9 93b21, 25-8). Some commentators have read Aristotle here as talking about kinds of demonstrations and/or definitions different from those discussed in Book 1, while some take him to be talking about different kinds of definienda. Many of those who belong to the first group of exegetes take the antecedent of "what has a different cause" at 2.8 93a5-6, 93b19, and 2.9 93b21-28 to be not a kind of entity, but a kind of definition which is made intelligible on the basis of an alternative, less provisional definition of the same thing. According to this line of interpretation, this more adequate, scientific demonstration is different from the less adequate, more provisional definition, insofar as it has

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<sup>9</sup> This is a point that Aristotle explicitly makes at 2.10 94a1-2, in which a definition like "an eclipse is a blocking of light from the moon on account of the interposition of the earth" is said to "differ from demonstration in the arrangement [of its terms]"; see also 94a12-3.

different semantic content, and is the cause (or explanation) of the latter insofar as it renders it intelligible.<sup>10</sup>

I have argued that the alternative strategy, which takes Aristotle to be distinguishing between kinds of being, not kinds of definitions, has its origin in the lost commentary of Alexander of Aphrodisias.<sup>11</sup> It was advocated by Ross (1949), and then lost a bit of favor in the following decades. Nonetheless it has recently gained a number of adherents, myself among them.<sup>12</sup> Those of us who take this line agree

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<sup>10</sup> For example “extinction of fire in the clouds” (2.8 93b8-9) is a different, more scientific definition of thunder than is “a certain noise” which at 2.8 93a21-3 is said to be what one grasps if one knows that there is thunder accidentally, by virtue of being in touch with “something of the thing itself” (*ekbontes to autou tou pragmatos*). This account makes its first appearance in the commentary on *APo.* 2 attributed to Philoponus, found in Wallies (1909, pp. 334-440) and translated in Goldin (2009). See Goldin (1996, pp. 102-7), Goldin (2010, pp. 176-82). A version of it can be found in Mansion (1976), pp. 183-97. On this account, even a substance or metaphysical simple could be the kind of thing for which a definition can be demonstrated. Some textual support for that might be found in two of the examples to which Aristotle appeals in his discussion of how definitions can in a sense be demonstrated: the definitions of human and soul (2.8 93a24). The partial definitions of these (“a kind of animal,” and “a self-mover”) that Aristotle gives are understood as partial definitions, of which the complements are “different causes.” See Zuppolini (2016, 202-3). But Aristotle here can be understood as giving examples of what he has in mind by partial definitions that express “something of the thing itself”; they need not also be taken as examples of things whose definitions can in a sense be demonstrated.

<sup>11</sup> Goldin (2010, 157-76).

<sup>12</sup> Goldin (1996), Harari (2004, pp. 143-4), Deslauriers (2007, pp. 45-65), Bronstein (2016, pp. 132-7). A variation is found in McKirahan (1994, pp. 200-1), where *aition*, rendered as “grounds”,

that sorts of entities for which demonstrations cannot reveal definitions in the manner described in 2.8, which Aristotle refers to as 'the things that do not have a different cause,' are the basic beings posited by the sciences.<sup>13</sup> For if something

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is apparently understood epistemologically rather than metaphysically: the things of which there are no different *aitia* are those for which the essences are immediate principles. One either gets them or not. McKirahan does not explicitly take the step of affirming that they have this status on account of a kind of inner ontological simplicity.

<sup>13</sup> Bronstein (2016, pp. 170-7) makes a distinction between two kinds of subjects posited by the sciences that study them: primary subjects and subordinate subjects. Both are "basic subjects" in the sense I am giving the phrase here. Bronstein's "primary subject" is the generic kind of which both the 'if it is' and the 'what it is' are posited by the science studying it. The specific kinds that fall under that are "subordinate subjects." Bronstein holds that in this case the sense of the term referring to it is assumed, but existence is nonetheless demonstrated (pp. 183-7). On Bronstein's account, the existence of the species of a genus is to be demonstrated on the basis of a prior determination of the differentiae under a genus (pp. 196-219). But Aristotle nowhere takes existence claims concerning differentiae to be independent principles; they are in effect assumptions that the corresponding species exist. Nor does he discuss such "demonstrations" that subordinate subjects exist. This is why I take the existence of both primary and subordinate subjects to be indemonstrable. 'Triangle' can function as a grammatical subject, but it is not for Aristotle a kind subordinate to the subject matter of geometry, for at 1.10 76a35-6 he says that this subject matter, of which both essence and existence are assumed, is line (referred to as 'magnitude'), not figure. To demonstrate that triangles exist is to demonstrate that lines are such as to form triangles when juxtaposed in a certain way. Demonstrable attributes of triangles (such as 2RA) are properly speaking demonstrable attributes of *lines*. Thus when Aristotle appeals to demonstration that triangles are 2RA as an example of

has a ‘different cause,’ that is to say, is present in the world on account of something belonging to another kind, that cause would serve as a middle term of a demonstration, the conclusion of which would be the predication of the kind in question of a more fundamental subject. For example, if the kind dog had a cause that was “different” from itself, call it M, one would demonstrate that there are dogs by means of a demonstration of the form “S is M, M is a dog, therefore S is a dog.” The only logically possible candidate for such an S would be a sub-breed of dog (say, miniature schnauzer, where M would be a less specific sub-breed like schnauzer),<sup>14</sup> but being a dog is part of the essence of even such an S. It

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conditional necessity, he writes “Since the straight [line] is such and such, a triangle must have two right angles, but not since this, that [i.e. conversely]. Though if this were not the case, the straight line is not [such and such] either” (*Phys.* 2.9 200a16-19). It is the definition of straight line, not that of triangle, that is identified as the premise of the demonstration that triangles are 2RA. There are of course severe problems in reconstructing such a syllogism, but these are shared by any attempt to formulate a geometrical proof as based solely on definitional premises, as Aristotle thinks they are.

<sup>14</sup> Barnes (1994, p. 219) understands at least a part of the sort of demonstration that Aristotle has in mind along these very lines: “(1) Deprivation of light holds of screening by the earth. (2) Screening of the earth holds of eclipse. Therefore: (3) Deprivation of light holds of eclipse.” On Barnes’ account, this sort of demonstration could just as well work with ‘miniature schnauzer’ as minor term, as he takes the distinction between what has a cause other than itself and what does not as the distinction between derived terms and primitive terms (p. 217). Barnes is unable to integrate his understanding of the what has a cause different from itself with his account of the sort of demonstration that reveals a definition, for which reason he condemns 2.9 as a “muddle” (p. 221).

is *what S is*, for which reason neither S nor a definitional attribute of S would not be a cause 'different from' dog. That S is a dog would be posited in the definition of S, and that this definition refers would be ensured by the 'hypothesis' that there is in fact such a thing as S.<sup>15</sup>

Accordingly, the canonical form of demonstration is "S is M, M is P; therefore S is P," where S is a basic subject and P is a predicate that is *kath' hauta sumbebēkos* of S, that is, not included in the essence of S although it is demonstrable of S. S, as a basic subject, does not have a cause different from itself. P, as a demonstrable predicate, does have a cause different from itself; this will be M, S, or an intermediate middle term. For this reason, Distinction C turns out to map onto Distinction A and Distinction B. The features of reality treated by each science can be classified into two groups. The first is constituted by certain primary subject kinds, both generic and specific. Although they may be ontologically dependent on other beings (as mathematical entities are quantities ontological dependent on their inherence in substances), the sciences that study them regard them as basic. (It is of no concern to the mathematician qua mathematician that a quantity under consideration is a quantitative aspect of a substance.)<sup>16</sup> That they exist, as having the basic features that they have, is presumed by those demonstrations that show why they have the derivative features that they have.<sup>17</sup> This is why each science considers

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<sup>15</sup> On this see Goldin (1996, pp. 61-9).

<sup>16</sup> On this see 1.13 79a6-10.

<sup>17</sup> "Proper [to each science] are, on the hand, those things which it assumes to be, about which the science studies the things that belong *kath' hauta*, for example, arithmetic assumes the monad, and geometry lines and points, for they assume these to be and to be just this" (1.10 76b3-6). Note that at 76b6-7 these entities, for

them as having no cause different from those kinds themselves. The definitional features of these kinds belong to this same group, for, although linguistically and conceptually they can be regarded by themselves (for example, being rational can in a way be conceptually isolated from being human) the positing of the essence and existence of the basic kinds is at the same time the positing of their definitional features.

The other class of beings considered by the science is made up of those things that *do* have a cause different from themselves. It is natural to read the distinction between things for which the cause is different and those for which it is not to be exhaustive. Given that the things for which there is no different cause are the basic subjects, of which each science assumes both the essence and the existence, we would expect that the things with a different cause (those whose definitions can in a sense be demonstrated), are the items (considered by a science) other than those basic subjects. According to Aristotle's syllogistic scheme, terms either appear as subjects or predicates. So those things for which there is a different cause will appear in demonstrations as predicates of the basic subjects. This class will exclude definitional predicates, for as noted above, these predicates are what their subjects are, and hence are not different from the subjects. It will be the class of *pathē kath' hauta* or *kath' hauta sumbebēkota* of the subject kind in question. Distinction C is to be identified with Distinctions A and B.

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which there are no middle terms that can express their cause, are distinguished from the *pathē kath' hauta*, identified as the other entities proper to the sciences.

### III

There is a wrinkle here: Aristotle's theory of demonstration admits of some subject terms that are not basic subjects, insofar as their existence is not presumed by the science that studies them but needs to be demonstrated. Aristotle's stock example here is that of the triangle. It is demonstrable that triangles are 2RA, but even though it would seem to be the case that triangle is the minor term of this demonstration, triangle is not a simple subject; one must demonstrate that there are triangles (1.1 71a14-16, 1.10 76a31-6). Following McKirahan (1992) let us call these 'derivative subjects'. Note that any demonstration that such exist would have to be on the basis of the principles concerning simple subjects. The demonstration that triangles exist would have to resemble the proof of Euclid *Elements* 1.1 (which constructs an equilateral triangle on a given line) insofar as, on the basis of what we know about lines, we can show that they are such as to be arranged in a way that satisfies what we mean by the term 'triangle'.<sup>18</sup> 'Triangle' then would be a nominalization of the predicate 'such as to be a side of a triangular figure when arranged in a certain way', inherent in 'straight line' or 'magnitude'. "Triangles are 2RA" is a short way of saying "lines are such that when arranged in a certain way they form the side of a three sided figure that is 2RA" and so forth.<sup>19</sup> For this reason, Distinction D, between atomic or simple subjects on

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<sup>18</sup> On this see McKirahan (1992, pp. 144-8).

<sup>19</sup> This is parallel to how a predication like "the color is bright" is to be ontologically understood as the predication of an attribute (bright color) of the substance that is the metaphysical subject of the color.

the one hand, and derivative subjects, on the other, turns out to be a subset of (or identical to<sup>20</sup>) Distinctions A, B, and C.<sup>21</sup>

#### IV

I read *APo.* 2.8 as working through how one can cull a kind of (nonfoundational) definition of demonstrable attribute or derivative subject on the basis of the demonstration concluding that such an entity holds of a basic subject. The demonstrations that are, in a sense, demonstrations of the definitions of such items do not have the definitions in question as their conclusions. That is to say, the demonstration that reveals the definition of P does not have a conclusion of the form “a P is such and such.” The term whose definition is revealed is not the minor term of the syllogisms in question. Rather, because “in all of these cases it is clear that the what is it and the why is it are the same” (2.2 90a14-5), the middle term of a demonstration that a basic subject S is P will be the cause of P, and once that middle term is revealed, a definitional formula of P can be compiled.<sup>22</sup> Aristotle discusses two examples. By

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<sup>20</sup> I make this suggestion at Goldin (1996, pp. 148-50).

<sup>21</sup> McKirahan (1992, p. 38) admits that on his account Aristotle is inconsistent at 1.10 76b3-10, where he distinguishes two kinds of entities studied by a science: subjects (of which the existence is assumed) and attributes (of which the existence is demonstrated). For McKirahan’s “derivative subjects” fall in neither group. On my account, the alleged inconsistency disappears. For more on understanding derivative subjects as demonstrable attributes, see Goldin (2004).

<sup>22</sup> At *APo.* 2.10 94a9-14 the basic subjects of the sciences are called immediates (for unlike the demonstrable predicates, there is no middle term between them and a more basic subject). Aristotle



demonstrating that the blocking of light that we identify with an eclipse belongs to the moon, by the middle term 'interposition of the earth' we, in a sense, 'demonstrate' that the (lunar) eclipse is a blocking of light from the moon that results from the interposition of the earth (2.8 94b4-7). By demonstrating that the noise that we identify as thunder belongs to the clouds, on the basis of the middle term 'quenching of fire', we, in a sense 'demonstrate' that thunder is a noise that results from the quenching of fire in the clouds (2.8 93b8-14).<sup>23</sup>

This is possible only if we already have a reliable way of identifying the explanandum, so that we can show that those features by which we identify it follow from and are explained by the essence of basic subjects. This is why in the explanations that Aristotle sketches the explanandum P is initially identified with a complex<sup>24</sup> of other terms, say Q and R. This might be done on pre-theoretical grounds.<sup>25</sup> The middle term M of the demonstration concluding that S is Q and R, will express why S is Q and R, and one can therefore on the basis of the demonstration formulate a definition of P as "Q and R in S on account of M." Aristotle's examples are that we begin with the initial identification of a lunar eclipse with a certain occlusion of light from the moon (or

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there contrasts their definitions with those which are revealed by the kind of demonstration discussed in 2.8, which will express the middle term by which the kind in question belongs to a basic subject.

<sup>23</sup> On this see Landor (1985).

<sup>24</sup> In the simplest cast this will be a conjunction.

<sup>25</sup> On this, the first stage of definition, see Charles (2000, pp. 64-67, 198-213). On the basis of his account of the three stages of Aristotelian definition, Charles finds in Aristotle the elements of a semantic theory for natural kind terms for all definienda.

even with the moon's failure to cast shadows, though full), or of thunder as a certain noise in the clouds. We demonstrate that Q and R belong to S. Given the premise that identifies P with Q and R, we can infer that S is P. So, having demonstrated that a certain occlusion of light belongs to the moon, we can then in a sense demonstrate that the moon is eclipsed, on the basis of the premise that this occlusion is an eclipse.<sup>26</sup>

## V

One might object to this this line of interpretation on the grounds that demonstrable attributes necessarily inhere in their subjects (1.4 73a21, 1.6 75a28-31) and always inhere in them (1.8 75b22-5). But at first sight that does not conform to Aristotle's own examples here: eclipse and thunder.<sup>27</sup> For eclipsing is not a universal, necessary attribute of the moon,

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<sup>26</sup> At 2.8 93a30 Aristotle identifies the terms of a syllogism as follows: "eclipse A, moon C, blocking of by the earth B." This syllogism cannot be understood as an explanatory demonstration, for it presupposes that A is B which is the very explanation in question. The real explanatory work would consist in two demonstrations, first, that B entails the set of attributes by which we identify an eclipse (for example, not producing a shadow during the full moon, 93a37-8, and second, that C is B. (I take it that this demonstration would be among "the remaining logoi" referred to at 93b13-4.) On this see Goldin (1996, pp. 144-6).

<sup>27</sup> Angioni's understanding of the requirement that the principles of demonstration be necessary as that they be requisite for explanation allows non-necessary states of affairs to fall within the ambit of demonstration. See Angioni (2014, p. 103). But the problem that "for the most part" predications and occasional events are not eternal, as demonstrables are supposed to be, would still remain.

since the moon is not always eclipsed. Similarly, clouds do not always thunder, nor do they thunder of necessity. Accordingly Ferejohn has argued that the beings for which there is a different cause are *events*, and that the middle term of the demonstrations that account for them are the efficient causes of those events.<sup>28</sup> On this understanding a demonstration of the sort that explains a lunar eclipse does not conform to the canonical form of demonstration discussed in Book 1, in which the explananda are the facts that certain necessary and eternal features are predicated of kinds studied by the sciences.<sup>29</sup>

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<sup>28</sup> Ferejohn (2013, pp. 131-54). Ferejohn does not take Aristotle to be fully aware that the “causal model” of demonstration does not conform to the “canonical” syllogistic model of Book 1. He rather sees a deep tension implicit in Aristotle’s views on how explanations in natural science proceed.

<sup>29</sup> Further evidence that the main point that Aristotle is making in 2.8 does not concern events is found at *APo.* 2.2 90a31-4 and 2.8 93a33-5. (Lucas Angioni and Breno Zuppolini brought to my attention the relevance of the first passage.) There, in the context of his discussion of how the definition of an eclipse is to be “demonstrated”, Aristotle employs the demonstration that a triangle is 2RA as an example showing how the middle term of a demonstration reveals the cause of the conclusion. Also note that back at 2.2 90a24-30 Aristotle offers two examples of how the ‘what it is’ is the same as the ‘why it is.’ The first is a lunar eclipse, the second is an acoustic concord. A concord might be temporally localizable, but the concord between middle C and the G that is a fifth above it is an eternal feature of the notes. A demonstration that the two notes are in concord is not as such revealing the cause of a particular event; nor is it saying that the subject of the concord (air? strings?) is such as to sometimes or regularly stand in the relationship of a concord with another subject. Like all demonstrations, it is providing insight into an eternal necessary feature of the subject kind of a science.

Can Aristotle's theory account for the demonstrations that explain occasional particular phenomena like eclipses or thunder? The proper object of scientific knowledge is not the particular event of an eclipse or thunder; it is rather the necessary, eternal fact that the moon is such as to eclipse, and the clouds are such as to thunder. The middle term, explaining what it is about the subject that make them subject to such events, could be employed to reveal why the events occur when and how they do. (For example, by showing why the moon is such as to have an orbit that results in the blockage of the sun's light from its surface, one could account for a particular occurrence of an eclipse, but that occurrence would not be a proper object of scientific explanation.<sup>30</sup>) Just as Aristotle says that in a sense the one who knows that the interior angles of a triangle add up to two right angles knows it about some particular triangle (1.1 71a31-b6), so too the one who understands the workings of lunar eclipses in some way understands why and how a particular eclipse occurs. To use an Aristotelian locution absent from the *Posterior Analytics*, the actual astronomer has the potentiality for rendering intelligible the particular eclipse. There is no need to suppose that the only sort of entity such as to have its definition revealed through demonstration in the manner accounted for in 2.8 is an event for which one can demonstrate that it occasionally or regularly holds of a basic subject.

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<sup>30</sup> It could however be considered an object of scientific understanding in an accidental sense (1.8 75b24-5) for one can apply the demonstration concerning the moon's eternal character of being susceptible to an eclipse to the moon at the time of its being eclipsed.

## VI

I now turn to consider the nature of demonstrable predicates and the role that they play in Aristotle's general theory of demonstration.

Commentators often write as though Aristotelian demonstrations are a matter of unpacking the genus-species relations implicit in the definition or 'what is it' of a minor term. For example, if the minor term S is its definition "G and D", and G itself is defined as G' and D', the form of an Aristotelian demonstration would be "S is G, G is G'; therefore S is G." An example is "Flounder are fish, fish are animals; therefore flounder are animals."<sup>31</sup> (Note that on the account argued for above, none of these terms would be 'different from' the minor term.) This view has several advantages. First, both premises are definitional, so it is easy to see how it is the case that a demonstration is based on unmediated premises that are first principles of the sciences. Second, Aristotle's own argument in 1.22-23 that no demonstration is of infinite length itself presupposes that all demonstrative premises are of this sort. But even if we grant that some demonstrations do indeed take this form, there are

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<sup>31</sup> See for example Barnes (1994, p. 119), Tierney (2001), and McKirahan (1992, pp. 111-21). On these views, all demonstrable attributes are implicit in some kind of basic account of the subject, whether we call it the "what is it" (Tierney) or a "fat definition" (McKirahan). This reduces demonstrations to rendering tautologies explicit, which would seem to exclude from the scope of demonstration propositions like "all triangles are 2RA". Taking this to be Aristotle's view ascribes to him an ignorance of the logic of mathematical proof that goes well beyond the commonly recognized error of taking all mathematical proofs to conform to his syllogistic. This is one of the main reasons why I opt for the account of demonstrated attributes that I present in Goldin (1996) and here.

severe problems in interpreting Aristotle as holding the view that they all do. First, demonstrative conclusions would thereby be limited to tautologies (at least for those who have mastered the appropriate science and for that reason have command of the relevant definitions). Second, it is hard to see how the middle term of such a demonstration could serve as identifying the cause of conclusion. Being a fish is not the cause of a flounder's being an animal in any straightforward way, as being animal is simply what a fish is. (Being an animal "has no other cause".) Third, Aristotle's own examples, such as 2RA, belie this view. On no plausible interpretation can we interpret Aristotle as taking this predicate to be part of the definition of triangle.

The demonstrable attributes are the *kath' hauto pathē* and the *kath' hauto sumbebēkota*. That they are not definitional presumably accounts for their being said to be accidental (*sumbebēkos*).<sup>32</sup> But in what sense are they *kath' hauto*? We

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<sup>32</sup> At 1.4 73b4-5 Aristotle says that accidents are terms that hold *neither* as having the predicate in the definitions of the subject nor as having the subject in the definition of the predicate. If this is the sense of *kath' hauto* employed in the expression *kath' hauto sumbebēkos*, my proposal below that the terms for which the subject is in the definition of the predicate are the *kath' hauto sumbebēkota* is easily refuted. There are two possible ways of dealing with the difficulty. The first is to see Aristotle as making a distinction between accidents and things that belong per accidens; the *kath' hauto sumbebēkota* would belong to the former but not the latter. This proposal is made by McKirahan (1992, p. 286, n. 60). The second is to see the term *kath' hauto sumbebēkos* as involving sense of 'accident' according to which it refers only to what is not *kath' hauto* in the sense of having the predicate in the definition of the subject. This is supported by *Meta.* Δ 30 1025a30-2: "Accident' has another sense, that of that of all of those <predicates> that belong in each thing *kath' hauto* though they are not in the essence (*ousia*), for example two right angles to triangle." It is presumably

can presume that Aristotle takes them to be *kath' hauta* in at least one of the four senses of the term that he delineated just a few lines above.<sup>33</sup> We have already noted that they cannot be definitional. This excludes the first sense of *kath' hauta* distinguished in 1.4 (which I refer to as *kath' hauta* 1): “Those things are *kath' hauta*, first, which belong in the ‘what is it’ [of their subject] (73a34-5).”<sup>34</sup> Two other possibilities have emerged (not mutually exclusive). The first is that the relevant sense is the fourth which Aristotle outlines at 1.4 73b10-11: “that which belongs to each thing because of itself (*di' hauta*) is *kath' hauta*”. This formulation itself suggests that Aristotle is saying that whenever S is P because of S we can say that S is P is *kath' hauta*. But the example that Aristotle proceeds to give (the animal’s death is *kath' hauta* in respect to its being sacrificed), shows that, even if the exact predicative form of the connection is unclear, the entities that Aristotle takes to be *kath' hauta* in this sense are

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the fact that the predicate is not in the essence that accounts for its being an accident.

<sup>33</sup> Barnes (1994), pp. 113-4, 120-22 denies this. But 1.4 73b31-2, in which triangle is explicitly said to be 2RA *kath' hauta*, follows shortly after the delineation of the four senses of *kath' hauta*.

<sup>34</sup> I am following scholarly consensus in presuming that *huparkebei* (‘belong to’) here has its usual sense of ‘is predicated of’, which is confirmed by the argument of 1.22 84a11-29, which presupposes that *kath' hauta* 1 predicates can serve as middle terms, and accordingly belong to their subjects insofar as they are predicated of them in their definitions. These are the predicates identified as *kath' hauta* in Meta. Δ 18 1022a27-9. There is unfortunately a problem in understanding the examples that Aristotle gives at 73a35, for a triangle is not a line, and a line is not a point. However, as I suggested above, ‘triangle’ is not properly understood as a subject, but as an attribute of lines: ‘such as to form a triangular figure when arranged in certain way’.

particular events, not kinds of event or regular or necessary features of being subject to a kind of event (for example, being such as to be subject to eclipse). This suggests that entities that are *kath' hauta* in this sense will fall outside the scope of demonstration, though, to be sure, demonstrations can be employed to make sense of them. (The situation is parallel to how demonstrations concerning triangle in general can be employed to render intelligible some feature of a particular triangle, cf. 1.1 71a29-72b8). This objection is not decisive however, as Aristotle could be understood as identifying a kind of intelligible connection between kinds of events, and these are predicates. It might be an incidental feature of Aristotle's examples that they are cases in which the predicates that stand in relation are kinds of temporally localizable events.<sup>35</sup> There is however another problem with understanding the *kath' hauta sumbebēkōta* as *kath' hauta* in the sense of 1.4 73b10-11. At *Topics* 2.3 110b22-5 Aristotle says 2RA is *sumbebēkos* in respect to isosceles but not triangle. At *APo.* 1.4 73b38-74a3 we are told that 2RA is *kath' hautō* in respect to triangle, not isosceles triangle. This is because a term definitional of 'triangle' as such (and not its genus or a subordinate species) must feature as a middle term of the demonstration that triangles are 2RA.<sup>36</sup> Showing that isosceles triangles are 2RA is properly accomplished only by means of an application of that demonstration.<sup>37</sup> Any

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<sup>35</sup> This is the suggestion of Zuppolini (2018, 130).

<sup>36</sup> Zuppolini (2018, pp. 120-1) points out the relevance of these passages to the question of why exactly the *kath' hauta sumbebēkōta* are *kath' hauta*. As noted below, he reaches conclusions different from mine.

<sup>37</sup> Such an application is a demonstration, in a sense. Accordingly, 2RA is *kath' hautō sumbebēkos* of isosceles, in a sense. Aristotle is using the terms *kath' hautō*, *sumbebēkos*, and *apodeiktikos* (demonstrative) in such secondary senses at 1.6 75a18-20: "There



demonstration that proceeds to show that isosceles triangles are 2RA on the basis of features unique to isosceles triangles misses the point insofar as it fails to identify the more basic feature that is ontologically responsible for the derivative feature.<sup>38</sup> But in the cases described at 1.4 73b10-11 all that is necessary is that the *kath' hauta* feature arises on account of (*dia*) that of which it is *kath' hauta*, as its effect.<sup>39</sup> There is no requirement that the latter be referred to at the appropriate level of specificity. In the very case that Aristotle

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is no demonstrative understanding of the things that are *sumbebekota* yet are not *kath' hauta*, according to how we have defined “the things that are *kath' hauta*, for it is not possible to prove the conclusion of necessity.” For it is possible to prove that isosceles are 2RA. Thanks are due to Breno Zuppolini for indicating the problem that these lines might be thought to raise for my account.

<sup>38</sup> On this see Angioni (2016, pp. 95-9).

<sup>39</sup> Zuppolini (2018, pp. 130-2) in contrast gives *dia* here a strong sense, according to which the object of the preposition is precisely the being that is responsible for the predicate, considered at the proper level of specificity. So on his account the *kath' hauta sumbebekota* are *kath' hauta* in the fourth sense of the phrase delineated in 1.4, as well as the second sense (that of the *kath' hauta* 2 predicates); *kath' hauta* 2 predications including those like “isosceles is 2RA” are *kath' hauta* in a looser sense. Like Code (1986, p. 351) I give *dia* a weaker sense, so that “isosceles is 2RA” is *kath' hauta* in the fourth sense, but would not be *kath' hauta sumbebekos* as it would not be the conclusion of a properly formed demonstration. I deny that “isosceles is 2RA” meets Aristotle’s criterion for being *kath' hauta* since, unlike Zuppolini, for whom Aristotle is requiring that isosceles be (somehow) metaphysically present in the definition of 2RA, I am saying that it would have to be actually present. (On this see Section 7, below.) It is not, but as I will argue, triangle is.

presents as an example, we lack that proper specification. Whether *to sphattesthai* refers to sacrifice or throat cutting, the term is too specific to be cause of death as such.<sup>40</sup> I suggest that this sense of *kath' hauto* is not relevant for demonstrative science. Aristotle is bringing up the term for the sense of completeness.<sup>41</sup>

By elimination, we can conclude that the *kath' hauto sumbebēkota* are those that are such that their subjects are present in their definitions (1.4 73a37-b3), which I call *kath' hauto 2*. Aristotle is explicit that all demonstrated predicates are *kath' hauto* in one of the first two senses: that of having the predicate present in the subject and that of having the subject present in the predicate (1.4 73b16-18, 6.74b5-12, 22.84a11-14). Since the first, third, and fourth senses of *kath' hauto* are not the relevant ones, the 'natural reading' is to take the second to be the relevant sense. On this account, the distinction between *kath' hauto 1* predicates and *kath' hauto 2* predicates, which (grouping among the *kath' hauto 1* predicates the subjects for which they are definitional) is Distinction E, turns out to map onto Distinctions A, B, C, and D.<sup>42</sup>

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<sup>40</sup> The proper cause of death would have to be something like loss of vital heat.

<sup>41</sup> The same can be said of the sense of the term discussed at 75b5-10, to refer to a subject not inherent in any more basic subject (or not considered as so inherent in the context of a science) which is not further employed in the work.

<sup>42</sup> As Breno Zuppolini has stressed to me, Distinction E can't be strictly speaking the same as the others, since an attribute, even a demonstrated attribute, has a "what is it" and can therefore serve as a subject of a *kath' hauto 1* predication. "Eclipses are occlusions of light" is *kath' hauto 1*, for example. Distinction E would be identical with the others only if we say that only expressions of "what is it" that will be relevant in determining whether or not a

## VII

This reading has encountered resistance because in many cases, including Aristotle's own favored example of 2RA, Aristotle's description of *kath' hauta* 2 predicates simply does not hold. The definition of 'having angles equal to two right angles,' whatever it may be<sup>43</sup> does not contain 'triangle'.<sup>44</sup> This is so even though no other plane figures have their interior angles summing to two right angles.

Zuppolini addresses this objection by appeal to a distinction familiar in the secondary literature on Aristotle, that between 'linguistic predication' and 'metaphysical predication'. Linguistic predication is a relation between terms in a logoi: whenever we say that S is P we are *saying* "S is P". Metaphysical predication is a relation that holds among realities. In the case in which 'S' signifies shoe and 'P' signifies pink, the linguistic predication "S is P" indicates that pink is metaphysically predicated of shoe. As this example shows, linguistic predication often mirrors metaphysical predication, like true propositions in a Russellian 'logically perfect language'.<sup>45</sup> Logos depends on

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predication is *kath' hauta* 1 or 2 will be those of first principles of the sciences.

<sup>43</sup> It would be reasonable to suppose that it is based on the definitions or primitive notions of sum and of right angle.

<sup>44</sup> See Tiles (1983), p. 7: "In no sense would it seem to be the case that 'triangle' belongs in the definition of '2R'." As I show below, the scientific definition of 2RA must mention its cause, and its cause is triangle (or more precisely, lines arrayed in a triangular fashion), not some other figure.

<sup>45</sup> "In a logically perfect language the words in a proposition would correspond one by one with the components of the corresponding fact." Russell (1918, p. 520).

this kind of isomorphism (DI 1 16a3-9). But the isomorphism is often merely apparent. *Categories* shows how linguistic predications that are formally indistinguishable express metaphysical predications of very different kinds.<sup>46</sup> On one influential account of the central books of the *Metaphysics*,<sup>47</sup> Aristotle re-employs the distinction between linguistic and metaphysical predication as a way of resolving ontological perplexities brought on by his hylomorphic analysis of substance: in spite of the truth of the linguistic proposition “Socrates is human,” the form ‘human’ is metaphysically predicated not of the composite substance Socrates but of Socrates’ matter. Even if Aristotle does not envisage a logically perfect language as such, Aristotle shares with Russell the convictions that metaphysical perplexities arise through being misled by the surface grammar of linguistic statements, and that ontological analysis largely consists in showing how this is so and through formulating (in a technical vocabulary) how things actually stand. That means that Aristotle thinks that it is in principle possible to formulate linguistic predications isomorphic to the metaphysical predications in the world.

Zuppolini employs this distinction between linguistic and metaphysical predication in his solution of the problem of how to find a place for the *kath’ hauto sumbebēkota* in the typology of *kath’ hauto* predications given in *APo*. 1.4. To say that S is P is *kath’ hauto* 2 is not necessarily to say that S is linguistically predicated in the definition of P. It might be (as it is in the case of “number is odd”) but it need not be. “The fact that the subjects of *per se* 2 predications ‘inhere in’

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<sup>46</sup> These are the relations of ‘being said of’ and ‘being in,’ the converses of which Code (1986) has labelled ‘izzing’ and ‘hazzing’ respectively.

<sup>47</sup> Lewis (1992).

the *λόγος* of the predicates does not make them linguistic items. Since the word '*λόγος*' denotes here the definition of an entity (and not of a term), neither are the predicates (i.e. the corresponding *definienda*) linguistic items. Therefore, *per se* 2<sup>48</sup> connections are also world-world relations (or metaphysical predications).<sup>49</sup> On this account, "triangle is 2RA" is a *kath' hauta* 2 predication because triangle (or triangularity?) is *metaphysically* predicated in the attribute of 2RA. But what does this mean?

Zuppolini argues that a *kath' hauta* 2 predication need not have the subject linguistically present in the definition of the predicate, even if the definition is a scientific one, formulated with as much accuracy and perspicuity as possible. For in *Metaphysics* Δ 18 1022a 29-31 Aristotle gives as an example of a *kath' hauta* 2 predication "the surface is white." Here the subject is not surface, understood universally, but a particular surface, and surely Aristotle is not suggesting that the particular surface is even metaphysically present in the definition of white. After all, the particular surface will come and go, but the definition of white abides eternal. For this reason, Zuppolini suggests the following as what Aristotle has in mind: "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*'.<sup>50</sup> Zuppolini argues that this allows us to understand why "triangle is 2RA" is *kath' hauta* 2. Triangles are a variety of rectilinear figure, and it is rectilinear figures that are (metaphysically) present in the definition of 2RA. For to be 2RA is to have interior angles, and even if this or that account of what it is to have interior angles does not mention 'rectilinear figure',

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<sup>48</sup> This is Zuppolini's term for *kath' hauta* 2 predications.

<sup>49</sup> Zuppolini (2018, p. 123).

<sup>50</sup> Zuppolini (2018, p. 127).

the notion is implicit, for which reason the attribute of being a rectilinear figure is metaphysically present in the definition of 2RA.

To be sure, even if Aristotle's writings sometimes seem to be subject to use/mention confusion, he is aware both of the distinction between a state of affairs and the linguistic account that expresses it, as well as of the philosophical confusion that can arise from reading ontological truth directly off of the structure of a linguistic predication. Definitions and demonstrations are both linguistic entities. A definition cannot reveal what something is, and a demonstration cannot reveal why something is the case, if that which it expresses does not correspond to reality. Terms need to be disambiguated and basic assumptions need to be made explicit. Accordingly, a demonstration can only do its job of isolating and explicating metaphysical relations if the premises and conclusion of the demonstration are formulated in a perspicuous way.

So I see no reason to think that Aristotle would ever deny that what is metaphysically present in the essence of a kind will be linguistically present in an adequate scientific definition of the kind, though it may well not be present in the initial grasp of the meaning of the term denoting the kind in question.<sup>51</sup> The "natural reading" according to which the

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<sup>51</sup> The big exception here, for which linguistic predication is unable to adequately explicate the ontological relations involved in metaphysical predication, is that of the metaphysical predication by which form belongs to matter. This is because within the metaphysical predication, the predicate and subject form a unity referred to by a single term even though they are metaphysically different aspects of that unity. It is in regard to this relationship that Code and Lewis have insisted on the importance of the distinction between metaphysical and linguistic predication in

subject is (linguistically) predicated in the definition of the demonstrated attribute, is the correct one.<sup>52</sup> But how?

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Aristotle's thought. But science as described within *APo.* does not deal with form and its relation to matter.

<sup>52</sup> Note that what Zuppolini calls the “natural reading,” which takes the *kath' hauta sumbebekota* to be *kath' hauta 2*, does not identify the two classes of predicates. For there are two other kinds of predicates that are explicitly identified as *kath' hauta* on the grounds that the subject is present in the definition of the predicate and would accordingly be *kath' hauta 2*. The first is a kind of predicative bond in which the predicate is by definition a determination of the subject. Aristotle's favorite example is “nose is snub” (*Meta.* Z 5 1030b14-20). This kind of predication is of special interest to Aristotle, as the predicate is a linguistic unit but refers to a metaphysical complex of a determination in what is determined, and Aristotle takes a term referring to a natural substance to do exactly the same thing (since it is a single term referring to a form/matter composite). On no construal could snubness be understood as a demonstrable predicate of a nose. The second is a case in which the predicate is paired with an opposing predicate, in such a way that the relevant subject must have one or the other predicate belong to it. This kind is illustrated by the examples that Aristotle explicitly gives in 1.4 of this kind of predicate: odd and even of number, curved and straight of line, etc. (73a38-b1). Odd is not a demonstrable predicate of number, though conceivably it could be considered a demonstrable predicate of some number (although at *APo.* 2 13 96a35-8 it is understood as a definitional predicate of the number three). But at 73b19-23, when defending his claim that the *kath' hauta* predicates considered by the sciences are necessary, Aristotle does not do so on the grounds that any given *kath' hauta* predicate follows of necessity from its subject but by indicating that a *kath' hauta 1* or *2* predicate holds of its subject either “without qualification or in regard to the opposites”, appealing to the disjunction “a number is necessarily even insofar as it is not odd”. Aristotle is either saying that a disjunctive predicate (such as even

## VIII

I have argued that those items said to “have another cause” in 2.8 and 9 are none other than the *kath’ hauta sumbebekota*. Understood in such a way, *APo.* 2.8 shows exactly how it is the case that the *kath’ hauta sumbebekota*, even those like 2RA, do indeed have their subjects present in their definitions.

Recall that for the demonstration of the definition of P to be the vehicle by which that definition becomes known, that very definition cannot be presupposed by the demonstration in question; otherwise the demonstration would be question begging. Nonetheless, there is an explanandum, the attribute or phenomenon in question, for which one has at least a preliminary understanding. Call F what is identified by such an account of P. (This may well be a conjunction of attributes.) To show how the features by which P is identified follow the essence of subject S<sup>53</sup> one must demonstrate that S is F by means of the middle term

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or odd) is necessarily predicated of a subject (number) or that a single predicate like even is demonstrable on the basis of something like a disjunctive syllogism. Both suggestions have problems; Aristotle does not say that “odd or even” is the *kath’ hauto* predicate in question; rather odd is, or even is. The second suggestion is problematic insofar as Aristotelian logic does not admit of formalizing a disjunctive syllogism. I take the latter problem to be less severe; after all, mathematical proofs in general do not admit of formalization by Aristotelian syllogistic alone, yet Aristotle seems blissfully unaware of this, even as he employs mathematical proofs as core examples of mathematical demonstrations.

<sup>53</sup> In the case of some if not all cases of P, this will follow more than one essence: the distinctive sound of thunder follows the essences of water and fire; the distinctive appearance of an eclipse follows the essence of more than one celestial body, and so forth.



M. On this basis, we can extract a definition of P as an F in S, by virtue of M.

If all demonstrations of *kath' hauta sumbebekota* are indeed of this form, there are two important results to which I would like to draw special attention. First, we can see why it is the case that demonstrable characteristics include their subjects in their definitions. For if the scientific definition of P is “F as predicated of S, by virtue of M” then S necessarily is present in the definition of P. (Because F is predicated of S, whatever is F is S. Accordingly, whatever is P is S.)

As noted above, the demonstration that explains what thunder or eclipse is will not primarily account for the individual events of thunder or eclipse (for such are temporally localizable particulars) but the universal necessary character of being such as to undergo such an event. And this, by definition, will have the subject of that character predicated within its definition. Further, we can see why it is the case that an attribute, scientifically understood, will convert with its subject; the thesis that a demonstrable predicate is a ‘commensurate universal’.<sup>54</sup> P not only follows

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<sup>54</sup> For a defense of the traditional understanding that demonstrable predicates are commensurately universal with their subjects see Inwood (1979, pp. 320-3). I differ from Inwood in my understanding of why demonstrable predicates are commensurate with their subjects. On the basis of 1 24 83b23-7, Inwood takes the *kath' hauta sumbebekota* to be commensurately universal insofar as they are “self explanatory”: the predicate’s cause, the nature of its subject, is “internal” to it. As I have argued here, this is not how Aristotle conceives of things. The cause of 2RA is the line, which is not internal to 2RA. The cause of being subject to the eclipse is not internal to that attribute, but is “something different”: the nature of the moon. 83b23-7 should be interpreted as saying that the subject of a *kath' hauta* predication (which is universal) is

from the essence of S (and other premises); S follows from the essence of P.<sup>55 56</sup>

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the cause of the predicate for that predicate itself (where *hautōi* modifies *tī*).

<sup>55</sup> We can on this basis answer Barnes' denial that "I2" (*kath' hauta* 2) predicates are the *kath' hauta sumbebēkota*: "[T]he suggestion that I2-predicates are, or at least include, 'in itself incidentals' is an attractive one. But it will not do: 'being capable of understanding' is proper to man; but 'All men are capable of understanding' is not an I2 predication. Again, being deciduous is an 'in itself incidental' of vines, but not a property of them." Barnes (1994, p. 114). On the account presented here, 'being capable of understanding,' if demonstrable and not definitional, would in fact have 'man' in its scientific definition. (If the gods are capable of understanding, it would be only in an equivocal sense. Cf. 2.7 99b4-7.) 'Deciduous' is properly speaking demonstrable not of 'vine' but 'broad-leafed plant' (2.16 98b5-10; 'broad-leafed plant' is the totality of subject terms of shedding referred to at 2.17 99a244-5).

<sup>56</sup> Note that in a well-formed demonstration, not only do the major and minor terms convert. The major and middle terms convert. Angioni (2018, p. 162) has argued that Aristotle's main conclusion at 1.13 78b13-28 is that "one important ingredient of the notion of an appropriate explanation is the notion of reciprocation between cause and effect: being a primary cause that delivers the appropriate explanation of its effect involves (but does not collapse into) being a necessary and sufficient condition for its effect to obtain". If all proper demonstrations are of the form discussed in 2.8, then for any predicate P which is *kath' hauta sumbebēkos* in respect to S, the demonstration that S is P will be through a middle term which expresses the essence of P. (On this point I agree with Angioni (2014).) In a well-formed demonstration the middle term must convert with the major term. Unless this middle term is itself definitional of the subject, it itself will be demonstrable, and hence *kath' hautos sumbebēkos*, starting a regress that must terminate in atomic convertible predications. Admittedly, how exactly that is thought to work is hard to see.

This sheds light on the theory of demonstration as laid out in Book 1. Ferejohn has argued that there is a tension between the formal requirements of demonstration as laid out in 1.2 and in 1.5.<sup>57</sup> For in 1.2, all that is required for a demonstration to qualify as a demonstration is that its premises be unmediated principles that are intrinsically intelligible and express the causes of the conclusion (71b20-23). In 1.5 we are told that there is *epistēmē* of a fact only if the demonstration that we have of that fact has a conclusion that is 'universal' in the sense delineated in 1.4 73b25-7,<sup>58</sup> according to which the predicate of a universal proposition must hold of its subject in every case and primitively and as such.<sup>59</sup> Demonstrations that satisfy the first but not the

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<sup>57</sup> Ferejohn (2013, pp. 85-90, 123-31).

<sup>58</sup> This is a narrower sense of 'universal' (*katholon*) than that usually employed by Aristotle, according to which the term applies to any predication that holds "in every case" (see *APr.* 24a18), which is why Ferejohn (2013, p. 83) refers to such predications not as "universal" but as "catholic".

<sup>59</sup> Aristotle here says that a predication that is *katholon* in this sense is *kath' hauto* and *hēi auto* (insofar as it is itself). The phrase *kath' hauto* is ambiguous; it should be no surprise that I understand it here to refer to what is *kath' hauto* 2, but other senses are possible. Aristotle himself unpacks what *hēi auto* means here: the predicate holds of a chance and primitive case of the subject. The predicate not only follows the subject; it is that very subject, at its own level of specificity, that is responsible for the predicate. Aristotle gives his usual example: isosceles is 2RA is not *hēi auto*; triangle is 2RA is. In other words, subject and predicate convert. On this see Angioni (2018, pp. 159-60, 179-81). Aristotle revisits this requirement in 2.16, which again declares that in a properly expressed demonstration, major and minor terms will convert. I take it that Aristotle is making this same point, that the *kath' hauto sumbebēkota* convert with their subjects, at *Meta.* Δ 18 1022a35-6: "*Kath' hanta* in yet another sense are all of those things which

second conditions are said to allow for *epistēmē* only in a sophistic sense (1.5 74a25-30). For example, a demonstration that isosceles triangles have 2RA would fail to qualify as a true demonstration, for it is insofar as it is a triangle that the figure is 2RA.

I have shown how to resolve the tension that arises in Ferejohn's reading of Aristotle's demonstrative theory. If one can demonstrate that S is P, one will be able to define P as a certain feature present in (and thereby caused by) the subject S. S will accordingly be predicated of P in its definition.<sup>60</sup> That would mean that if one has a legitimate demonstration that isosceles triangles are 2RA, isosceles

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belong to [a subject] along and on account of it alone, [regarded] in isolation," but the text is too terse and obscure to be used as supporting evidence for my account.

<sup>60</sup> The point is well made by Bronstein (2016, p. 47): "Aristotle says that the middle term signifies the cause and thus part of the essence of eclipse. He makes the same claim about other demonstrable attributes: thunder (2.8, 93b7–14 . . .), which belongs to cloud; harmony (2.2, 90a18–23 . . .), which belongs to high and low notes; leaf-shedding (2.16, 98b33–8, 2.17, 99a21–9), which belongs to broad-leafed plant. We would call these processes or events, but it is characteristic of Aristotle's thinking in the *APo* that he treats them as attributes of an underlying subject, just like 2R, which is an attribute of triangle. He indicates that the complete essence and definition of each of these attributes includes both the cause (signified by the middle term) and the subject to which the attribute belongs. . . . Since each of these attributes belongs to a subject partly in terms of which it is defined, each belongs in itself<sub>2</sub> to its subject. In addition, since each can be demonstrated to belong to its subject through a middle term that signifies part of the attribute's essence, each is a demonstrable attribute of its subject." I differ from Bronstein in taking *all* demonstrable attributes (including the non-twinkling of planets and so forth) to be of this kind.

would be present in the definition of 2RA. But the feature of 2RA as present in scalene triangle is the same feature as present in isosceles. The two features do not have different definitions. Because their 'what is it' is the same, their 'why is it' is the same. It follows that the 'demonstration' that isosceles triangles are 2RA does not, as such, reveal the 'why is it' of 2RA. This is why a definition of 2RA could be culled not from it<sup>61</sup> but from the proof that triangles are 2RA.<sup>62</sup>

The account I have given considerably tidies up Aristotle's philosophy of science. The *kath' hauta sumbebékota* (which include derivative subjects) are the same as the *kath' hauta 2* predicates. In order to understand how this is so we need not import the distinction between metaphysical and linguistic predication and put it to a use to which Aristotle himself does not put it. We are able to make good sense of

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<sup>61</sup> To be sure, it would not be hard to demonstrate that isosceles triangles are 2RA on the basis of the fact that it is isosceles: drop a perpendicular from the angle that is not equal to another, and from the other vertices construct parallels to that, and the proof is fairly straightforward. One can prove that isosceles triangles are 2RA on this basis, or through an application of a proof like that of Euclid, *Elements* 1.17. If multiple constructions will allow for demonstrating the same theorem, then there will be multiple middle terms. Would that mean that there are multiple mathematical definitions of 2RA? Perhaps, but this only shows the limits of Aristotle's analysis of geometrical thinking, which does not appeal to the intuition of those spatial relations that makes possible alternative proofs through alternative constructions. On this see Harari (2004, pp. 109-16).

<sup>62</sup> I grant that the notion of a scientific or mathematical definition of 2RA, apart from simply "having angles that sum to the sum of two right angles" seems weird. But "having angles etc." would be at best a pretheoretical account fixing the reference of the phrase without giving the cause. That it makes sense to ask "Why are triangles 2RA?" but not "What, mathematically speaking, *is* 2RA?" is a matter of the pragmatics of discourse.

the doctrine of the commensurate universal, and to show how the long discussion of whether and how a definition can be demonstrated forms an integral part of Aristotle's account of the logical structure of scientific explanation.

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